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Advancing Priority Culvert Right-Sizing Projects in the Naugatuck River Watershed

Final Report to CIRCA
August 2025

Executive summary

We assessed 521 road-stream crossing structures using the North Atlantic Aquatic Connectivity Collaborative (NAACC) protocol, and conducted additional assessment at close-bottomed structures (culverts) to support flood risk modelling by our partners at the University of Connecticut (UConn). We developed Road-Stream Crossing Inventory documents for each community that include the results of NAACC assessments and UConn flood risk modelling. Road-Stream Crossing Inventory documents were used as the basis for collaborative prioritization of culvert replacement projects. We held prioritization workshops with each community, during which we selected structures for design development based on potential to reconnect diadromous fish habitat, reduce flood risk and structure condition. We conducted detailed surveys to support demonstration design development for two culverts in Watertown on an unnamed tributary of Steele Brook, and three culverts in Beacon Falls on Hockanum Brook. Our partners at Trout Unlimited completed Preliminary designs for replacement of these five structures, using the Stream Simulation Design method. We also completed a detailed survey at a culvert on Fulling Mill Brook in the Town of Naugatuck. Inventory documents, prioritization results, and Preliminary designs were combined with supporting information as Road-Stream Crossing Management Plans for each town.

Project background and context

HVA has led collaborative efforts to restore and protect the landscapes of the Housatonic watershed since the organization was founded in 1941. We have been working to identify barriers to fish and wildlife movement at road-stream crossings since 2010 using protocols developed by the North Atlantic Aquatic Connectivity Collaborative (NAACC). Since then, our staff have assessed over 2,500 structures in the Housatonic watershed, and HVA has emerged as a leader in road-stream crossing assessment and replacement planning in our service area and beyond.

Our approach has evolved over the years to focus on bridging the gap between road-stream crossing assessment and implementation of priority replacement projects,

primarily through the development of town-scale Road-Stream Crossing Management Plans (RSCMPs). HVA developed the RSCMP process to address the fact that the scale of the culvert issue is massive; our data indicate that around 60% of the non-bridge structures we have assessed to date (non-bridge structures account for around 80% of the total) are moderate or worse barriers to fish and wildlife. Based on modelling conducted by our partners at the University of Connecticut's Civil and Environmental Engineering Department (UConn), approximately 15% of those structures are also predicted to fail (water reaching the road elevation) in relatively frequent flood events (25-year recurrence interval or smaller). We recognize that a fundamental change in management philosophy is necessary if we hope to reduce flood risk and restore stream habitat connectivity in a comprehensive way across the watershed. The RSCMP process offers the opportunity to work closely with local highway managers and decision-makers to identify high priority projects based on conservation value, flood risk reduction potential and maintenance need, and then use those projects to demonstrate Best Management Practices that restore habitat connectivity while reducing flood risk and maintenance costs. The completed RSCMPs are a tool that communities can use to take advantage of every opportunity to secure financing for priority replacement projects, including capital planning, grant-seeking, and recovery operations in the wake of large floods.

This project builds on over ten years of culvert assessment and replacement project prioritization in the Housatonic River watershed, representing significant investments of time and resources from funders, watershed communities, regional, state and federal agencies and conservation non-profits. That investment has supported the identification of several culvert replacement projects that will meaningfully increase the climate resilience of the built and natural environments, as well as reduce maintenance costs for watershed communities. By the end of this year, HVA will have completed Road-Stream Crossing Management Plans (RSCMPs) for 14 towns in Connecticut, and 22 towns across the Housatonic watershed. The RSCMPs use information about flood risk, maintenance need and conservation value (particularly restoration of stream continuity for native fish such as Eastern Brook Trout, River Herring and American Eel) to collaboratively prioritize culvert replacement

projects and recommend culvert design Best Management Practices (BMPs) that reduce flood risk and maintenance costs while restoring habitat connectivity- with an emphasis on Stream Simulation Design (SSD)[1]. These projects will accomplish multiple objectives- mitigate flood risk, reduce ongoing maintenance costs and restore stream habitat continuity for diadromous fish that travel between Long Island Sound and the Naugatuck watershed to complete different phases of their life cycles.

