Building Climate Resiliency in the Clesson Brook Watershed

Findings from the Fluvial Geomorphic Assessment

February 14th, 2023

Buckland Selectboard

Project Partners:

Town of Buckland

Franklin Regional Council of Governments

GZA GeoEnvironmental

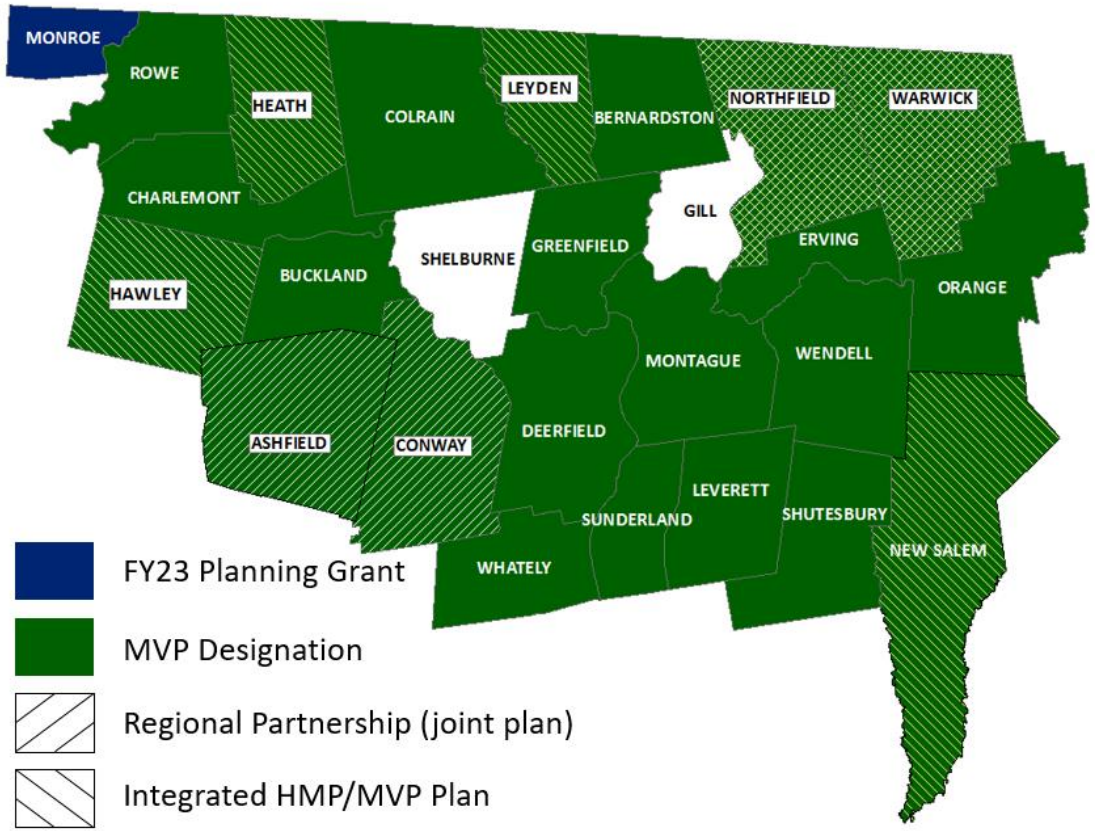
Field Geology Services
Fluvial Geomorphology

Funding provided by:

MVP
Municipal Vulnerability Preparedness

MassDEP
Massachusetts Department of Environmental Protection

Project Background



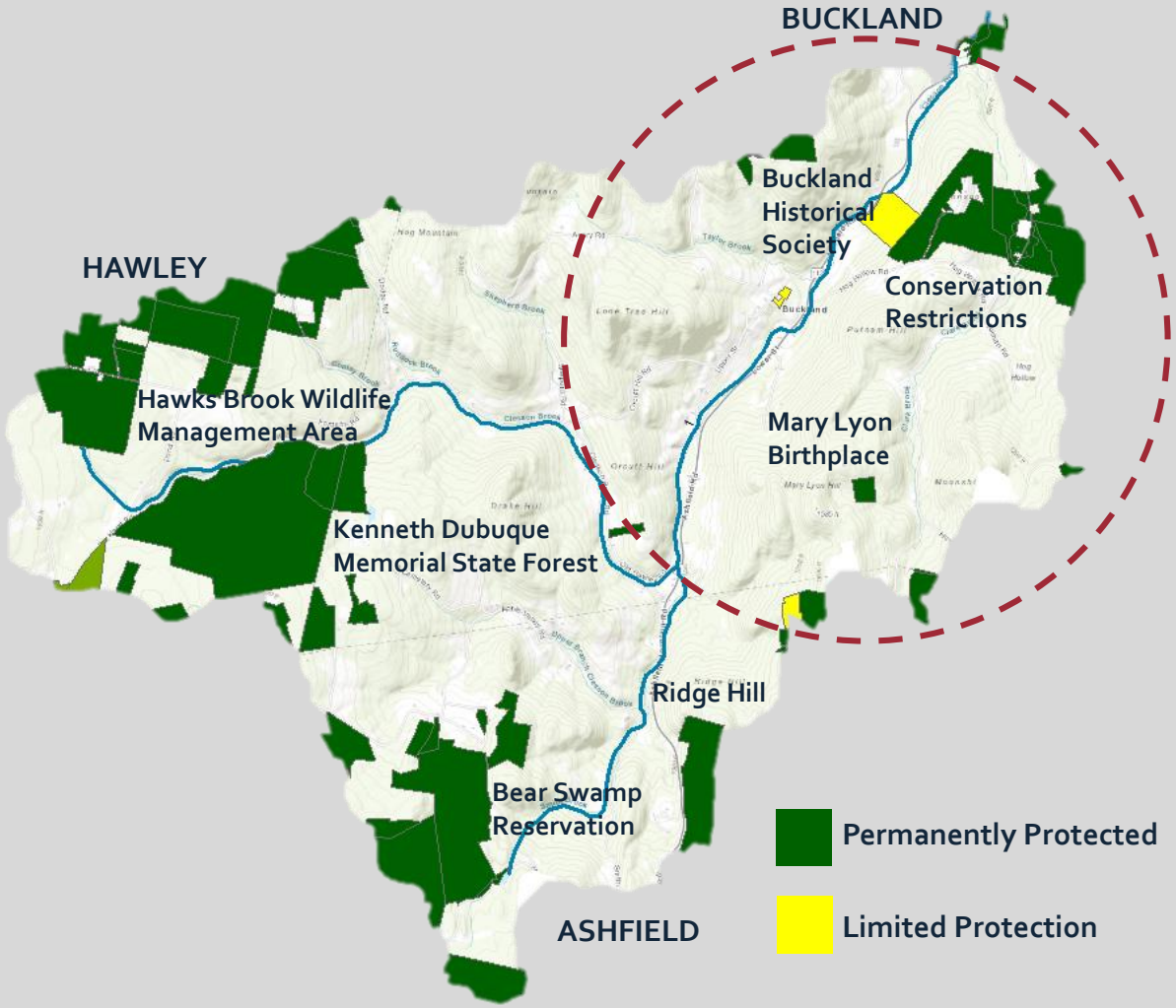
Buckland received a $100,117 grant from **the state's Municipal Vulnerability Preparedness (MVP) program** for a project to develop a *Watershed-Based Assessment and Climate Resiliency Plan for the Clesson Brook Watershed*.

An additional $38,500 grant awarded to the Franklin Regional Council of Governments by the **MassDEP's 604b Water Quality Management Grant Program** will be used to develop this comprehensive plan.

Project Background

Concerns Raised in the 2017 Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed

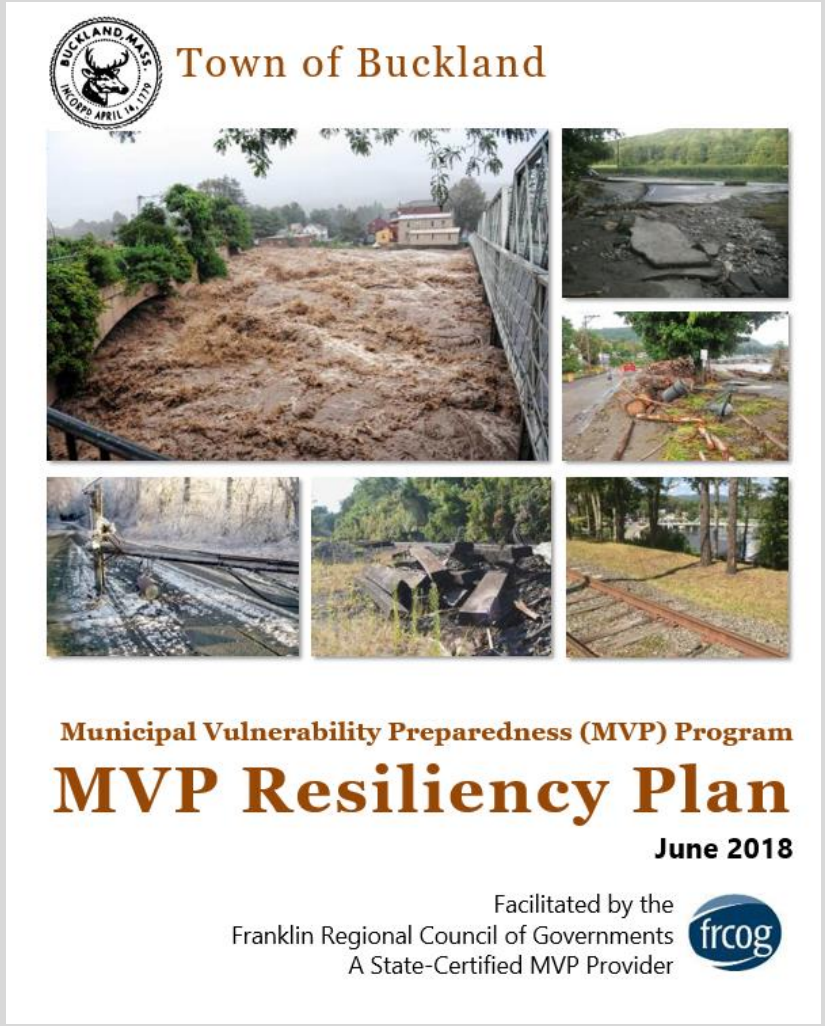
- **Very little protected land in the upland tributary areas and the watershed as a whole**
- Agricultural uses **along the stream corridors**
- **Stormwater runoff from Route 112 and other roads** that are adjacent to Clesson Brook and its tributaries



