BYRAM RIVER WATERSHED MANAGEMENT PLAN

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Southwest Conservation District

Byram Watershed Coalition

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1. INTRODUCTION TO THE BYRAM RIVER AND WATERSHED

1.1 An Overview

The Byram River drains a watershed area of 29 square miles. The river flows through six towns located in the border region of southwestern Connecticut and southeastern New York. The majority of the watershed is located within the towns of Greenwich, Connecticut (62 % of the watershed), and North Castle, New York (29 % of the watershed). The remaining 9% portion of the watershed is spread within the Westchester County, New York towns of Port Chester, Bedford, New Castle, and Rye Brook.

The river is approximately 20 miles in length. The river begins in New York at elevation 750 feet, flows through Greenwich and along the lower Westchester NY boundary, and eventually discharging at sea level into the Long Island Sound in Port Chester Harbor.

The surrounding watershed to the Byram is characterized by a mixture of urban and suburban residential parcels and densely populated commercial areas. The upper and mid portions of the river flow through a hilly forested landscape that is predominately residential. The lower portions of the river flow through a flatter, more urbanized landscape. There are four major urban transportation corridors (NY Route 684, Interstate 95, Merritt Parkway, and CT Route 1) that cross the watershed, as well as a network of locally maintained roads.

There are also tracts of lesser-developed open space within the watershed. The open space areas includes both managed and natural landscapes such as forested parks, golf courses, nature preserves, and horse farms. A greenway is currently being considered under the CT DEEP Greenways Council. CT State Law (Public Act 95-335) defines greenways as a "corridor of open space" that may protect natural resources, preserve scenic landscapes and historical resources or offer opportunities for recreation or non-motorized transportation; connect existing protected areas and provide access to the outdoors; be located along a defining natural feature, such as a waterway, along a man-made corridor, including an unused right of way, traditional trail routes or historic barge canals; or be open space along a highway or around a village. For official designation as a greenway, the CT DEEP requires that open spaces and/or pathways have the critical element of "connectivity." (Witkos 2010)

The headwaters of the river are located within New Castle, North Castle and Bedford, NY near the Byram Lake Reservoir, the public drinking supply for Mount Kisco, NY. The river flows south through the Hamlet of Armonk, the urban center for the Town of North Castle, then across the Connecticut border and then southwesterly across the northern part of Greenwich. Within the town of Greenwich, several tributaries merge with the river to form the central main stem. The floodplain to the river flattens out as the river passes through higher density urban development located in the lower portion of the watershed. The southern end of the river eventually empties into Long Island Sound in Port Chester harbor.

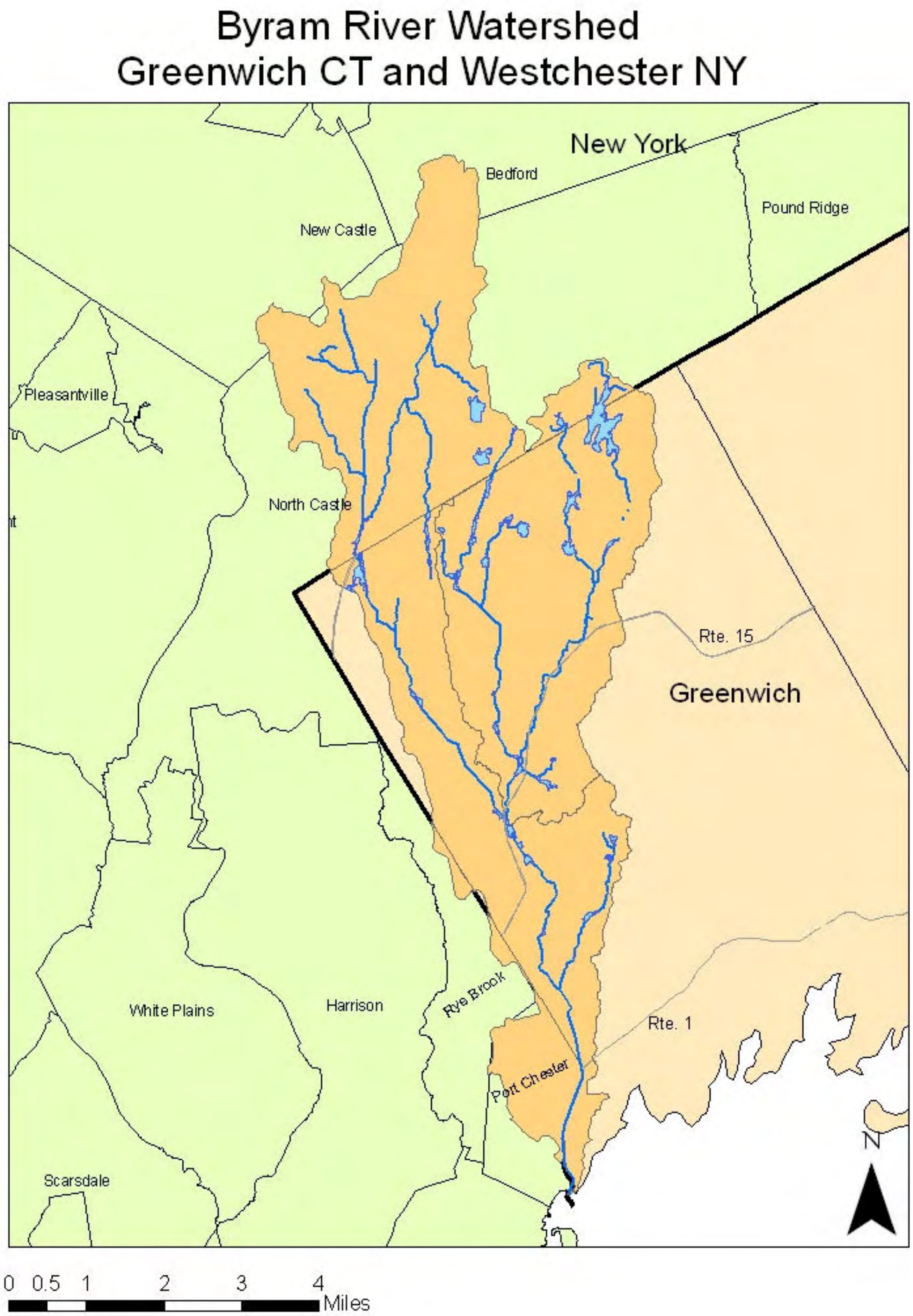

Figure 1. Byram Watershed.

The length of the river including its major tributaries can be separated into six segments. The Watershed is spread over two states and six municipalities.

1) **The upper main stem** flows from the Byram Lake reservoir located in North Castle and Bedford, NY to Tollgate Pond in Greenwich, CT, just south of the Merritt Parkway. It also includes the Wampus River, a tributary to the Byram which originates from Wampus Pond, a waterbody shared by North Castle and New Castle, NY. The Wampus River joins with the main river slightly west of I-684 in the Hamlet of Armonk (Town of North Castle), NY).

2) **The East Branch** flows from just north of the Greenwich – North Castle border to its confluence with Converse Pond Brook and the main stem of the river, above the Merritt Parkway in Greenwich about 0.9 miles above Tollgate pond. Although considered a separate segment for the purpose of this plan, the East Branch is actually a tributary of Converse Brook.

3) **Converse Pond Brook** flows from Converse Lake on the border of Greenwich and North Castle, to its confluence with the East Branch and the lower main stem of the river, above the Merritt Parkway in Greenwich about 0.9 miles above Tollgate pond.

4) **The lower main stem** of the river flows from the confluence of East Branch and Converse Brook (about 0.9 miles above Tollgate Pond) through Greenwich to CT Route 1.

5) **Pemberwick Brook** flows from a pond located at the corner of Lismore Lane and Sheffield Way in the Glenville section of Greenwich to its confluence with the lower main stem of the river along Pemberwick Road about 150 feet south of Comley Avenue.

6) **The tidal section of the river** is generally located below Route 1, where the Byram widens and becomes a tidal estuary, defining the border between Port Chester, NY and Byram, CT. It then empties into the Long Island Sound in Port Chester Harbor. Salinity measurements indicate that brackish tidewater can extend north to Den Road in the Pemberwick neighborhood of Greenwich. CT DEEP’s *highest* predicted tide elevation is above Caroline Pond.

The watershed spans two different states and a variety of overlapping and/or complimentary regulatory jurisdictions. The New York portion of the watershed is located within EPA Region 2. The EPA Region 2 is currently working with Port Chester to identify and correct problems on the NY side. The Connecticut portion is located within EPA Region 1. The New York portion of the watershed is regulated and managed by the NY DEC, while the Connecticut portion is regulated and managed by the CT DEEP. The local municipalities manage and regulate the portions of the watershed located within their own boundaries as well. This all makes data collection, data analysis, data storage, river management, and regulation a complex challenge.