Despite access to high-quality information about which projects are most urgent, and a general understanding of the long-term cost-effectiveness of culvert design

BMPs like SSD among highway managers that have gone through an RSCMP process, the pace of BMP deployment in the Housatonic watershed remains inadequate to comprehensively reducing flood damage risk and restoring stream habitat continuity. Our experience working with 22 communities to create RSCMPs, as well as the experience of our partners doing similar work to build local capacity for culvert replacement in the Northeast, has revealed near-universal barriers to the regular use of culvert design BMPs like SSD by local highway managers. The most important of these are higher fees for required site assessment and engineering, complicated permitting processes, and higher costs for the materials and services required for construction of structures that use practices like SSD. Meanwhile, municipalities generally lack the capacity needed to secure and manage larger, more complicated grants that could support these projects, leaving potentially significant resources for replacing undersized culverts underutilized in the region. CIRCA funding will allow HVA and our partners to help Watertown, Naugatuck and Beacon Falls to overcome these barriers to implement the priority projects identified in their RSCMPs, and reduce their overall risk exposure during large floods.

Project description, including goals and methods

The Road-Stream Crossing Management Plans (RSCMPs) developed for each community will be a tool for securing the significant amount of funding required for building culvert replacement projects using the Stream Simulation Design method. Towns and their partners will be able to point to the rigorous prioritization process we used to identify the most impactful projects for restoring diadromous fish habitat, reducing flood risk and addressing maintenance needs when pursuing competitive grants, developing capital improvement plans, and/or negotiating with state and federal agencies in the wake of flood disasters.

Road-Stream Crossing Management Plans developed for each community (Watertown, Beacon Falls and Naugatuck) combine the following elements:

1. **A comprehensive Bridge and Culvert Inventory, including:**
    a. Field data and photos collected using the protocol developed by the North Atlantic Aquatic Connectivity Collaborative (NAACC)
    b. Barrier status/Aquatic Organism Passage information from NAACC
    c. Risk-of-Failure modeling conducted by our partners at the University of Connecticut's Civil and Environmental Engineering Department (UConn) for close-bottomed structures (culverts)

We assessed 521 road-stream crossing structures using the North Atlantic Aquatic Connectivity Collaborative (NAACC) protocol, and conducted additional assessment at close-bottomed structures (e.g. culverts) to support flood risk modelling conducted by our partners at the University of Connecticut. This includes all the assessments necessary for developing Road-Stream Crossing Management Plans for the Towns of Naugatuck (132), Watertown (200) and Beacon Falls (51), and assessments in contiguous sub-watersheds extending into the neighboring towns of Waterbury (31), Middlebury (66), Prospect (23) and Bethany (18) necessary for prioritization of replacement projects.

2. **A replacement project prioritization developed in collaboration with each community. This prioritization was based on the following:**
    a. Flood risk (understood through UConn's modelling and local knowledge)
    b. Conservation value (understood through structure location on the landscape, particularly potential reconnection the mainstem Naugatuck River; downstream and upstream barriers; Connecticut Department of Energy and Environmental Protection's Macroinvertebrate Multimetric Index; and, the University of Massachusetts/The Nature Conservancy Critical Linkages project.
    c. Condition/maintenance priority (understood through local knowledge and NAACC assessments).

