

TECHNICAL MEMO

Weekeepeemee River Streamwalk Assessment Survey Woodbury and Bethlehem, CT

Field Assessments Completed July and August 2021
by Pomperaug River Watershed Coalition

Project Led and Memo Prepared by
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INTRODUCTION

Pomperaug River Watershed Coalition (PRWC) deployed a project team in Summer 2021 to conduct visual field investigations of the Weekeepeemee River watershed to further assess potential sources of bacteria that contribute to the recreational use water quality impairment of this river. This impairment was designated in 2012 based ambient water quality monitoring data collected by the Connecticut Department of Energy and Environmental Protection (CTDEEP) at Hotchkissville Bridge in Woodbury, CT in 2010 (CTDEEP, 2012). PRWC developed a Watershed Based Plan (WBP) in 2018 to identify strategies to improve water quality (i.e. decrease bacteria counts) in this and other impaired river segments in the Pomperaug Watershed (**Figure 1**). Development of the WBP included reviewing stream monitoring data and watershed attributes, running a pollutant load model, and conducting visual assessments (or “streamwalk surveys”) of impaired rivers. Due to funding constraints for that project, full assessments of each impaired stream reach within the Pomperaug Watershed could not be conducted at the time the WBP was developed. The Weekeepeemee River was one such area that was not fully assessed. Visual field investigations (or streamwalk surveys) are an important screening-level tool for locating potential pollutant sources in a watershed and identifying possible locations where restoration opportunities and mitigation measures could be implemented to yield water quality improvements.

Conducting a streamwalk survey of the impaired segment of the Weekeepeemee River was a key recommendation made in the Watershed Based Plan (WBP). Implementing an ambient water quality monitoring program was also a high priority, near term recommendation in the WBP. Additional monitoring data would help evaluate the extent of the existing impairments, particularly for the Weekeepeemee wherein a 9.61 mile stretch of the river (the full length of the main stem) is listed as impaired for recreational uses. Pairing the findings from these two assessment methods would help track down and bracket potential pollution sources and also determine if high bacteria counts are present across the full length of the river and/or if the counts vary in different weather conditions.

This memorandum describes the field assessment methods and findings for the visual field investigation completed by PRWC over the full-length of the Weekeepeemee River in Summer 2021. This assessment was part of the Watershed Based Plan Implementation Groundwork Project funded in part by the Connecticut Department of Energy and Environmental Protection through a United States Environmental Protection Agency Clean Water Act Section 319 Nonpoint Source Grant.

METHODS

The impaired length of the Weekeepeemee River was the focus area for visual field investigations during Summer 2021. Full methods for the visual assessments are detailed and documented in the Quality Assurance Project Plan (QAPP) (approved May 27, 2021; modified March 2022) that supports this Section 319 Nonpoint Source Grant-funded project (**Appendix A**).

In 2018, portions of the Weekeepeemee River subregional watershed were evaluated by Fuss & O’Neill, an environmental consulting team hired by Pomperaug River Watershed Coalition (PRWC) to help develop an updated Pomperaug Watershed Based Plan (WBP). When the WBP was prepared, areas of concern (i.e., potential pollutant sources contributing to water

quality impairments in the watershed) were initially identified based on a review of existing data and information including the 2001 State of the Watershed Report, the 2006 Pomperaug Watershed Management Plan, the 2010 Pomperaug River Watershed Streamwalk Summary Report, updated watershed mapping, and recommendations from PRWC's Land Use Committee. These areas of concern are generally located within the Pomperaug River and Weekepeemee River subregional basins, which are the two primary subwatershed areas associated with the bacterial impairments in the watershed (**Figure 2**). Potential areas of concern located along impaired stream reaches (**Figure 2**) were subject to streamwalk assessment surveys and/or "windshield surveys" (i.e. "hot spot investigations" and "neighborhood assessments" conducted from behind the windshield of a motor vehicle) following methods established by the Center for Watershed Protection (CWP). Specifically, the assessments were conducted following the CWP's "Unified Stream Assessment" and "Unified Subwatershed and Site Reconnaissance" methods (Kitchell & Schueler, 2005; Wright et al., 2005). Based on the assessments, potential best management practices were identified and conceptual plans for BMPs were drafted and prioritized for future implementation – all of which are detailed in the Pomperaug Watershed Based Plan.

To more thoroughly evaluate potential sources of bacteria contributing to the Weekepeemee River impairment, the 2021 assessment, under the current project, included visually inspecting the stream corridor and parcels immediately adjacent to the watercourse from the vantage point of the stream channel following the same CWP methods cited above. While the primary pollutant of concern was bacteria, observations were also recorded in regards to physical attributes associated with overall stream health and included bank erosion, the presence of trash and debris, stormwater outfalls, vegetated buffer conditions, and channel modification.

The 9.61 mile length of the Weekepeemee River was divided into nine reaches, which were defined by road crossings that provided access to the river within a public right-of-way (**Figure 3 / Table 1**). Each reach was approximately a mile in length, though the length varied. Planimetric and aerial image maps were generated for each reach using data layers available through the interactive Regional Map Viewer tool available through the Naugatuck Valley Council of Governments website (<https://nvcogct.gov/maps-data/>). The individual reach maps featured data layers including parcels, hydrography, roads, and impervious cover as well as high resolution aerial images from 2016 and 2019 (**Appendix B**).

A field team of 4 to 5 people conducted field assessments on July 23, July 27, July 30, August 3 - 5, August 8, and August 10 - 11, 2021, which included reach level stream corridor assessments along the main stem of the Weekepeemee River and upland source assessments in selected neighborhoods.

Prior to conducting the assessments, PRWC mailed a postcard to all of the property owners directly adjacent to the river to notify them of the survey and why it was being conducted (**Figure 4**). Only a few landowners reached out with questions and or to ask PRWC to not enter their property. Respecting such requests, PRWC was unable to assess a portion of Reach 4 from the river channel. The most current aerial images (2019) were referenced to evaluate this area. The upper section of Reach 8 was inaccessible due to a natural obstacle -- beaver dam and swamp -- that made it impossible to wade in the river channel. Reach 9 was not accessible due to private property restrictions and security barriers at the beginning of this reach. Aerial images were also referenced to evaluate these reaches. Assessment of upland areas included inventories of selected representative residential neighborhoods, streets and storm drainage systems, and land uses with higher potential pollutant loads (i.e., "hotspot" land uses).

Starting at Reach 1 and working their way upstream, the field team recorded data including latitude and longitude and site observations notes on field sheets specific to the type of observation being documented (ex. impacted buffer, bank erosion, stormwater outfall, etc); additional notes were recorded in a field notebook (**Appendix C**). Data were then compiled into a spreadsheet that could be used to generate maps to locate issues of concern, to tally the types observations made, and to present the observations along with recommendations for best management practices that could be implemented to help correct issues of concern (**Table 2**). These data are included the Results section of this Technical Memo.

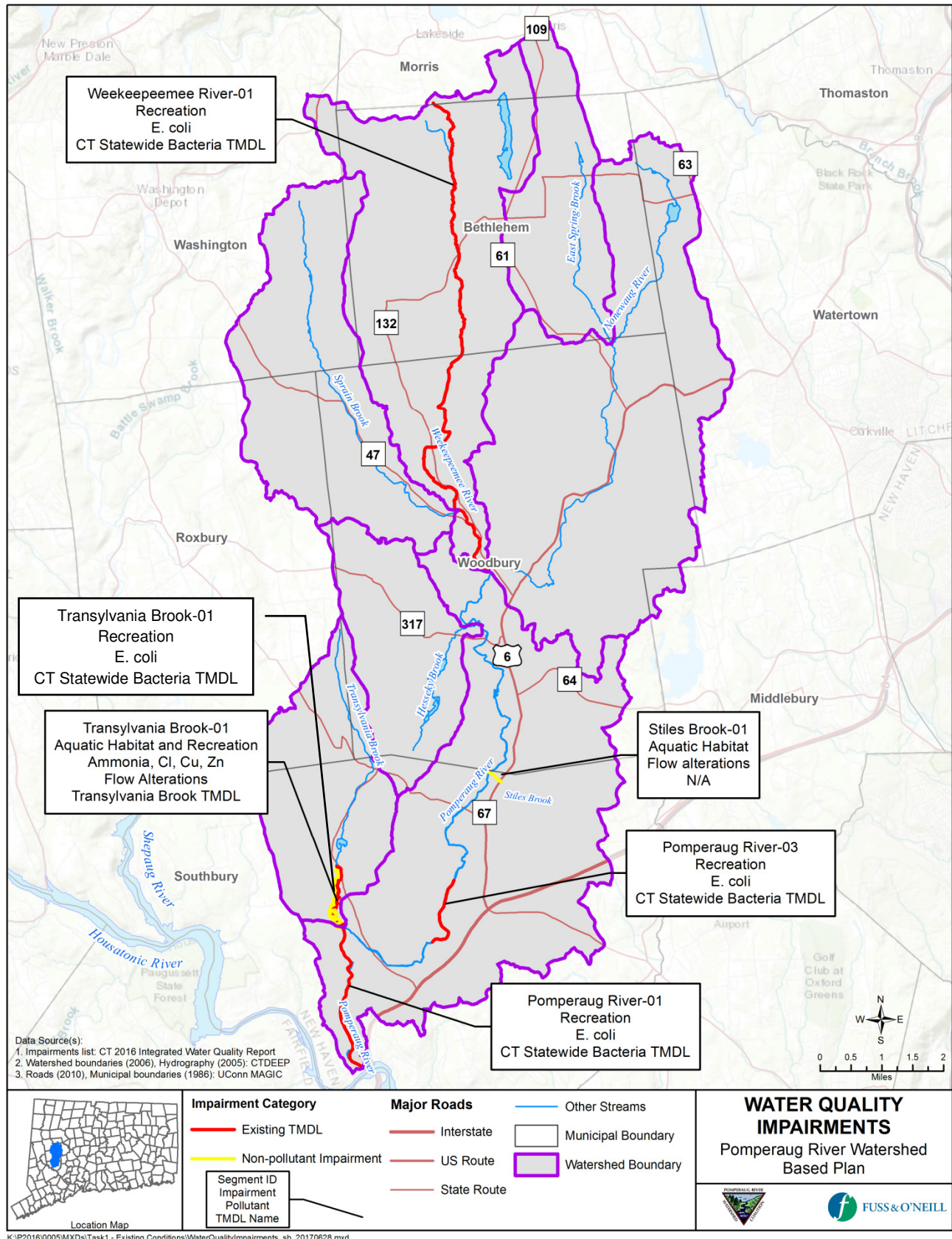


Figure 1. Water Quality Impairments of the Pomperaug River Watershed.

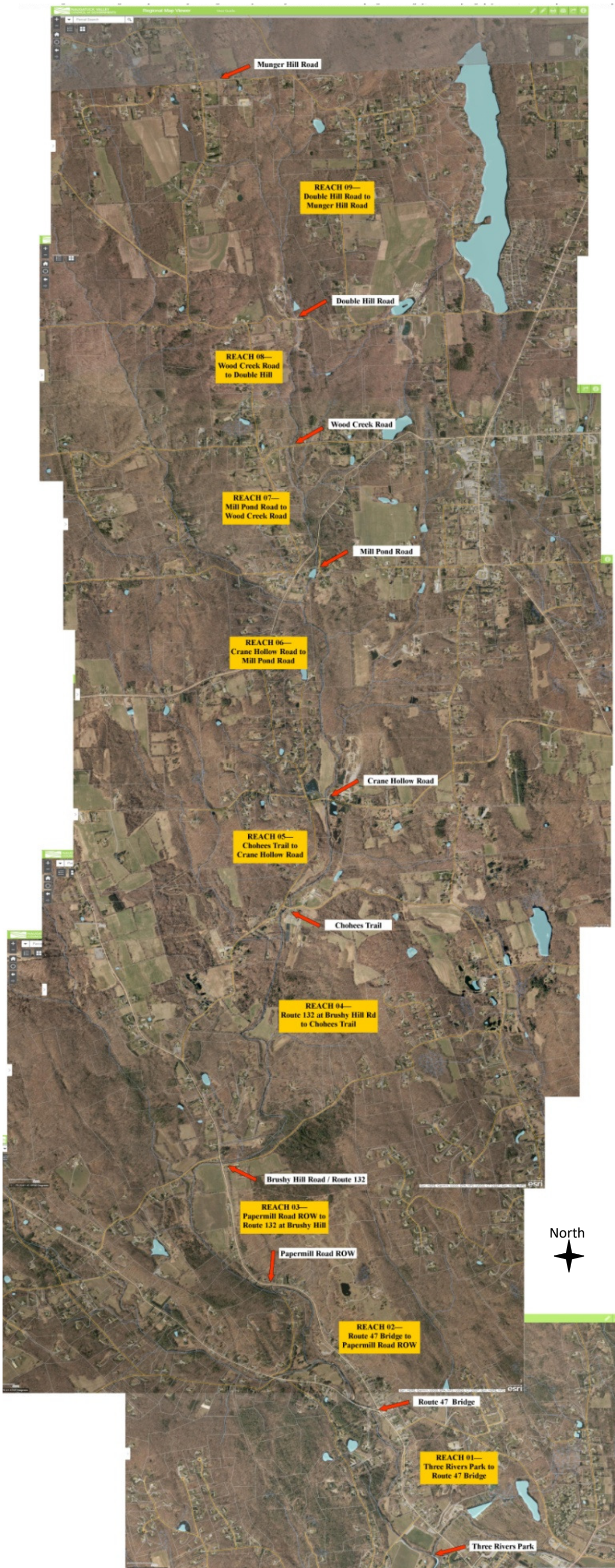


Figure 3. Streamwalk assessment survey reaches of the Weekepeemee River from Bethlehem to Woodbury, CT. The 9.61 mile long river was broken into 9 reaches using road crossings (denoted by red arrows) to define the start and end of each reach segment.

