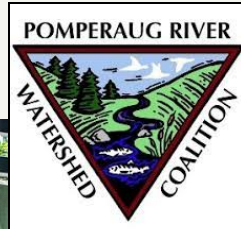


Town of Bethlehem

Road-Stream Crossing Assessment Inventory



Prepared by:
Pomperaug River Watershed Coalition
2025

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Summary

The 90 square-mile (56,958 acre) Pomperaug River Watershed (HUC10 code: 0110000509) is located in west central Connecticut. One of the most important geological features of this watershed is the underlying stratified-drift aquifer, which is the predominant source of potable water in the region. The main stem of the Pomperaug River flows from the center of Woodbury through the town of Southbury, and ultimately discharges into the Housatonic River at Lake Zoar.

The Pomperaug River Watershed includes three main rivers, the Pomperaug, Nonnewaug, and Weekeepeemee, and the underground aquifer, as well as the land that encompasses these water resources. Many residents of the towns of Woodbury, Southbury, Bethlehem, and neighboring communities receive their water from the Pomperaug aquifer. Residential growth, land use and development continues to challenge the health of the watershed. With 240 miles of rivers and streams and over 400 miles of road throughout the watershed, there are approximately 515 points where the two intersect. In Bethlehem, there are approximately 83 road-stream crossings. At these points, infrastructure has been installed to allow water to pass under roads.

Historically, road-stream crossings (bridges and culverts) were designed to quickly convey water from one side of the road to the other and sizing was determined by a predicted volume of water based on storm return frequency. Sizing often did not consider migration of aquatic organisms and other wildlife that move up and down in and along stream corridors. Therefore, road-stream crossing assessments that inventory the existing infrastructure and evaluate how severe of a barrier each crossing is to aquatic life passage will help local communities to better understand the impact development has on the streams within their watershed.

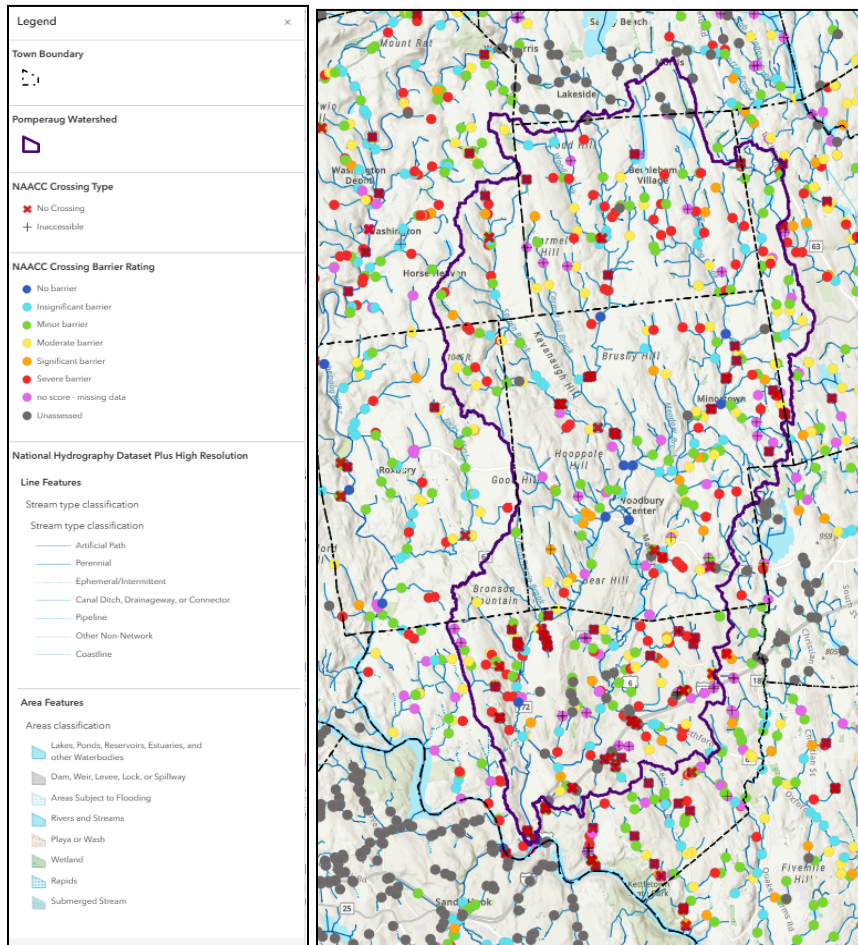
During the typical low-flow summer months in 2024 and 2025, Pomperaug River Watershed Coalition staff evaluated road-stream crossings (culverts and bridges) in the Town of Bethlehem for fish and wildlife passage (stream habitat continuity) using the [North Atlantic Aquatic Connectivity Collaborative \(NAACC\) protocol](#). Road-stream crossing attribute data collected in the field were uploaded to a regional online database which calculated a “passability score” and a barrier evaluation, ranking each site’s ability to support up and downstream migration of aquatic organisms and other wildlife from 0 (severe barrier) to 1 (no barrier). The aquatic organism passage (AOP) barrier rankings serve as surrogate for evaluating the overall size and ability of each crossing to convey the associated stream. Data collected in the field includes attributes of alignment, channel width, structure width, structure materials and condition, and tail water scour which help identify crossings that may be undersized.

This report presents a coarse overview of the overall crossing conditions in the Town of Bethlehem through the lens of the AOP barrier score that ranks crossings from severe to significant to minor to insignificant to no barrier for aquatic organism passage. The crossings illustrated in this report as the highest priority for infrastructure improvement were selected for having the lowest AOP scores. However, other attributes, like condition, may be used to determine priority for upgrade. In the best case scenario, multiple criteria should be used to prioritize crossings for upgrade including ecological benefit (AOP score and number of stream miles reconnected), flood risk (constriction and flow alignment), infrastructure condition (age, erosion, and deformation), etc. The **National Aquatic Barrier Inventory & Prioritization Tool** available online at <https://aquaticbarriers.org> is an excellent interactive resource to help determine which road-stream crossings are high priority using multiple criteria which can be selected by the user.

The impacts of climate change, including more frequent and severe natural hazard events, will increase the risk of culvert failures throughout the region. The damage resulting from these culvert failures and the subsequent flood damage to roads and other developed areas will be costly. Proactively replacing culverts within Bethlehem that have been identified as problematic across a number of variables (constriction, alignment, condition, scour, barrier, and passability) is a single solution to reduce infrastructure losses and increase the climate resiliency of both natural and developed spaces. As infrastructure is repaired or replaced, crossing attribute data should be freshly captured and entered to the online NAACC Data Center (https://naacc.org/naacc_data_center_home.cfm) to keep the most up-to-date crossing inventory possible.

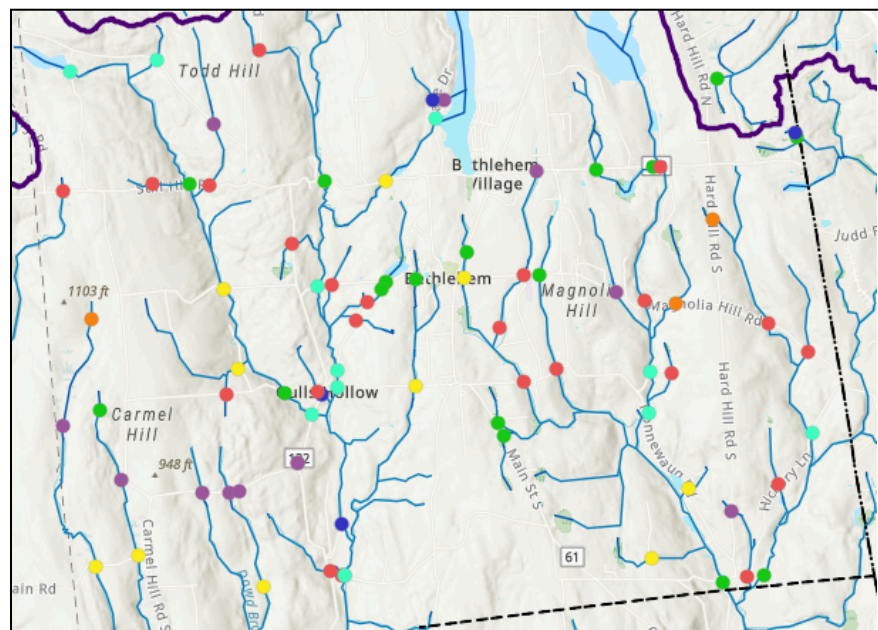
For more information, please contact PRWC Executive Director Carol Haskins at (203) 263-0076 or info@pomperaug.org.