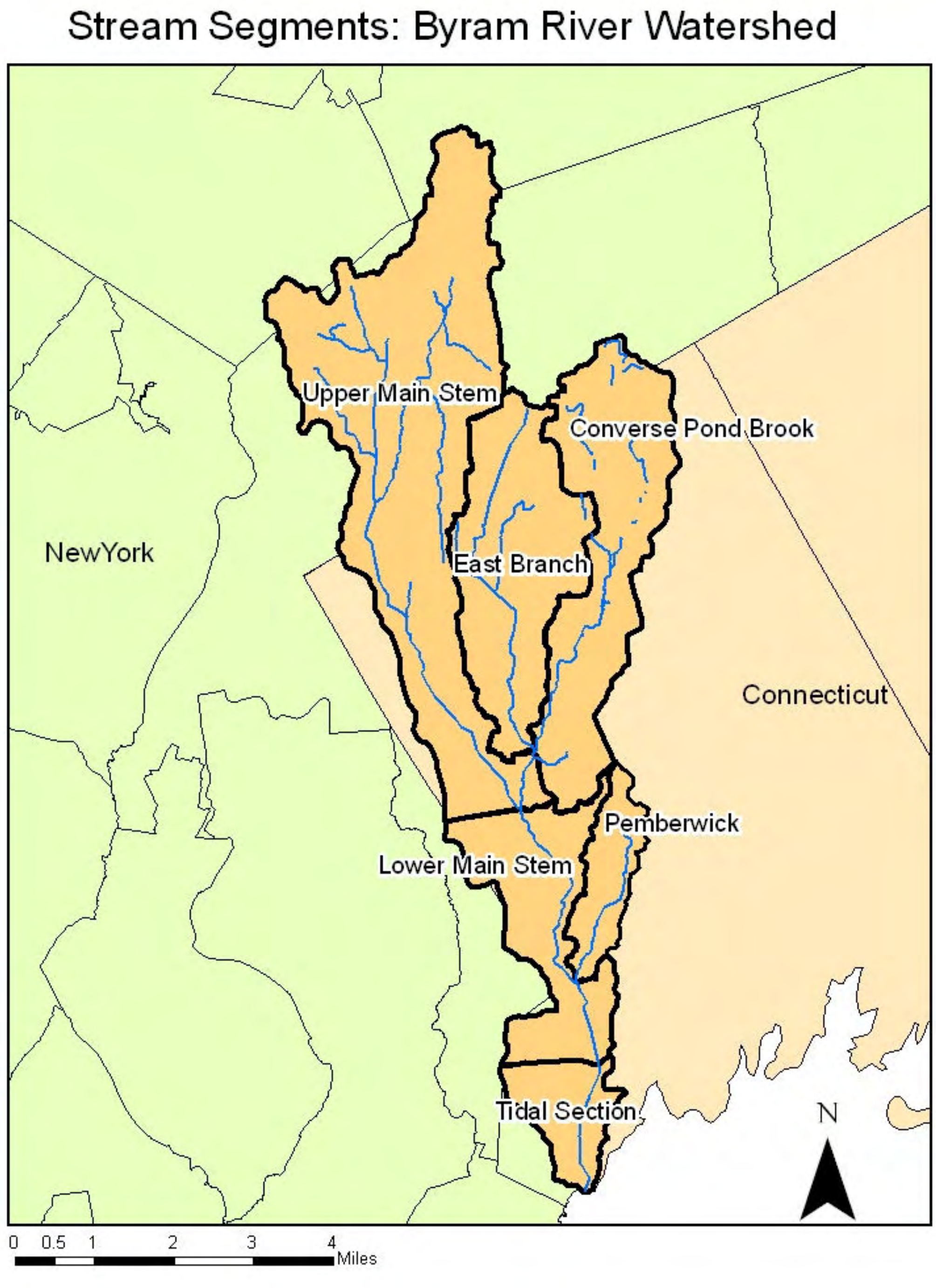

Figure 2. Stream Segments of Byram River Watershed.

1.2 Geology, Vegetation, and History

The Byram River watershed is underlain by two major types of surficial geological deposits: glacial till and meltwater outwash deposits. These two types of deposits are common throughout southern New England and eastern New York. Glacial till underlies the majority of the watershed, deposited during the advancement and retreat of ice during glacial periods that occurred up to 16,000 years ago. Glacial till is a mixture of compacted gravel, sand, silt, and clay. Depth to bedrock under the till can be as shallow as a few inches with an average of 12 feet. Deep glacial tills to 80 ft and Paxton/Woodbridge soils make this watershed different than the Mianus River watershed. Meltwater deposits are less commonly found than glacial till and are slightly more erodible. Meltwater deposits, also called "glacial outwash", consist of stratified layers of sand and gravel deposited by meltwater streams that drained the retreating glaciers (Mullaney 2004).

Outcrops of exposed bedrock are also common within the watershed. The rolling hill topography of the upper portions of the watershed is due to a combination of bedrock outcrops and drumlins (elongated hills formed by subsequent glacial action over pre-existing till material). Bedrock parent material within the watershed includes granitic gneiss, gneiss, schistose marble, schist, and amphibolite (Mullaney 2004). Soils formed from the parent material vary from excessively well drained soils located on tops and sides of hills to well drained soils and somewhat poorly drained soils on stream terraces and gently graded floodplains, to poorly drained soils and very poorly drained soils located on flat bottomed wetlands. Soil drainage depends on a combination of factors, including topography, soil type, parent material, groundwater depth and local hydrology.

The stream channel substrates within the Byram watershed are of more recent origin. The channels are incised within a mixture of deposits resulting from scour of bed and banks, deposition on nbed and banks, bank collapse, sheet wash on exposed soil within the watershed and delivery by tributaries which drain adjacent terraces, footslopes or hillsides. The stream channel substrates primarily consist of sand, gravel, silt, clay, organic material, overlying deeper layers of either stratified drift, till material or ledge.

Wetlands within the watershed exist in a variety of surroundings; on slopes, in self enclosed depressions, on stream terraces adjacent to channels, and on the fringes of impounded waterbodies. Wetlands are located within poorly drained and very poorly drained soils, in both organic substrates (e.g. deep swamps) and inorganic substrates (e.g. shallow swamps, slopes, and depressions).

Deciduous broadleaf trees such as oak, beech, birch, maple and hickory largely dominate existing natural vegetative cover within the watershed. Hemlock and white pine are also locally abundant. Most of the watershed is developed under mixed forest – residential land cover, with lawn areas and ornamentally introduced plantings supplementing the natural forest cover. Portions of the river environs where forest cover is still evident are characterized by additional riparian forest species such as elm, red maple, pin oak, sycamore, ash, sweet gum, birches and tupelo. Forested wetlands within the stream terraces and backwaters of the smaller order streams tend to be dominated by red maple, with understories of tussock sedge, winterberry, high bush blueberry, spice bush, sweet pepperbush, and skunk cabbage (Metzler and Barret 2006).

The river corridor has experienced increasing levels of development since Colonial times. Prior to European settlement, an indigenous population who took advantage of the river to fish and hunt settled the area lightly. The river provided an easy passage down to the Long Island Sound coast. The area began to be colonized in the mid 1640s by settlers from Massachusetts. For the next two hundred years, much of the upland area was farmed. The area became a source of commerce for New York City. Dams were constructed across portions of the rivers for gristmills, corn mills, and sawmills. By the early 19th century the lower watershed around Byram and Port Chester became progressively more industrialized. The railroad was completed in 1848, bringing in successive waves of additional immigrant workers for the factories, foundries, and stone masonries. Shipbuilding and fishing became major industries for the Byram and Port Chester areas. The upper portions of the watershed became a mixture of farms and gentleman estates.

At the end of the 19th century many of the mills and factories built on or near the banks of the river were abandoned. The remaining farmland within the community of Byram in the lower portion of the watershed was subdivided, and a higher density village was created by the early 1900s. The population growth within the region continued at an increasing rate throughout the 20th century. As industry waned on the river itself, estates and farms located adjacent to the banks were subdivided into comparatively smaller residential lots. Toll Gate Pond was originally a quarry used to provide material for the construction of the Merritt Parkway in 1938. The Byram River later diverted to fill it (Wikimapia 2011). There are numerous borrow pits and quarries in the vicinity of the Merrit Parkway that are now part of the Byram River. Interstate 95 was constructed across the lower section of the Byram in 1957. The increase in population and land development primarily for residential use continues into today, due to the growth of the region and its proximity to New York City.

1.3 Byram Watershed Coalition

A coalition work group was established in early 2008 to collaboratively addressing some of the major concerns of the river and the watershed.
The coalition's concerns included nonpoint source pollution, hydrological flashiness and flooding, physical alteration of the channel including dams and channelization, and the degradation of stream and adjacent upland habitat. All of these were perceived as interrelated and having impact on water quality and habitat. The jurisdictional complexity of managing a river and watershed that spans across two states, six municipalities, two state environmental agencies, two US Army Corp of Engineers Districts, and two federal EPA regions was perceived as an additional challenge by the coalition.

Participants in the coalition include representatives from the major regulatory stakeholders, interested groups, and private individuals. The work group is called the

Byram Watershed Coalition (BWC) under the organizational authority of the Southwest Conservation District. The BWC has been meeting regularly since its inception to share data and concerns, and to begin to outline fundamental goals regarding river and watershed assessment, planning and environmental protection, ecological restoration, education, and watershed management.

The BWC initially formed four subcommittees to pursue specific goal areas; Water Quality, Flood Management and Water Resources, Public Access/Open Space, and Plan Forum. After two years of capacity building and out-reach, the group decided in May 2010 to consolidate the four subcommittees to improve communication, flatten the organization, and focus on their core goal of developing a watershed management plan.