Project Background

Concerns Raised in Buckland's 2018 Municipal Vulnerability Preparedness Plan

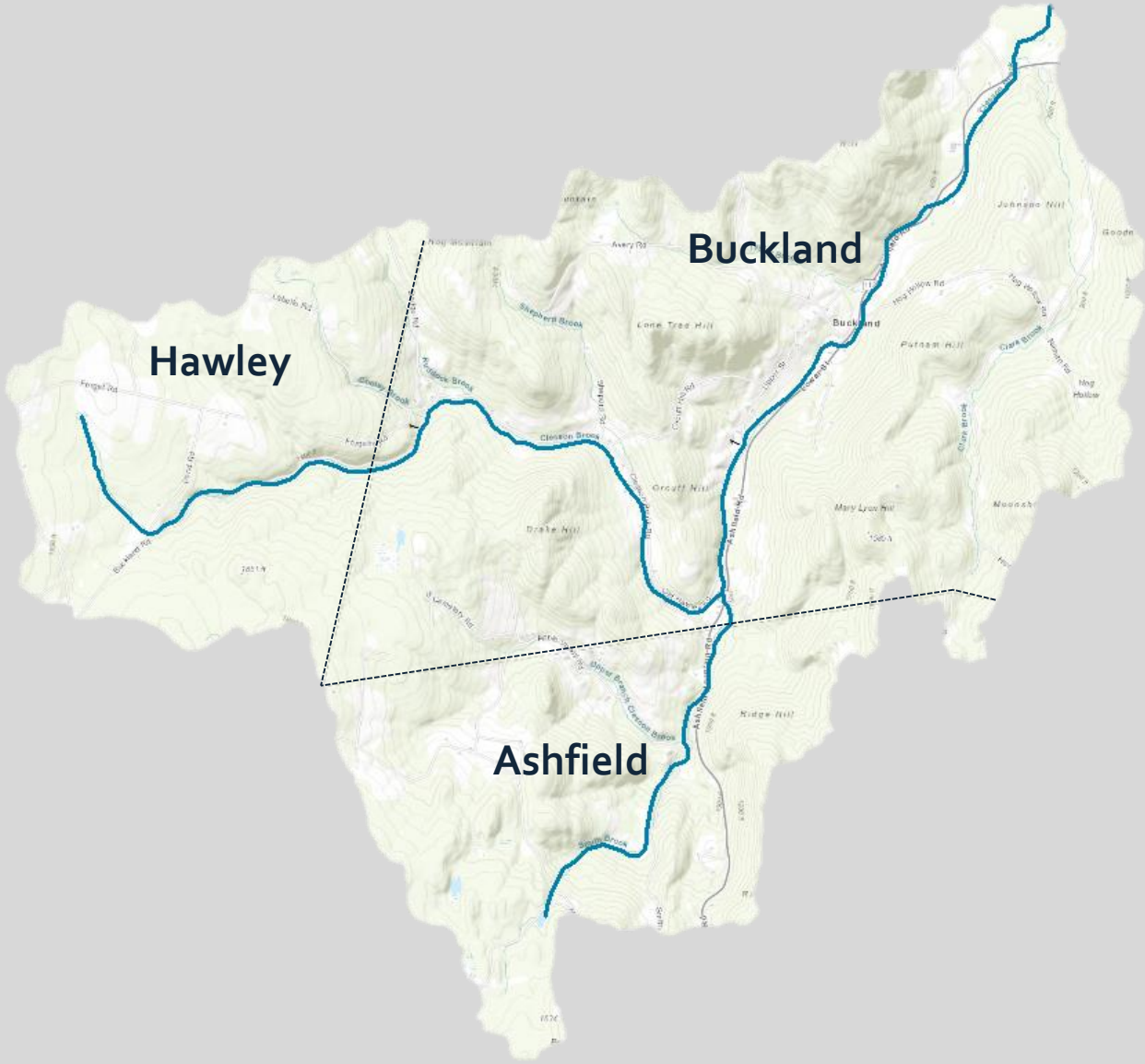
- **Undersized and failing culverts** in the Clesson Brook Watershed
  - These pose a current and future risk to transportation and emergency response
- **Flooding and fluvial erosion** along Clesson Brook
  - Areas damaged by TS Irene are still experiencing severe erosion that threatens roads and bridges
- The Buckland Recreation Area is plagued by **chronic flooding and erosion**



Thinking Like a Watershed

Watersheds don't conform to our local boundaries.

By working at the watershed scale with the neighboring towns of Ashfield and Hawley, Buckland can **build a framework of actions that not only improve the climate resiliency of each town**, but over time, create a more resilient Clesson Brook Watershed.



Project Goals & Outcomes

1. **Fluvial geomorphic assessment** of the Clesson Brook watershed to provide information on the causes of erosion, channel instability, and habitat degradation

2. **Prepare a Hydrologic and Hydraulic Model** of the Clesson Brook to estimate peak flow rates and evaluate flood water surface elevations and flow paths under current conditions and projected future conditions considering climate change

3. **Develop a database of road-stream crossings** along the Clesson Brook to be used for prioritizing replacements

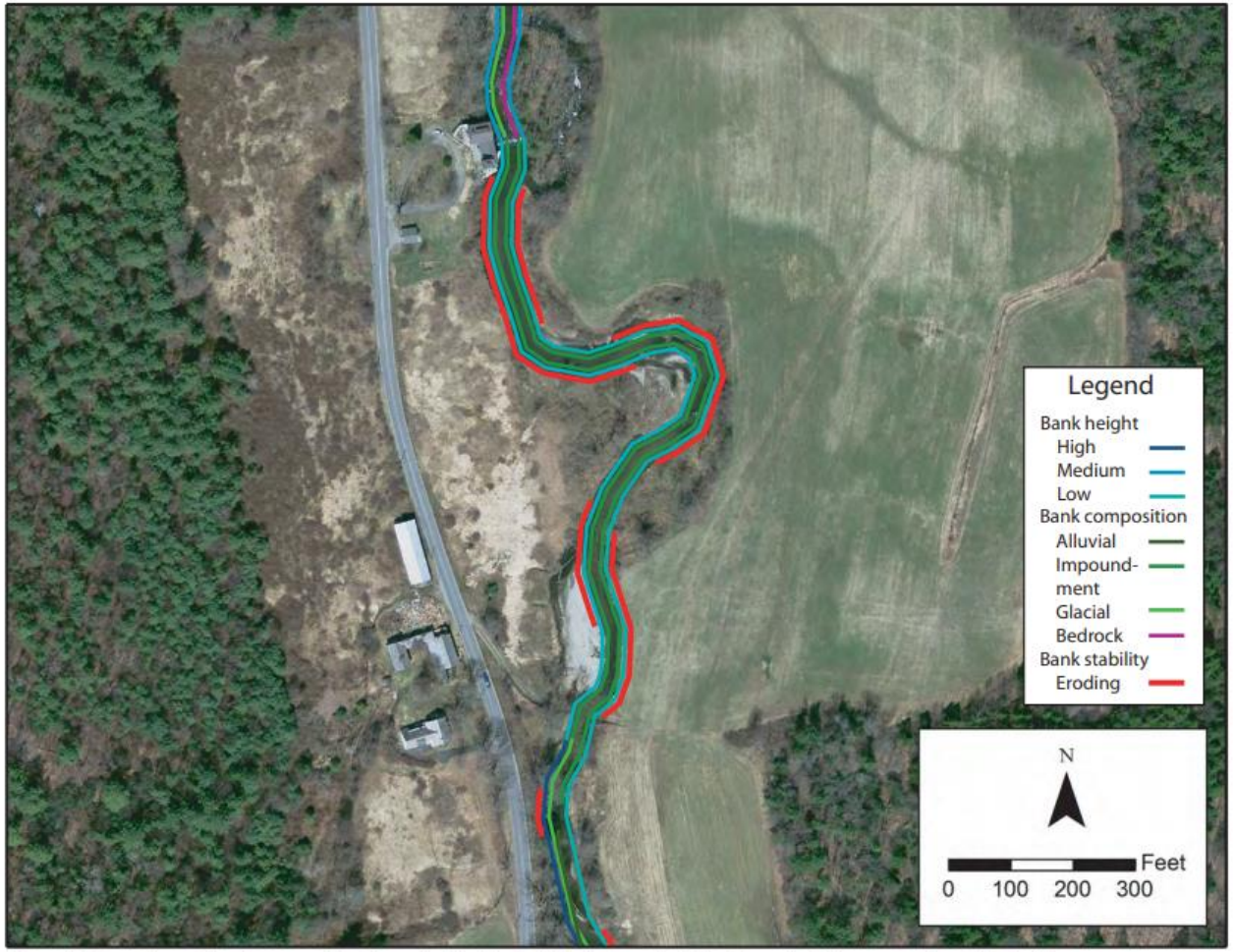


Figure 11. Comparison of bank composition (inner line), height (middle line), and stability (outer line) along a portion of South River.

Example of a fluvial geomorphic assessment completed for the South River Watershed in Ashfield and Conway

Project Goals & Outcomes (cont.)