Table 1. Description of starting and ending points for Weekepeemee River Streamwalk Assessment Survey.

Reach #	Start	End
1	Three Rivers Park Woodbury	Route 47 Bridge Woodbury
2	Route 47 Bridge Woodbury	Papermill Road Right of Way Woodbury
3	Papermill Road Right of Way Woodbury	Route 132 Bridge at Brushy Hill Road Woodbury
4	Route 132 Bridge at Brushy Hill Road Woodbury	Chohees Trail Woodbury
5	Chohees Trail Woodbury	Crane Hollow Road Bethlehem
6	Crane Hollow Road Bethlehem	Mill Pond Road Bethlehem
7	Mill Pond Road Bethlehem	Wood Creek Road Bethlehem
8	Wood Creek Road Bethlehem	Double Hill Road Bethlehem
9	Double Hill Road Bethlehem	Munger Hill Road / Bergemann Hill Road Bethlehem

(Front)

(Back)



Figure 4. Postcard notification distributed to riparian property owners along the Weekeeppeemee River to advise them of the Streamwalk Assessment Survey being conducted by Pomperaug River Watershed Coalition.

RESULTS

During July and August 2021, the Pomperaug River Watershed Coalition project team visually assessed the land areas immediately adjacent to the Weekeeppeemee River to further evaluate potential sources of water quality impairments in the Weekeeppeemee River watershed. While the primary pollutant of concern was bacteria, observations were also recorded in relation to physical attributes that relate to overall stream health and included bank erosion, the presence of trash and debris, stormwater outfalls, vegetated buffer conditions, and channel modification (**Figure 5**). The most common observation made was that of impaired buffer areas followed by road crossings, trash and debris accumulations, stormwater outfalls, channelized sections, and sites with livestock present. PRWC also observed areas of bank erosion, water diversions for irrigation, small temporary stone dams, a beaver dam, ford-style stream crossings, and abundant evidence of wildlife. In total, PRWC completed datasheets for 63 unique observations made from the vantage point of the river channel between Three Rivers Park in Woodbury and Double Hill Road in Bethlehem (**Appendix B**). The following list summarizes the frequency for each broad category of the observations recorded:

- 19 Impaired Buffer Areas
- 8 Road Crossings
- 6 Trash and Debris Accumulations
- 5 Stormwater Outfalls
- 5 Channelized Sections
- 5 Sites with Livestock Present (at least two more visible from aerial images)
- 4 Bank Erosion Areas
- 3 Small, Temporary Stone Dams (appear to be hand-constructed)
- 3 Water Diversions (Irrigation)
- 3 Miscellaneous Observations
- 1 Beaver Dam
- 1 Ford-style stream crossing (at least two more visible from aerial images)
- Lots of evidence of wildlife – deer, raccoons, beaver, coyote, squirrels, mice, birds, fish

In several instances, more than one river observation type was observed at a given site. For example, locations with an impacted buffer may have also had livestock present or many have also been channelized or exhibited bank erosion.

Major findings of the field assessments are further summarized below while individual site observations are detailed in **Table 2**. These findings will be used to guide best management practice recommendations that will supplement and refine those already included in the Pomperaug Watershed Based Plan (2018).

- **Lack of Stream Buffer** – Stream buffer encroachments were prevalent along the Weekepeemee River and are most often associated with residential and agricultural properties. Residential lawns and some agricultural practices extend down to the banks of the stream in many areas (**Figure 5**). The degree of stream buffer encroachment can have a significant impact on the overall stream and habitat conditions. In general, larger natural buffers are associated with better stream health, including channel substrate, flow regime, water quality, and shading as well as better upland and wetland habitat that provide larger areas available to native flora and fauna.
- **Trash and debris accumulation** – Evidence of littering and illegal dumping was observed in at least three locations along state and town roads. While this does not contribute to the bacteria impairment that makes for unsafe recreation, it does present other hazards like broken glass and rusty metal that make recreation undesirable (**Figure 6**). Trash and debris found at other sites consisted of items that appeared to be deposited by high streamflows in slower moving areas. Increased “No dumping” / “No littering” signs or surveillance cameras may be needed along certain road areas to help prevent further accumulation. These areas should also be included in municipal “adopt a road” programs where volunteers conduct regular litter clean-up efforts. More frequent in-stream trash clean-up efforts may also be warranted.
- **Stormwater outfalls** – Storm drains and catch basins are quite prevalent throughout the Pomperaug Watershed and are an important safety component of transportation system infrastructure. Precipitation which falls directly on roadways of which flows off adjacent surfaces onto roadways is collected in these structures which are tied to a series of pipes that eventually discharge stormwater onto the ground (i.e. in the woods or onto a grassy area) or into a river or stream near the roadway (**Figure 7**). The pipe that discharges the stormwater is called the outfall. The discharge consists of untreated stormwater that has flowed off of the road and/or over the landscape where it may pick up pollutants including bacteria; nutrients; chemicals and other pollutants from landscaping; agriculture; automotive fluids, oils, and greases; and other human and wildlife activities. Depending on the volume and velocity of a stormwater discharge onto land and slope of the land, an outfall may cause erosion and a gully may form which could add to sediment loading if the gully extends downhill to a stream. Along the Weekepeemee River, the Town of Woodbury is responsible for testing outfalls that discharge to the impaired stretch of river under the provisions of their MS4 permit requirements. Bethlehem does not have population density large enough for their community to be subject to the MS4 permit program. Regardless, municipalities can employ best practices for educating residents about stormwater runoff, for mapping and testing outfalls, for cleaning out catch basins on a regular basis to ensure they function as designed, and for detecting and eliminating illicit discharges that may be connected to the stormwater conveyance system. The implementation of best management practices should be prioritized for areas where the bacteria counts in stormwater outfalls exceed thresholds for safe recreation.
- **Agricultural Land Use** – Hobby farms, equestrian centers, and more intensive livestock farming practices were frequently observed in the Weekepeemee watershed. While some farms maintain animal exclusion fencing to separate livestock from streams, other locations have grazing or feeding areas with apparent channelization or full access to streams and discharges to streams. Exclusion fencing, alternative approaches to manure management, such as moving manure piles further away from streams, and other agricultural BMPs can yield water quality improvements (**Figure 8**). Crop production is also common in the Weekepeemee watershed; manure based fertilizers may be used in these areas along with other soil amendments and pest controls. Additional best practices may be suitable in these areas for nutrient and pest management and prevention of soil erosion in these areas including the establishment and maintenance of riparian buffers.
- **Channelization** – Historic realignment of stream channels was not uncommon throughout the Pomperaug Watershed (**Figure 9**). Many areas were straightened and/or had berms built up along the streambank prior to the adoption of wetlands and watercourses regulations in order to develop transportation routes, commercial areas, neighborhoods, to make agricultural areas easier to cultivate, and to provide faster drainage of water from roads, fields, driveways, and parking lots to help prevent flooding. These practices often result in the river becoming cut off from its floodplain, stream velocity increasing, and river banks/beds eroding which can significantly alter in-stream habitat for aquatic life and exacerbate downstream flooding. Such channelization was observed in several areas

along the length of the Weekepeemee River, many of which coincided with observations of streambank erosion. Restoring channelized section to more natural, meandering paths face many challenges including physical infrastructure and obtaining agreements among multiple property owners. While challenging and costly to restore some of these areas, there are opportunities that could support a healthier fishery and enhance recreational opportunities (example: Site Code R01-CM-01). These efforts are a low priority through the lens of addressing bacteria related impairments.



Figure 5. Examples of residential and agricultural sites where there are opportunities for riparian buffer restoration. A healthy riparian buffer should consist of vegetation that includes trees, shrubs, and perennial ground cover to provide stream shade, soil stability, stormwater infiltration, and habitat and food for a variety of organisms including dragonflies, frogs, turtles, birds, and mammals.



Figure 6. Examples of trash and debris observed in and along the Weekeepeemee River. Smaller items were collected during the survey and properly disposed of by the field team.



Figure 7. Examples of stormwater outfalls that discharge water in catch basins located on roadways and other impervious surfaces; their associated network of drainage pipes discharge stormwater away from the roadway and onto the ground or into a nearby river /stream.





Figure 8. Examples of hobby and commercial agricultural activities in the Weekeepemee Watershed.

Goats, alpaca, cattle, and chickens are common types of livestock present. Crop production is also common in this watershed. Best management practices for these properties include increased livestock fencing setback distances, manure management and storage practices, and riparian buffer restoration and maintenance.



Figure 9. Examples of channel modification where portions of the Weekeepemee River had been straightened at some point in its history; typically in areas adjacent to agricultural fields and transportation routes.

Figures 10 – 16 illustrate the spatial distribution of the types of impairments within each Streamwalk Survey Reach of the Weekeepemee River. **Table 2** provides a summary detailing the site code, location description, observation notes, site photos, if there are potential sources of bacteria, appropriate best practices, other recommendations along with the relative priority level for implementing the best practices and estimated costs for implementation. Data recorded in **Table 2** can be matched to the data points displayed on the maps in **Figures 10 to 16** by recognizing that observations were recorded sequentially by type starting at the downstream portion of the reach and moving upstream. Cost estimates presented in Table 2 are defined as follows: Low (Less than \$10,000); Medium (\$10,000 to \$50,000); High (Greater than \$50,000).

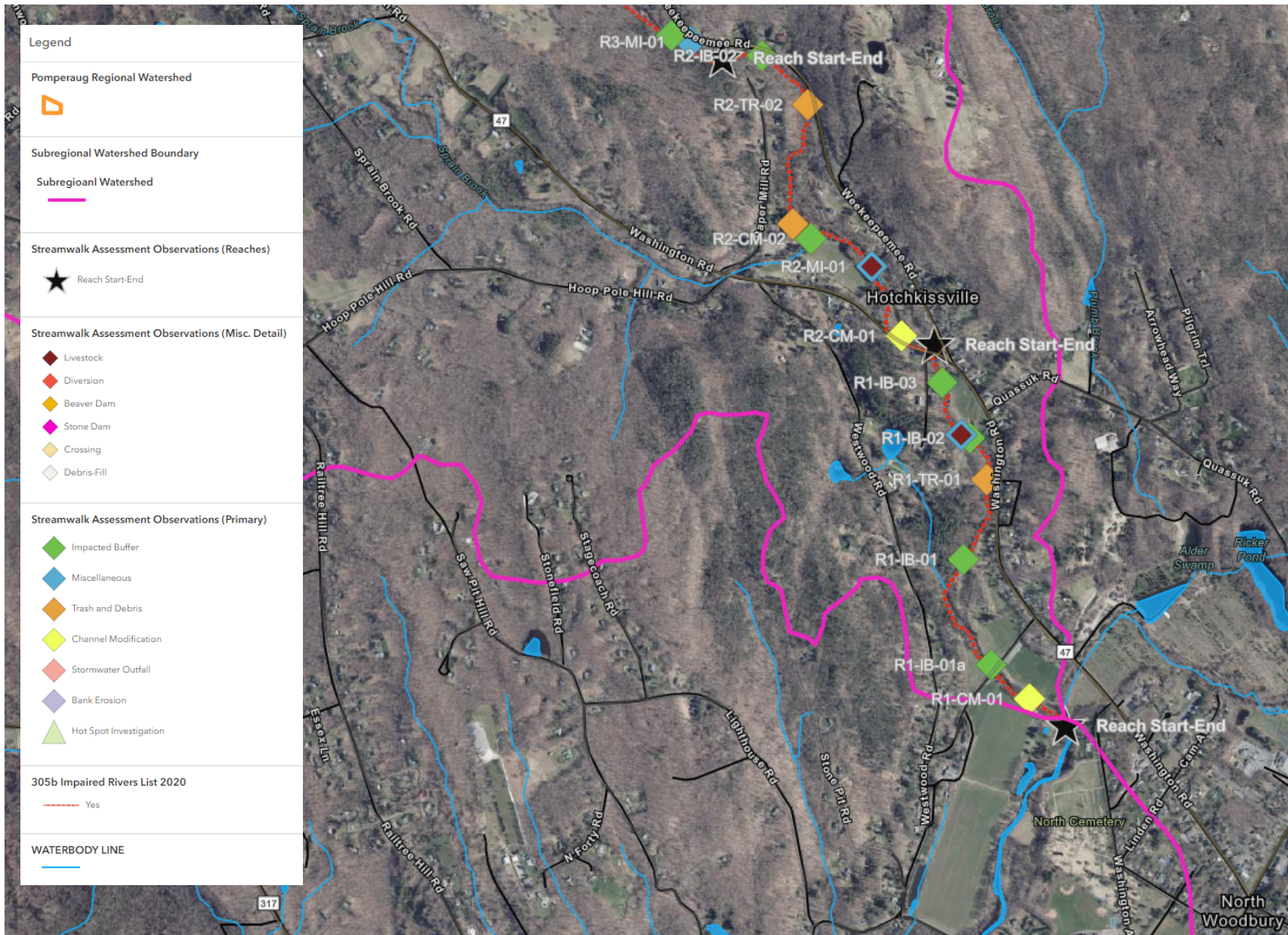


Figure 10. Weekepeemee River Streamwalk Survey Observations - Reach 1 & Reach 2. Reach 1 extends from the confluence with Nonnewaug River at Three Rivers Park to the Hotchkissville Bridge on Route 47 in Woodbury, CT. Reach 2 extends from the Hotchkissville Bridge on Route 47 to the former Papermill Road Bridge at Route 132 in Woodbury, CT.