A number of other organizations work concurrently and in coordination with BWC to collect data on the Byram or provide supportive assistance. These groups include the Interstate Environmental Commission (IEC), the New York State Department of Environmental Conservation (NY DEC), the Connecticut Department of Energy and Environmental Protection (CT DEEP), and the Greenwich Health Department, as well as the (CT) Southwest Conservation District, the Natural Resource Conservation Service, the Environmental Protection Agency Regional Offices, Pace University, Columbia University, Westchester County, Westchester Land Trust, Greenwich Riding and Trails Association, and the Mianus River Watershed Council.

Several organizations in communication with the BWC have begun to develop GIS data layers that pertain to the watershed. The organizations include Pace University, the Westchester Land trust, the County of Westchester, and the Town of Greenwich. The Town of Greenwich has committed resources to pool GIS data in support of the watershed management plan to provide a single repository for as-needed GIS data support.

2. IMPACTS TO WATER AND AQUATIC HABITAT QUALITY

Byram Watershed Coalition participants have identified challenges, problems and concerns regarding the Byram watershed. They include nonpoint source pollution, hydrological flashiness and flooding, physical alteration of the channel including dams and channelization, and the degradation of stream and adjacent upland habitat. These issues are interrelated and impact both the water quality and quality of aquatic habitat within the river.

Nonpoint Source Pollution

Nonpoint pollutants into the Byram include pathogens, nutrients, sediment, floatables, metals, pesticides, and thermal pollution. At this time pathogens are considered the most significant source of pollutants, based upon the CT DEP 303(d) water quality sampling within the lower reaches of the river. Further discussion of existing pollutant data is included in section 3 of this report.

Hydrological Flashiness and Flooding

Before the watershed was settled, most of the watershed was under forest cover. The mid and upper portions of the watershed are now a mixture of residential development and fragmented forests, and the lower portions are developed into urbanized areas. The amount of impervious cover is expected to increase as the surrounding watershed continues to be developed. The capacity of the watershed to retain water has diminished because of the increase in impervious cover. Stormwater runoff into the river has also increased. Alterations to stream channels and flood plains have reduced the river's storage capacity. The river's time of concentration, the time required for a drop of water to travel from the most remote point in a catchment or drainage area to the watershed outlet, has been significantly diminished. As a result the river flow is now flashier, showing a more immediate response to storm events. This alteration of the hydrologic regime has also impacted the water quality through increased sedimentation and erosion. The quality of the habitat within the river corridor has also been affected since the system is more unstable with more frequent disturbances. Lower and mid sections of the Byram River are now subject to more frequent flooding. Large areas adjacent to the river were flooded during an April 2007 storm, which caused significant damage to properties. In September 2011, tropical storm Irene caused significant flooding as well.

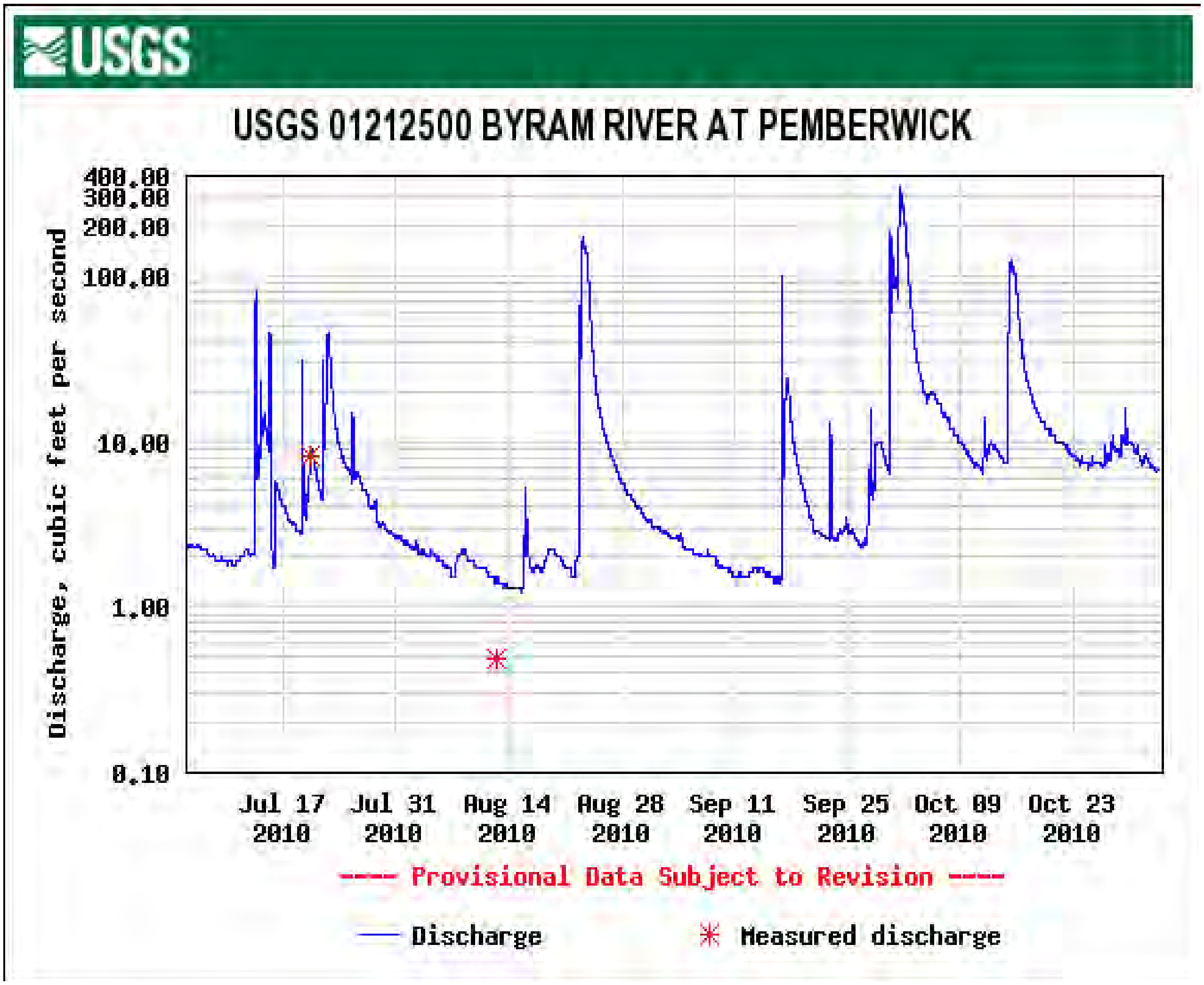

Figure 3. A representative Discharge Graph indicating the flashiness of the Byram River. Each spike corresponds to a rain event.

Physical Alteration of the Channel

A significant portion of the river channel has been altered from its natural condition. Over 40 dams, remnants of the mill pond history, man-made ponds, and river crossings are found along the length of the river, creating impoundments of varying sizes. Large stretches of the banks have been lined with stone masonry or concrete. The most significant channel modification for flood control is a half mile length of trapezoidal channel with stone rip rap constructed by the Army Corp of Engineers in about 1956 from the first dam on the river, Pemberwick Dam, to Caroline Pond. Side flow from stormwater outflows and culverts converge with the mainstream channel, causing channel/bank erosion. These physical modifications alter the normal flow of the river, by both impeding and accelerating flows, affecting both the water and habitat quality.

Figure 4. An example of both a fish barrier (dam) and a modified channel in the Byram River.

Degradation of Habitat

The aquatic habitat within the river has been negatively impacted by the alterations in hydrology and physical changes in the channel. The ecology of the river has been further impacted by the loss of vegetative cover near its banks, which has led to unnatural heating of the water in small headwater streams. Other factors detrimentally affecting the quantity and quality of habitat include: removal of riparian vegetation, invasive species introductions, conversion of forest to lawn or impervious surfaces, the generation of non point source pollution, less desirable land management practices, and the loss of buffer.