4. **Prioritize parcels** within the Clesson Brook watershed for conservation

5. **Identify restoration projects** and prepare proposed conceptual designs

6. Complete **Watershed-Based Plan for Clesson Brook**

7. **Community engagement!**

Site assessments will be conducted throughout the watershed to assess areas for conservation & restoration

Example of a completed restoration project: boulder deflectors positioned in stream to help slow the flow

Community Input – January 2022 to Present

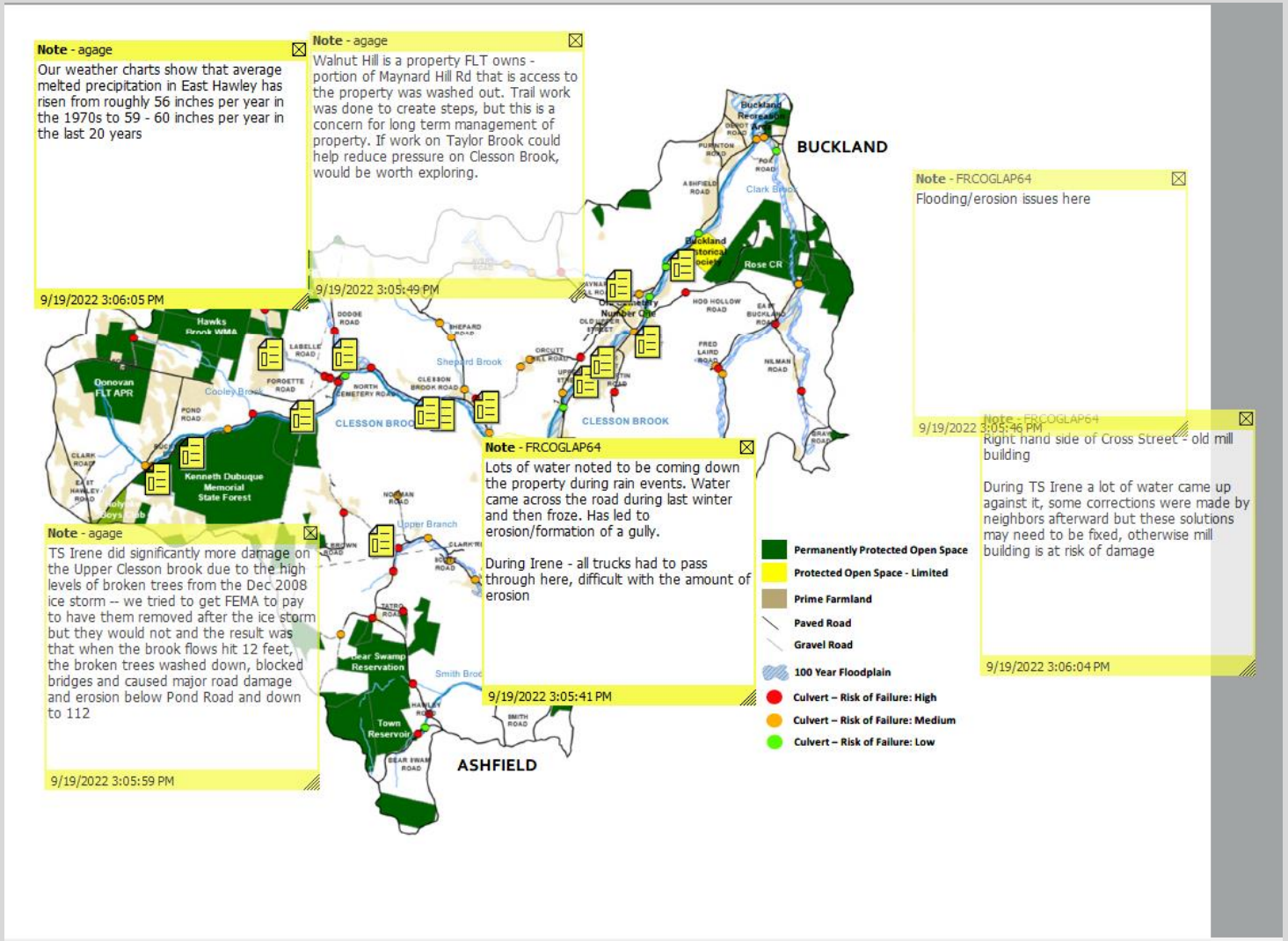
Project StoryMap

- Interested residents can learn about the project and find project updates
- Bit.ly/clessonbrookmap

Community Open House

- ~45 community members attended, including residents from all three towns in the watershed
- Provided feedback on their concerns related to climate change and areas frequently impacted by flooding or erosion

Presentation & Fieldtrip with MTRS Students

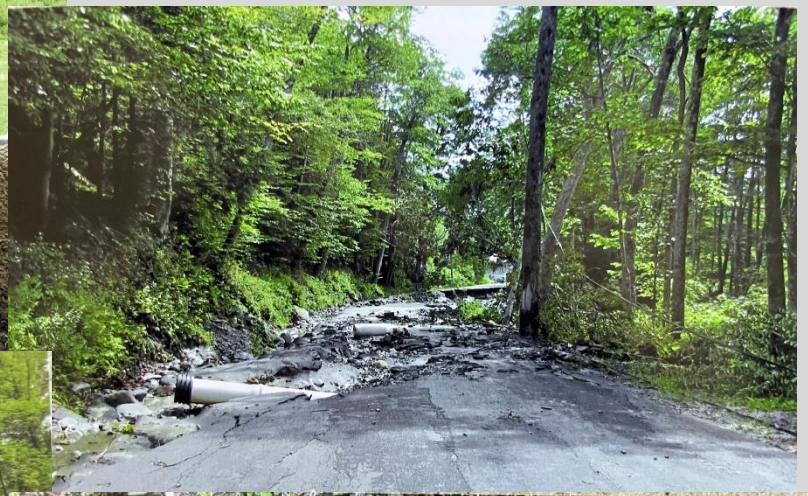


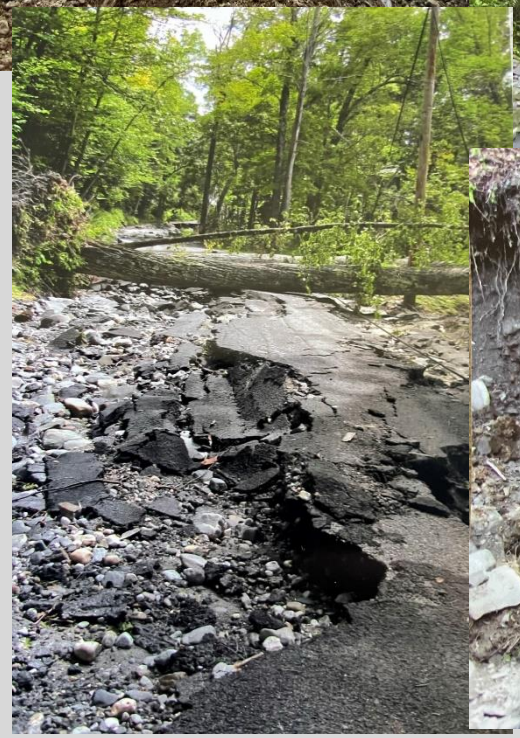
During the virtual Community Open House, community members identified areas of concern in the Clesson Brook watershed

Community Input – January 2022 to Present

Site Visits with Landowners

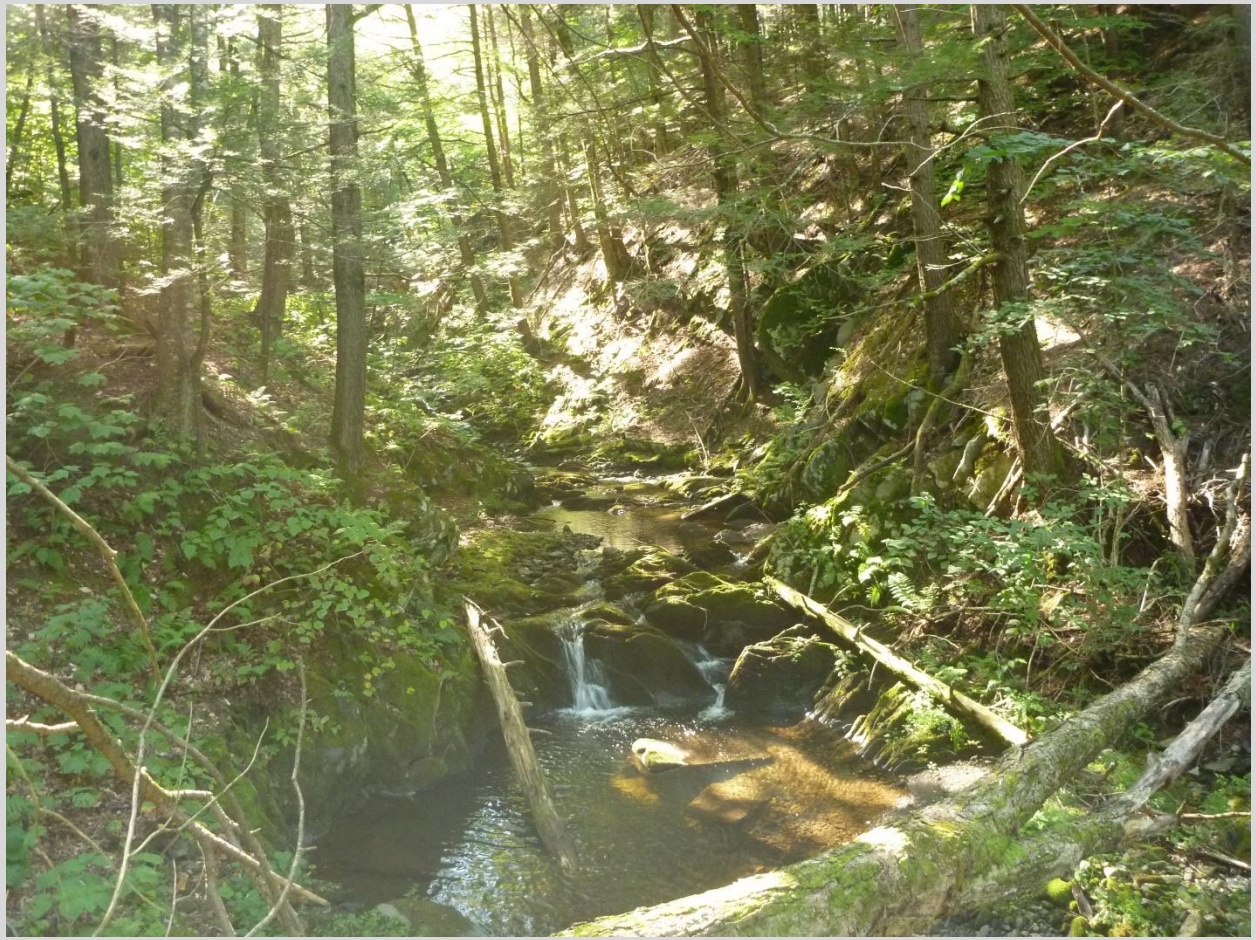
Cheryl and Russel Dodge made a scrapbook detailing damage in the watershed after TS Irene; Sandra Brown similarly kept many photos of conditions after the storm





What is Fluvial Geomorphology?