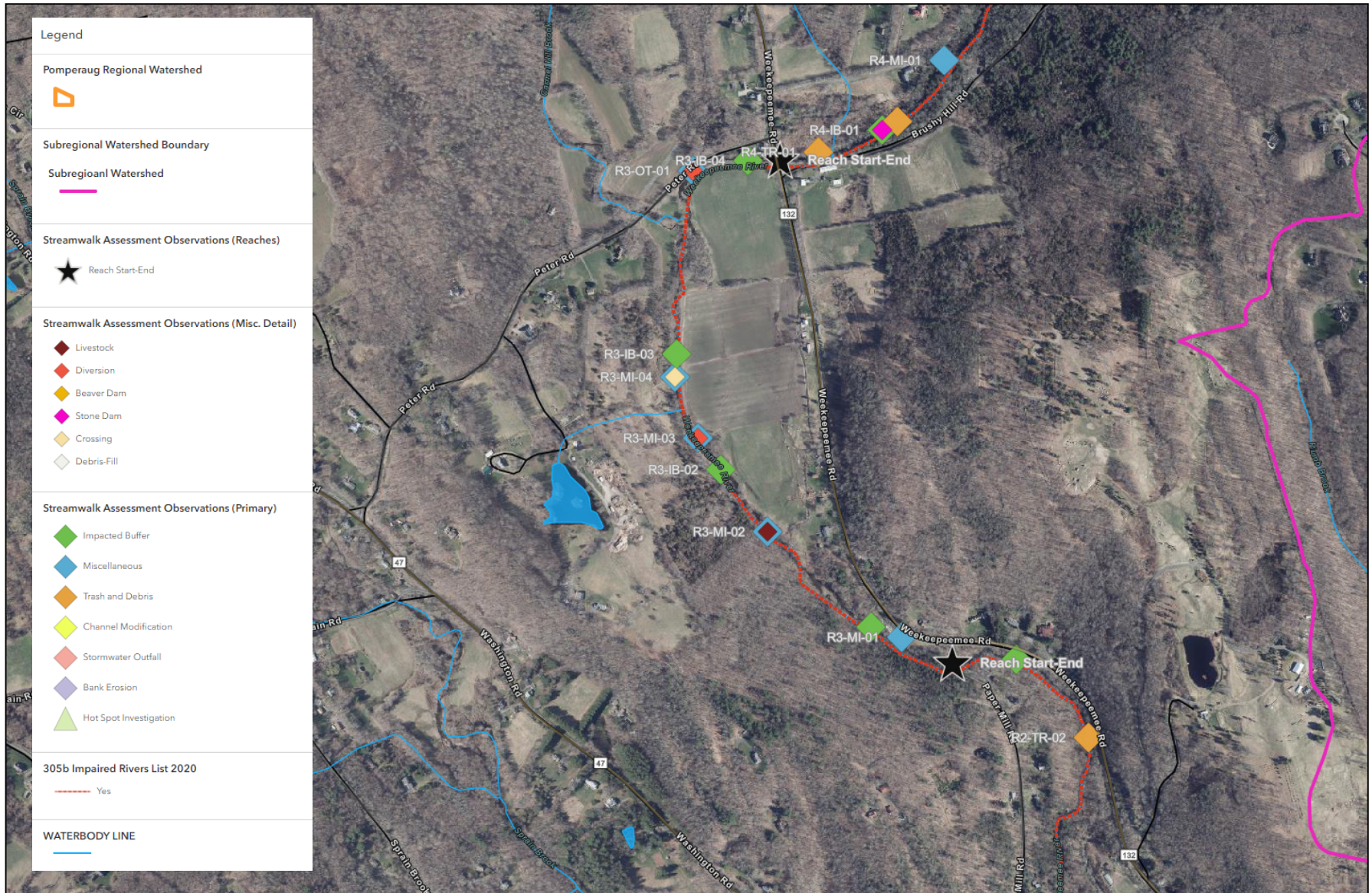


Figure 11. Weekepeemee River Streamwalk Survey Observations - Reach 3. Reach 3 extends from the former Papermill Road Bridge at Route 132 to the Route 132 Bridge located at the intersection with Peter Road and Brushy Hill Road in Woodbury, CT.

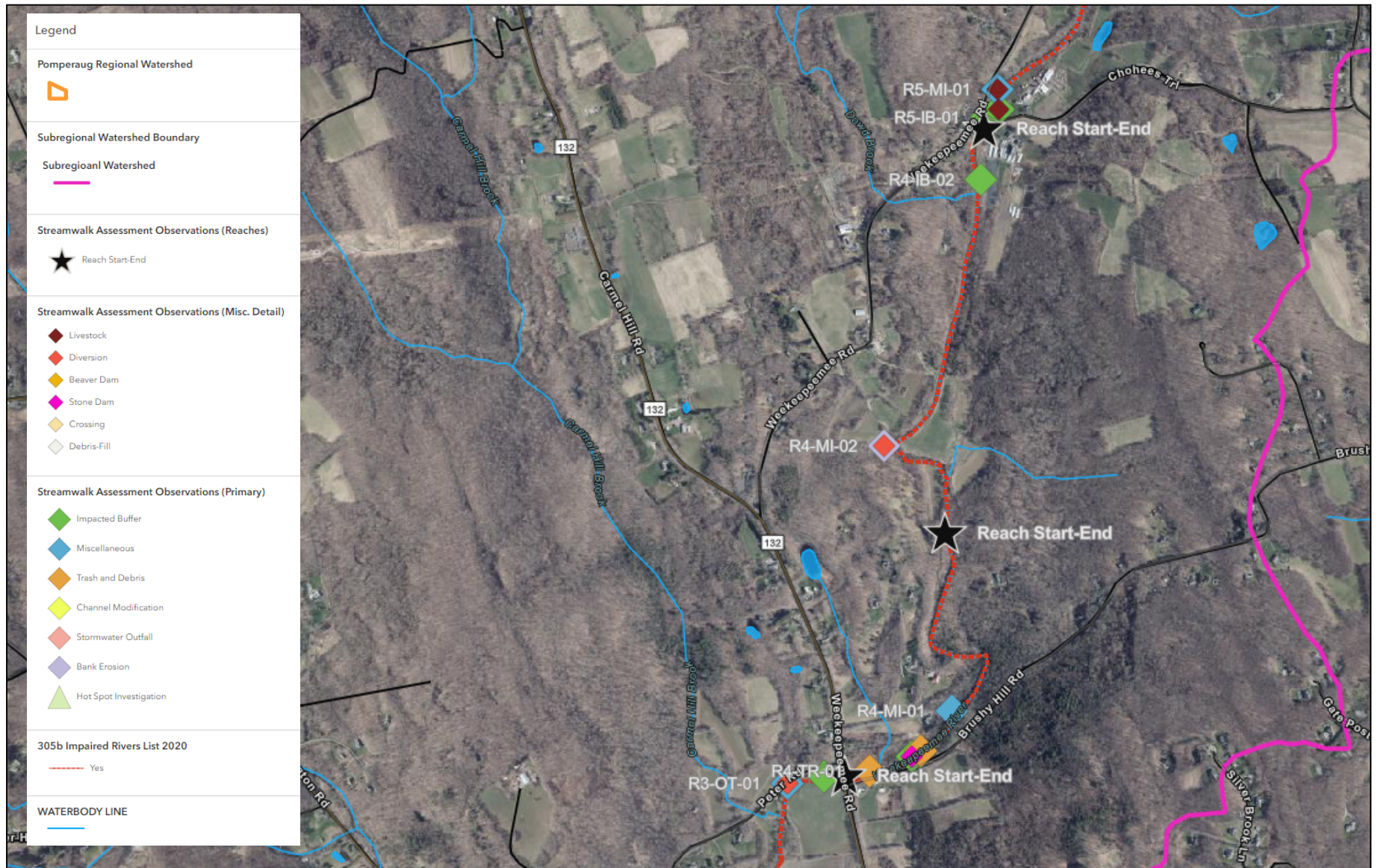


Figure 12. Weekepeemee River Streamwalk Survey Observations - Reach 4. Reach 4 extends from the Route 132 Bridge located at the intersection with Peter Road and Brushy Hill Road to the Chohees Trail Bridge in Woodbury, CT.

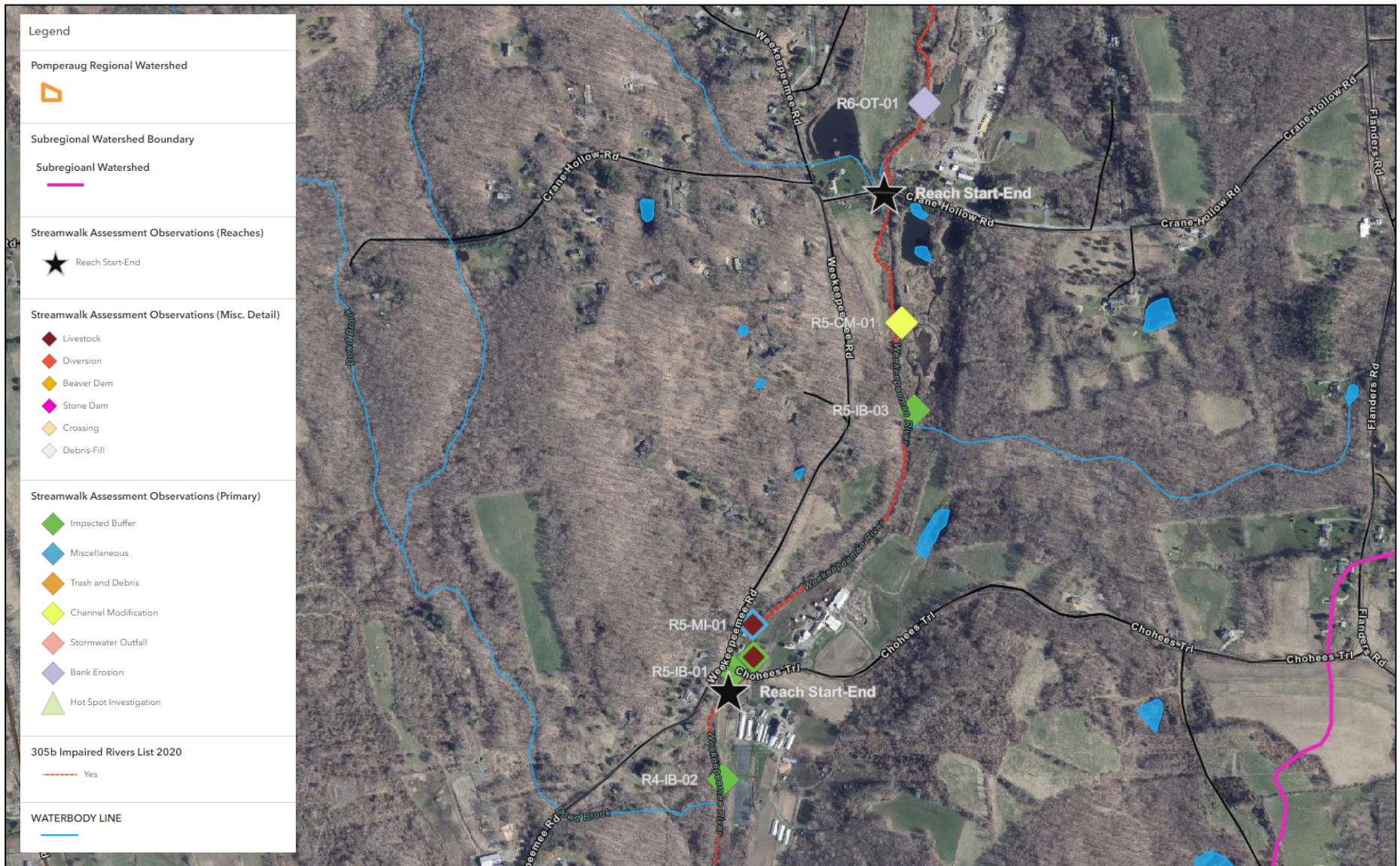


Figure 13. Weekepeemee River Streamwalk Survey Observations - Reach 5. Reach 5 extends from the Chohees Trail bridge in Woodbury, CT to the Crane Hollow Road bridge located on the town line between Woodbury and Bethlehem, CT.