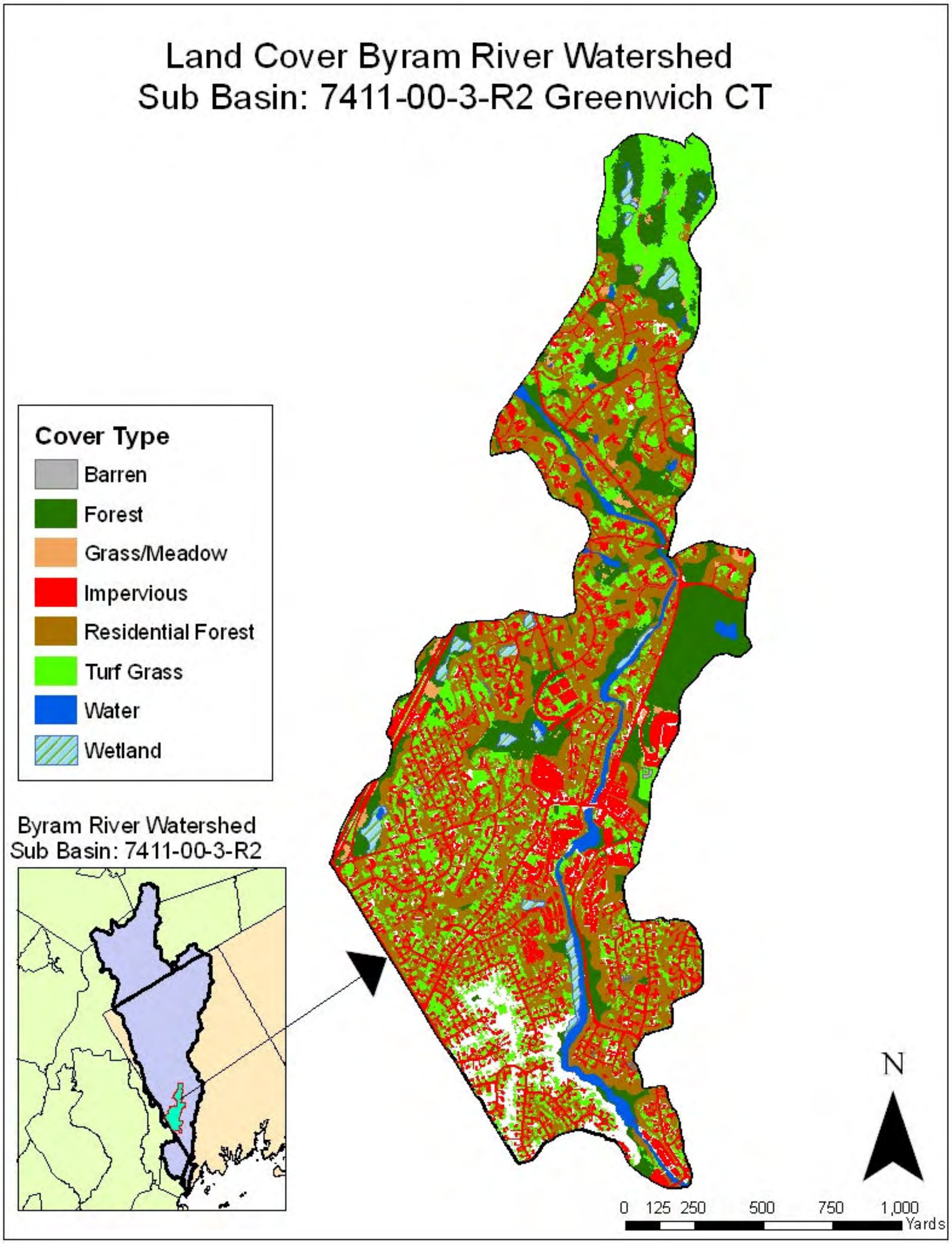

Figure 5. An example of one of the more developed regions of the Byram River Watershed. Note the amount of Impervious Cover, Turf Grass, and Residential Forest buffering the river.

3. NON-POINT POLLUTANT ASSESSMENT

3.1 Existing Data 2010

A review of existing data was conducted in the spring of 2010. The purpose of the review was to identify all relevant existing data sets and studies to date regarding nonpoint source pollutants and their causes. Datasets and studies were obtained from the following sources: Interstate Environmental Commission, US Environmental Protection Agency (Storet database), CT Department of Energy and Environmental Protection, NY State Department of Environmental Conservation, Greenwich Health Department, and Greenwich Conservation Department. The data was reviewed, summarized, and analyzed. Data gaps important to the understanding of the Byram were also identified. Individual Data Summaries are found in Appendix 1. Westchester County was not queried for data.

3.2 Assessment of Pollutants and Impairment 2010-2012

There are several ongoing efforts, which involve the collection and assessment of pollutant and impairment data. These projects will likely lead to future adjustments and refinements to the plan. A summary of these efforts are presented as follows:

1) Sampling, Analysis, and Load Model Calibration - The Interstate Environmental Commission in conjunction with Columbia University received funding under the American Recovery and Reinvestment Act in conjunction with a NYSDEC 604(b) grant to sample within a large length of the Byram River. The intent of the sampling and analysis is "to help design specific flow and water quality monitoring programs, to prioritize sub-basins that contribute significant nutrient and pathogen loads, and to identify infrastructure projects for funding recommendations". The data will be used to model the river for water quality and quantity, and to support eventual calculation of Total Maximum Daily Loads (TMDLs) pursuant to NYSDEC criteria. Sampling, analysis, and model calibration commenced in the spring of 2010 and is expected to be completed by December 2011. The project plan specifies ten sampling locations distributed along the lower Byram River, the main stem of the river, East Branch, and West Branch. Three of the ten sampling locations are in NY (in the West Branch), in the town of North Castle. There are no sampling locations specified on the Converse Brook branch.

2) Sampling – the Greenwich Department of Health conducts routine sampling of the lower reaches of the Byram River. Their monitoring confirms the bacteriological problem in the impaired segments of the Byram River. See Appendix 1 for an explanation of the sampling protocol.

3) Stream Walk Assessments – The BWC is sponsoring volunteer streamwalk surveys. The program commenced during the late spring of 2010. CT office of the NRCS and the (CT) Southwest Conservation District furnished training to volunteers. Volunteers were

assigned to walk segments of the Byram and document potential water quality concerns and influences such as algae, aquatic plant life, substrate, erosion, buffer habitat, impoundments, culverts, trash, and discharge pipes. Additional training of new volunteers and fieldwork to evaluate additional stream segments began in the summer of 2011. Fieldwork is expected until the end of Fall 2011, followed up by data summarization and analysis. Additional fieldwork will likely be needed in 2012.

4) Fisheries Resource Assessments – The CT DEEP Inland Fisheries Division has an ongoing statewide fisheries resource assessment that includes survey locations within the Byram. To date, assessment has not included the West Branch of the river, but has included areas within the lower river, the main stem, East Branch, and Converse Pond Brook. There are historical records for alewives, blueblack herring, and gizzard shad, and at least one record for native brook trout in the upper reaches. American eels have been observed in the Byram. The first impoundment is the Pemberwick Dam. It is located 3.1 miles upstream from Long Island Sound. The second dam upstream is the Glenville Dam. It is about .75 miles upstream of the Pemberwick Dam. It is unclear if river herring migrate upstream to below the first impoundment. The majority of the species on the river are warm water and pond habitat species, a likely result of the impoundments and channel modifications within the river.

5) Illicit Sanitary Connection Elimination – In July 2009, EPA Region 2 issued an enforcement action (CWA-02-2009-3060) to the Village of Port Chester, NY regarding their stormwater management program and water quality in the lower portion of the Byram River and Byram Harbor. EPA ordered corrective measures to eliminate sources of pollution began September 1, 2010. This has resulted in increased effort by Port Chester in investigations of storm water outfalls to identify and correct bacteria and other pollutant problems caused by illicit sanitary connections. Routine sampling in storm drain catch basins, manholes, and the Byram River outfalls for total and fecal coliform, e-coli, ammonia, and surfactants is underway. Video inspections, smoke testing, and dye testing of sanitary sewers and storm drains are being conducted. (Greenwich Time November 29, 2010). In August 2010, EPA Region 2 issued a follow up enforcement action (CWA-02-2010-3048) requiring Port Chester to complete all work necessary to eliminate illicit sanitary connections to the Village of Port Chester's storm water system by July 2011 and complete outfall sampling to verify elimination of illicit sanitary connections to the storm sewer system by January 2012. The Village of Port Chester received a $725,000 grant from NYDEC in November 2010 to fund the illicit sanitary connection track down and repair project. Port Chester estimates that the total cost of the project to be twice that amount.

3.3 Additional Studies 2011

As a result of the data analysis conducted in 2010, further data refinement was conducted in 2011 by a consultant working in cooperation with Town of Greenwich Conservation Department staff. An impervious cover analysis was performed for the watershed and each sub basin using GIS data from Columbia University, the Town of Greenwich, and Westchester County. Long-term ambient water quality monitoring data was obtained from the CT DEP and analyzed for trends with regard to benthic assemblages. Preliminary data was obtained from the Interstate Environmental Commission (IEC) 2010 water quality assessment and analyzed for general trends in physical parameters. The findings from all three endeavors were applied to the previous 2010 findings to refine the available knowledge of pollutant impairments.

3.4 Analysis of Watershed Data

3.41 Project Results 2010

Based on the reporting from the 2010 data sources and understandings of the watershed, the major causes of pollution to the Byram are:

1) Bacteria (indicator species E. Coli, Enterococcus ,total coliform, and fecal coliform),
2) Nutrients (nitrates),
3) Floatables,
4) Sediment (turbidity).

Other pollutants documented in the river's sediments include:

5) Pesticides,
6) Heavy metals in the Byram (metals were found downstream in LIS),
7) PCBs (Reports by NY DEC and ATSDR)
8) PAHs

2010 Summary Of Existing Data For Byram Watershed

The causes and sources of pollution to the Byram, as reported in the above data sources are summarized in Table 1. Point sources were not included in this analysis as watershed planning efforts will be focused on nonpoint sources.

The specific terminology used to describe causes and sources was adopted directly from each of the data sources, and therefore reflect the scale that each study report addresses. For example, report data from the NYSDEC uses the terminology "pathogens" while the Greenwich Health Department separates pathogens into "Fecal Coliform", "Total Coliform", and "Enterococcus". Similarly, the IEC reports use the term "runoff" while the CT DEP uses the term "stormwater". Although this may pose some methodological problems in comparing the results, the table is qualitatively helpful in that it still portrays a broad survey of the problems within the river that need to be addressed.