Study of stream response to natural watershed characteristics and human land use

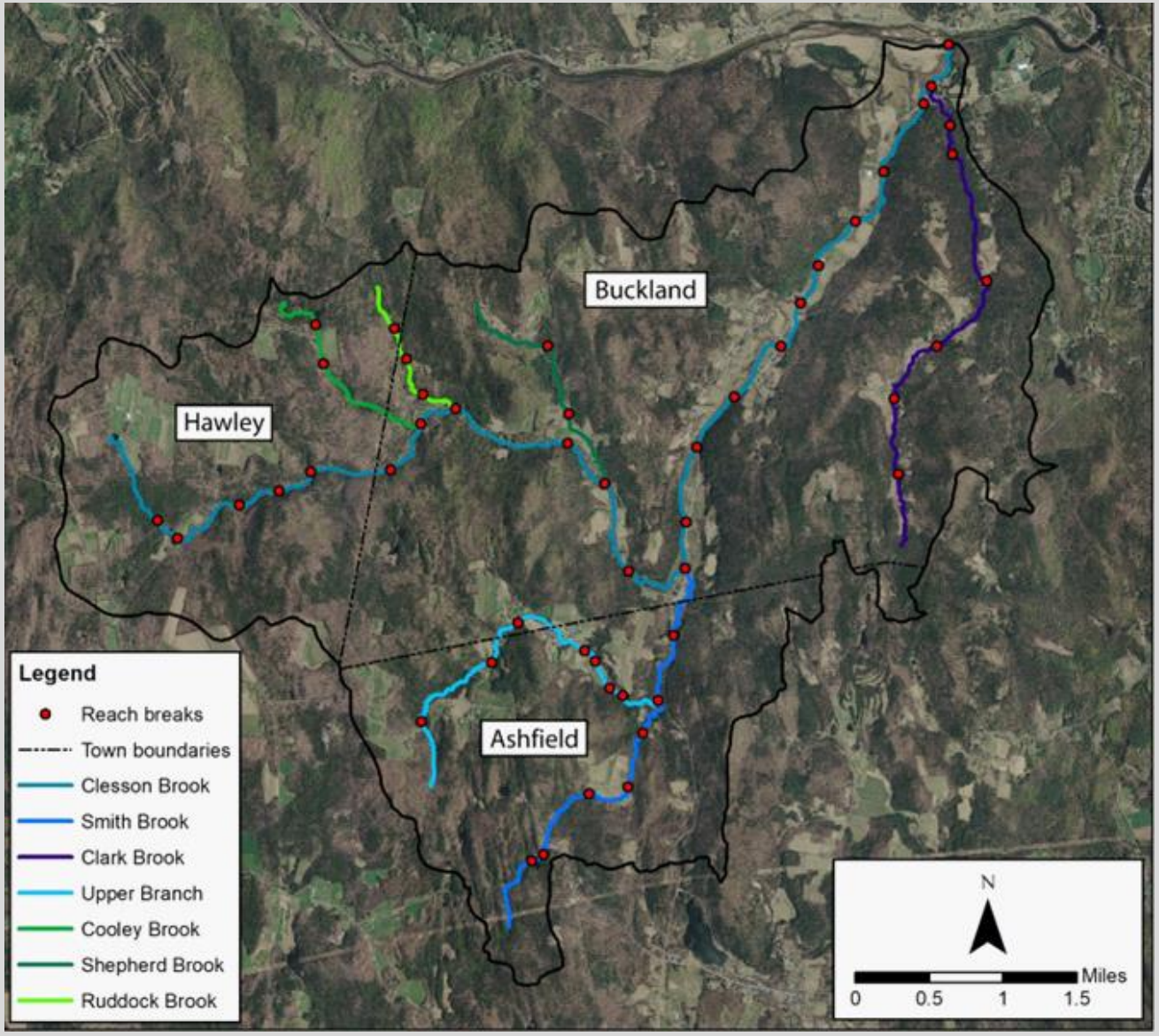


Fluvial Geomorphic Assessment of the Clesson Brook Watershed

Work completed to date

Reach and segment delineation

- Remote sensing and field data
- Phase 1 reach breaks on Clesson Brook and major tributaries
- Clesson Brook – 23 reaches (further subdivided into 66 segments)
- Reach breaks at changes in confinement, slope, channel planform, grade controls, etc.
- Segment breaks at changes in channel manipulation, land use, sediment load and character, bank stability, etc.



Work completed to date

Review of existing studies and available data

- Soils and surficial geology
- Climate, stream flow, and precipitation
- LiDAR and elevation data
- Historic maps and town history
- Historic aerial photographs
- Photos of flooding and emergency work

"It must be remembered that, when the hills were covered with virgin timber, the brooks and rivers were much larger than at the present time. This was especially true of Clesson's River which runs through the center of the town. Almost its entire length small turning, sawing and grinding mills dotted the banks at short intervals. Through the west part of the town, near the Hawley boundary, business was so flourishing that the section was known as the Upper City."

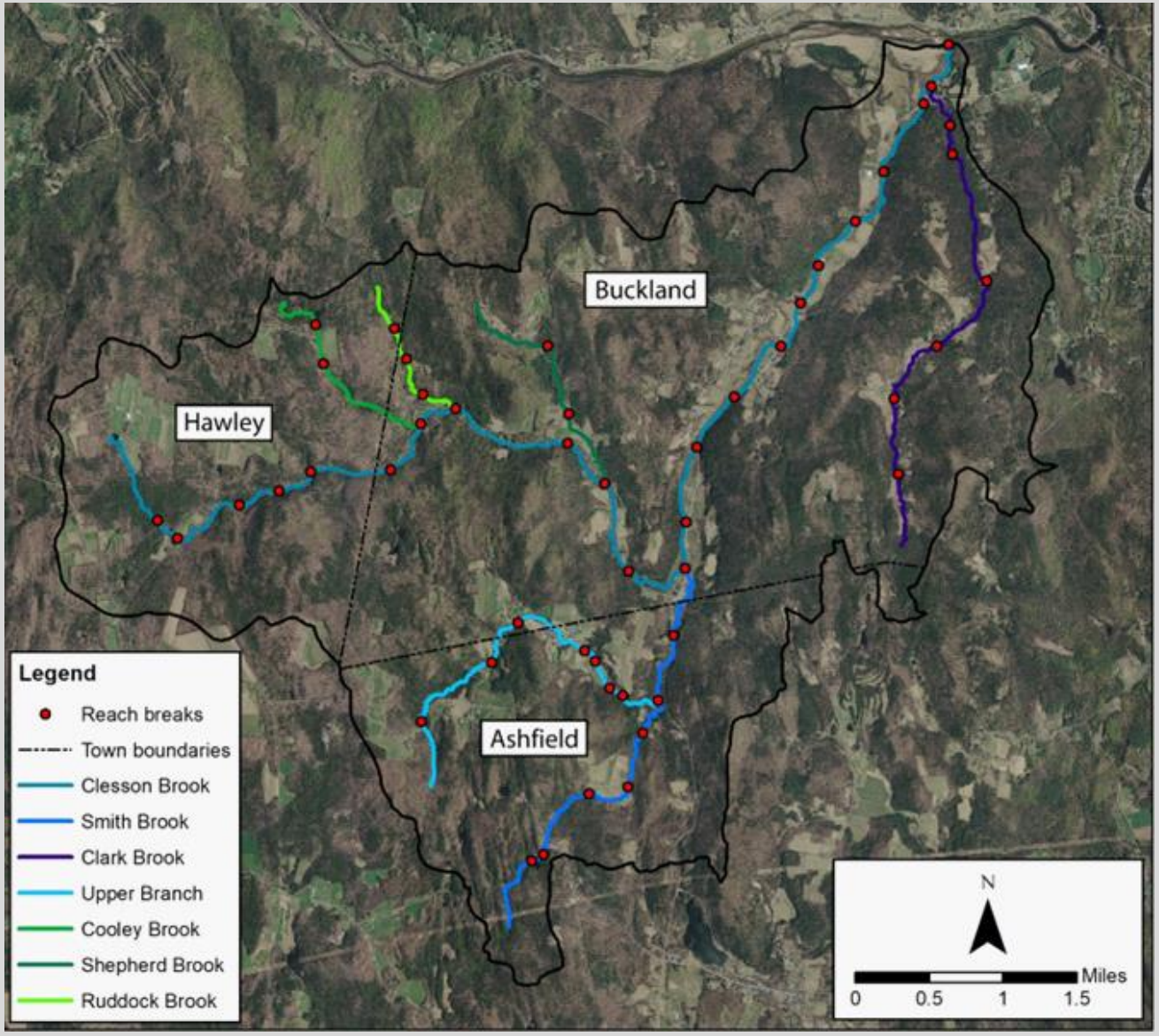
- From the *History of Buckland, 1779-1935* by Fannie Shaw Kendrick, 1937