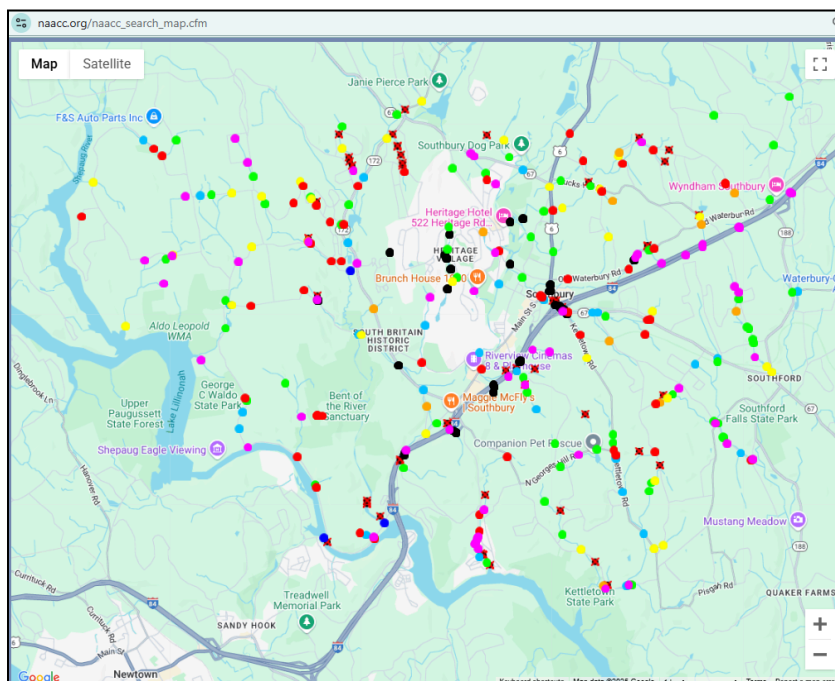
All Bethlehem Stream-Road Crossings by Barrier Evaluation



There are approximately 515 road stream crossing located in the Pomperaug Watershed. Of these, approximately 428 have been inventoried and assessed for how severe of a barrier they are for Aquatic Organism Passage through the culvert or bridge structure. There are approximately 83 road-stream crossings in the Town of Bethlehem.

Road-stream crossing evaluations following NAACC assessment protocols displayed by Aquatic Life Barrier Rating for the Pomperaug Watershed (above) and Bethlehem, CT (right)





All crossing data can be downloaded in an Excel or shapefile format from the NAACC Data Center with a link and an interactive map where users can click on any point on the map to view all of the data and pictures captured for each crossing. To access data and interactive map, visit: https://naacc.org/naacc_data_center_home.cfm

1. The colored circles on the map represent surveyed NAACC crossings (Non-tidal Aquatic Connectivity, Terrestrial Connectivity, Tidal Aquatic Connectivity or Culvert Condition Assessments) and colored squares represent UMass Stream Continuity Project crossings color coded as follows:

- **No barrier:** blue ●■
- **Insignificant barrier:** blue green ●■
- **Minor barrier:** green ●■
- **Moderate barrier:** yellow ●■
- **Significant barrier:** orange ●■
- **Severe barrier:** red ●■
- **Missing data:** magenta ●■
- **No crossing:** black circle with bold red x ●
- **New crossing pending approval:** black circle with red slash ●

TIP: To get the most recent information (i.e. most recent 'Date observed in field' AND most recent 'Last updated') for a surveyed crossing, click on it. Please be aware that to view all records for a surveyed crossing, you must use the "Search Crossings" page to search using the crossing code.

2. **Black circles ●** are unsurveyed crossings that have been assigned xy crossing codes by using Geographic Information System (GIS) software. Depending on the area covered by your search results, you may not see any black circles until you have zoomed in. When you hover over black points, the xy crossing code will appear.

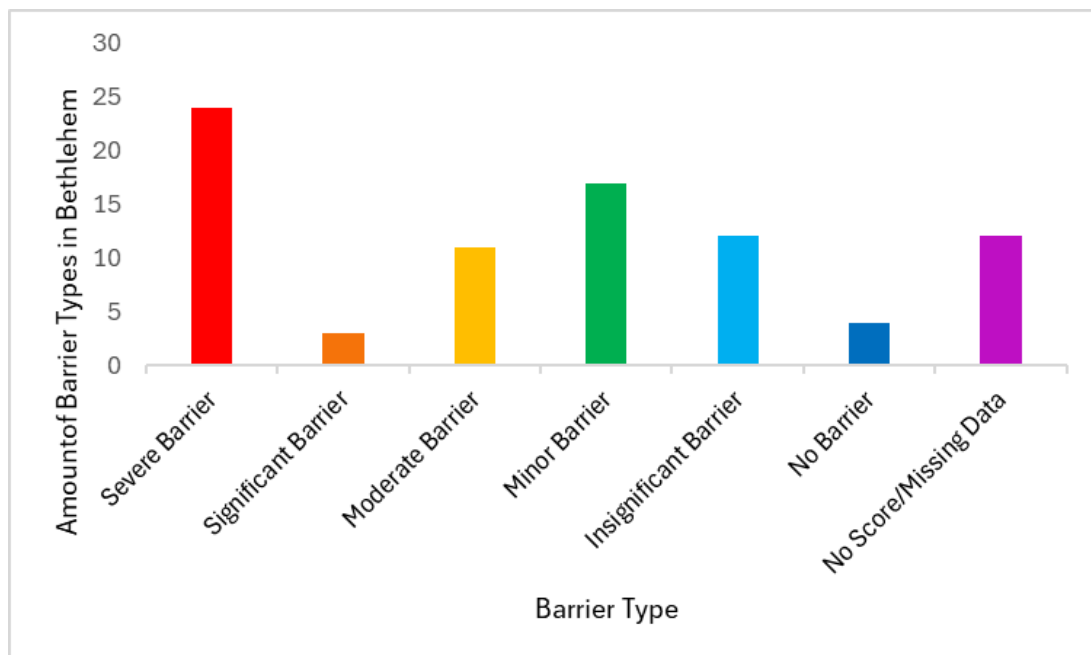
Comprehensive Bethlehem Road-Stream Crossing Evaluations

Summary of Aquatic Organism Passage (AOP) Barrier Ratings for Road-Stream Crossings in Bethlehem, CT (as of July 2025)

AOP Barrier Evaluation	Number of Crossings	Percentage of total*
Severe Barrier	24	28.9%
Significant Barrier	3	3.6%
Moderate Barrier	11	13.2%
Minor Barrier	17	20.5%
Insignificant Barrier	12	14.5%
No Barrier (Full Passage)	4	4.8%
No Score - Missing Data**	12	14.5%
TOTAL ASSESSED CROSSINGS	83	100.0%