    The top 8-10 replacement projects in each Town were selected during a collaborative workshop with each Town that generally included the following participants:

a. Chief Executive/Executive Board members
b. Highway/Public Works staff
c. Emergency Services staff
d. Other community members with knowledge of past flood events
e. HVA staff

In Watertown, we identified two structures on a tributary of Steele Brook that are barriers to fish and wildlife movement for preliminary design development. These structures are within 200' of one another, and should be combined into a single project. This tributary is confluent with Steele Brook just below the Pin Shop dam, and has potential to be high- quality habitat for diadromous fish. HVA completed a detailed rod-and-level survey and geomorphic assessment of these structures and the stream corridor upstream and downstream, and also surveyed adjacent infrastructure that could influence design of a replacement project. This information was given to our partners at Trout Unlimited, who completed preliminary designs for replacing both structures.

In Beacon Falls, we identified three structures in the Hockanum Brook watershed that are high priorities for replacement. Hockanum Brook has potential to be excellent habitat for diadromous fish. These structures are close together, near the confluence of two branches of Hockanum Brook. Given their proximity to one another and their hydrologic/hydraulic relationship, they must be considered holistically. HVA completed a detailed rod-and-level survey and geomorphic assessment of each of these structures and the stream corridors upstream and downstream, and also surveyed adjacent infrastructure that could influence design of a replacement project. This information was given to our partners at Trout Unlimited, who completed preliminary designs for replacing all three structures.

In Naugatuck, we identified a barrier structure in the Fulling Mill Brook watershed. Fulling Mill Brook has potential to serve as high quality habitat for diadromous fish. HVA completed a detailed rod-and-level survey and geomorphic assessment of this structure and the stream corridor upstream and downstream, and also surveyed adjacent infrastructure that could influence design of a replacement project. Preliminary designs were not completed for this structure, as we encountered the multiple-structure situations in Watertown and Beacon Falls.

3. **Preliminary Designs for replacing priority structures that demonstrate CT Stream Crossing Standards/Stream Simulation Design**
    a. HVA staff conducted rod-and-level survey and geomorphic assessment at priority culverts and provided this information to our partners at Trout Unlimited.

HVA staff re-visited priority culverts to collect additional data in general accordance with methods outlined in "Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings" and conducted a detailed assessment of the road-stream crossing structure, the stream, and the surrounding landscape over 2-3 days in the field to make observations related to valley form and floodplain width, bed and bank conditions, stream type and morphology, key pieces (elements on the streambed or banks that are large and immobile enough to control channel slope and dimensions, affect water velocity and flow direction, and/or retain sediment over a fairly long period of time), utilities (e.g., overhead powerlines, underground water lines, gas lines, and stormwater infrastructure), and transportation infrastructure (e.g., sidewalks, curbs, guiderails, and stormwater structures). In addition to a rod-and level survey of each site, observations were captured in a hand sketch that denotes the spatial relationship of various site features, and multiple site photos were taken. HVA also conducted a riverbed substrate analysis to understand existing and ideal conditions and provide data to calculate the design stream bed material. Wolman Pebble Counts were conducted upstream and downstream of the structure in reaches found to be representative of stream geomorphic characteristics. HVA collected topographic survey data with a Leica Flexline TS02 Total Station, Trimble GeoXT 6000 and Field Genius 9 Software. This information was then transferred to TU for design of a replacement structure that demonstrates Stream Simulation Design.

    b. Trout Unlimited developed Preliminary Designs, including initial structure selection, channel design and a memo that discusses design methods and next steps to attain shovel-ready status. Note that TU did not complete Preliminary Design in Town of Naugatuck, as we diverted our resources to multiple structures in Watertown and Beacon Falls. This is discussed in more detail under Lessons Learned below.

4. **The Bridge and Culvert Inventory, replacement project prioritization, and Preliminary Designs were combined with recommendations and supporting information (including common issues at culverts and Best Management Practices) to create the Road-Stream Crossing Management Plan for each Town.**

Description of any CIRCA collaboration or research product(s) utilized

As noted above, we worked with Dr. Xinyi Shen and his team from the UConn Civil and Environmental Engineering Department on the culvert Risk-of Failure modelling included as part of the Bridge and Culvert Inventory, and used to support collaborative prioritization with each community. UConn used their Coupled Routing and Excess Storage (CREST) hydrologic model (developed with support from CIRCA) to determine stage heights for floods of different recurrence intervals at all close-bottomed structures we assessed. They then used those stage heights in a hydraulic model that incorporated data collected by HVA in the field, which gave us a prediction of which recurrence interval flood a given structure would fail (water reaching the road elevation).