Photo courtesy of Andrea Donlon

Work completed to date

Mapping of channel features

- Clesson Brook – 9.5 miles
- Smith Brook – 1.5 miles



Mapping and analysis of channel features

Headcuts (knickpoints)

- 87 headcuts mapped along Clesson Brook
- Vertical instability following excessive sediment mobilization and deposition during TS Irene

Mapping and analysis of channel features

Headcuts (knickpoints)

- In the 11 years since TS Irene, Clesson Brook and its tributaries have been adjusting to lower discharges (relative to TS Irene) and a higher sediment load
- Bed morphology in transition

Mapping and analysis of channel features

Headcuts (knickpoints)

- Headcuts migrate upstream leaving a deeper channel (ie. more flow contained within channel and impaired floodplain connection)
- Vertical instability leads to lateral instability and potential undermining of infrastructure

Mapping and analysis of channel features

Bank stability

- Eroding banks – 20%
- Armored banks – 15%

Eroding banks

Mapping and analysis of channel features

Mass failures (landslides)

- Major sediment source – sediment loading and water quality impairments
- 28 mapped – largest ~180 feet long and 40 feet high

Mapping and analysis of channel features

Wood provides geomorphic and habitat benefits

- Increased flow complexity
- Sediment sorting and storage
- Pool creation and maintenance
- Provide cover habitat

Mapping and analysis of channel features

Individual pieces of wood and log jams mapped

- 1062 pieces
- 97 pcs/mile
- Natural conditions = 175 to 225 pcs/mile (McKinley et al., undated)

Mapping and analysis of channel features

Log jams provide cover and encourage meander formation in previously straightened channels

Mapping and analysis of channel features

Channel straightening

- Long segments of stream are artificially straightened
- Increased slope = increased velocities and capacity to transport sediment
- Wood is unevenly distributed

Mapping and analysis of channel features

Migration features and stream corridor encroachments

- Avulsions
- Side channels / flood chutes
- Braiding / anabranching

- Development / infrastructure within stream corridor
- Rt 112 and Clesson Brook Rd
- Berms / windrows

Work completed to date

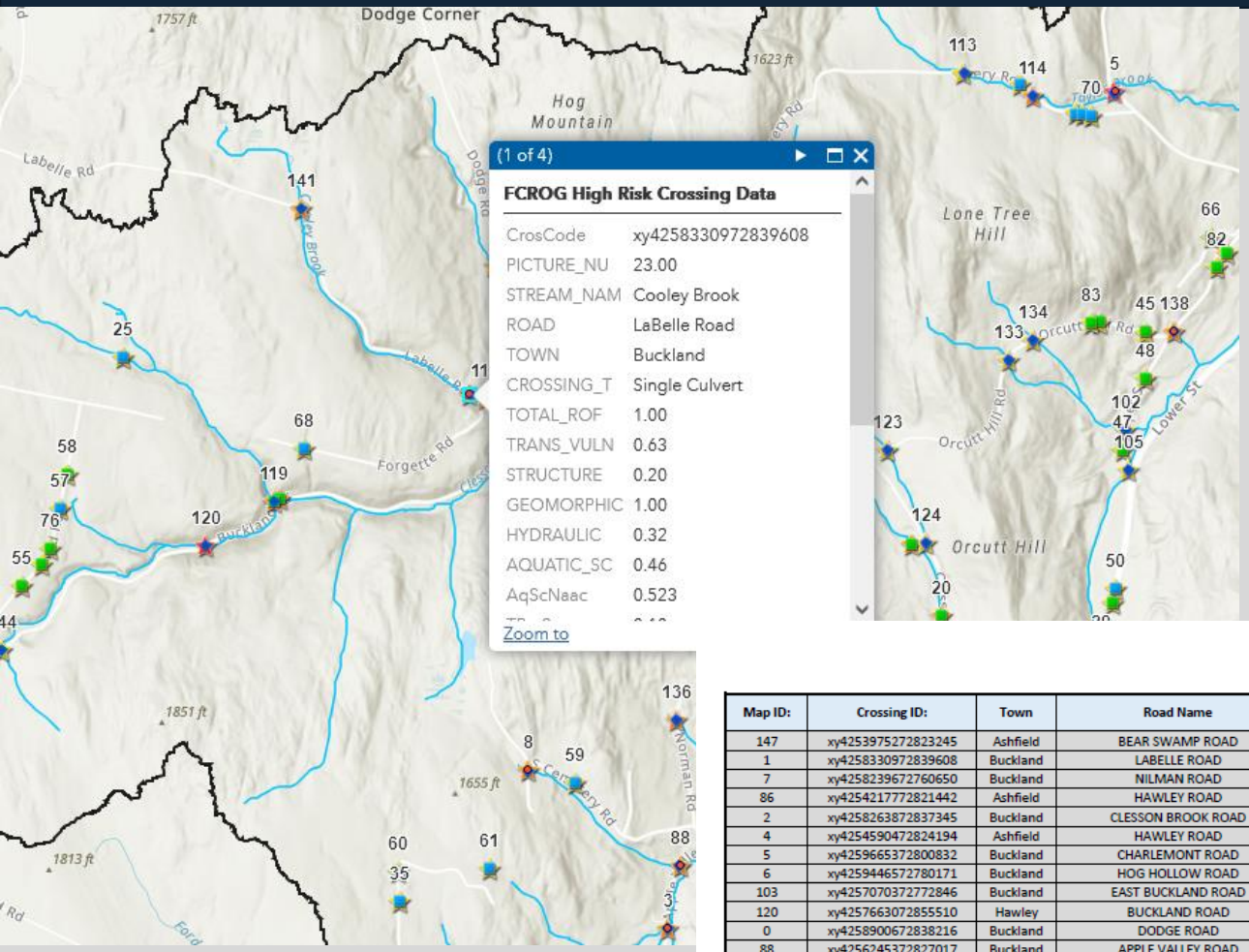
Stream crossing assessment

- Prioritized 152 culverts and bridges in watershed
- Rated on hazard risk, detour length, AOP, habitat value (coldwater fisheries, NHESP, BioMap 2, etc.)

Results published to Clesson Brook Watershed Crossing App:

https://gza.maps.arcgis.com/apps/webappviewer/index.html?id=4dd9dbc00f644631bf1f7c45af8cc98b

Clesson Brook Watershed Crossing App



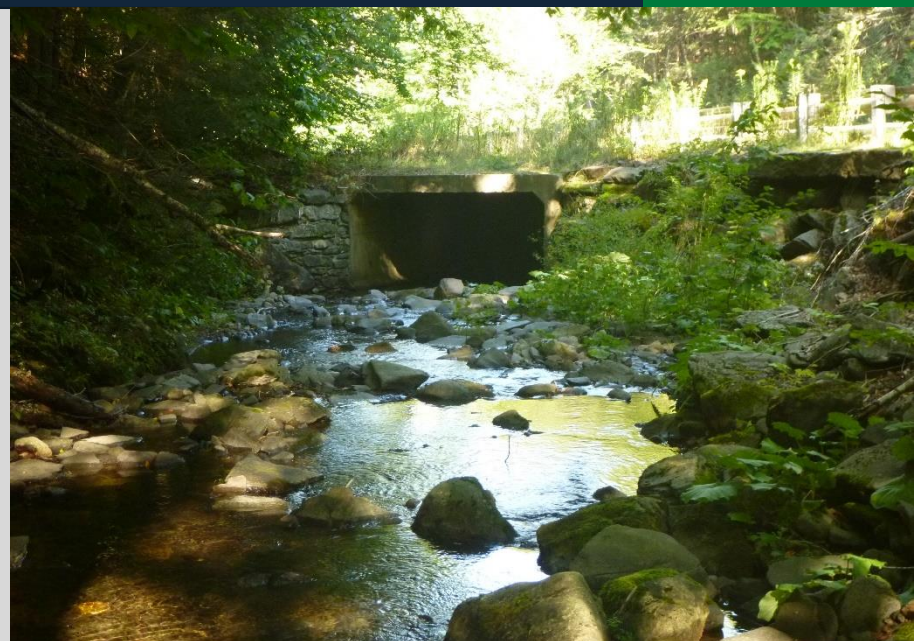
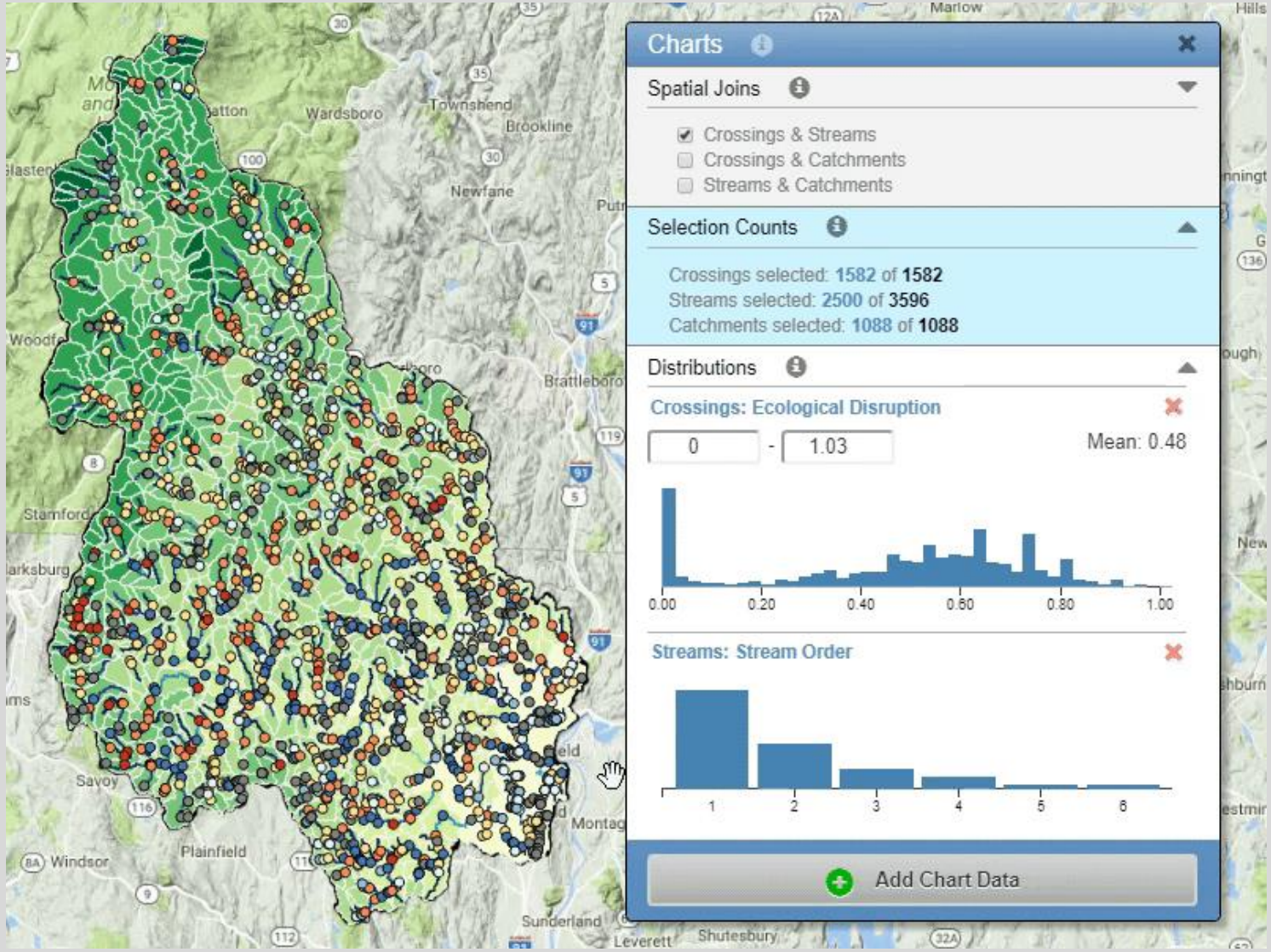