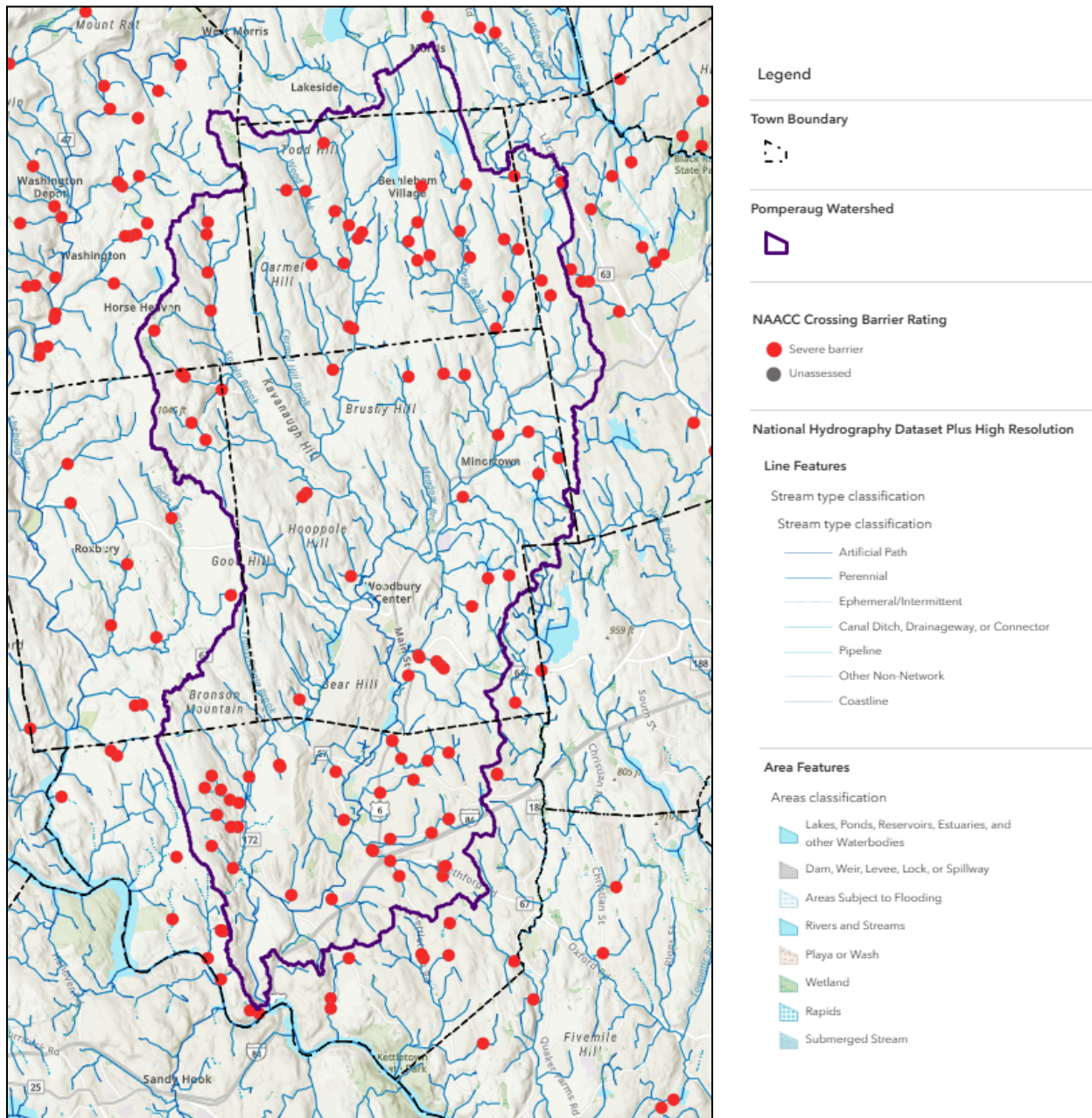
* Values rounded to the nearest tenth of a percent

** No score values are most frequently attributed to fully or partially inaccessible crossings associated with access limitations such as private property, posted no trespassing, and safety concerns like heavy traffic or steep and unstable slopes.

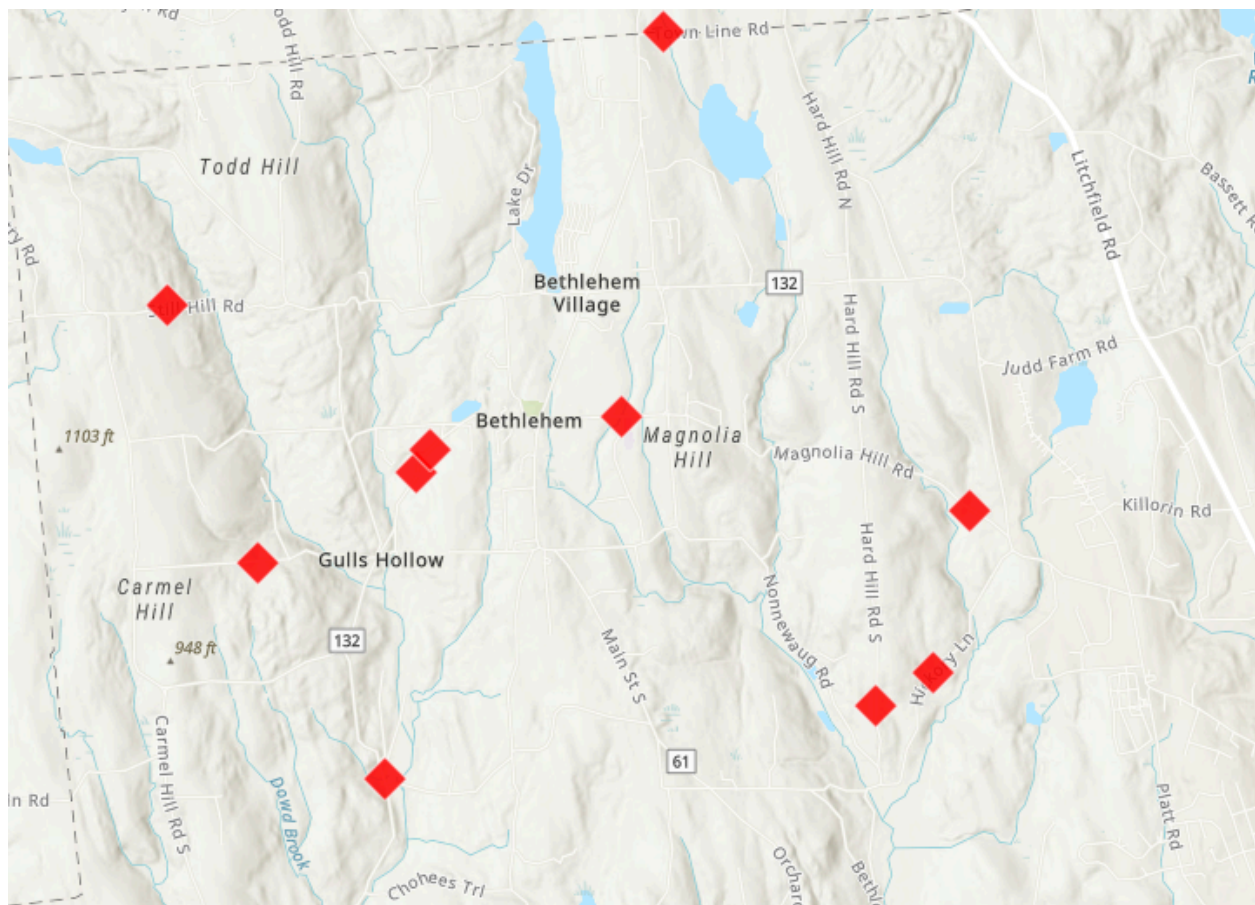


Priority Crossings for Infrastructure Improvements

Of the 83 assessed crossings in Bethlehem, 24 crossings are ranked as “Severe Barriers” for Aquatic Organism Passage (see map below). The number of severe barriers is not atypical for this part of Connecticut given the age of the road infrastructure and the sizing and construction conventions that were used when the crossings were installed.



With 83 assessed crossings in Bethlehem, PRWC further aimed to identify the top 10 crossings in the greatest need of modification or replacement to support aquatic life passage. Crossings in greatest need of replacement/improvement were prioritized using the numeric AOP score calculated by NAACC. From the 24 crossings, 7 of the severe barriers had an AOP score of 0.00, indicating it would be impossible for aquatic life to pass through the structure. The remaining crossings selected for the top 10 typically had severe AOP barrier rating and characteristics of severe streamflow constriction, outlet grades that were free fall or cascade, and presence of a scour pool, which together, greatly impede aquatic life passage.



The top 10 priority crossings are highlighted on the map of Bethlehem above. Specific characteristics of each of these 10 crossings are illustrated in the crossing data summaries presented in the pages that follow.

Highest Priority Crossings in Bethlehem for Infrastructure Improvement Based on Aquatic Life Passage Barrier Rating

Priority Rank	Crossing Code	Road Name	Stream Name
1	xy4163287273165784	Magnolia Hill Road	Unnamed Tributary of Nonnewaug River
2	xy4163574673220422	Guilds Hollow Road	Unnamed Tributary of Weekepeemee River
3	xy4161307973223539	Weekepeemee Road	Unnamed Tributary of Weekepeemee
4	xy4162091473169426	Hickory Lane	Unnamed Tributary of Nonnewaug River
5	xy4163981673200267	East Street	Unnamed Tributary of East Spring Brook
6	xy4162898373236085	Arch Bridge Road	Unnamed Tributary of Wood Creek
7	xy4164796873244934	Still Hill Road	Unnamed Tributary of Wood Creek
8	xy4163732073219056	Guilds Hollow Road	Unnamed Tributary of Weekepeemee River
9	xy4166810973196011	Town Line Road	Unnamed Tributary of East Spring Brook
10	xy4163542073170598	Magnolia Hill Road	Unnamed Tributary of Nonnewaug River

Road: Magnolia Hill Road

Stream: Unnamed Tributary of Nonnewaug River

Results:

Barrier Evaluation: Severe Barrier

Crossing Condition: OK

NAACC Aquatic Passability Score: 0.00

AOP: No AOP

Location:

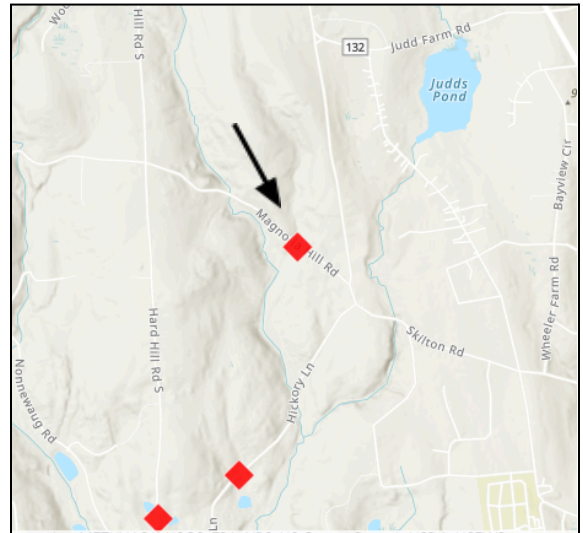
Coordinates: 41.63295, -73.16579

Location Description: At the bottom of the hill by wooden guard rails

Date Observed: 07/23/2024

Crossing Code: xy4163287273165784

Protocol: NAACC



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**
Number of structures/cells: **1**
Constriction: **Moderate**
Alignment: **Flow-Aligned**

Inlet Shape: **Round Culvert**
Inlet Type: **Mithered to Slope**
Inlet Grade: **At Stream Grade**
Material: **Plastic**

Outlet Shape: **Round Culvert**
Outlet Grade: **Cascade**
Outlet Armoring: **Extensive**
Outlet drop to water surface: **3.3 ft**
Outlet drop to stream bottom: **4.5 ft**
Tailwater Scour Pool: **Large**

Road: **Paved**



Inlet



Outlet

Comments:

- Moderate debris accumulation at inlet
- Outlet grade (cascade) has caused a 3ft-deep scour pool at outlet
- Culvert is made of thin grey plastic
- No substrate inside the structure
- No dry passage

Road: Guilds Hollow Road
Stream: Unnamed Tributary of Weekepeemee River

Results:

Barrier Evaluation: Severe Barrier

Crossing Condition: OK

NAACC Aquatic Passability Score: 0.00

AOP: No AOP

Location:

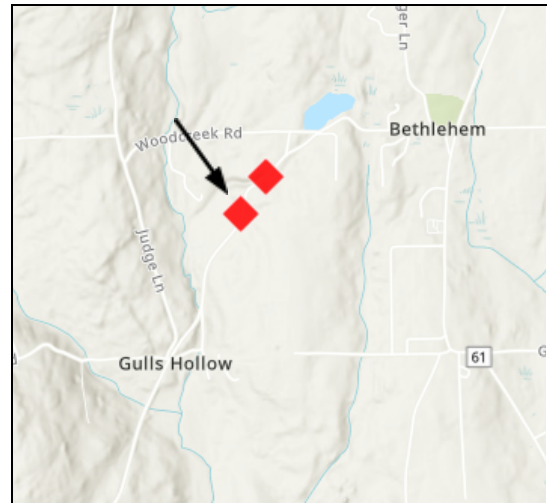
Coordinates: 41.63587, -73.22033

Location Description: By house #69

Date Observed: 07/22/2024

Crossing Code: xy4163574673220422

Protocol: NAACC



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**
Number of structures/cells: **1**
Constriction: **Moderate**
Alignment: **Flow-Aligned**

Inlet Shape: **Box Culvert**
Inlet Type: **None**
Inlet Grade: **Inlet Drop**
Material: **Concrete**

Outlet Shape: **Box Culvert**
Outlet Grade: **Cascade**
Outlet Armoring: **Extensive**
Outlet drop to water surface: **5.0 ft**
Outlet drop to stream bottom: **5.3 ft**
Tailwater Scour Pool: **None**

Road: **Paved**



Inlet



Outlet

Comments:

- “Puzzle piece” shaped inlet is much smaller than outlet
- Large inlet drop into culvert
- Appears a new, smaller inlet may have been built in front of existing culvert inlet to accommodate catch basin system
- 5ft drop (cascade) from outlet to water surface
- Stream was dry at the time of assessment
- No dry passage if stream was flowing
- Extensive armoring needed because of cascade outlet grade to prevent scour



Road: Weekepeemee Road
Stream: Unnamed Tributary of Weekepeemee River

Results:

Barrier Evaluation: Severe Barrier

Crossing Condition: OK

NAACC Aquatic Passability Score: 0.00

AOP: No AOP

Location:

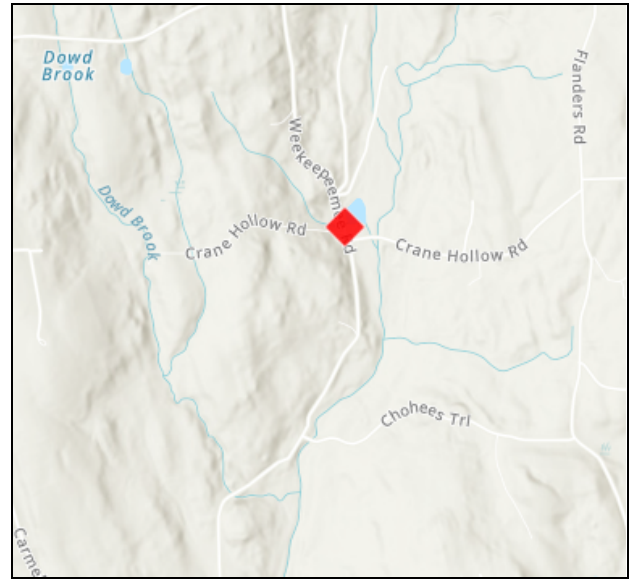
Coordinates: 41.61318, -73.22361

Location Description: At Hollow Pond

Date Observed: 07/29/2024

Crossing Code: xy4161307973223539

Protocol: NAACC



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**
Number of structures/cells: **1**
Constriction: **Severe**
Alignment: **Flow-Aligned**

Inlet Shape: **Round Culvert**
Inlet Type: **Headwall**
Inlet Grade: **At Stream Grade**
Material: **Concrete**

Outlet Shape: **Round Culvert**
Outlet Grade: **Free Fall onto Cascade**
Outlet Armoring: **Extensive**
Outlet drop to water surface: **3.8 ft**
Outlet drop to stream bottom: **4.3 ft**
Tailwater Scour Pool: **Small**

Road: **Paved**



Inlet



Outlet

Comments:

- 3.8 ft drop from outlet to water surface
- Outlet grade (free fall onto cascade) has contributed to the formation of a small scour pool at outlet
- Extensive armoring placed at outlet to prevent scour
- No dry passage through structure

Road: Hickory Lane

Stream: Unnamed Tributary of Nonnewaug River

Results:

Barrier Evaluation: **Severe Barrier**

Crossing Condition: **OK**

NAACC Aquatic Passability Score: **0.00**

AOP: **No AOP**

Location:

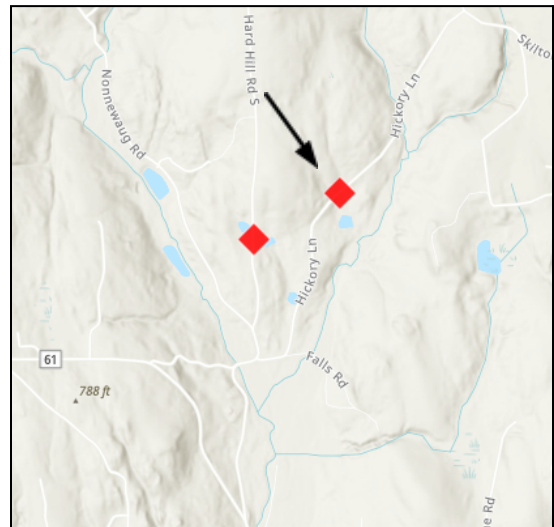
Coordinates: **41.63105, -73.16936**

Location Description: **Downhill of house #5**

Date Observed: **07/01/2024**

Crossing Code: **xy4162091473169426**

Protocol: **NAACC**



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**
Number of structures/cells: **1**
Constriction: **Severe**
Alignment: **Flow-Aligned**