Outcomes and any lessons learned

At the close of this project, we had not gotten as far as we had initially hoped with individual culvert project development.

There are a few key reasons for thst. The first is that HVA lost project management staff three times during the course of this project. As a mid-size non-profit, it can be difficult for us to get back up to full steam when we lose someone. We were also behind with fieldwork related to this project at the beginning of the contract, due to stringent Covid-19 protocols developed by our Board and Executive Director and the fact that we encountered about a hundred more structures in the field than our preliminary desktop analysis predicted.

We also encountered situations in Watertown and Beacon Falls that necessitated addressing multiple structures along one reach in order to meaningfully address flood risk, restore stream habitat connectivity for our conservation targets and address key maintenance needs. This is discussed in more detail below.

In more densely developed areas, generally we do not encounter situations where restoring AOP at a single barrier will restore access to a significant amount of stream habitat. Also in densely developed areas, we often encounter situations where the hydraulic relationship between barrier structures requires that we address them within a single intervention, in order to avoid increasing flood risk to infrastructure and property. In our proposal, we planned to address a single priority structure in each community. This approach was short-sighted. When we collected and assessed data on road-stream crossing barrier status and flood risk in our partner communities (including working with towns to prioritize replacement projects), we realized that the single structures identified as priorities in Watertown and Beacon Falls could not be properly addressed without including adjacent structures. As we continue similar road-stream crossing planning work in developed areas- which will be essential for effective restoration/reconnection of diadromous fish habitat in the Naugatuck River watershed- we have to use a more holistic approach to understand what the scope of our interventions need to be to accomplish our goals of restoring habitat, restoring habitat connectivity, mitigating flood risk, and reducing municipal maintenance costs. One positive aspect of this challenge related to this project is that we were able to advance replacement planning for five structures, when we had initially planned for three- just not as far as we had hoped.

In our proposal, we were operating under the assumption that the 2014 installation of a fish bypass channel at the Tingue Dam in Seymour opened up nearly 27 miles of habitat along the Naugatuck River mainstem to diadromous fish, and made the mouths of tributary streams along that distance accessible- including Hockanum Brook, Fulling Mill Brook and Steele Brook. Since then, we learned that the fish passage structures at Kinneytown Dam in Seymour are ineffective. While this does not negate the value of our work under this grant (we are confident that passage at Kinneytown Dam will be restored eventually, ideally through removal of that dam entirely) we want to note that these investments in access to upstream habitat make restoration of passage at Kinneytown Dam even more imperative.

During our work surveying priority structures in our partner communities, we identified many opportunities for improving habitat for diadromous fish in the Hockanum Brook, Fulling Mill Brook and Steele Brook watersheds. In short, restoring Aquatic Organism Passage at barrier culverts is only one piece of the puzzle for restoring successful diadromous fish runs in Naugatuck River tributaries. We also need to mitigate water quality impacts arising from development. It doesn't make sense to bring these fish home to polluted streams. In addition to restoring habitat connectivity at the structures we've prioritized for replacement in the Hockanum Brook, Fulling Mill Brook and Steele Brook watersheds, we plan to pursue a whole-watershed approach that includes stormwater retrofits, riparian buffer restoration, and other Green Infrastructure practices, targeted at subwatersheds that have the most potential for restoration of diadromous fish runs. We are working on this approach with partners in the Steele Brook watershed; we plan to seek funding for this approach in the Hockanum Brook watershed in 2026.

Copies of products

RSCMP documents are too large to attach. Links to documents for each Town are below:

Town of Beacon Falls

Town of Watertown

Borough of Naugatuck