Table of Prioritized Road-Stream Crossings for Replacement
June 6, 2022

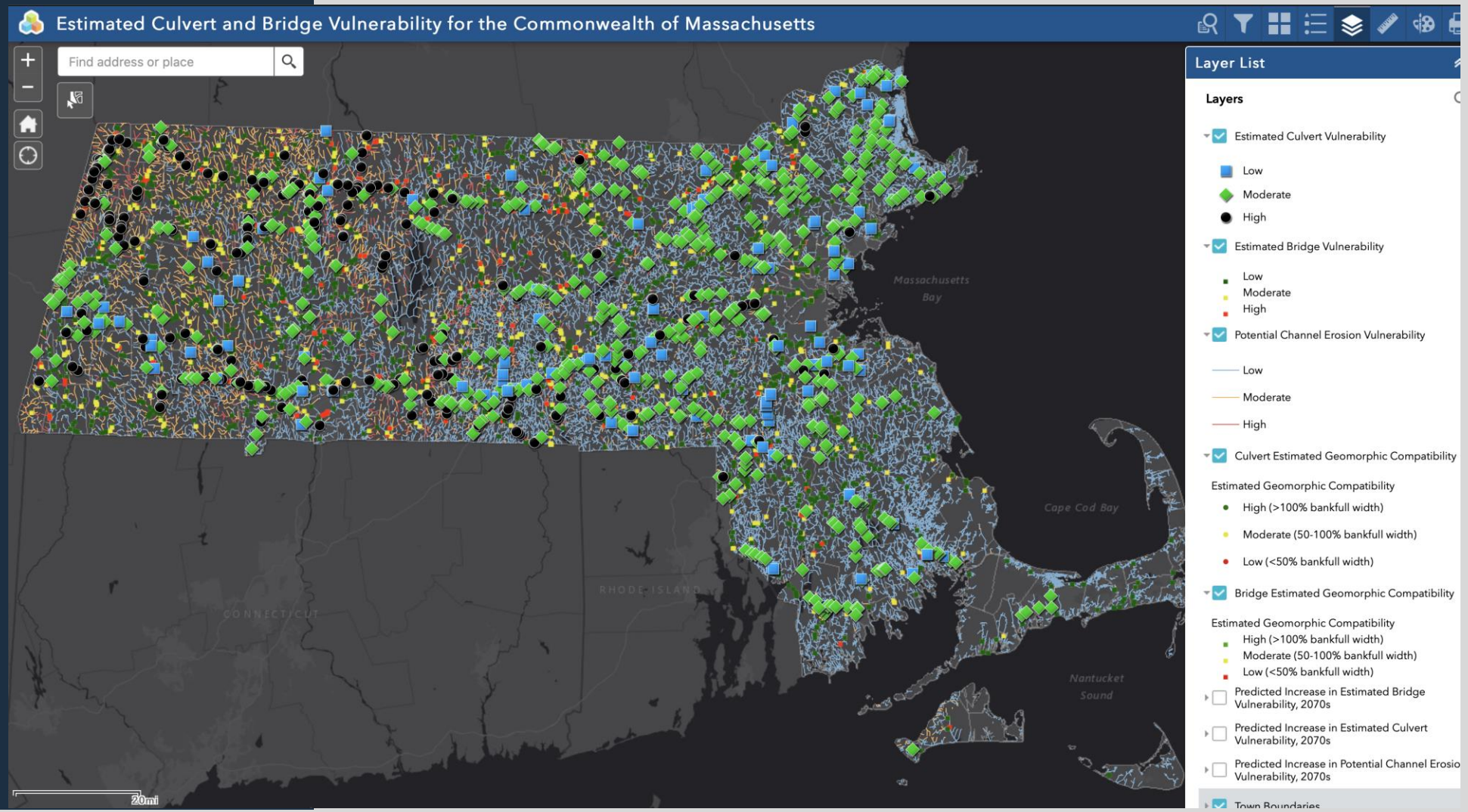
Map ID:	Crossing ID:	Town	Road Name	Stream Name	FRCOG High Risk Crossings	NAACC Barrier	Detour Length	Open Space	ORW	NHESP	Coldwater Fisheries	BioMap 2	Total Points	Priority Rank
147	xy4253975272823245	Ashfield	BEAR SWAMP ROAD	Smith Brook	3	3	2	1	1	1	0	1	12	1
1	xy4258330972839608	Buckland	LABELLE ROAD	Cooley Brook	3	4	2	0	0	0	1	1	11	2
7	xy4258239672760650	Buckland	NILMAN ROAD	Trib Clark Brook	3	4	2	0	0	0	1	1	11	2
86	xy4254217772821442	Ashfield	HAWLEY ROAD	Smith Brook	3	3	2	0	0	1	1	0	10	3
2	xy4258263872837345	Buckland	CLESSON BROOK ROAD	Cooley Brook	3	2	2	0	0	0	1	1	9	4
4	xy4254590472824194	Ashfield	HAWLEY ROAD	Smith Brook	3	2	2	0	0	1	0	1	9	4
5	xy4259665372800832	Buckland	CHARLEMONT ROAD	Taylor Brook	3	4	2	0	0	0	0	0	9	4
6	xy4259446572780171	Buckland	HOG HOLLOW ROAD	Trib Clesson Brook	3	4	2	0	0	0	0	0	9	4
103	xy4257070372772846	Buckland	EAST BUCKLAND ROAD	Clark Brook	3	4	0	0	0	0	1	1	9	4
120	xy4257663072855510	Hawley	BUCKLAND ROAD	Clesson Brook	0	3	2	0	1	1	1	1	9	4
0	xy4258900672838216	Buckland	DODGE ROAD	Ruddock Brook	3	1	2	0	0	0	1	1	8	5
88	xy4256245372827017	Buckland	APPLE VALLEY ROAD	Upper Branch Clesson Brook	3	3	0	0	0	0	1	1	8	5
119	xy4257855972851418	Hawley	BUCKLAND ROAD	Trib Clesson Brook	0	3	2	0	1	1	0	1	8	5
137	xy4258768972871307	Hawley	EAST ROAD	Trib Clesson Brook	0	3	2	0	1	1	0	1	8	5
22	GZA-13	Ashfield	BEAR SWAMP ROAD	Smith Brook	0	0	2	1	1	1	1	1	7	6
91	xy4259562072761487	Buckland	EAST BUCKLAND ROAD	Clark Brook	0	2	2	0	1	0	1	1	7	6
114	xy4259655772805730	Buckland	AVERY ROAD	Taylor Brook	0	4	2	0	0	0	0	1	7	6
115	xy4259027572820828	Buckland	SHEPARD ROAD	Shepherd Brook	0	3	2	0	0	0	1	1	7	6
116	xy4258443872831934	Buckland	CLESSON BROOK ROAD	Ruddock Brook	0	3	2	0	0	1	1	0	7	6
118	xy4258312972838703	Buckland	LABELLE ROAD	Cooley Brook	0	3	2	0	0	0	1	1	7	6
121	xy4258840372818784	Buckland	SHEPARD ROAD	Shepherd Brook	0	3	2	0	0	0	1	1	7	6
130	xy4253753272826057	Ashfield	BEAR SWAMP ROAD	Smith Brook	0	2	2	1	0	1	0	1	7	6
141	xy4259155072849799	Hawley	LABELLE ROAD	Trib Cooley Brook	0	2	2	0	1	0	1	1	7	6
146	xy4255478872826006	Ashfield	TATRO ROAD	Trib Upper Branch Clesson Brook	3	3	0	0	1	0	0	0	7	6