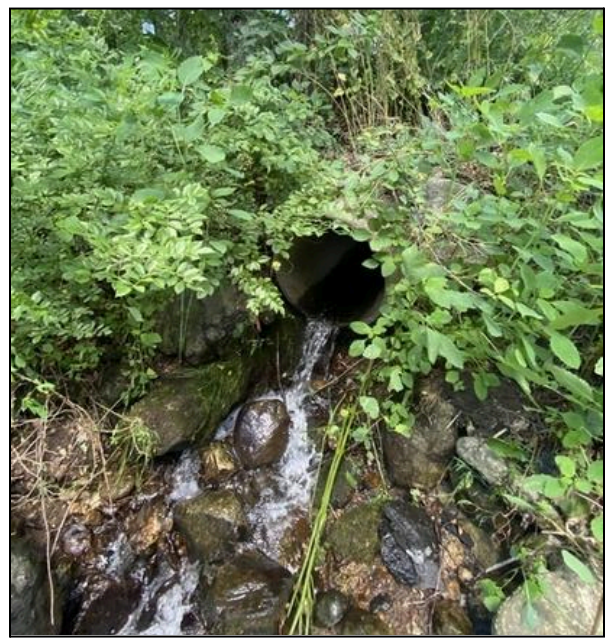
Inlet Shape: **Round Culvert**
Inlet Type: **Headwall**
Inlet Grade: **At Stream Grade**
Material: **Concrete**

Outlet Shape: **Round Culvert**
Outlet Grade: **Free Fall onto Cascade**
Outlet Armoring: **Not Extensive**
Outlet drop to water surface: **3.1 ft**
Outlet drop to stream bottom: **3.4 ft**
Tailwater Scour Pool: **Large**

Road: **Paved**



Inlet



Outlet

Comments:

- **Severe constriction**
- **3.1 ft drop from outlet to water surface**
- **Outlet grade (free fall onto cascade) has contributed to the formation of a large, 1.8ft-deep scour pool at outlet**
- **Inlet very overgrown**
- **Minor erosion of culvert bottom**
- **No dry passage**

Road: East Street

Stream: Unnamed Tributary of East Spring Brook

Results:

Barrier Evaluation: **Severe Barrier**

Crossing Condition: **OK**

NAACC Aquatic Passability Score: **0.00**

AOP: **No AOP**

Location:

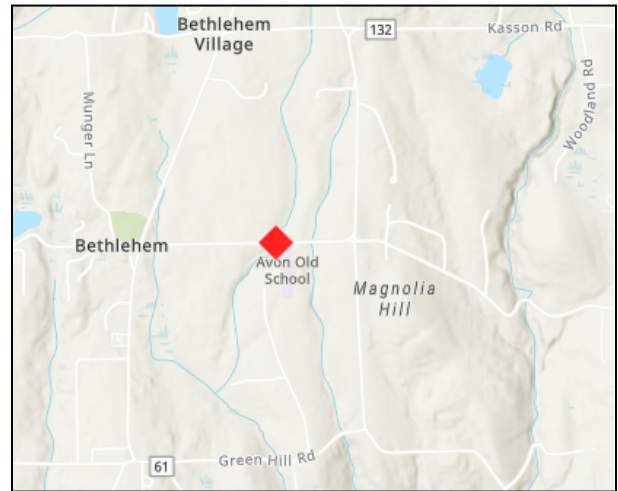
Coordinates: **41.63981, -73.20070**

Location Description: **Next to Bethlehem
Elementary School**

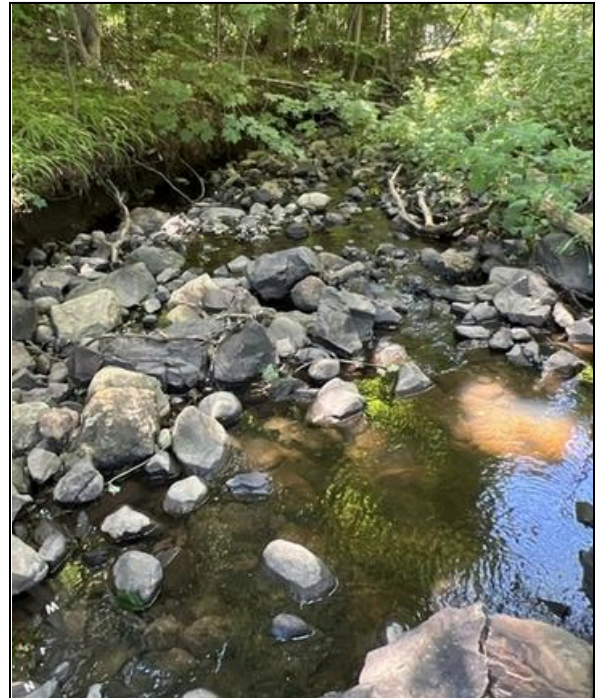
Date Observed: **07/02/2024**

Crossing Code: **xy4163981673200267**

Protocol: **NAACC**



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**
Number of structures/cells: **1**
Constriction: **Severe**
Alignment: **Flow-Aligned**

Inlet Shape: **Round Culvert**
Inlet Type: **Headwall**
Inlet Grade: **At Stream Grade**
Material: **Combination**

Outlet Shape: **Round Culvert**
Outlet Grade: **Cascade**
Outlet Armoring: **Extensive**
Outlet drop to water surface: **6.0 ft**
Outlet drop to stream bottom: **6.7 ft**
Tailwater Scour Pool: **Large**

Road: **Paved**



Inlet



Outlet

Comments:

- Erosion of culvert and headwall at inlet
- Dammed pond upstream of inlet
- Outlet grade (cascade) has resulted in a large, 1.8 ft-deep scour pool
- Storm water outflow to right of outlet
- Outlet is plastic while inlet is concrete
- Extensive armoring at outlet to mitigate scour from outlet grade
- Plastic wingwalls at outlet deformed by weight of rip rap
- No dry passage through structure

Road: Arch Bridge Road

Stream: Unnamed Tributary of Wood Creek

Results:

Barrier Evaluation: **Severe Barrier**

Crossing Condition: **OK**

NAACC Aquatic Passability Score: **0.00**

AOP: **No AOP**

Location:

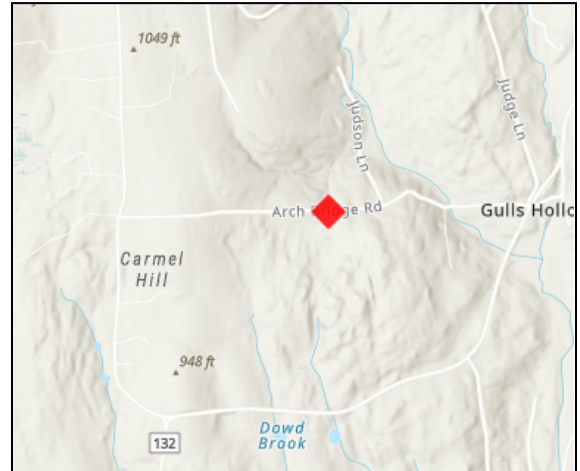
Coordinates: **41.62891, -73.23617**

Location Description: **By yellow mailbox of house #117; near gray farmhouse**

Date Observed: **07/03/2024**

Crossing Code: **xy4162898373236085**

Protocol: **NAACC**



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**
Number of structures/cells: **1**
Constriction: **Severe**
Alignment: **Skewed (>45°)**
Road: **Paved**

Outlet Shape: **Round Culvert**
Outlet Grade: **Free Fall onto Cascade**
Outlet Armoring: **Extensive**
Outlet drop to water surface: **4.8 ft**
Outlet drop to stream bottom: **5.9 ft**
Tailwater Scour Pool: **Small**

Inlet Shape: **Round Culvert**
Inlet Type: **Headwall**
Inlet Grade: **At Stream Grade**
Material: **Concrete**



Inlet



Outlet

Comments:

- Cracking of culvert segments inside structure
- 4.8ft drop from outlet to water surface
- Extensive armoring at outlet to mitigate scour
- Inlet is fed by 2 streams, both have skewed alignment relative to inlet
- Erosion of headwall around culvert at inlet
- Overgrown thorny vegetation and minor debris buildup at inlet
- No dry passage through structure

Road: Still Hill Road

Stream: Unnamed Tributary of Wood Creek

Results:

Barrier Evaluation: **Severe Barrier**

Crossing Condition: **OK**

NAACC Aquatic Passability Score: **0.00**

AOP: **No AOP**

Location:

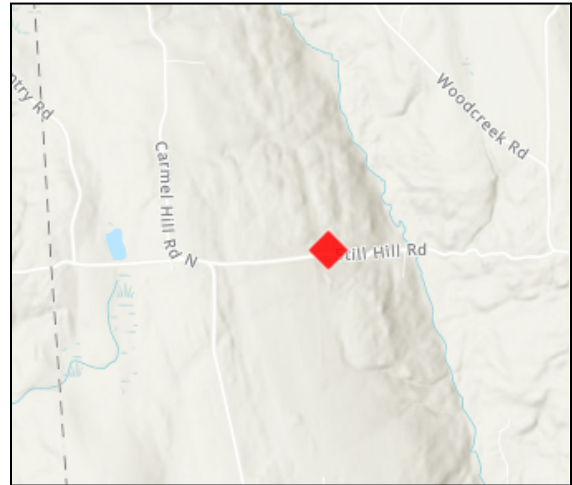
Coordinates: **41.64789, -73.24274**

Location Description: **At second sharp bend in the road**

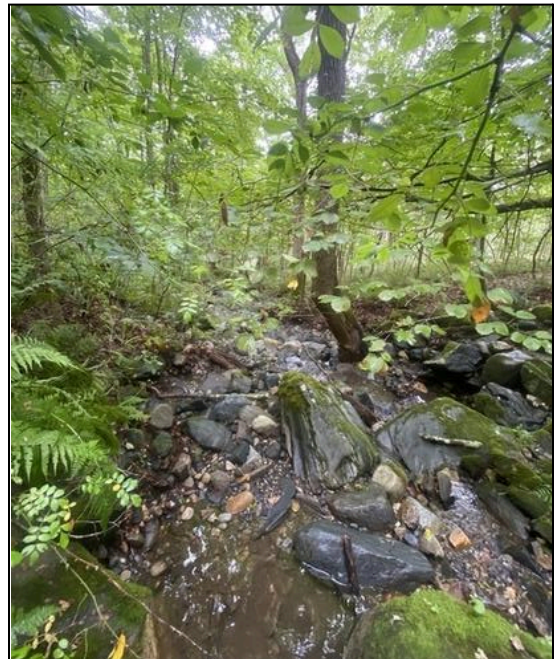
Date Observed: **07/29/2024**

Crossing Code: **xy4164796873244934**

Protocol: **NAACC**



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**
Number of structures/cells: **1**
Constriction: **Severe**
Alignment: **Flow-Aligned**

Inlet Shape: **Round Culvert**
Inlet Type: **Projecting**
Inlet Grade: **Inlet Drop**
Material: **Concrete**

Outlet Shape: **Round Culvert**
Outlet Grade: **Free Fall onto Cascade**
Outlet Armoring: **Extensive**
Outlet drop to water surface: **4.1 ft**
Outlet drop to stream bottom: **4.9 ft**
Tailwater Scour Pool: **Large**

Road: **Unpaved**



Inlet



Outlet

Comments:

- **Rocks piled around culvert inlet, no true headwall**
- **2.6 ft inlet drop as a result of sediment and debris buildup**
- **Severe constriction**
- **2 streams converge downstream of culvert outlet**
- **4.1 ft drop from outlet to water surface has contributed to the formation of a large 1.4 ft-deep scour pool despite extensive armoring**
- **No dry passage through the structure**

Road: Guilds Hollow Road

Stream: Unnamed Tributary of Weekeepeemee River

Results:

Barrier Evaluation: **Severe Barrier**

Crossing Condition: **OK**

NAACC Aquatic Passability Score: **0.00**

AOP: **No AOP**

Location:

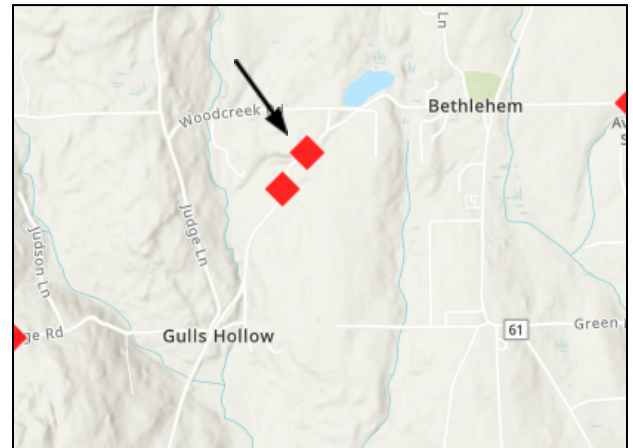
Coordinates: **41.63738, -73.21903**

Location Description: **By house #49**

Date Observed: **07/09/2024**

Crossing Code: **xy4163732073219056**

Protocol: **NAACC**



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**
Number of structures/cells: **1**
Constriction: **Severe**
Alignment: **Skewed (>45°)**

Inlet Shape: **Round Culvert**
Inlet Type: **Projecting**
Inlet Grade: **At Stream Grade**
Material: **Metal**

Outlet Shape: **Round Culvert**
Outlet Grade: **Free Fall onto Cascade**
Outlet Armoring: **Extensive**
Outlet drop to water surface: **2.8 ft**
Outlet drop to stream bottom: **3.7 ft**
Tailwater Scour Pool: **Small**

Road: **Paved**



Inlet



Outlet

Comments:

- Severe constriction
- Outlet grade (free fall onto cascade) has contributed to the formation of a small scour pool at outlet
- No dry passage through structure
- Rubber-lined metal culvert is rusted and eroded
- Outlet is very overgrown
- Skewed alignment

Road: Town Line Road

Stream: Unnamed Tributary of East Spring Brook

Results:

Barrier Evaluation: **Severe Barrier**

Crossing Condition: **OK**

NAACC Aquatic Passability Score: **0.01**

AOP: **No AOP**

Location:

Coordinates: **41.66816, -73.19583**

Location Description: **By golfing area
along the road**

Date Observed: **07/02/2025**

Crossing Code: **xy4166810973196011**

Protocol: **NAACC**



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**

Number of structures/cells: **1**

Constriction: **Moderate**

Alignment: **Skewed (>45°)**

Inlet Shape: **Round Culvert**

Inlet Type: **Projecting**

Inlet Grade: **At Stream Grade**

Material: **Concrete**

Outlet Shape: **Round Culvert**

Outlet Grade: **Free Fall onto Cascade**

Outlet Armoring: **Not Extensive**

Outlet drop to water surface: **2.5 ft**

Outlet drop to stream bottom: **2.8 ft**

Tailwater Scour Pool: **Large**

Road: **Paved**



Inlet



Comments:

- Moderate constriction
- 2.5 ft drop from outlet to water surface
- Large, 1.5ft-deep scour pool at outlet caused by outlet grade (free fall onto cascade)
- No dry passage through structure
- Extensive overgrowth and rip rap at outlet
- Headwall present at inlet but culvert projects
- Culvert segments separating at inlet
- Erosion of culvert inlet, rebar exposed



Outlet

Road: Magnolia Hill Road

Stream: Unnamed Tributary of Nonnewaug River

Results:

Barrier Evaluation: **Severe Barrier**

Crossing Condition: **OK**

NAACC Aquatic Passability Score: **0.03**

AOP: **No AOP**

Location:

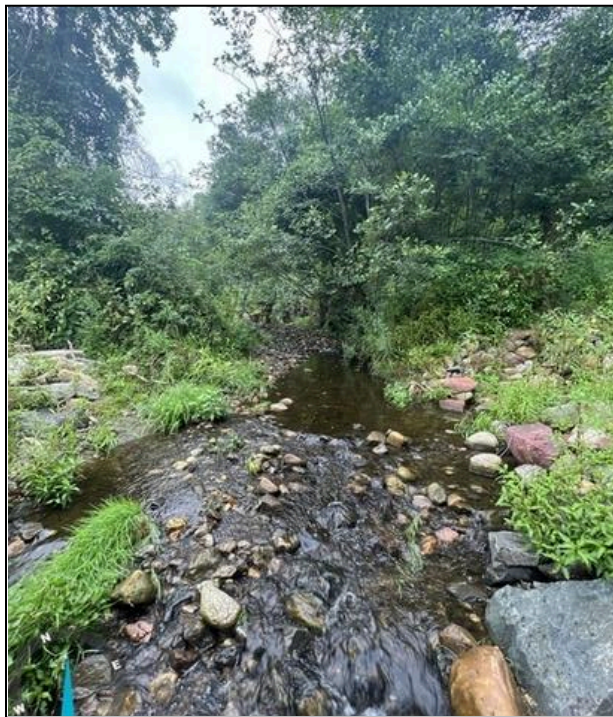
Coordinates: **41.63538, -73.17045**

Location Description: **Near South Farms**

Date Observed: **7/23/2024**

Crossing Code: **xy4163542073170598**

Protocol: **NAACC**



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Culvert**

Number of structures/cells: **1**

Constriction: **Moderate**

Alignment: **Flow-Aligned**

Inlet Shape: **Round Culvert**

Inlet Type: **Headwall**

Inlet Grade: **At Stream Grade**

Material: **Concrete**

Outlet Shape: **Round Culvert**

Outlet Grade: **Free Fall onto Cascade**

Outlet Armoring: **Extensive**

Outlet drop to water surface: **2.0 ft**

Outlet drop to stream bottom: **3.4 ft**

Tailwater Scour Pool: **Large**

Road: **Paved**



Inlet



Outlet

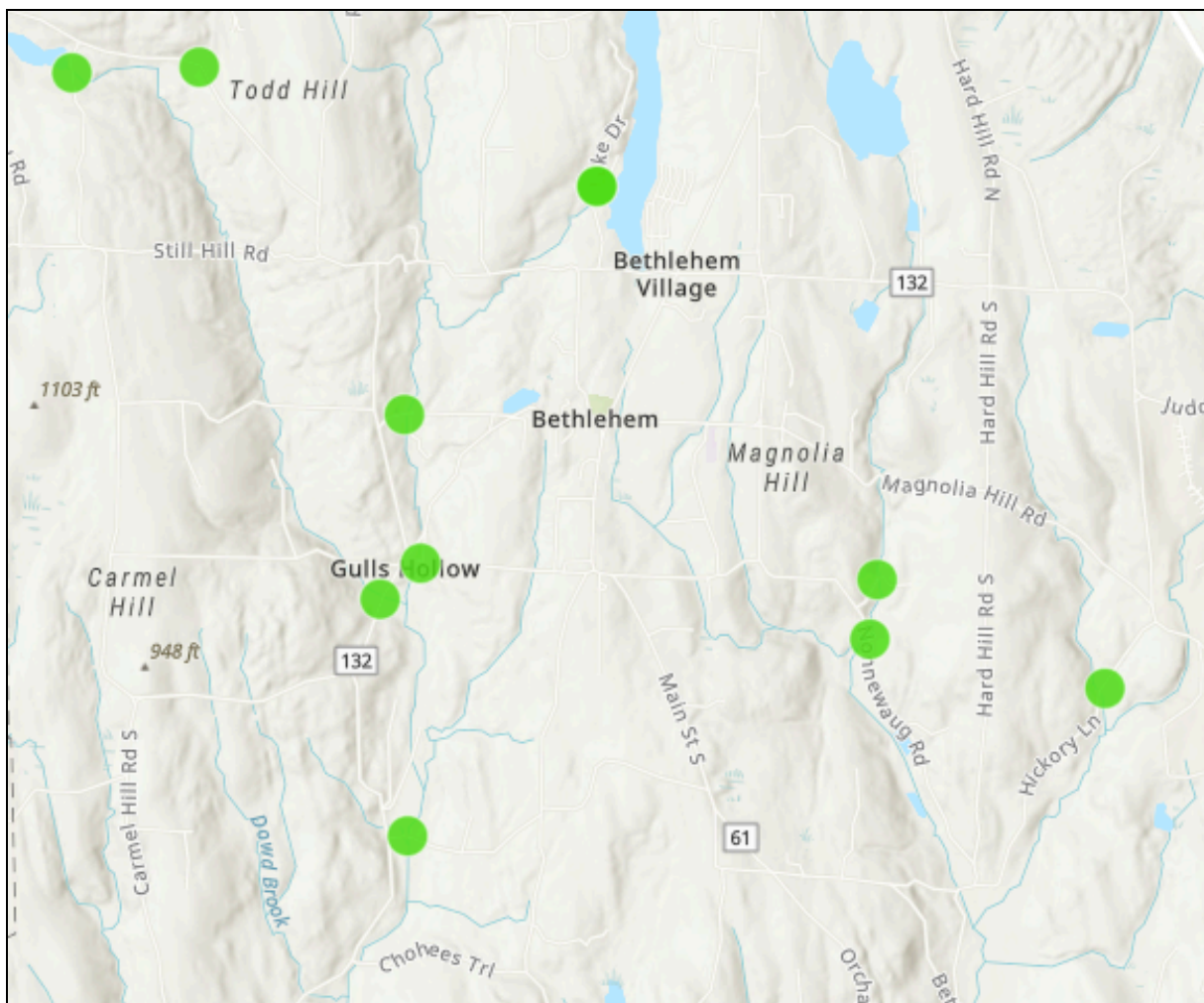
Comments:

- Moderate constriction
- 2.0 ft drop from outlet to water surface
- Large, 2.5 ft-deep scour pool at outlet caused by outlet grade (free fall onto cascade)
- No dry passage through structure
- Heavy rip rap at both the inlet and outlet and extensive armoring at outlet

Adequate Crossings

Examples of Well-Designed/Sized Infrastructure

Of 83 crossings in Bethlehem, 12 are ranked as “Insignificant Barrier” for Aquatic Organism Passage (see map below). Of these 12 crossings, 5 have full Aquatic Organism Passage, while the other 7 have reduced Aquatic Organism Passage. Three crossings highlighted below represent what well designed road-stream crossings are like. As road improvements are made, stream crossing improvements are often included in the construction projects, which means older culverts and bridges are replaced with new structures sized according to new design standards that consider more recent storm return volume data.



Road: Wood Creek Road
Stream: Weekeepeemee River

Results:

Barrier Evaluation: Insignificant Barrier

Crossing Condition: New

NAACC Aquatic Passability Score: .97

AOP: Reduced AOP

Location:

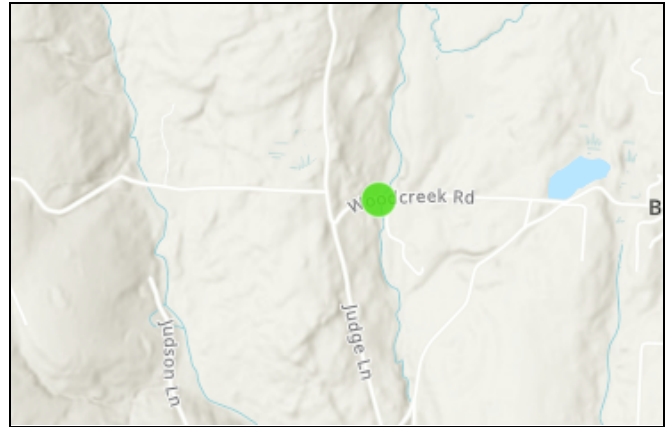
Coordinates: 41.63884, -73.22501

Location Description: 100 ft west of
house #89

Date Observed: 08/11/2021

Crossing Code: xy4163877373225035

Protocol: NAACC



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Bridge**

Number of structures/cells: **1**

Constriction: **Spans Full Channel and Banks**

Alignment: **Flow-Aligned**

Inlet Shape: **Box/Bridge with Abutments**

Inlet Type: **Headwall and Wingwalls**

Inlet Grade: **At Stream Grade**

Material: **Combination**

Outlet Shape: **Box/Bridge with Abutments**

Outlet Grade: **At Stream Grade**

Outlet Armoring: **None**

Outlet drop to water surface: **0 ft**

Outlet drop to stream bottom: **0 ft**

Tailwater Scour Pool: **None**

Road: **Paved**



Inlet



Outlet

Positive Characteristics:

- Culvert spans the full width of the active channel (bankfull) and therefore does not constrict the streamflow
- The inlet and outlet are both at stream grade, allowing fish and other aquatic organisms to pass through safely
- The outlet being at stream grade eliminates the potential for scour and the need for additional armoring
- The 100% cobble substrate at base of the culvert matches that of the stream and aids organism passage through the structure
- No physical barriers restrict streamflow/aquatic organism passage
- The stream's water depth and velocity are maintained throughout

Road: Nonnewaug Road
Stream: East Spring Brook

Results:

Barrier Evaluation: **Insignificant Barrier**

Crossing Condition: **New**

NAACC Aquatic Passability Score: **0.96**

AOP: **Full AOP**

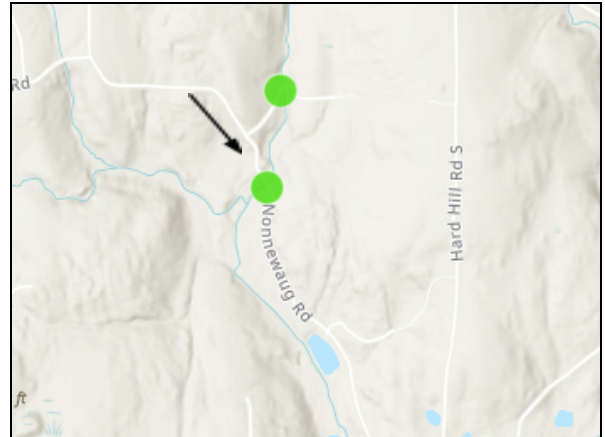
Location:

Coordinates: **41.62738. -73.18525**

Location Description: **Between houses #255
and #252; Near red barn**

Crossing Code: **xy4162732873185154**

Protocol: **NAACC**



Upstream



Downstream

Crossing Characteristics:

Crossing Type: Bridge

Number of structures/cells: 1

Constriction: Spans Full Bankfull/Active Channel

Alignment: Flow-Aligned

Inlet Shape: Open Bottom Arch Bridge/Culvert

Inlet Type: Headwall

Inlet Grade: At Stream Grade

Material: Concrete

Outlet Shape: Open Bottom Arch
Bridge/Culvert

Outlet Grade: At Stream Grade

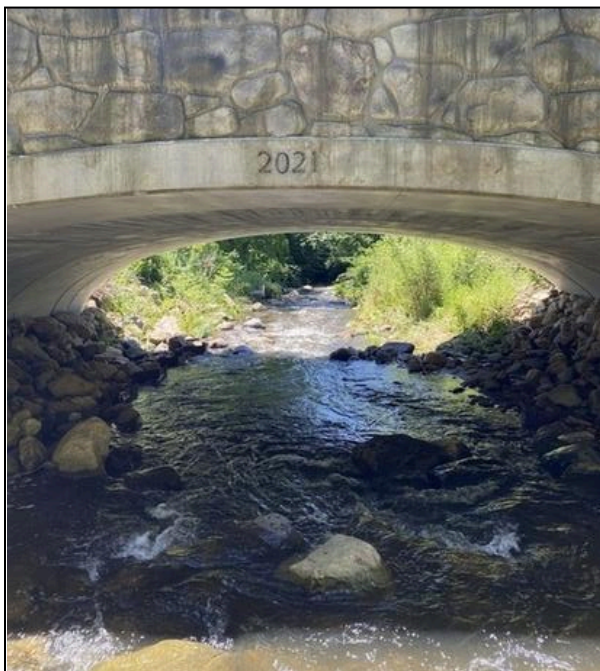
Outlet Armoring: Extensive

Outlet drop to water surface: 0 ft

Outlet drop to stream bottom: 0 ft

Tailwater Scour Pool: None

Road: Paved



Inlet



Outlet

Positive Characteristics:

- The bridge spans the bankfull/active channel width of the stream and therefore does not constrict streamflow
- The inlet and outlet are both at stream grade, allowing aquatic organisms to pass through and reducing scour and need for additional armoring.
- The culvert being flow-aligned instead of skewed ($>45^\circ$) reduces bank and structure erosion and maintains proper streamflow direction and velocity.
- The 100% cobble substrate under the bridge matches that of the stream.
- Dry passage with 6ft above allows large terrestrial animal passage.
- The stream's water depth and velocity are maintained throughout.

Road: Hickory Lane

Stream: Unnamed Tributary of Nonnewaug River

Results:

Barrier Evaluation: **Insignificant Barrier**

Crossing Condition: **OK**

NAACC Aquatic Passability Score: **0.9**

AOP: **Full AOP**

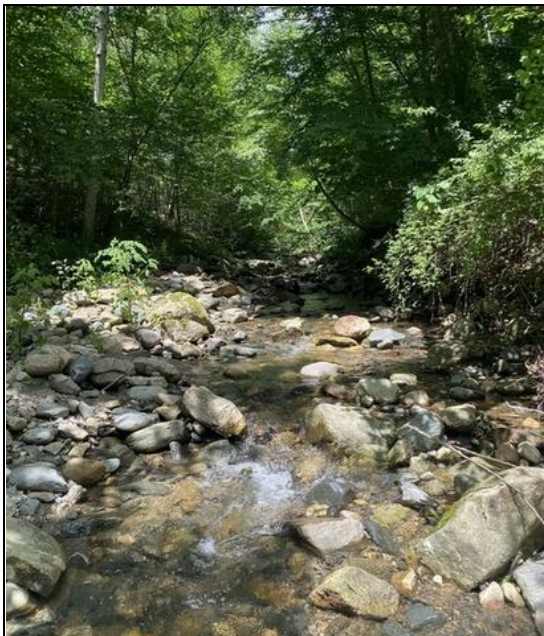
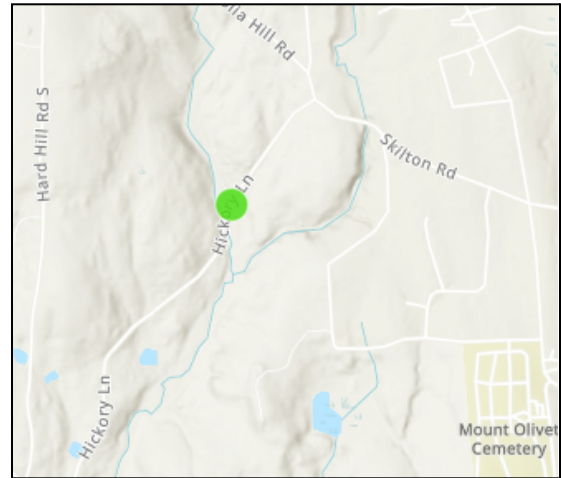
Location:

Coordinates: **41.62529, -73.16589**

Location Description: **Near “Osuch Property” at trailhead kiosk**

Crossing Code: **xy4162563173165398**

Protocol: **NAACC**



Upstream



Downstream

Crossing Characteristics:

Crossing Type: **Bridge**

Number of structures/cells: **1**

Constriction: **Spans Full Channel and Banks**

Alignment: **Flow-Aligned**

Inlet Shape: **Box/Bridge with Abutments**

Inlet Type: **Wingwalls**

Inlet Grade: **At Stream Grade**

Material: **Concrete**

Outlet Shape: **Box/Bridge with Abutments**

Outlet Grade: **At Stream Grade**

Outlet Armoring: **None**

Outlet drop to water surface: **0 ft**

Outlet drop to stream bottom: **0 ft**

Tailwater Scour Pool: **Small**

Road: **Paved**



Inlet



Outlet

Positive Characteristics:

- **Fish observed moving through the structure at time of assessment**
- **The bridge spans the full channel and banks of the stream and therefore does not constrict streamflow and accounts for higher flows.**
- **The inlet and outlet are both at stream grade, allowing fish and other aquatic organisms to pass through safely.**
- **The outlet being at stream grade results in only minor scouring and eliminates the need for additional armoring.**
- **The culvert being flow-aligned instead of skewed ($>45^\circ$) reduces bank and structure erosion and maintains proper streamflow direction and velocity.**
- **The 100% cobble substrate under the bridge matches that of the stream and aids organism passage through the structure.**
- **No physical barriers restrict streamflow/aquatic organism passage.**
- **The stream's water depth and velocity are maintained through the structure.**

Developing a Road-Stream Crossing Management Plan

Proactively replacing culverts within Bethlehem that have been identified as problematic across a number of variables (constriction, alignment, condition, scour, barrier, and passability) is a single solution to reduce future infrastructure losses and increase the climate resiliency of both natural and developed spaces.

The **Town of Bethlehem** Land Use and Public Works Departments **should download the GIS shapefile of the Road-Stream Crossing Assessment Dataset for Bethlehem from the [NAACC Data Center](#)** and integrate it into their own mapping tools used in their infrastructure maintenance and longer range resiliency planning efforts. Initially, it is recommended that the Town of Bethlehem **review the crossing barrier evaluations against the list of roads already included in its five-year road budget capital plan** as it would be fiscally prudent to include culvert upgrades with other paving or construction projects already planned along a particular route.

Multiple criteria should be used to prioritize crossings for upgrade including ecological benefit (AOP score and number of stream miles reconnected), flood risk (inlet size compared to bankfull width, constriction, and alignment), infrastructure condition (age, erosion, and deformation), etc. The **National Aquatic Barrier Inventory & Prioritization Tool** available online at <https://aquaticbarriers.org> is an excellent interactive resource to help determine which road-stream crossings are high priority using multiple criteria which can be selected by the user.

As infrastructure is repaired or replaced, crossing attribute data should be freshly captured and entered to the online NAACC Data Center to keep the most up-to-date crossing inventory possible. As a certified Level 1 Coordinator, PRWC can provide access to municipal staff to become certified Lead Observers to assess road-stream crossings following the NAACC protocols (see Appendix).

APPENDIX:

Essential Supporting Documents from the North Atlantic Aquatic Connectivity Collaborative (NAACC)

NAACC Instruction Manual for Assessing Aquatic Connectivity on Non-tidal Streams

NAACC Non-tidal Aquatic Connectivity Data Form

For the most up-to-date versions of the protocol and field data sheet along with complimentary protocols for assessing terrestrial connectivity and culvert condition, visit: [Documents : North Atlantic Aquatic Connectivity Collaborative : UMass Amherst](#)