Table 1. Summary of Existing Data for Byram Watershed*

Location (data)	Types of Pollutants	Sources	Affected Use
LIS (iec)	PCBs, Cadmium, Dioxin, Mercury (Hg), Lead (Pb)	Past chemical spills, contaminated sed/ resusp., atmospheric deposition.	Fish Consumption
LIS (iec)	Fecal Coliform, Total Coliform, Parasites	Runoff	Shellfish
LIS (iec)	Low Dissolved Oxygen, Nutrients, Organics	Runoff, atmospheric deposition	Aquatic Life
LIS (iec)	Elevated Bacteria	Rain, sewage, runoff	Primary Contact Recreation
LIS (ctdep)	Low Dissolved Oxygen, Total Nitrogen, Nutrient/Eutrophication, Fecal Coliform, Enterococcus	Stormwater, Highway/road/bridge, waterfowl, sanitary sewers, boats	Habitat, Shellfish, Recreation
Port Chester Harbor (nysdec)	Floatables, Pathogens	Urban/storm runoff, municipal	Primary & Secondary Contact Recreation & Fishing
Lower Byram River – Tidal Section (nysdec)	Pathogens	Urban, on-site water treatment systems	Fishing
Lower Byram River - Tidal Section (ctdep)	Fecal Coliform, Enterococcus	Stormwater, residential districts, sanitary sewers, illicit connections, boats, marinas	Shellfish, Recreation
Lower Byram River Tidal Section (ghd)	Total Coliform, Fecal Coliform, Nitrate	Unreported storm sewers - illicit connections	N/A
Lower Main Stem (ctdep)	Escherichia Coli	N/A	Recreation, Habitat
Lower Main Stem (gpz)	Fecal Coliform	Animals, septics, leaky sewers	N/A

*Note: Emphasis is on nonpoint sources and causes. Terminology regarding causes/sources directly adopted from the data sources, and redundancies reflect the differences in reporting scales.

iec = Interstate Environmental Commission; ctdep = CT Dept. of Energy and Environmental Protection; nysdec = NY State Dept. of Environmental Conservation; ghd = Greenwich Health Dept.; gpz = Greenwich Planning and Zoning

Sources of pollution

1) Major *bacterial* sources include sewage from leaky septics, illicit sanitary connections to stormwater pipes, waterfowl (geese), sewage from boats, marinas, and runoff from urban infrastructure such as roads, bridges, parking lots and other impervious surfaces.

2) Major *nutrient* sources include fertilizer runoff, leaky septics, horse farms, golf courses and other managed landscapes, and runoff from impervious surfaces.

3) Major *floatable* sources include bridges, roads, stormwater outflows, boats, individual littering and dumping, and impervious surfaces.

4) Major *sediment* sources include erosion from upstream construction, road/stream crossings, streambank erosion due to flooding and degraded vegetation, stormwater runoff, post construction land development, and impervious surfaces.

5) Although *pesticides* (including herbicides) were not reported within the cited data sources, it would be expected that there would be some amount of pesticide runoff within the watershed considering the level of development and land uses within the region. Major pesticide sources would include runoff from suburban and managed urban landscapes.

6) Similarly, even though *metals* were not reported as a major cause of impairment within the waters of the river, it would be expected that there would still be some presence of metals within the sediments. Major sources would be from polluted runoff from transportation related impervious surfaces, including parking lots, highways, roads, fleet and road maintenance yards and river crossings, as well as from local site contamination.

Data Gaps

Several data gaps and inherent methodological biases were identified during the course of the 2010 review. These gaps may affect the current understanding of any patterns of contamination within the Byram, and will require the collection of additional information. Collecting data and identifying gaps is part of an iterative data gathering process, as future data is collected and analyzed, there will be additional gaps identified as well that may need to be addressed.

The EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters (March 2008) suggests that there are three types of data gaps often encountered during the assessment process. *Informational data gaps* refer to whether the existing information is relevant to the types of information needed to assess the watersheds goals. *Temporal data gaps* refer to whether the existing information was collected within the appropriate time frames relevant to the analysis. *Spatial data gaps* refer to the spatial relevancy and over all spatial applicability of generalizations based upon the data. Although there were gaps in the data in all three categories, the significant data gaps were primarily *spatial* and *informational*.

Spatial Data Gaps

The majority of the data assessment points were located in the tidal portion of the Lower Byram and in the LIS. There are few data assessment points located within the lower main stem, the upper main branch, the East Branch, or Converse Pond Brook. Since the lower portion of the river likely aggregates pollutants that originate from both the upstream and the lower stream segments, the data still has value since it may indicate in a single snapshot some of the potential threats to the health of the river at that location. It would be important to know if there are pollutants that only impair the upstream. It would also be important to determine the proportion of contribution of any upstream pollutants to the downstream assessment points. The 2010-1011 study by the IEC will bring forth more data to begin to address this issue.

Informational Data Gaps

Pesticides and Heavy Metals: There was little mention in the above data sources of the role of pesticides and heavy metals within the river. Given the level of suburbanization and urbanization in the watershed, it is reasonable to expect some level of pollution by these agents. There may be a few reasons why these parameters were understated. The agents may not have been fully sampled for. The agents may be present at a level below the detectable or impairment level of the particular study. Local contamination upstream may be diluted downstream or locally bound to sediments or settled out during low flows and not mobile. Furthermore, the sampling sites might not constitute a representative sample, as previously discussed.

Other Pollutants: It should be noted that for each reported pollutant to be listed, it had to be present in amount relative to a threshold to trigger impairment relative to a specific use. It is conceivable that a pollutant could have been present at a base level, at a level sufficient to pose a concern to those interested in the health of the river, but not at a level high enough to trigger the impairment threshold for a designated use as specified by the regulatory agencies, and therefore not reported in their data.

3.42 Impervious Cover Analysis - 2011

The percent impervious cover (percent IC) for each of the fifty-five hydrologic subbasins (8-digit HUC subbasins) in the Byram watershed was calculated using Arc GIS mapping software. Impervious coverage was compiled from existing datasets from the Town of Greenwich GIS Department and the Westchester County GIS data warehouse. The individual subasins were then summarized by the watershed segments of the major tributaries. A detailed description of methods and tabulated results for individual sub basins is provided in Appendix 3.

The entire Byram River watershed is 19.13 percent IC. Impervious cover is not evenly distributed throughout the watershed. There is a general gradient from North to South where the sub basins to the North are less developed and the southernmost sub basins are heavily developed, with some basins exceeding 70 percent IC. However, there is a cluster of heavy development and high percent IC to the North in the North Castle area in the Upper Main Steam stream segment. Much of the central watershed is moderately developed with predominantly single-family homes. The southernmost stream segments, Tidal Section and the Lower Main Stem, are located in Port Chester and lower Greenwich; these areas are heavily urbanized.

Table 2 summarizes total area, impervious area, and percent impervious area for each major stream segment.

Table 2. Byram River Watershed Percent Impervious Cover by Major Stream Segment

Stream Segment	Area (acres)	Impervious Acreage	Percent Impervious Area
Tidal Section	979	855	87.33
Pemberwick	913	120	13.14
Lower Main Stem	2379	906	38.08
Converse Pond Brook	3697	376	10.17
East Branch	3337	314	9.41
Upper Main Stem	7911	1106	13.98
Byram River Watershed	19216	3677	19.13

In the context of watershed management, analysis of percent IC is useful as a surrogate measure for the impacts of stormwater on a stream; this technique is outlined in "A TMDL Analysis for Eagleville Brook, Mansfield CT" (State of Connecticut 2007). The amount of stormwater delivered to a stream will increase with higher levels of impervious cover due to increased runoff. Stormwater carries an array of pollutants and can cause a variety of negative impacts to a stream. Figure 6 and 7 illustrate the percentage impervious cover for each major stream section and sub basin, respectively, of the Byram River watershed.