Deerfield River Watershed Stream Crossings Explorer

Stream Crossings Explorer



MassDOT statewide culvert & bridge vulnerability map

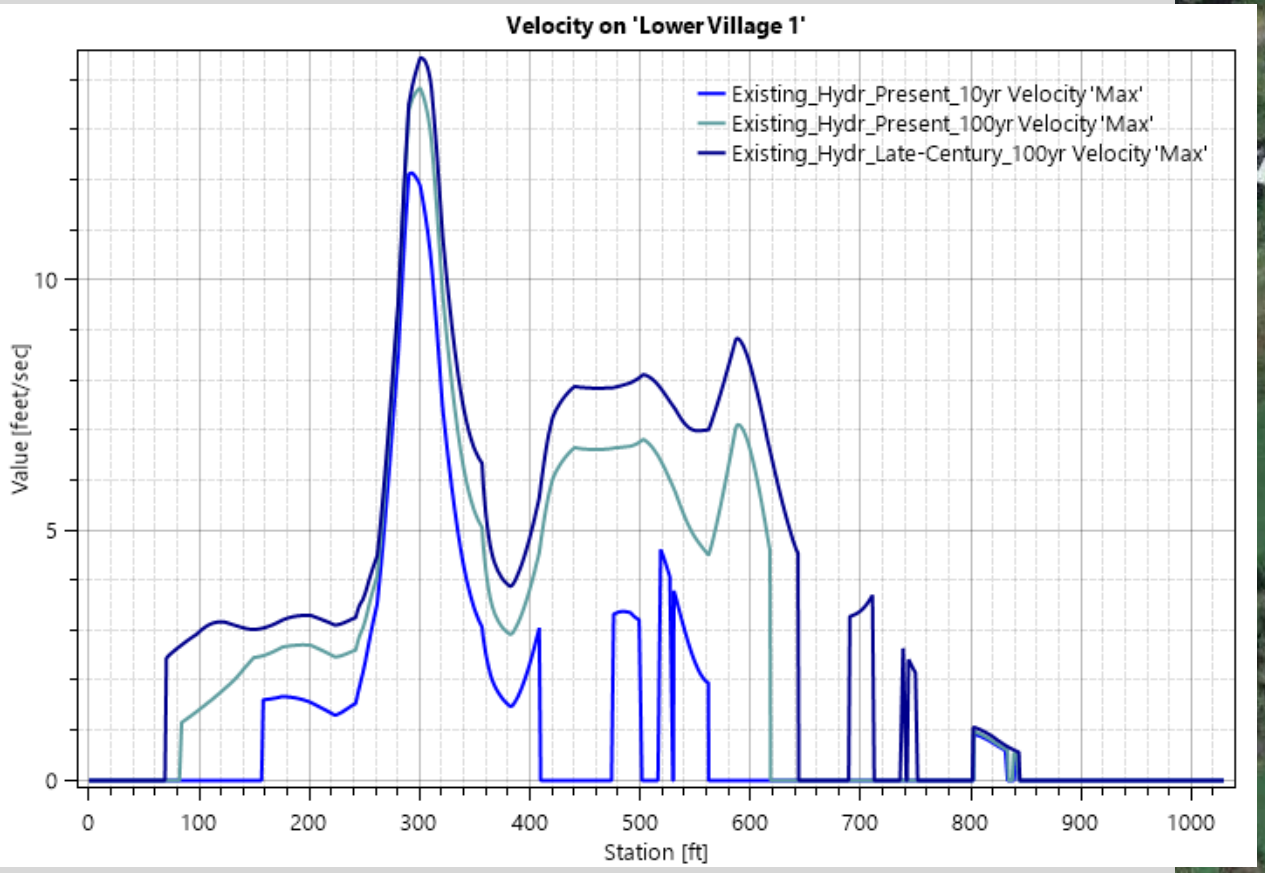


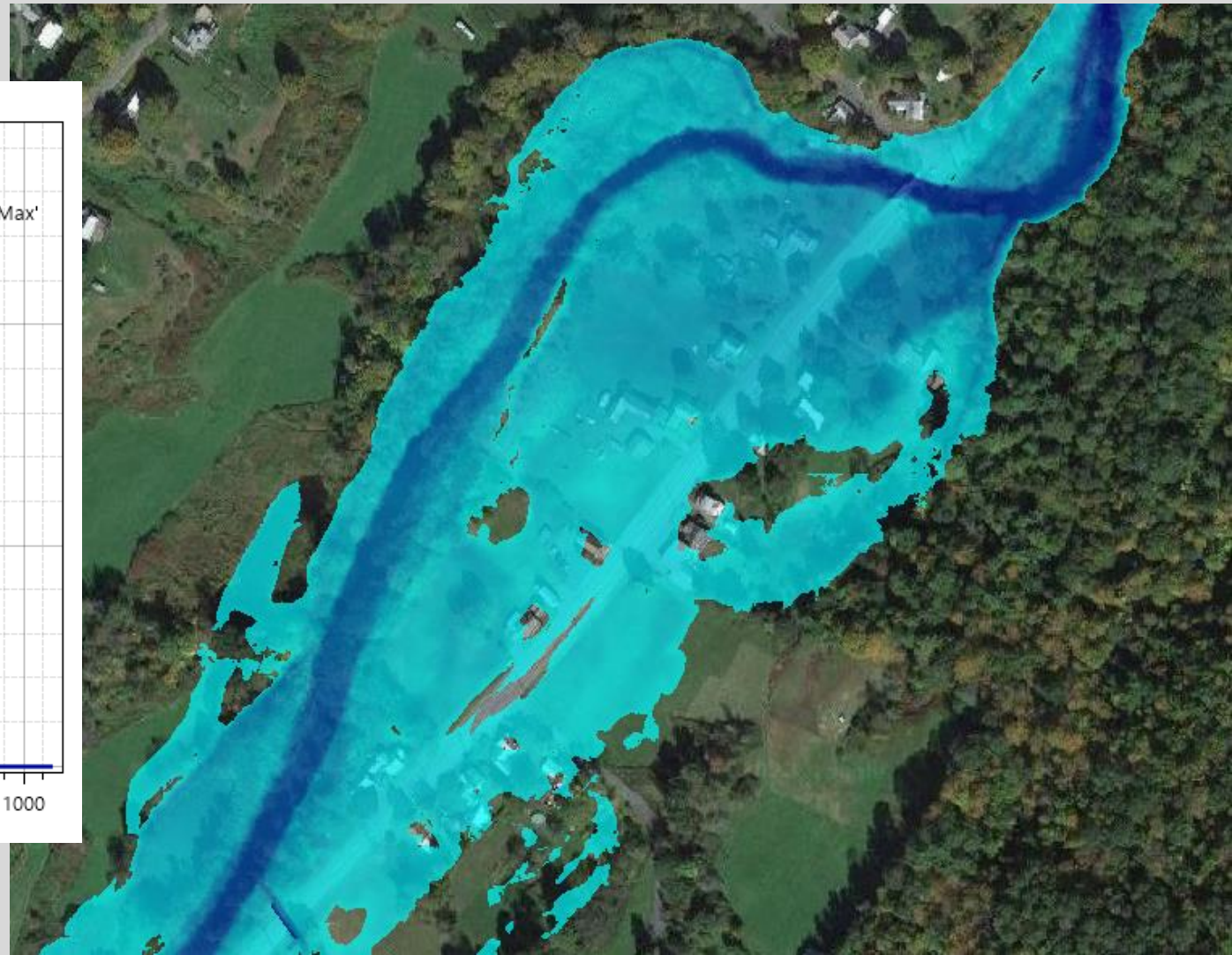
https://www.arcgis.com/apps/webappviewer/index.html?id=015b900027ab465bac7cffe934dcce46