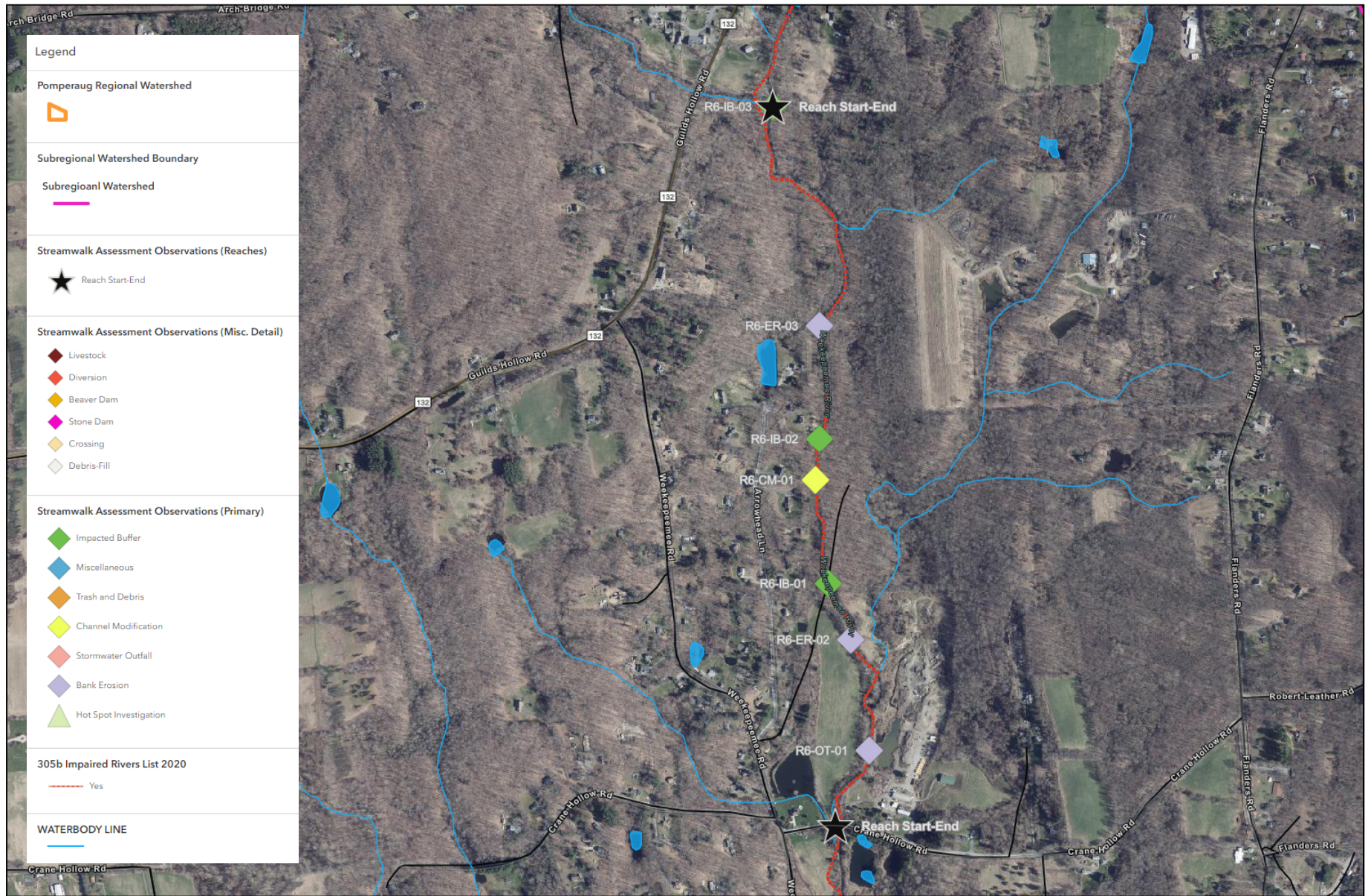


Figure 14. Weekepeemee River Streamwalk Survey Observations - Reach 6. Reach 6 extends from the Crane Hollow Road Bridge located at the town line between Woodbury and Bethlehem, CT to the confluence with Wood Creek at Two Rivers Preserve on Route 132 in Bethlehem, CT.

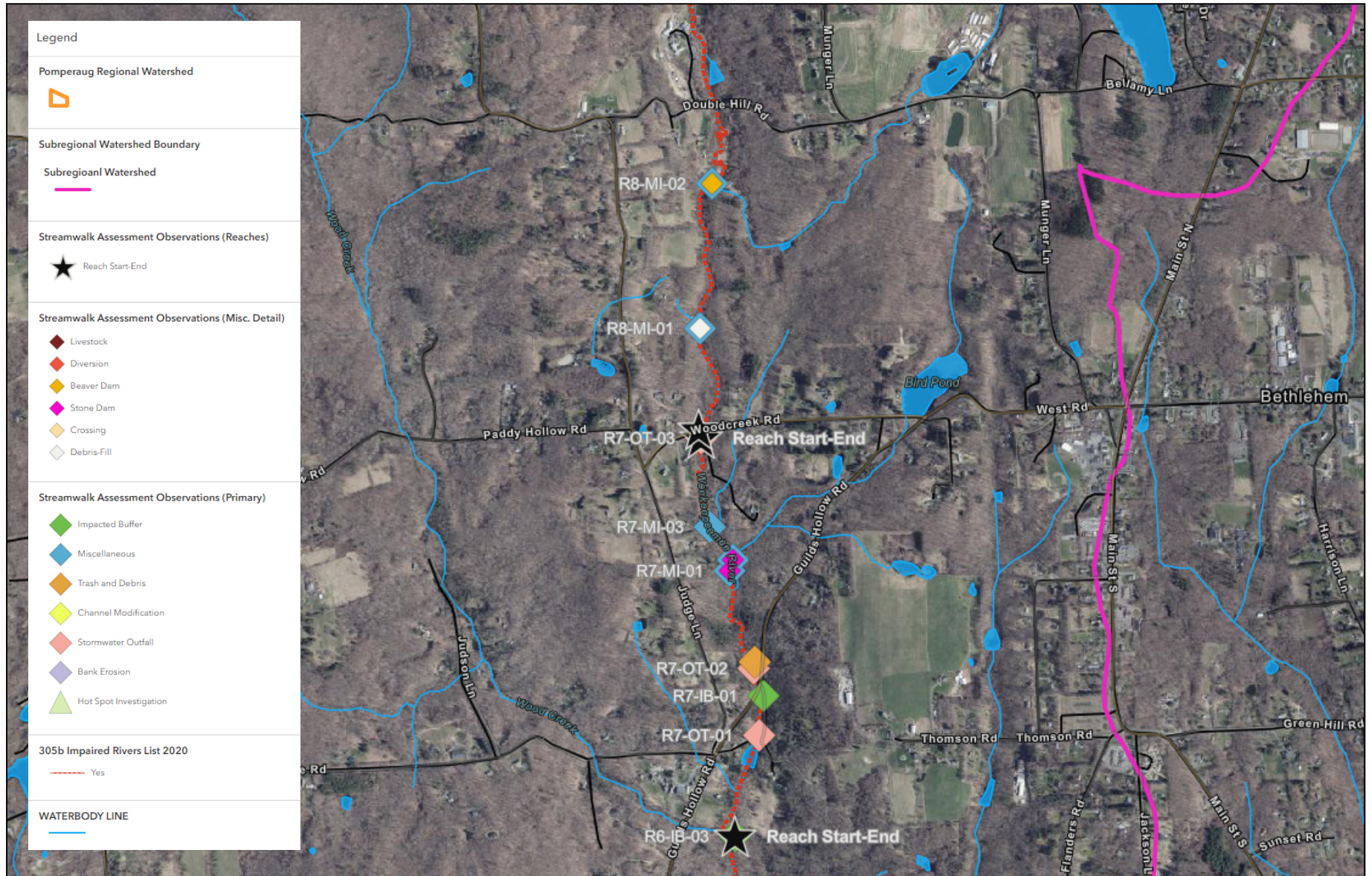


Figure 15. Weekepeemee River Streamwalk Survey Observations - Reach 7 & 8. Reach 7 extends from Molzon Lane to the Wood Creek Road Bridge in Bethlehem, CT. Reach 8 extends from the Wood Creek Road Bridge to Double Hill Road in Bethlehem, CT. The presence of a beaver swamp made the northern section of Reach 8 inaccessible.

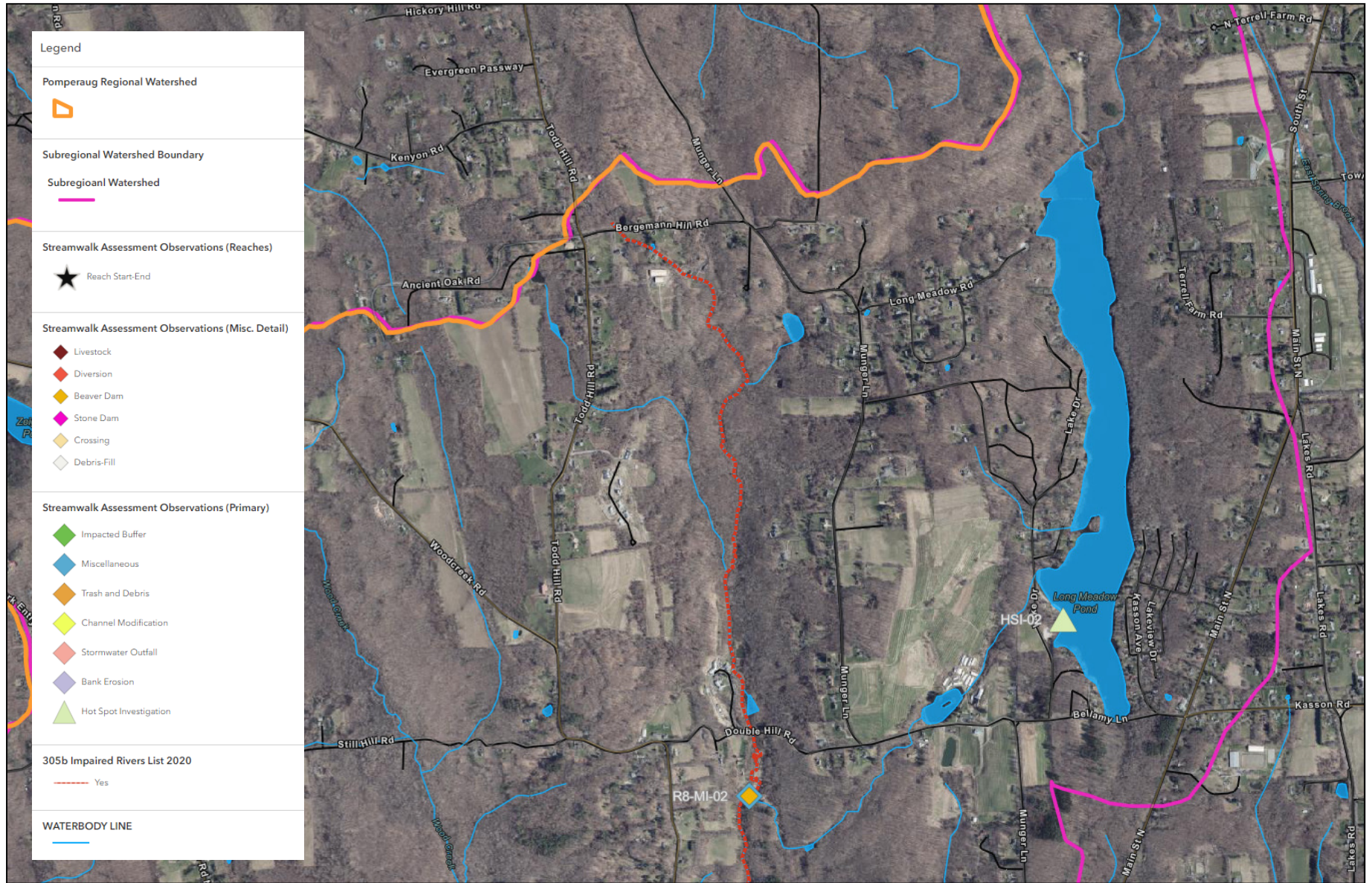












Figure 16. Weekepeemee River Streamwalk Survey Observations - Reach 9. Reach 9 extends from Double Hill Road in Bethlehem, CT to Munger Ln / Bergemann Hill Road at the town line in Morris, CT. This section was inaccessible for the Streamwalk Survey due to high security fences and gates around two large properties at the southern end of the reach.