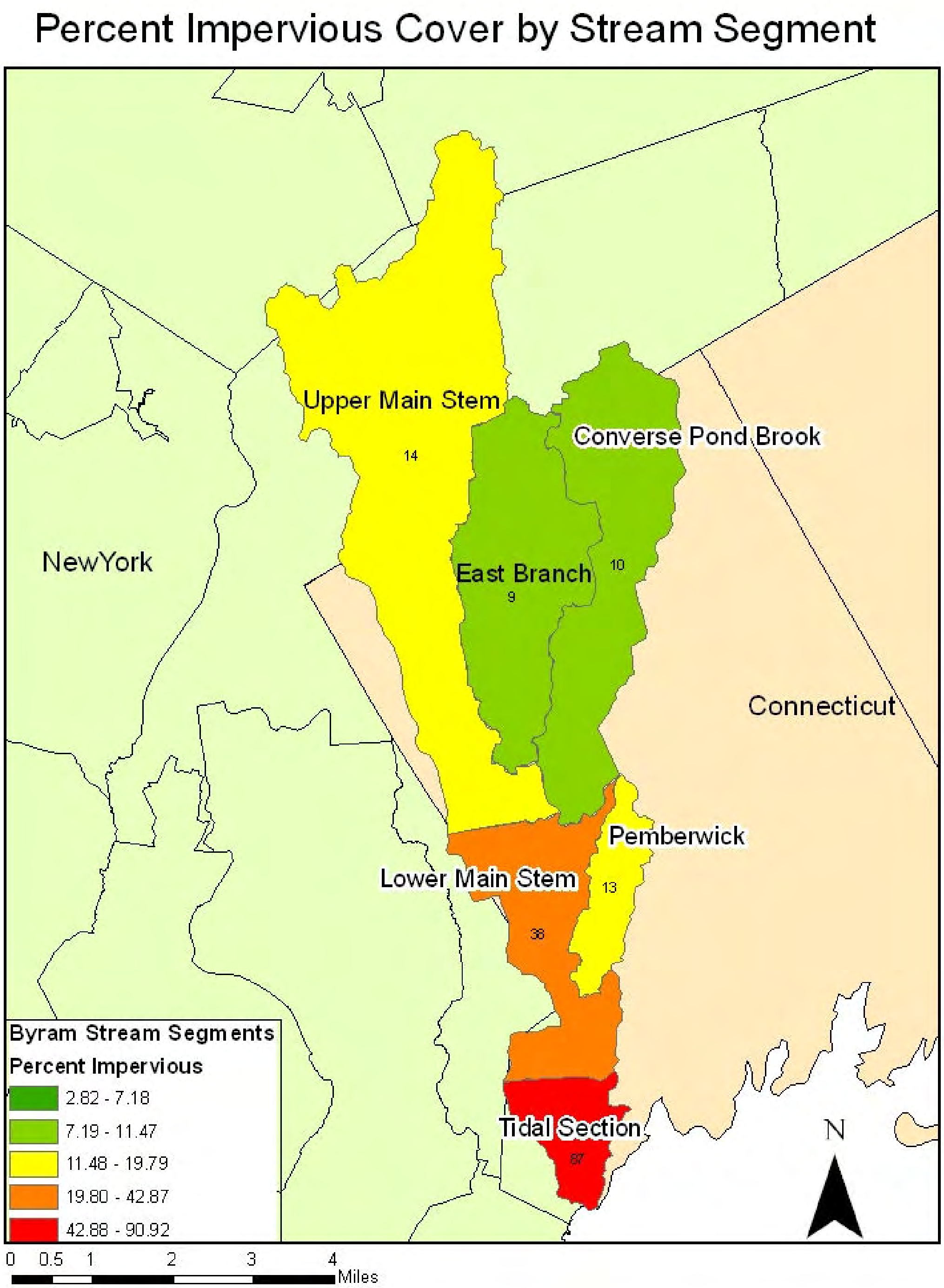

Figure 6. Percent Impervious Cover by Stream segment

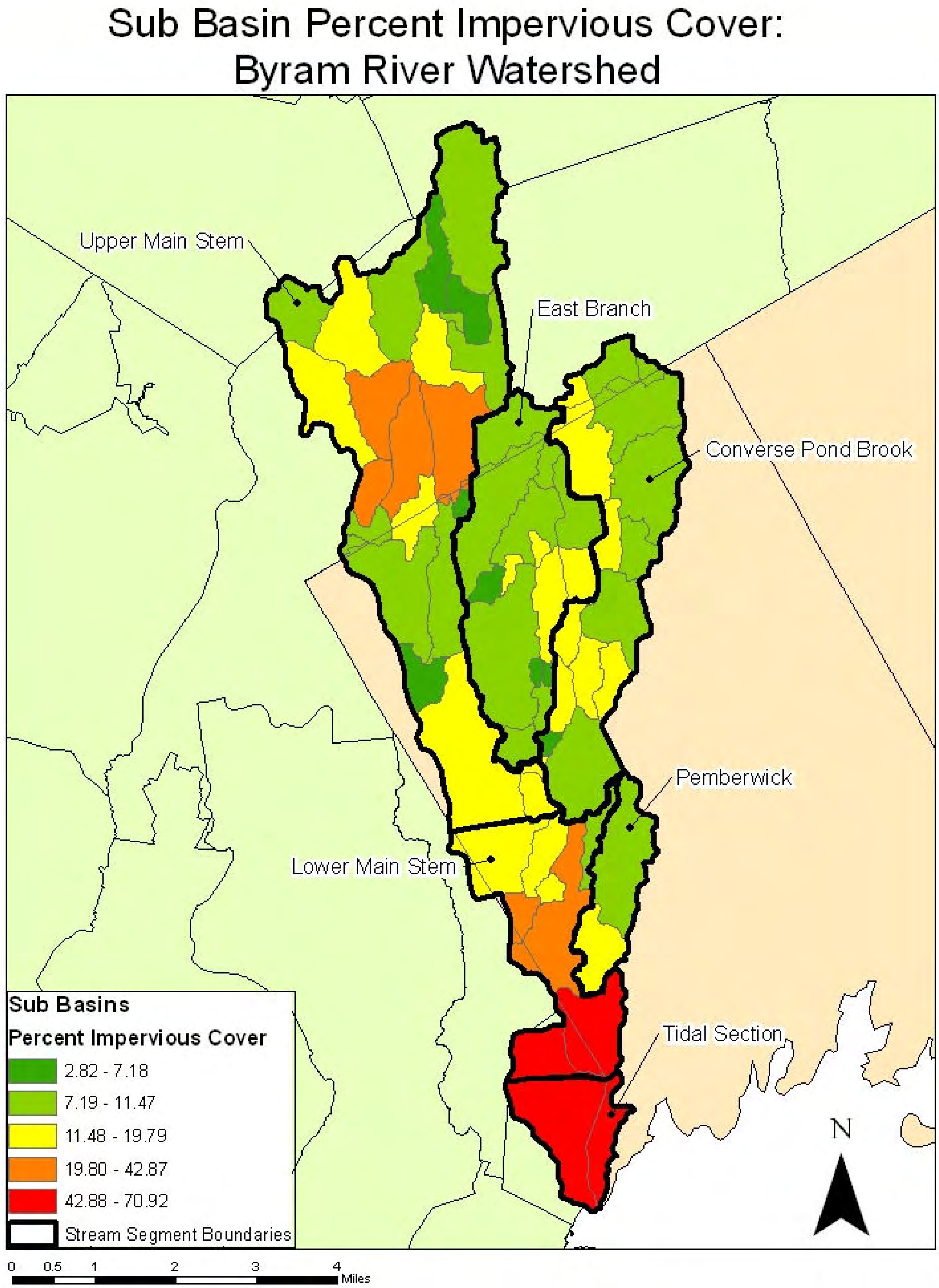

Figure 7. Byram River Watershed Percent Impervious Area for Individual Sub Basins

The negative relationship between impervious cover and water quality has been well documented by the State of Connecticut and the scientific community (Belluci et al. 2008, Walsh et al. 2005). In a 2008 report on moderately developed watersheds, Belluci et al. 2008 assert that streams with upstream catchments greater than 12 percent IC are likely to have poor biological communities and fail to meet Connecticut's aquatic life goals. The whole Byram watershed has a total percent IC of 19 percent, with a number of sub basins that greatly exceed 12 percent IC.

Only the East Branch and Converse Pond Brook segments are below the 12 percent threshold outlined in (State of Connecticut 2007, Belluci at al. 2008). The Pemberwick section and Upper Main Stem are slightly above (13.15 and 13.98 percent respectively). The Tidal and Lower Main Stem segments greatly exceed the 12 percent threshold (87 and 38 percent respectively).

Benthic Macroinvertebrate Analysis

The CT DEEP conducted benthic macroinvertebrate sampling at three points along the Byram River as part of their statewide water quality monitoring effort. The sampling points are located at – John Street (East Branch), under Route 15 adjacent to Riversville Road (at the top of the Lower main stem), and Comley Avenue (Lower main stem of the river). Data was available from sampling events in 1987, 1996, 2002, 2007 and 2009. Benthic macroinvertebrates are insects in various stages of their life history that inhabit the stream bottom. Benthic macroinvertebrates have varying sensitivities to pollution and it is possible to make observations about stream health based upon the presence or absence and relative abundance of specific macroinvertebrate species.

Macroinvertebrate Multi Metric Index (MMI) scores from the Byram were evaluated to assess water quality trends, and examine any relationships to impervious cover. A sampling site's macroinvertebrate MMI score is based upon a series of 7 metrics that measure different attributes of the benthic macroinvertebrate community. In a study of 125 Connecticut watersheds with similar levels of development, the CT DEEP found that MMI scores decreased with increasing levels of impervious cover (Belluci et al. 2008)

The MMI results are presented in Table 3 and Table 4. Of the three sample points: John Street, Route 15 adjacent to Riversville Road, and Comley Avenue, only the John Street location met the state's aquatic life goals outlined in CT DEEP / EPA Water Quality Standards (State of Connecticut 2002).

Table 3. Macroinvertebrate (MMI) Scores in the Byram River Watershed
MMI scoring convention from the CT DEP report on Moderately Developed Watersheds (Bellucci et al. 2008).

Sample Date	MMI score	Sample Site Landmark	305 (b) and 303 (d)
10/3/2002	58.22	John Street	Pass
10/3/2002	70.01	John Street	Pass
10/3/2002	70.53	John Street	Pass
10/18/2007	37.01	Rt 15 adj to Riverville Rd	Fail
10/18/2007	41.76	Rt 15 adj to Riverville Rd	Fail
10/18/2007	41.76	Rt 15 adj to Riverville Rd	Fail
10/18/2007	30.33	Comley Avenue	Fail
10/18/2007	30.33	Comley Avenue	Fail
9/29/2009	33.45	Comley Avenue	Fail
9/29/2009	33.45	Comley Avenue	Fail

KEY

Rank	MMI Score
Failing	<44
Ambiguous	45-55
Passing	>56

Table 4. Relationship Between Impervious Cover and Macroinvertebrate (MMI) Scores for Sampling Locations in the Byram River Watershed

Location	Percent IC immediate Upstream Catchment	Most Recent MMI Score
John Street	2.82 and 13.31	70.53
Rte 15 adjacent to Riversville	13.92	41.76
Comley Ave	32.5	33.45

A longitudinal pattern of MMI scores is shown in Figure 8 where the higher scores occur to the north, and the lower scores to the south. John Street is the northernmost sample point, followed by under Rte 15 adjacent to Riversville Road and Comley Avenue located farthest to the south. In the portion of Byram Watershed within the Town of Greenwich there is a similar longitudinal pattern in the percentage IC where the basins to the south are more heavily developed than the basins to the north. The southernmost basins are the most heavily developed, with some basins exceeding 70 percent IC.