Work completed to date

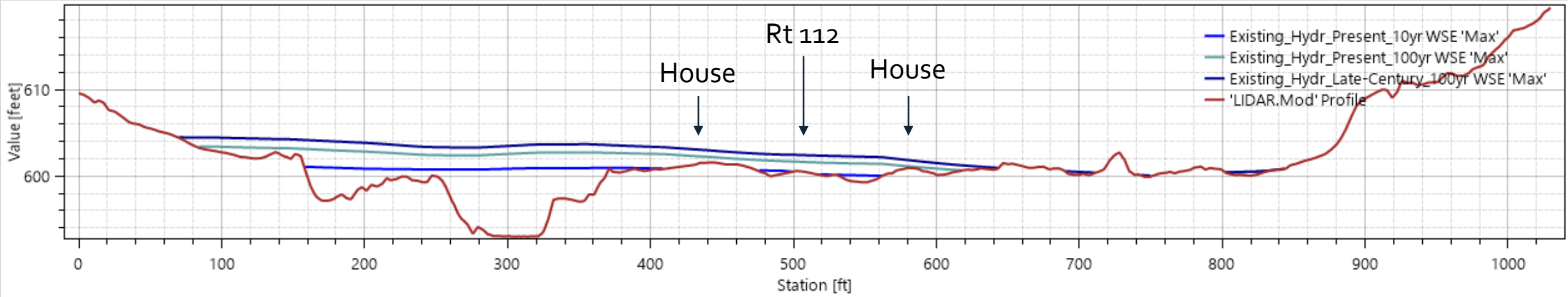
Hydraulic modeling of Clesson Brook

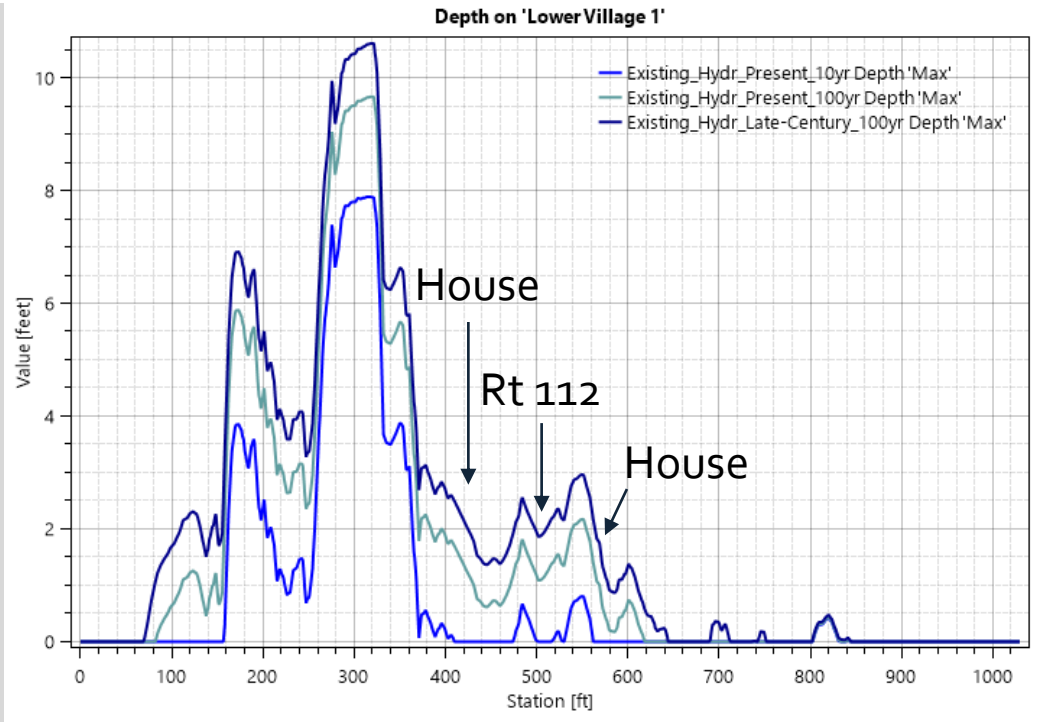
- 2D HEC-RAS model





Hydraulic modeling

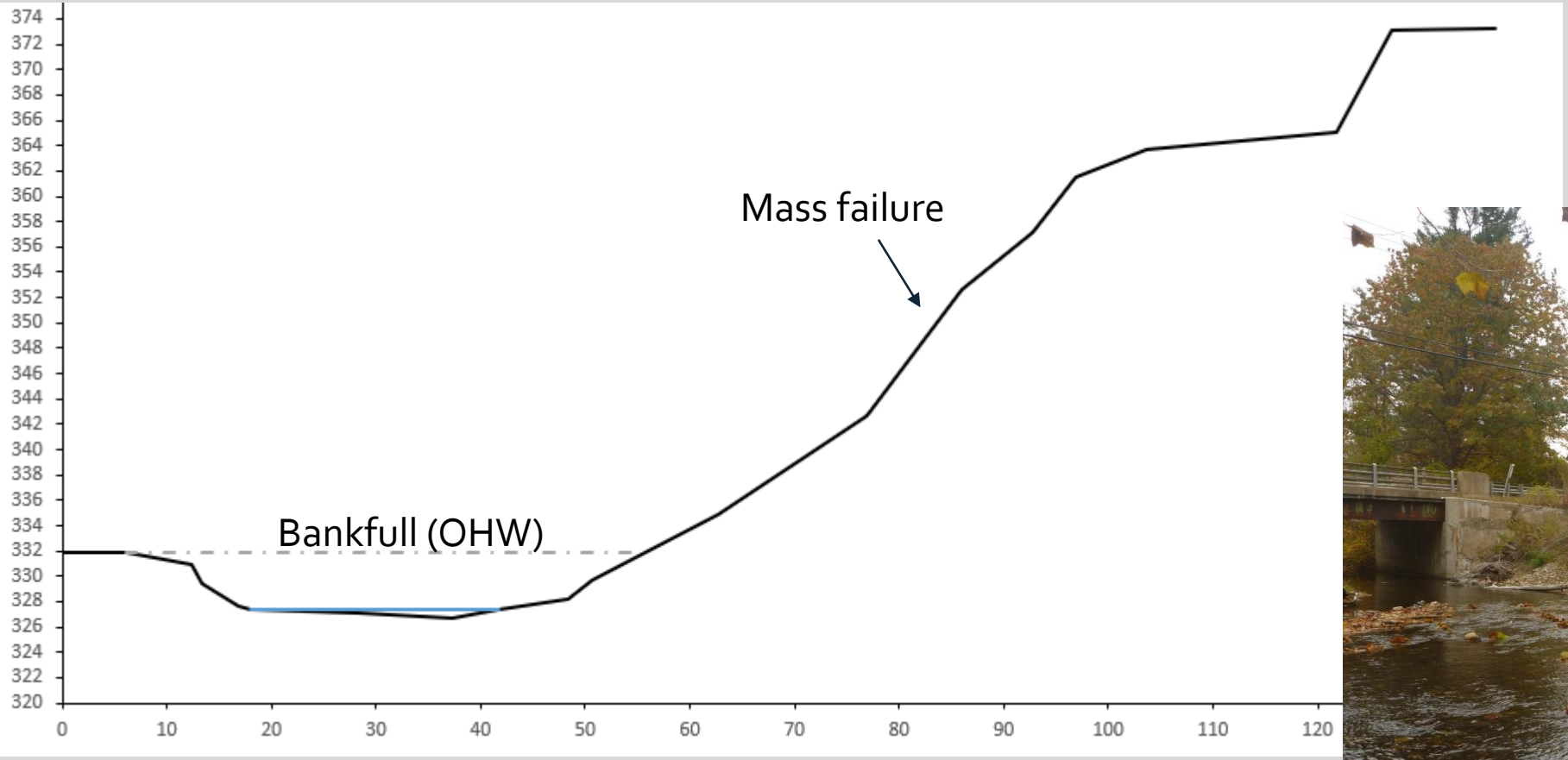




Work completed to date

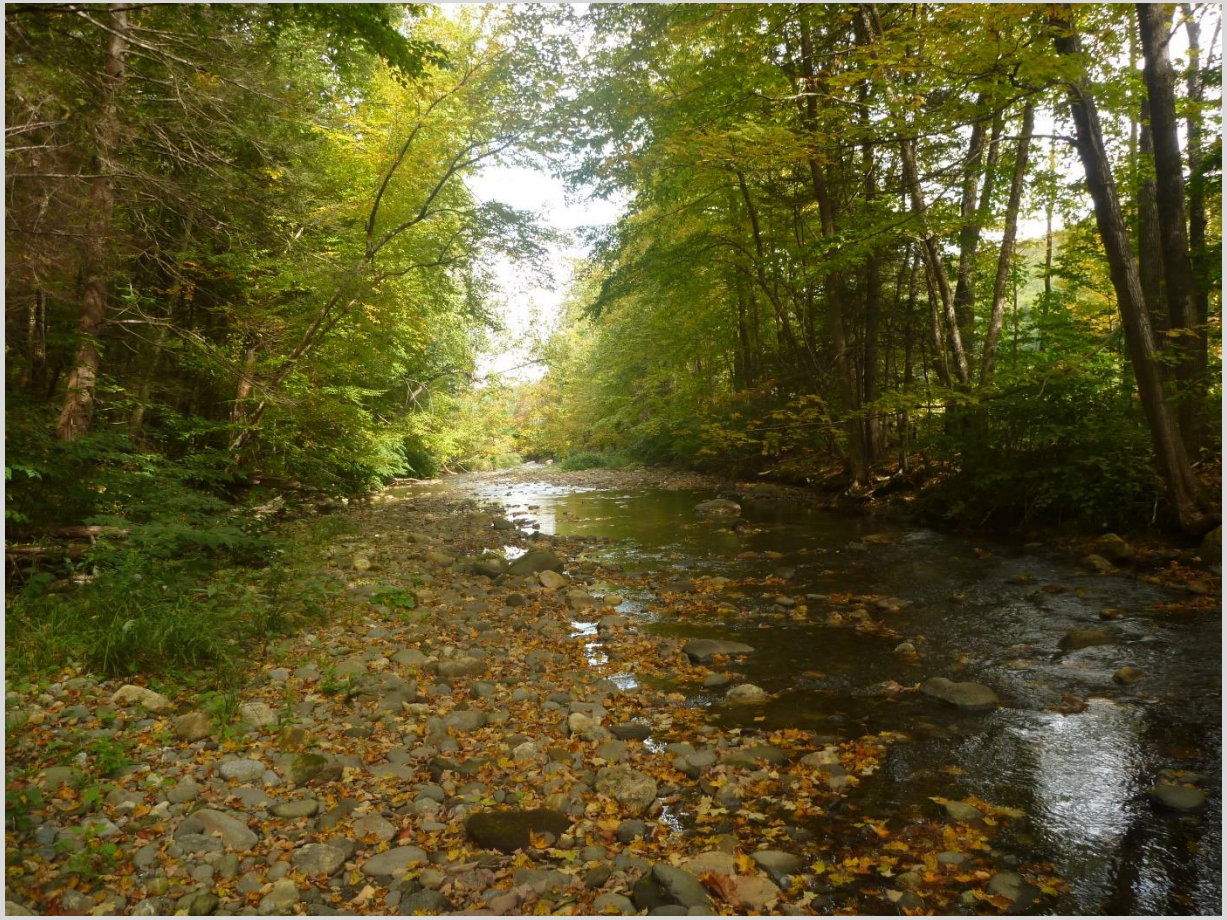
Topographic surveying

- 4 sites along Clesson Brook



Ongoing work

- Segment and parcel prioritization
- Restoration conceptual designs
- Stream corridor delineation
- Landowner outreach



Questions?