Table 2. Weekeepeemee River Streamwalk Survey Observations, Potential Sources of Bacteria, BMP Recommendations and Prioritization.
 BMP cost estimates are defined as follows: Low (Less than \$10,000); Medium (\$10,000 to \$50,000); High (Greater than \$50,000).




Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R1-CM-01	Three Rivers Park Route 47 at Jack's Bridge Rd	Channel Modification (CM-01) - 50 feet of heavy armoring on the right bank; Exposed tree roots on right bank; berm between the cornfield and the river; river channelized from Jack's Bridge to the Confluence	Popular dog walk area Manure spreading on cornfield	Root wads, large woody debris, strategically placed boulders, lower or strategically breach the berm to help reconnect the river to the floodplain, native tree and shrub plantings, invasive plant removal	Town owned property on both sides. Pet waste bags and trash receptacles are well managed. Pomperaug WBP previously identified an opportunity to relocate the parking area away from the river.	Med	Med	High	 <p>(2019 Aerial – NVCOG)</p>
R1-IB-01	Meadow Farm Route 47 at Jack's Bridge Rd	Impacted Buffer (IB-01a) - Less than 25% shading of the river channel for a length of approximately 600 feet; ample vegetation dominated by shrub and tall grasses along both sides of the river providing buffer between the hayfields and the river, yet little canopy to provide shade. A few younger sycamores are established on both sides. Minimally shaded area spans from Jack's Bridge to Rock Outcrop located on the right bank approximately 600 feet upstream from the bridge.	No livestock present but possibly manure if spread on fields as fertilizer	Add shade trees along the river bank	Landowner has been working to clear invasive species from the riparian buffer	High	Med	Med	 <p>(2019 Aerial – NVCOG)</p>




Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R1-IB-01	Route 47 / Upstream Jacks Bridge Road	Impacted Buffer (IB-01) - Three houses on the left bank with lawns mowed to the edge of the river bank; some large shade trees (sycamores) interspersed; shrub layer or no mow zone recommended to cover approximately 100 feet x 15 feet along the river bank. Houses are set back from the river approximately 50 feet. Right bank is well vegetated.	None apparent	Plant shrub layer; shade tolerant perennials; and/or establish a no mow zone	Stream is partially shaded	Med	Low	Low	  <p>(2019 Aerial – NVCOG)</p>



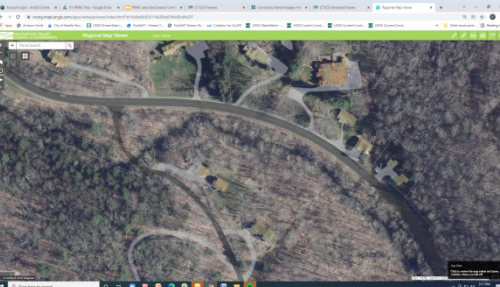
Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R1-TR-01	Route 47 Right of Way near Easy St	Trash and Debris (TR-01) - Pool liner embedded in the sediment on the left bank within the right-of-way. Requires additional tools (shovels, scissors, blade, pry bar) and a canoe or kayak to float the trash to an easier removal point.	None apparent	Remove trash and debris		High	Low	Low	
R1-IB-02	Washington Road near Quassuk Rd	Impacted Buffer (IB-02) - Three houses on the left bank with large, open, level lawns mowed to the edge of the river bank; some large shade trees (sycamores) interspersed;	None apparent	Recommend planting a shrub layer or establishing a no mow zone. Approximately 200 feet x 15 feet along the river bank available for planting.	Houses are set back from the river approximately 100 feet. Right bank is well vegetated.	Med	Med	Med	 

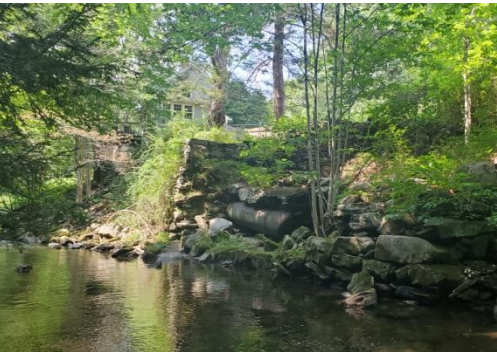


Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R1-MI-01	Off Westwood Road	Miscellaneous (MI-01) – Half dozen goats are present at the top of a steep slope; within a fenced area approximately 100 feet from the right on the right bank. The steeply sloped bank between the goats and the hill could use some understory plantings (ferns, grasses, shrubs); established cover over young trees (less than 30 years old) provides stability and shading. The floodplain is terraced; the river bank is approximately 4.5 feet above the water's surface.	Goats and possibly other livestock. During leaf-off conditions in Fall 2021, cattle were observed on the Westwood Road side of the river when looking at Route 47 toward Westwood Road. Based on the aerial image, there may be other livestock in the area.	Understory planting on steep slope area for added filtration and bank stability.	There is a level, well-vegetated area that extends approximately 50 feet back from the river before rising steeply towards the goat area. Minor bank erosion was also noted where undercutting has exposed tree roots.	Low	Low	Med	  <p>(2016 aerial – CT ECO)</p>
R1-IB-03	Ruffin Road	Impacted Buffer (IB-03) - Buffer area is less than 5 feet wide over a length of 150 feet that consists primarily of invasive species including Japanese knotweed and mugwort.	None observed; potential for septic or pet associated bacteria	Recommendation to remove invasive species and plant natives, establish a no mow zone along 150 feet of riverbank.	House is less than 50 feet from the river but it doesn't appear the lawn area is used, and could establish at least a 10 foot wide buffer.	Med	Med	Med	



Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R2-CM-01	Route 47 at Route 132	Channel Modification (CM-01) - River is straightened for approximately 1000 feet on the right bank where it flows along the edge of Route 47 upstream of the bridge. The area between the river and the road is only about 10 to 15 feet wide and is heavily armored. There is a large scour at the upstream end of the channelized area where the river is forced to make a sharp turn as it flows towards the armored bank. The river is also forced to make a sharp turn to flow under the bridge.	Wildlife	Update / replace / realign Hotchkissville Bridge at Route 47 so that it spans beyond the banks and is better aligned to the river channel. Root wads, woody debris, strategically placed boulders for in-stream habitat diversity, dissipating energy in the river channel, and better connecting the river to its floodplain.	Note restoration challenge presented by Route 47 as well as the power lines located along the river-side of the road. There is room on the left bank for the river to spill into the floodplain. In heavy storms, the river will also spill over Route 47.	Low	Med	High	   <p>(2019 Aerial – NVCOG)</p>





Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R2-MI-01	Route 132	Miscellaneous (MI-01) - Chickens in a fenced area well set back from the river. Recently-cut tree on the river bank with only the stump remaining.	Chickens	Enhance understory vegetation	Distribute education materials on clearing vegetation in and along wetlands and watercourses (and the inverse re: planting riparian buffers)	Low	Low	Low	
R2-CM-02	Confluence at Sprain Brook	Channel Modification (CM-02) - Right bank is armored with boulders for a length of about 150 feet where Sprain Brook flows into the Weekepeemee; armoring continues along the right bank of the Weekepeemee another 200 feet upstream of the confluence. Armoring is not extensive and there is plenty of room for restoration on both sides of the river (100 to 200 feet back from the river); the area along the river is mostly meadow. Bank height is approximately 5 feet.	Wildlife	Remove or breach armoring to help reconnect the river to the floodplain; beyond the vegetated buffer area are open fields with a few buildings set more than 100 feet from the river.	Verify if houses fall within the FEMA flood risk zones.	Low	Low	High	  <p>(2019 Aerial – NVCOG)</p>

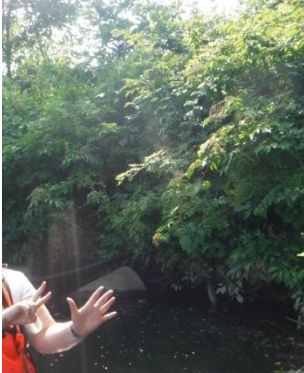

Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R2-IB-01	Route 132 Vineyard	Impacted Buffer (IB-01) - Vegetation on the Left bank has been cleared, active earth excavation higher up on the slope. No silt fencing or erosion controls around the excavation zone. Area spanning 200 to 300 feet long and 100 to 150 feet wide has been cleared for agricultural purposes (vineyard). Stumps have been left in place; sparsely covered with some sapling and shrub volunteers. Cleared vegetation was mulched in place and covers the bank. Recommendation to establish at least 25 feet of buffer at the toe of the steep slope to filter runoff and stabilize the bank.	None apparent	Vegetate the toe of the slope at least 25 feet up the bank to provide stability and shading. Coir logs, hay bays, and/or silt fence would be appropriate erosion control measures to employ while the area is being cleared / excavated.		Med	Med/High	Med/High	 
R2-TR-01	Papermill Road	Trash and Debris (TR-01) - Private property with a small amount of trash in a localized area; most of it was picked up during the streamwalk survey. Mostly plastic, metal, and styrofoam carried to this point by flooding.	None apparent	Periodic trash clean up, particularly after flooding events; flood deposition area		Low	Low	Low	



Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R2-TR-02	Route 132 Right of Way near Hogpen Hill	Trash and Debris (TR-02) - On the left bank, there is lots of small trash items near the roadside / in the right of way; generally litter from passing vehicles (i.e. cans and bottles); most of it was picked up during the streamwalk survey, but tires remain between the road and the river. Will need a pick-up truck to remove; a pry bar or shovel might be helpful.	None apparent	Periodic trash clean up	Install "No Littering" or "No Illegal Dumping" signs along roadway.	Low	Low	Low	
R2-IB-02	Papermill Road	Impacted Buffer (IB-02) - Understory clearing in the floodplain approximately 250 feet along the right bank of the river; house is set back from river approximately 150 feet. Yard area is flat and lacking a shrub layer but has scattered trees bordering the river.	None apparent	Enhance riparian buffers. May be an opportunity for rain garden installation or other downspout disconnection.	Recommendation to restore up to 30 feet with native shrubs or perennials to create an understory.	Med	Low	Low/Med	 



Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R3-MI-01	Route 132	Miscellaneous (MI-01) - Exposed iron tank/pipe at the base of an old foundation on the left bank. Very rusty pipe/tank is approximately 2.5 foot diameter by 10 feet long and extends out of the stonewall / foundation; appears to be long since emptied and out of service.	None apparent	N/A	Inquire with the property owner about the nature of the stonewall / foundation feature around the tank.	Low	Low	Low	
R3-IB-01	Route 132	Impacted Buffer (IB-01) - Historic house elevated from the river on the left bank; yard area north of the house is dominated by turf/grass; no trees or shrubs; some invasive species present; some bank armoring with steps down to the river.	None apparent	Recommend removing invasive species and planting natives to create a 10 foot wide buffer over a 75 foot length or establish a no mow zone for natural re-vegetation.		Med	Med	Low	
R3-MI-02	Route 132, Quickwater Farm	Miscellaneous (MI-02) - Cows (fewer than a dozen), chickens, and goats in pasture 25 feet away from the river on the left bank; livestock fencing in good repair and property is fairly level so low manure runoff potential; pastures do not appear to be overgrazed and appear to be using rotational pasturing practices.	Cows and other livestock	See notes for Site R3-IB-02					



Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R3-IB-02	Route 132, Quickwater Farm	Impacted Buffer (IB-02) - Left bank. Open pasture land where livestock fencing is in good shape and a good distance from the river; pasture land is level in the floodplain; area between the fence and the river is mowed and the tree / shrub / herbaceous layer is somewhat sparse.	Cows and other livestock	Area between the fence and the river is mowed and the tree / shrub / herbaceous layer is somewhat sparse. Enhance the buffer with more deep rooted plants to reinforce the bank and provide shade in an area 100 feet long by 5 to 10 feet wide.		Med	Med	Med	
R3-MI-03	Route 132, The Farm	Miscellaneous (MI-03) - Two irrigation pumps located on the left bank with unsecured gas canisters sitting adjacent to them. Also a small amount of trash in the area.	None apparent	Recommend securing the gas canisters and/or having some kind of spill kit / spill containment associated with the irrigation pumps.		High	Med	Low	


Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R3-MI-04	Route 132, The Farm	Miscellaneous (MI-04) - Ford-style tractor crossing between crop fields on opposite sides of the river. Water downstream of the crossing was noticeably turbid.	None apparent	May be an opportunity to formalize the crossing as a ford wherein the riverbed is stabilized to prevent bed erosion or to establish a bridge crossing.	“Hog panel” or “GeoWeb” style crossing materials may be appropriate for this site. See NRCS bulletin: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167481.pdf	Med	Med	Med /High	 
R3-IB-03	Route 132, The Farm	Impacted Buffer (IB-03) - On the left bank, farm/crop field has a narrow row of established trees along the river with minimal understory.	None apparent; possibly manure if spread as fertilizer on the crop fields.	Could use an additional row of shrubs, trees, and/or perennials between the river and the crop field. Area available for planting spans approximately 300 feet by 10 feet. Opposite bank also has room for similar planting or letting it naturally regenerate.	Aim to balance crop production area with river protections.	Med	High	High	 




Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R3-OT-01	Peter Road	Stormwater Outfall (OT-01). Concrete stormwater pipe / old stormwater outfall on the right bank along the edge of Peter Road.	None apparent	Regularly inspect and clear sediment trap.	Should already be accounted for in town's MS4 inventory. Continue outfall monitoring as required by MS4 permit.	High	Low	Low	N/A
R3-MI-05	Peter Road	Miscellaneous (MI-05) - Irrigation pipe - likely inactive; possibly deposited by flooding.	n/a	Remove pipe if not in active use.	Located next to concrete stormwater pipe / old stormwater outfall on the right bank along the edge of Peter Road that should be accounted for in town's MS4 inventory.	High	Low	Low	
R3-IB-04	Peter Road	Impacted Buffer (IB-04) - House located very close to the river with minimal yard area which is dominated by lawn that is mowed and weed-whacked right up to the river's edge including vegetation growing between rocks that make up the streambank. No tree, shrub, or herbaceous layer; river has direct sun exposure.	None apparent	Recommend establishing at least 5 feet of a no-mow zone and/or strategically planting native perennials and shrubs along up to 100 feet of river bank. Small area could be kept clear (mowed) for view and or river access if desired.		Medium	Medium	Medium	



Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R4-TR-01	Brushy Hill Road	Trash and Debris (TR-01) - Area along the left bank littered with a wide variety of trash and debris which appears to include items deposited by the river as well as roadside dumping. Items present included layers of plastic sheeting, plywood, chicken wire, and scrap metal. Layers of plastic sheeting are embedded in the riverbank about halfway up to the road. Smaller items including bottles, cans, bicycle, table, sink, plastic, glass, and metal items were collected.	None apparent	Remove trash and debris. Establish an "Adopt-a-Spot" as the site appears to be a chronic deposition area for flood swept debris. Install "No Dumping" signs on Brushy Hill Road to discourage illegal trash dumping.	Area requires further attention for clean-up; tools like shovels, pry bars, and sharp blades will be needed to remove the plastic sheeting so it can be bagged and walked up the bank or floated by boat down the river to an exit point. Note: some trash/debris could be associated with the farm across the road and/or farm operations upstream (greenhouse and/or weed barrier plastics). Use caution removing materials embedded in the streambank; disruption may cause erosion. Unclear if this is private property or a town right of way.	Medium	Medium	Medium	 



Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R4-IB-01	Brushy Hill Road	Impacted Buffer (IB-01) - Private residence where there are a number of brush piles located in the floodplain which appear to be associated with active clearing along the right bank. A good number of large trees are present which provide 75% shading over the stream. Construction equipment is present.	Wildlife	Recommendation adding more understory vegetation along 200 feet of the bank to enhance the riparian buffer. Area approximately 25 feet wide is available for planting.	Stonewall and terracing down to the river. Stones somewhat piled in the river to enhance / deepen an existing pool. Disassemble this "dam" and redistribute rocks throughout the immediate area.	Medium	Low	Medium	
R4-TR-02	Brushy Hill Road	Trash and Debris (TR-02) - Items either associated with old farm operations or items that were illegally dumped including a 30 gallon barrel labeled "Agitene" which is a combustible solvent and a 1 gallon metal gas can and other metal items like tools; also cans, bottles, cups, styrofoam.	n/a	Area could be revisited along with TR-01 for additional clean-up by volunteers. Note - steep bank from road-side down to the river; best to float trash downstream to the bridge for removal. Establish an "Adopt-a-Spot" as the site appears to be a chronic deposition area for flood swept debris. Install "No Dumping" signs on Brushy Hill Road to curb illegal trash dumping.	Barrel reported to CT DEEP Spill Response Team and Town of Woodbury and removed at time of the Streamwalk Survey in August 2021.	High	High	Low	




Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R4-MI-01	Brushy Hill Road	Miscellaneous (MI-01) - Assorted metal and PVC pipes on the left streambank. Pipes range in size from 1 to 2 inch diameter; purpose is unknown. Might just be stockpiled material though some sticking out of the bank.	n/a	Secure pipes so they are not swept away in a flood.		Low	Low	Low	
R4-MI-02	Weekeepemee River Farm	Miscellaneous (MI-02) - Irrigation pump / water withdrawal on the right bank. Pipe connected to the pump has a 3" diameter; the pump is also connected to a filtration system and holding tanks. Irrigation pumps are located at the top of a steep, sandy bank on an outside bend in the river which may not be overly stable (nearly a 1:1 slope).	Livestock - goats, chickens, sheep, cattle	Move irrigation pumps and holding tanks further up the bank and extend the pipe length. Potential for a bank stabilization project / riparian planting along the sandy bank at an outside bend in the river which may not be overly stable (nearly a 1:1 slope). Unclear if livestock have access to the river. If so, livestock fencing and an alternate water source may be appropriate BMPs.	Aerial image shows evidence of a couple ford-style stream crossings; consider stream crossing structures to stabilize river bed / prevent erosion. May be an opportunity to formalize the crossing as a ford wherein the riverbed is stabilized to prevent bed erosion or to establish a bridge crossing. "Hog panel" or "GeoWeb" style crossing materials may be appropriate for this site. See NRCS bulletin: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167481.pdf	Med	High	High	 (2019 aerial – NVCOG)




Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R4-IB-02	Chohees Trail, The Farm	Impacted Buffer (IB-02) - Area under the power transmission lines has been cleared leaving the stream 95% unshaded for a length of 300 to 350 feet. There is ample understory vegetation providing stability, but the area is dominated by multiflora rose, Russian olive, mugwort, and other invasives.	None apparent	Recommend establishing shrub height vegetation so not to compete with maintenance of the power lines and in effort to provide some shading. More room on the right bank for natural revegetation or planting - 50 feet available. About 10 feet is available on the left bank where there is active crop production and where greenhouses are present.	Livestock presence was noted in the Pomperaug Watershed Based Plan (2018); they are no longer a component of the operations at this site. Adding vegetation under the power lines might not be feasible based on line maintenance practices and access needs of the power copy. Water conservation practices and other BMPs including drip irrigation; infiltration of stormwater runoff; rainfall capture (i.e. cistern); limited application of fertilizers and pesticides may be appropriate. Farm is already known to be using Integrated Pest Management strategies.	Low/ Med	Med	High	 <p>(2019 aerial – NVCOG)</p>



Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R5-IB-01	Weekepeemee Road	Impacted Buffer (IB-01) - Right bank upstream of the bridge is dominated by open, residential lawn area along 100 to 150 feet of the streambank. Lawn is mowed to the top of the rocky bank/gravel bar which is not touched. Stream is minimally shaded on the right bank.	None apparent; Septic / Pets	Recommend establishing a no mow zone at least 2 feet wide and/or plant a few trees or shrubs (only about 12 feet of space is available for planting).		Med	Med	Low	
R5-IB-02	Chohees Trail Farm	Impacted Buffer (IB-02) - Length of 1000 feet on the left bank provides little canopy cover over the river. Area runs along the edge of pasture that shows some signs of overgrazing. Approximately 20 beef cattle are present in the pasture. Livestock fencing is placed approximately 8 feet from the river with pasture sloping down towards the river.	Beef Cattle	Recommend moving the livestock fencing further back from the river and/or repairing existing fencing; move up the bank to a 15 foot setback from the water and naturally revegetate or enhance with strategically planted trees or shrubs to replace invasive plants.	See conceptual design presented in Pomperaug Watershed Based Plan (2018). Based on walking the length of the Weekepeemee River; this site has the highest potential for contributing bacteria pollution. Thus, it remains high on the priority list for installation of BMPs.	Med	High	Med	  (2019 aerial – NVCOG)


Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R5-MI-01	Weekeepeemee Road	Miscellaneous (MI-01) – Hobby farm with livestock in the floodplain. Half a dozen goats and two dozen chickens pastured 10 feet from the river; pasture extends approximately 150 along the right bank. There is an ample shrub layer and some tree cover providing bank stability. Livestock fencing present.	Goats; chickens; dog	Recommend moving the chickens back a bit and maintaining the existing buffer, potentially enhance the buffer with shrubs or perennials. Challenge will be to keep the goats from browsing through / beyond the fence line.	Small area available for pasturing the goats and chickens; suggest not expanding the herd size or flock size in order to balance protection of the river.	Med	Med	Low	
R5-IB-03	Downstream Crane Hollow Road	Impacted Buffer (IB-03) - Section along the left bank where old gravel ponds remain from former earth excavation operation is stabilized by an ample shrub layer with abundance of invasives including Russian Olive, Phragmites, and Japanese Knotweed. Stream is not well shaded due to lack of tree canopy along a 600 feet length.		Recommend adding trees to provide shade and try to remove invasive species.	The invasive plants provide an ample buffer for filtering runoff, preventing erosion, and absorbing flood waters but could provide better habitat and food for wildlife along with shade for the river if enhanced with native species including trees.	Low	Low	High	

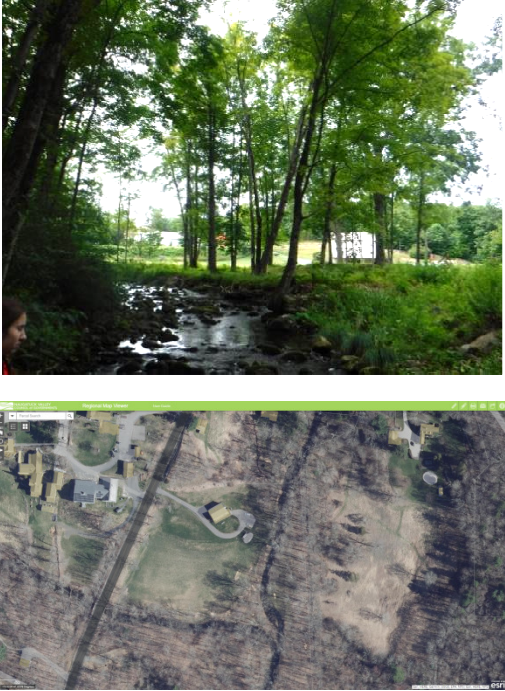

Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R5-CM-01	Downstream Crane Hollow Road	Channel Modification (CM-01) - Approximately 500 feet length of the channel was historically straightened. Channel width is approximately 25 feet and the bank height is about 10 feet; the river is not connected to the floodplain and there isn't evidence of sediment deposition. There was a notable amount of algae covering the rocks and water weed (native <i>Elodea</i> sp.) growing in the river.	None apparent	Recommend strategically placing woody debris and or boulders to create channel diversity. May be a future opportunity to abandon earth excavation activities and re-introduce meanders within the river channel.	There is a decent buffer on both banks (though some areas open to sun – see R5-IB-03) and room for the river to spill into the floodplain without impacting infrastructure.	Low	Med	High	 <p>(2019 aerial – NVCOG)</p>
R6-OT-01	Upstream Crane Hollow Road	Stormwater Outfall (OT-01) - Natural, open stream channel on the left bank that is between 24 and 36 inches wide and is 4 inches deep with moderate flow. Unclear is if this is a tributary or a stormwater outfall; intense land use on the east side of the river suggests it is an outfall and there is no tributary shown on the map. Water is clear, not turbid, no benthic growth, no odor, no staining, and no floatables.	None apparent	Confirm source of flow; aerial image suggests it may be the outfall from a sediment or detention pond associated with earth excavation activities. These activities cannot be seen from the river channel; riparian buffers are adequate through this area.	Site with known waste water discharge permit issued by CT DEEP.	Low	Low	Low	 <p>(2019 aerial – NVCOG)</p>




Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R6-ER-01	Upstream Crane Hollow Road	Bank Erosion (ER-01) - Exposed roots along an area where down-cutting is occurring on the right bank; approximately 100 feet long with a bank height of 5 feet. Stream bottom/wetted width is about 15 feet wide; top width is approximately 35 feet wide.	None apparent	Could add features like root wads to help reconnect the river to the floodplain, but challenging in regards to access. More areas would be disrupted to achieve installation of BMPs.	There is no infrastructure at risk and there is 50 to 75 feet of well vegetated riparian land abutting. Stream channel is also noticeably straight.	Low	Low	High	
R6-ER-02	Upstream Crane Hollow Road	Bank Erosion (ER-02) - Long stretch (1000 feet) of bank erosion that alternates between the right and left bank. Bank height on the left is 6.5 feet and 4 feet on the right bank. There is very little plant growth along the bank; there are exposed roots with some overhang. There is scouring on the outside of the curve on the left bank and sand deposition along the right bank.	None apparent	Could add features like root wads and strategically placed boulders to help reconnect the river to the floodplain, but challenging in regards to access. More areas would be disrupted to achieve installation of BMPs.	No infrastructure is at risk with 50 to 75 feet of open riparian land abutting. Might be a candidate for bank stabilization through access would be difficult and would require vegetation clearing to get to. There is room to let the river naturally find equilibrium. Active processes appear to be down-cutting, widening, bank scour, and sediment deposition.	Low	Low	High	 




Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R6-IB-01	Arrowhead Lane	Impaired Buffer (IB-01) - Area less than 100 feet long on the right bank that has been partially cleared to create a campsite near the river. House is more than 100 feet back from the river with a well vegetated area between the house and campsite. Campsite features a mowed spot for tenting, a fire pit, and seating. Established trees within the mowed area provide shade for the river.	None apparent	A few shrubs or perennials could be added along the water's edge for bank stability.	Low priority for restoration as the buffer impairment is VERY MINOR as there is no impervious cover in the area immediately adjacent to the river.	Low	Low	Low	
R6-CM-01	Arrowhead Lane	Channel Modification (CM-01) - Old stone wall armors the stream along the left bank. The wall is approximately 200 feet long and 3 to 4 feet high. It appears that water can flow over (and probably through the wall) into the floodplain in high flow events. The wall doesn't appear to alter the flow pattern in the river; no evidence of sediment deposition or vegetation growth in the channel.	None apparent / wildlife	None	Ample room for the river to move and let nature take its course. The stonewall is the only infrastructure at risk for failure and there are no major consequences evident if it collapses.	Low	Low	Low	 



Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R6-IB-02	Arrowhead Lane	Impacted Buffer (IB-02) - Approximately 125 feet of open lawn up to the water's edge on the right bank. No trees or shrubs and no shade cover. There is an above ground pool situated about 100 feet upslope of the stream, while the house is about 150 feet from the stream.	None apparent	Recommend planting native trees, shrubs, perennials to create at least a 15 foot wide riparian buffer along the 125 feet of streambank.		Med	Med	Med	 



Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R6-ER-03	Arrowhead Lane	Bank Erosion (ER-03) - Stretch of exposed tree roots on the right bank. Bank height ranges from 4 to 7 feet high. Down-cutting and bank scour is occurring on the inside of a meander on the right bank with deposition on the left bank. There is a gravel bar approximately 15 feet wide on the left bank. Some wetlands present in the adjoining riparian area; riparian area is dominated by forest cover; no infrastructure is at risk.	Wildlife	None	Low priority for restoration; let banks naturally find equilibrium given privately owned forest lands.	Low	Low	Low	 <p>The photos show a stream with a gravel bar on the left bank and exposed tree roots on the right bank. A person is visible in the photos for scale.</p>




Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R6-IB-03	Upstream Arrowhead Lane; Flanders Road interior	Impacted Buffer (IB-03) - Both right and left bank upstream of the confluence of Wood Creek is open lawn area with minimal trees and shrubs along 300 feet of each river (Left bank of Wood Creek; Right bank of Weekepeemee - property upstream of confluence). Some bank erosion is evident; the stream is not shaded.	None apparent	Good potential for riparian buffer planting as house/driveway/pool are set away from the river; at least 25 feet available for planting. Could also add some plants along the left bank of the Weekepeemee.	Consider bacteria sampling site on Wood Creek to consider inputs from land use activities in this sub-watershed	Med	Med	Low/Med	
R7-OT-01	Mill Pond Road	Stormwater Outfall (OT-01) - 18 inch concrete, circular pipe flush with concrete retaining wall on the left bank just upstream of the covered bridge; outfall is 3 to 4 feet above stream grade. There is some benthic growth in the pipe that is brown and green in color, but there is no flow, no odor. Staining and algae growth is along the flow line. Note the road is within 10 feet from the river and the catch basin is visible.	None apparent.	Regular inspection and clean-out of the catch basin.	Proactively conduct outfall sampling to mirror MS4 permit requirements, which are not yet applicable in Bethlehem.	Med	Low	Low	

Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R7-IB-01	Mill Pond Road	Impacted Buffer (IB-01) - Approximately 300 foot stretch along Mill Pond Road, downstream of Route 132 appears to have been straightened; both banks are armored with cobble to boulder sized riprap. The bank between the road and the river is slightly steeper than a 1:1 slope and the width to the road is only about 10 feet (this is on the left bank of the river). Sparse vegetation grows between the rocks and is dominated by poison ivy and jewelweed. The right bank is a little lower and opens into a narrow floodplain. There is some minor undercutting along the right bank.	None apparent		There is room for some plantings on the right bank, but not possible on the left given the intensive riprap. Stream is more than 50% shaded. Stability of the banks and potential for road washing out is the greater concern here.	Low	Med	High	 
R7-OT-02	Upstream Route 132	Stormwater Outfall (OT-02) - 24 inch circular, singular, concrete outfall with concrete headwall/retaining wall located in the road right of way along Route 132; left bank of the river but discharges more than 20 feet from the river. No flow; no odor; no staining; minimal algae growth; no dry weather discharge.	None apparent	Regular inspection and clean-out of the catch basin.	Proactively conduct outfall sampling to mirror MS4 permit requirements, which are not yet applicable in Bethlehem.	Med	Med	Low	

Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R7-TR-01	Upstream Route 132	Trash and Debris (TR-01) - Lots of roadside litter including bottles, cans, plastic, cups, wrappers, etc.	None apparent	Establish "Adopt-a-Spot" for town clean up days.	Less than a pick-up truck load was picked up, but may need more attention for town clean-up days. Most litter seems to be tossed from cars on Route 132; add "No Littering" sign along roadway.	Med	Low	Low	N/A
R7-MI-01	Between Judge Lane and Route 132	Miscellaneous (MI-01) - Small rock dam/stonewall 2 to 3 feet high across the river; easily removed. Also noted is understory clearing on the right bank, mostly brush removal in an area out 100 feet wide in effort to provide a view towards the river; appears to be an invasive plant removal effort; the house is about 500 feet away from the river up a gently sloping hill.	None apparent	Recommend removing "dam" and strategically planting a couple trees in cleared swath to prevent long-term erosion.		Med	Low	Low	 
R7-MI-02	Between Judge Lane and Route 132	Miscellaneous (MI-02) - Small rock dam/stonewall 2 to 3 feet high across the river; easily removed.	None apparent	Remove dam / redistribute river rocks from pile to streambed.	May need to create / circulate educational materials to discourage building small dams like these (at least three observed during streamwalk survey).	Med	Low	Low	

Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R7-MI-03	Between Judge Lane and Route 132	Miscellaneous (MI-03) - Long green garden hose that extends up the right bank; approximately 100 ft long hose; purpose unknown - no pump to indicate water withdrawal; possible discharge hose associated with sump pump (not flowing).	None apparent	Recommend removing the hose if not associated with irrigation or sump drainage or otherwise necessary		Med	Low	Low	N/A
R7-OT-03	Wood Creek Road	Stormwater Outfall (OT-03) - Brand new 1 foot diameter corrugated metal pipe with concrete retaining wall/headwall support on the right bank. Relatively large, heavily rip-rapped sediment / plunge pool below outfall about 25 feet from the water's edge.	None apparent	Regular inspection and clean-out of the catch basin. Proactively conduct outfall sampling to mirror MS4 permit requirements, which are not yet applicable in Bethlehem.	Noted that new catch basins and curbing was installed along Wood Creek Road as part of the recent road and bridge rehabilitation projects. No dry weather flow, no odor, no staining, no benthic growth in the pipe.	Med	Low	Low	
R8-MI-01	Upstream Wood Creek Road Bridge	Miscellaneous (MI-01) - Brush / log dump pile on the right bank immediately adjacent to the river that is about 25 wide by 25 long by 8 to 10 feet high. Majority of the logs are 6 to 12 inches in diameter; there is a timber road that runs perpendicular to the slope down to the river.	None apparent	Circulate educational materials on fill in and along wetlands and watercourses. Move the brush pile back away from the river.	Potential for erosion on the timber road. Brush pile could be considered as fill in a wetland; only visible from the river.	Med	Low	Low	

Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
R8-MI-02	Downstream Double Hill Road	Miscellaneous (MI-02) - Beaver dam across the river that is about 3 to 4 feet high and 12 feet wide; water is coming through the dam; adjacent riparian area consists of meadow and hayfield on the right bank; forested on the left bank. No infrastructure is at risk. Area upstream of the dam may be a bit more open to sun as arials indicate a series of beaver dams in a swampy area dominated by shrubs.	Wildlife – Beaver	Resume ambient water quality monitoring at Wood Creek Road bridge to track bacteria that might be associated with beaver activity (also note tributary from Long Meadow Lake that runs through March Farm on aerial image where livestock are present).	Let nature take its course; not infrastructure immediately at risk of damage or failure in relation to beaver activity	Low	Low	Low	 

Site Code	Location Description	Observations	Potential Bacteria Sources	Potential BMPs	Other Recommendations and Notes	BMP Potential	BMP Priority	BMP Cost	Photos
HSI-02	Long Meadow Pond Town Beach	Hotspot Site Investigation (HSI-02) - Long Meadow Pond Beach. Lots of duck and goose poop scattered throughout the beach, playground, picnic and boat launch area. Port-o-potty located immediately adjacent to the water at the boat launch; potential bacteria source if leaking or if pushed over / backed into by a car.	Ducks / Geese / Port-o-let / Septic	Highly visible / high traffic area suitable for demonstration projects like native buffer plantings or a rain garden. A Rain garden could capture runoff from the pavilion or the building used for summer camp. Pervious gravel parking lots are already in place along with a stormwater detention pond.	Low risk for septic failure given seasonal use of bathrooms.	Med	Med	Med /High	  

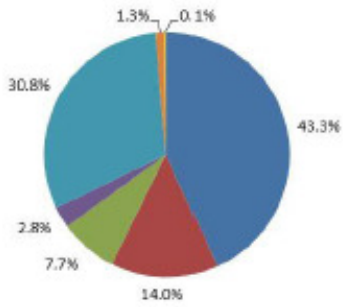
DISCUSSION

Observations made during the 2021 visual assessment survey of the Weekepeemee River reiterate findings from previous visual assessments made along impaired stream segments in the Pomperaug Watershed as well as pollutant load reduction goals and opportunities that were included in the Pomperaug Watershed Based Plan. For example, restoring riparian vegetation, improving manure management practices, enhancing livestock fencing, and retrofitting impervious surfaces with green infrastructure were opportunities identified in the WBP as well as through this recent streamwalk survey.

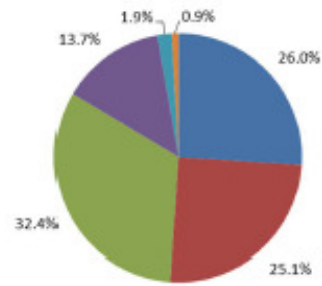
In relation to prioritizing best management practice (BMP) recommendations, it is worth revisiting the relative pollutant load estimates for each of the subregional watersheds in the Pomperaug Watershed which were calculated using the Watershed Treatment Model and presented in the Watershed Based Plan (**Figure 13**). The model inputs included physical attributes of the watershed (land use, land cover, soil types, impervious cover, etc.), different levels bacteria and sources associated with various land use types, as well as runoff coefficients for different soil and land cover types. The relative pollutant load estimates for each subregional watershed helped identify which land use types were most prominent sources of bacteria and therefore the general categories of best management practices that could be applied to help achieve water quality improvements. Specifically, the Pomperaug Watershed Based Plan (Mas *et al*, 2018) detailed that:

“In the more-developed Pomperaug River subregional basin, modeled bacteria loads are dominated by stormwater runoff from urban land use (43%) and potential illicit connections associated with residential and commercial land use (31%), with agricultural sources estimated to contribute approximately 10% of the estimated annual load. By contrast, in the more rural Weekepeemee River subregional basin, agricultural land uses (rural land and livestock) contribute an estimated 45% of the annual bacteria load, with stormwater runoff contributing approximately 25% of the annual load. This comparison points out some of the opportunities and challenges in watersheds with mixed land use. in the more rural subregional basins such as the Weekepeemee, livestock and agricultural practices are key drivers of bacteria loads, though pockets of residential and commercial development in these areas also contribute bacteria loads from urban runoff. Agricultural sources of bacteria typically require a combination of structural and non-structural best management practices (BMPs) to reduce loadings, including identification of “hot spot” bacteria sources and site-specific management strategies to achieve load reductions. Livestock in particular represent a considerable bacteria source in the Weekepeemee River, Nonnewaug River, and Hesseky Brook subregional basins. Where practicable, load reduction in these basins should focus on agricultural BMPs such as exclusion fencing, vegetated buffers, alternative approaches to manure management, such as moving manure piles further away from streams, and other agricultural BMPs.”