The pattern indicated by the three sample sites within the Byram Watershed is consistent with findings statewide; where MMI scores decline with increasing impervious cover. The upstream catchments for both the Comley Avenue and Route 15 adjacent to Riversville Road sites exceed 12 percent IC. Both sampling sites have failing MMI scores. The John Street site is at the confluence of two tributaries whose respective upstream catchments have a percent IC of 2.82 and 13.31. Further upstream from the sample site are multiple basins with percent IC < 12. The sampling site has a relatively good MMI score (70.53) indicating relatively good stream health. This suggests that the influence of multiple upstream basins with lower percent IC can outweigh the influence of the single impaired basin; this idea is at the core of any successful watershed management effort.

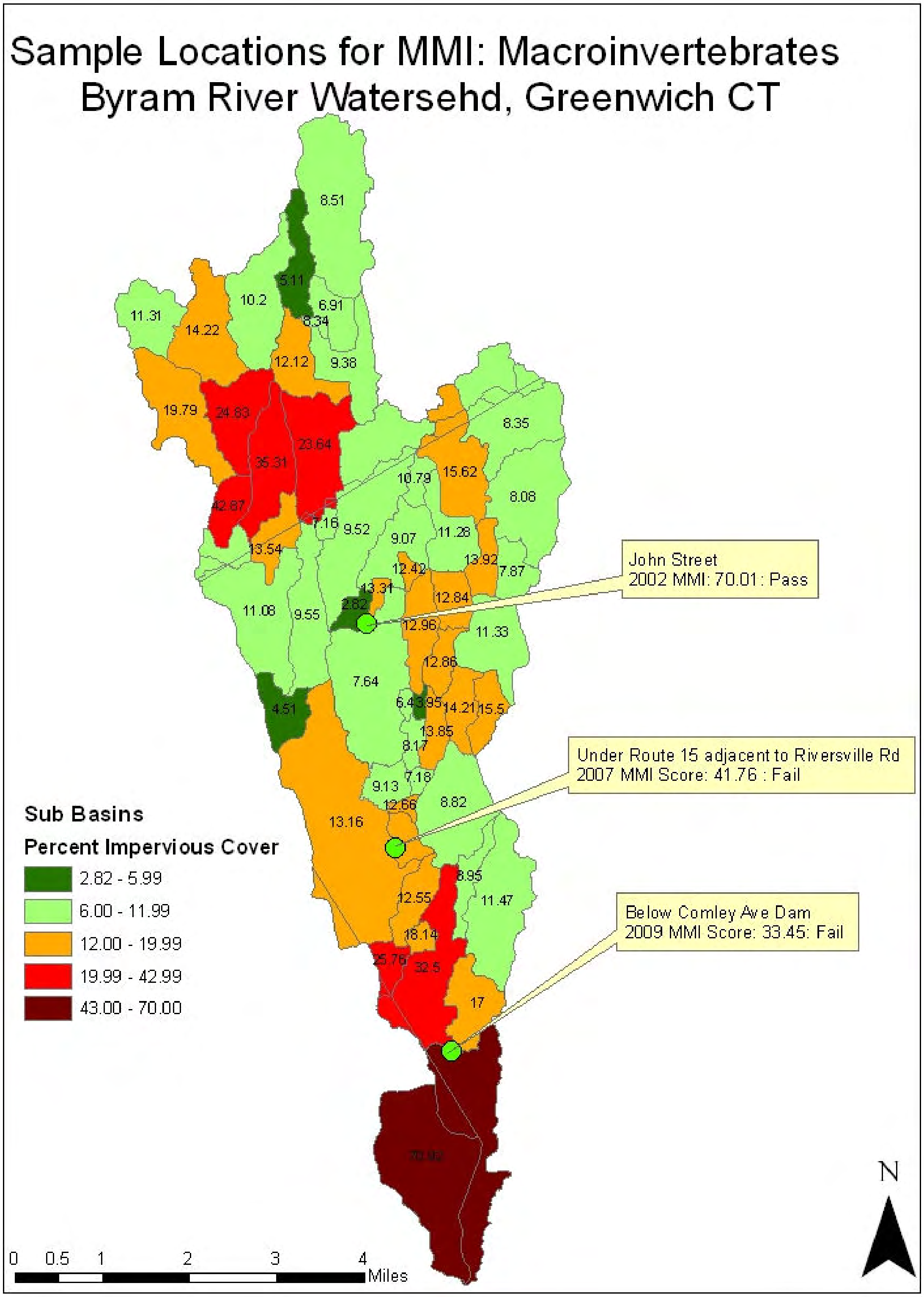

Figure 8. Sampling Locations and Macroinvertebrate (MMI) Scores in the Byram River Watershed.

Physical Parameter Analysis

Preliminary data was obtained from the Interstate Environmental Commission (IEC) 2010 water quality assessment, and analyzed for general trends in physical parameters. The data was initially collected in order to prepare a pollutant loading model for the river through a funding agreement with NYSDEC in 2009. The modeling results of this project were not publically available at time of this 2011 report. However, the IEC was still able to share the preliminary data with the BRWC in order to tease out any general trends that could be useful to a more complete understanding of the existing pollutants in the Byram.

Interstate Environmental Commission sampling locations are shown in Figure 9.

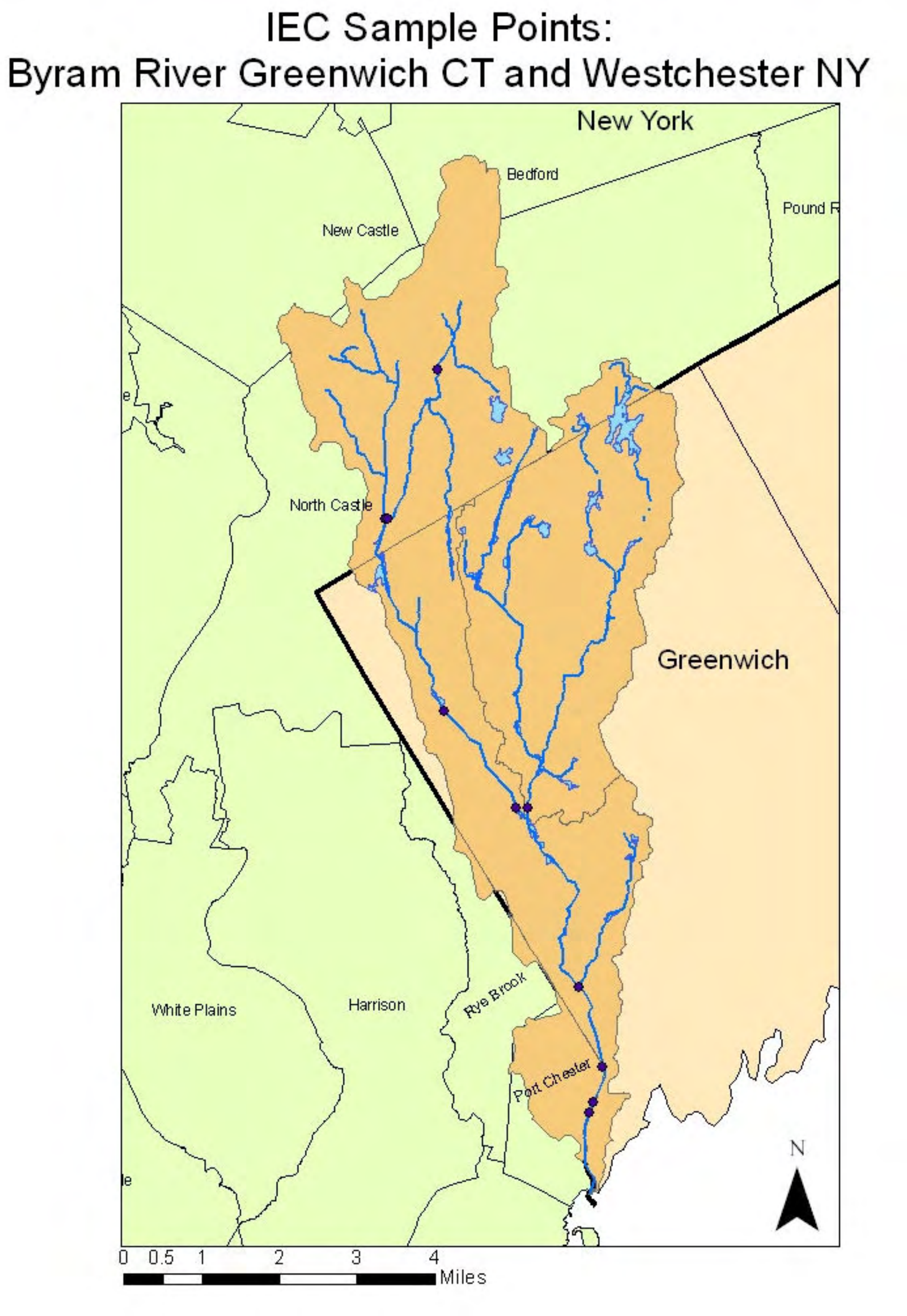

Figure 9. Sampling Locations for Water Quality Sampling Conducted by Interstate Environmental Commission (2010-11).