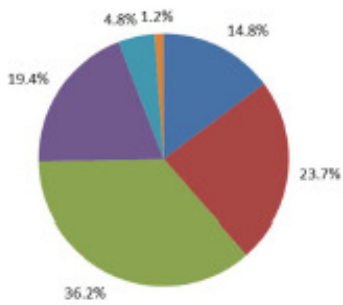
Section 5 of the WBP went on to detail management measures and projected pollutant load reductions that could be achieved if such measures were implemented. The types of management actions evaluated for their ability to reduce pollutant loads to the Pomperaug River and its tributaries, emanating from the various types of land uses and other activities/sources, included: Green Infrastructure/Low Impact Development; Vegetated Buffer Restoration; Public Education; Illicit Discharge Detection and Elimination; and, Septic System Repairs. The analysis illustrated that widespread establishment, restoration, and maintenance of riparian buffers is one of the most effective measures in reducing the bacteria load. In particular, restoring 50% of the watershed with a 50 foot buffer width would reduce the estimated pollutant load by 6% of the maximum 18.5% achievable in the most ambitious BMP implementation scenarios. Implementation of green infrastructure retrofits to impervious areas and implementation of livestock BMP's were the next greatest area for achieving pollutant load reductions.



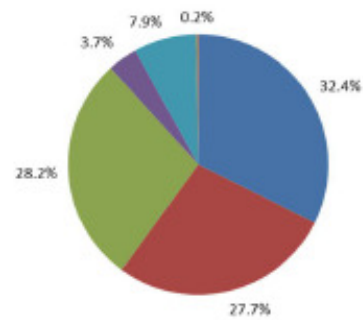
Pomperaug River Subregional Basin
Total annual load: 354,000 billion CFU (29% of watershed load)



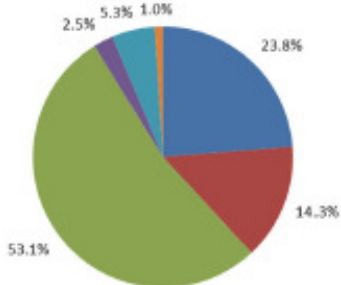
Weekeepemee River Subregional Basin
Total annual load: 213,000 billion CFU (17%)



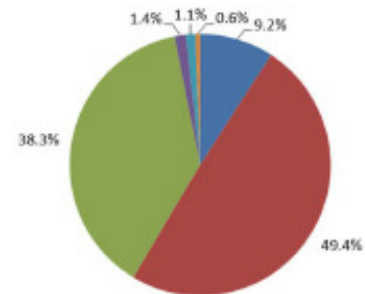
Nonnewaug River Subregional Basin
Total annual load: 275,000 billion CFU (23%)



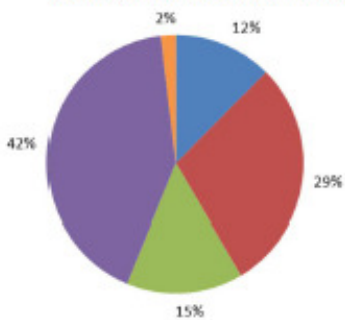
Transylvania Brook Subregional Basin
Total annual load: 107,000 billion CFU (9%)



East Spring Brook Subregional Basin
Total annual load: 81,000 billion CFU (7%)



Sprain Brook Subregional Basin
Total annual load: 109,000 billion CFU (9%)



Hesseky Brook Subregional Basin
Total annual load: 75,000 billion CFU (6%)

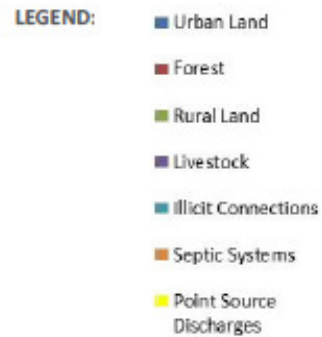


Figure 13. Relative contributions of bacteria sources for subregional basins in the Pomperaug River Watershed (Mas *et al.*, 2018).

With consideration for the efficacy of the management measures described in Section 5 of the Watershed Based Plan, sites identified in the 2021 visual assessment survey were assigned as low, medium, and high priority level for implementation. Along the Weekeepemee River, the highest BMP priority rankings were assigned to three agricultural sites while medium priority BMP recommendations were typically associated with residential and municipal properties that presented riparian buffer restoration opportunities (**Table 2**). Low priority sites were typically those where channelization, bank erosion, and trash and debris were observed as the recommended BMPs were not directly associated with reducing the bacteria pollutant load. The agricultural sites were ranked higher in priority than residential sites mainly for the potential bacteria sources present (livestock present or manure applications to crop fields) as well as the size of each parcel along the water course. Residential properties were ranked in the middle as they may have bacteria sources like pet waste, septic systems, and wildlife present but are typically smaller scale parcels with less space to achieve the desired buffer width. In most residential cases, only 5 to 15 feet of buffer width restoration could be achieved along a small stretch of river frontage (<100 feet) compared to 25 to 50 foot width potential along longer frontage areas that could be achieved at larger municipal parcels and agricultural operations.

Ultimately, five agriculture sites rose to the top as high priority sites for implementing riparian buffer and livestock related BMPs along the Weekeepemee River. Three of the sites observed in the 2021 streamwalk survey had already been included in the WBP as high priority sites for implementation of best management practices. Conceptual BMP designs and cost estimates for these sites were drafted and included in the Plan (see “4.8 Town Park 2” page 119; “4.9 Livestock 1” page 121; and “4.11 Cropland/Livestock 1” page 123). From the BMPs already included in the Watershed Based Plan, recommendations for “Livestock 1” should be refined to show that there are two distinctly separate agricultural operations adjacent to each other with their own BMP recommendations. The updated recommendations should emphasize the opportunity for buffer restoration and establishing a more formal stream crossing at the more northern of the two operations (see Site Codes R3-MI-03, R3-MI-04, and 04, R3-IB-03 in Table 2).

Two new high priority areas for implementing of agricultural BMPs were identified during the 2021 visual assessment survey and should be added to the recommendations already included in the Watershed Based Plan. The first is associated with Site Code R4-MI-02 in **Table 2**. The PRWC field team did not actually walk the stream channel through this parcel, but was able to identify potential bacteria sources from aerial images and driving along the road that provides access to this operation. Several types of livestock (cows, chickens, sheep, goats, etc) are present and it appears there are a couple of areas where vehicles are driving through stream channel to access fields on the opposite side. The second site, a site where crops are produced, is associated with Site Code R2-IB-01 in **Table 2**. An extensive area of a steeply sloped streambank was cleared of woody vegetation, exposing the river to intense sunlight and presented high risk for soil erosion. Restoration of the buffer here is considered a medium to high priority because of the erosion potential and lack of shade over the stream. Conceptual BMP plans with cost estimates should be created for these two sites and integrated into the recommendations already included in the Watershed Based Plan.

While individual residential sites with buffer restoration potential were ranked medium priority for implementation, the number of opportunities in this category help illustrate that buffer restoration overall should be a high priority especially when considering the efficacy of riparian buffers in reducing bacteria pollutant loads. Accordingly, this particular “River Smart” practice should be featured in community outreach and education efforts with messages tailored to different target groups of landowners (residential, municipal, agricultural, and commercial). PRWC has already secured funding from the Long Island Sound Stewardship Fund to support a “River Smart” stewardship campaign targeted to riparian landowners throughout the watershed. The campaign will run between July 2023 and June 2024.

At the time of the visual assessment survey, PRWC also identified a high-priority, immediate-action item which was addressed at the time of the survey (see Site Code R4-TR-02 in Table 2). A 30 gallon barrel labeled “Agitene” (a combustible solvent) was observed on a steep streambank along with a 1 gallon gas canister. Without knowing if these containers actually held any hazardous fluids, they were immediately reported to the CT DEEP Spill Response Team and the Fire Marshall for Town of Woodbury. The response teams from these agencies coordinated to remove these items immediately; they no longer present an immediate hazard to the river. The presence of these items along with other trash and debris illustrate the need for “No Dumping” signage, broader promotion of hazardous waste disposal events in the region, and general education on waste reduction and disposal practices are important even though they do not directly relate to reducing bacteria loads to the river.

CONCLUSIONS

While implementation of agricultural BMPs and riparian buffer enhancements will continue to be priority for reducing bacteria in the Weekeepeemee subregional watershed, their overall priority ranking among the actions recommended across the entire Pomperaug regional (not subregional) watershed should take into account the findings of PRWC's ambient water quality monitoring program and municipal stormwater outfall monitoring data. Ambient water quality monitoring data suggest that bacteria load reduction actions are a higher priority in the Nonnewaug Watershed than the Weekeepeemee Watershed. Regardless of the priority level, implementation of any runoff reducing best management practices will come as a benefit to the overall health of local wetlands and watercourses and those waterbodies further downstream especially when they are implemented widely. In order for rivers to thrive in the Pomperaug Watershed (support swimming and fishing), it will take the collective implementation of green infrastructure retrofits to replace impervious surfaces, establishment and maintenance of 50 foot wide stream buffers, elimination of illicit discharges, regular septic system maintenance, implementation of livestock best management practices (fencing, manure management, rotation grazing, etc), and monitoring of point source discharges.

NEXT STEPS

All of the sites observations from the Visual Assessment Survey should be added to the Watershed Based Plan as an addendum so they are identified as sites with BMP opportunities and potentially be eligible for grant funding to support implementation of the recommended BMPs.

Sites ranked as high priority BMP implementation sites should have conceptual site designs prepared or updated (if previously included in the Watershed Based Plan) based on the observations made during the Streamwalk Assessment Survey. PRWC will need to continue building relations with agricultural operators in the watershed and applying for project funds to support implementation of best management practices. The Conservationist staff at the local Natural Resource Conservation Service office has already been identified as a suitable partner in helping to move these projects forward as there are several funding opportunities through their agency and they are equipped to provide the technical assistance needed to create more specific design plans.

For implementation of best practices suitable to residential properties, PRWC should plan to host workshops and provide educational resources on how to select plants, develop planting plans, and how to install and maintain riparian buffers. PRWC should consider partnering with local garden clubs, nature centers, land trusts, plant nurseries, and libraries for hosting such programs. PRWC will begin sharing riparian land care tips directly to all landowners who abut wetlands and watercourses in the Pomperaug Watershed and inviting the landowners to various workshops/presentations in 2023-2024 to review local water quality conditions and restoration opportunities.

PRWC should also plan to present restoration opportunities to town leaders as they relate to town parks, designated open space and rights-of-way so they can be integrated into capital improvement plans, property management plans, and the like. Opportunities include riparian buffer management, trash clean-up efforts, illicit discharge detection and elimination, and green infrastructure retrofits to impervious cover. PRWC should also work with the town to secure grants to support implementation of these actions.

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Connecticut Department of Energy and Environmental Protection (CTDEEP). 2020. Integrated Water Quality Report. Hartford, CT.

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Wright, T, C Swann, K Cappiella, and T Schueler. 2004. Unified Subwatershed and Site Reconnaissance: A User's Manual. Center for Watershed Protection. Ellicott City, MD.

APPENDIX A

***Quality Assurance Project Plan
Dated May 7, 2021 and modified March 3, 2022***

EPA RFA No. 21059

This document is available on Pomperaug River Watershed Coalition's website
https://www.pomperaug.org/files/ugd/ecda6a_fc2749ab466146d78fe1d983940a5444.pdf

APPENDIX B

Streamwalk Assessment Survey Planimetric & Aerial View Reach Maps for Weekepeemee River Bethlehem and Woodbury, CT

The Reach Maps featured in this Appendix were compiled from screenshots captured from the Regional Map Viewer tool made available by Naugatuck Valley Council of Governments (<https://nvcogct.gov/maps-data/>).

The full set of Reach Maps is available on Pomperaug River Watershed Coalition's website https://www.pomperaug.org/files/ugd/ecda6a_f20b7bb2d4714597a0d034a7dea9d485.pdf

Printed copies of the Reach Maps were used by the field team to make notes while conducting visual assessments surveys along the Weekepeemee River.

APPENDIX C

Streamwalk Assessment Survey Completed Field Data Sheets, Reach Map Notes, & Field Notebook Entries for Weekepeemee River, Bethlehem and Woodbury, CT

Scanned copies of these materials are available on Pomperaug River Watershed Coalition's website:
https://www.pomperaug.org/files/ugd/ecda6a_f7947bf5639a42e39c291c95860930c3.pdf