The locations were along the lower Byram River, the main stem of the river, the East Branch, and the West Branch. Three of the ten sampling locations are in NY (in the West Branch), in the town of North Castle. There were no sampling points on the East branch or Converse Brook, however a sample point was located below their confluence on the main stem of the river, above Tollgate Pond.

Sampling was conducted 4 times in 2010. There were two wet sampling events (during or shortly after a rain event) and two dry sampling events. Sampling was for an array of physical parameters. Draft results were obtained from the IEC and then compared with published CT, NY, and EPA water quality standards by the consultant working with the BRWC.

Findings included the following:

- The sampling point below the North Castle Treatment Plant (on the Wampus River) was consistently polluted across an array of parameters. It exceeded standards for turbidity, conductivity and TP for wet and dry sampling. It had problematic DO for dry sampling, and E. coli for wet sampling. N values did not appear to be problematic.

- Within the Main stem of the river (below Toll Gate pond), the results were more varied. E coli exceeded standards during wet sampling, but not during dry sampling. Similarly, TP exceeded standards during wet sampling, but not during dry sampling. This indicates that runoff is a prime contributor to pollution. N did not appear to be an issue during wet or dry sampling. DO was below minimum standards in the Cliffdale road site only, and only during wet sampling. Turbidity was an issue above Route 15 during wet and dry, but relatively benign at the sites below Route 15.

- At the confluence of Converse Brook and East Branch, E. Coli was elevated during both wet and dry sampling. Turbidity was elevated during wet sampling. Total Phosphorus, Nitrogen, and Dissolved Oxygen were not problematic during wet or dry sampling.

- Overall, pathogens (E. Coli), Total Phosphorus and Turbidity appear to be the main issues within the river, depending on location. Pollution appears to be exacerbated by stormwater runoff in several locations.

- Nitrogen did not appear to be a major issue within the sampling points, contrary to previously articulated concerns and assumptions. It is recommended that additional sampling be conducted to explore nitrogen levels to see if this was an artifact or a trend.

- It should also be noted that there is some ambiguity in the literature regarding standards for N in flowing water bodies, making definitive conclusions about the implications of N loading more difficult. Furthermore, even if N levels are found to be consistently non problematic in the Byram on the basis of additional sampling, most research being conducted in the LIS indicates that N is still a problem within in the Sound, therefore it would still be important to plan to reduce N loadings within the Byram regardless.

3.43 A Pollutant Reduction Strategy through Reduction in Impervious Coverage

The 2010 and 2011 data analysis endeavors have resulted in a more refined understanding of the issues that confront the Byram River.

The major stressors to the river system appear to be pathogens, nutrients, high magnitude flood events, and structural alterations to the channel. The likely sources of these stressors, their impact, and the resulting impairments to the river are outlined below in a conceptual model labeled Table 5.

Table 5. Conceptual Model of Bacteria, Nutrients, Hydrological, and Structural Alteration Stressors.

	Bacteria	**Nutrients**
Source	Septic, geese, deer, pets, stormwater	Septic, Stormwater - illicit sanitary connections - impoundments - land-use practices
Stressor	Bacteria	Nitrogen, Phosphorus
Mechanism of Impact	Harm to human and aquatic health	Decrease in DO
Impairment	Limited Recreation Decrease in Aquatic Life	Eutrophication of LIS Decrease in Aquatic Life

	Hydrological	**Structural Alterations**
Source	Structural alterations - decreased channel capacity - increased impervious surfaces in channel	Channelization, dams, Unvegetated buffers
Stressor	Flashiness (timing) Peak flow (magnitude)	Structural alterations
Mechanism of Impact	Flooding, erosion, turbidity, Reduced base flow	Degraded natural habitat - riparian and aquatic Erosion and Sedimentation

Impairment	Impaired benthic & riparian habitat Property damage	Impaired aquatic life use Decreased biological diversity

The common thread throughout the multiple chains of causation depicted in the above model is stormwater.

Stormwater runoff consists of a mixture of pollutants, including the pathogens and nutrients which impact and impair the river ecosystem. The transport of large quantities of stormwater over short periods of time causes the physical damage to the stream ecosystem that is evident, and to its adjacent upland buffers. One of the most efficient methods to control the generation and transport of pollutants is therefore to focus on ways to decrease the generation and transportation of stormwater.

The CT DEEP has documented throughout the state strong correlations between pollutant loads and macroinvertebrates, stormwater flows, and impervious land cover in the watersheds. (CT DEP 2002) The CT DEEP has stated through their public outreach materials that the most efficient method to decrease the negative impact of stormwater throughout a river basin is to decrease impervious coverage within its contributing watershed to values less than the 12% impervious coverage threshold (CT DEP 2002, 2008).

A focus on the reduction of impervious area as a primary strategy to address pollutant loads in the Byram is based on watershed planning work done in the Eagleville Brook in Mansfield, CT. A Total Maximum Daily Load Analysis (TMDL) was compiled for Eagleville Brook based upon impervious cover values, after a stressor identification analysis determined that a “complex array of pollutants transported by stormwater” was the most probable cause of the impairment (CT DEP 2007). The impervious coverage TMDL was reviewed and approved by the CT DEP and US EPA. Eleven (11) percent was set as a goal target. (Federal methods for TMDL calculation required a 1% margin of safety). The calculation of a TMDL is beyond the scope of this watershed plan, however, it is recommended that a similar impervious cover approach be adopted and applied to the Byram River watershed, to set planning goals to improve stream health.

An impervious cover approach would involve the following:

A target reduction value of 12% per major stream segment or watershed sub basin would be adopted to provide a benchmark goal for the implementation of future specified BMPs within the watershed. As in the case of Eagleville Brook, an adaptive management strategy would be adopted to identify and implement these BMPs. The strategy framework would include:

1) Reducing impervious cover where practical

2) Disconnecting impervious cover from the streams wherever possible

3) Minimizing additional disturbance to the stream and the adjacent upland to maintain existing natural buffering capacity

4) Installing engineered BMPs to reduce the impact of impervious coverage on receiving water hydrology and water quality.

Monitoring performance towards these goals would involve continuing to obtain and analyze DEEP sampling data from their on going 5 year rotating basin water quality monitoring effort. Since the DEEP data was used as a baseline for the 2011 data analysis summarized above, it makes the most sense to continue utilizing it to determine compliance with future goals. This data would be supplemented with additional citizen science benthic monitoring, in coordination with the local schools and other volunteers, and, where funding can be obtained, with professional benthic monitoring and water quality analysis.

The proposal to achieve a 12% IC for each subwatershed may be out of reach for many of the lower portions of the watershed. However, it might appear to be a reasonable goal for upper watershed areas. The Town of Greenwich is going forward with a P&Z regulation that would require minimum green space according to lot sizes. (October 2011). The regulation will complement the proposed goal of a 12% impervious cover advocated in the above analysis. As presently proposed (November 6, 2011) the Town of Greenwich regulation (Green Lot Percent of Cover Regulation proposed as 6-5(a)(34.1)) sets goals for green lot coverage based on lot size as follows

RA-4 - 84%
RA-2 - 78%
RA-1 - 72%
R-20 - 62%
R-12 - 55%
R-7 - 50%
R-6 - 35% (single and two-family)

Additional analysis of the regulation with regard to the impacts it will have on IC in the long term for the Byram watershed will be needed along with a basis for measuring and monitoring success toward the proposed 12% impervious cover goal. The background development studies conducted by P&Z may provide this needed information.

4. WATERSHED MANAGEMENT PLAN GOALS & ACTION PLAN

4.1 Watershed Management Plan Goals

The central goal for the Byram River is to improve its water quality and habitat. Based on the analysis of available data, the following list of goals is proposed for the Byram River watershed management plan.

A. **Provide Data Support:** Create a structure and process to acquire, share, and analyze baseline and monitoring data for the river and watershed.

B. **Nonpoint Source Reduction:** Diminish or eliminate nonpoint sources of pollution into the Byram including (but not limited to) pathogens, nutrients, sediment, floatables, metals, pesticides, temperature, and sodium.

C. **Improve Base Flow and Minimize Peak Flow:** Encourage appropriate studies to determine why the Byram River floods and what alternatives should be considered to improve base flow and minimize peak flow.

D. **Promote Sustainable Land-use:** Encourage land-use practices and planning that contribute to the ecological health of the river.

E. **Protect Riverine Habitat:** Protect, restore, and enhance habitat for fish, aquatic life, and wildlife within the channel and riparian corridor.

F. **Protect Upland and Non-riverine Landscape:** Conserve, protect, restore, and enhance critical landscape located in the upland watershed that contributes to the health, stability, and value of the river.

G. **Protect and Promote Compatible Recreational Uses:** Protect, restore, promote, and enhance portions of the river to compatible recreational uses as appropriate

The follow sections provide additional detail on these goals and an outline of strategies for their implementation.

4.2 Watershed Management Action Plan

CATEGORY A: Data Support

Create a structure and process to acquire, share, and analyze baseline and monitoring data for the river and watershed.

Objectives:

A1. Create and compile a GIS database repository to support data acquisition and analysis.

A2. Delineate Watershed Assessment Units for use in data acquisition and analysis.

A3. Compile baseline data for a basin by basin assessment of land use patterns.

A4. Perform a comparative subwatershed analysis to determine the basins with the greatest vulnerability/conservation needs and the basins with the greatest restoration potential.

A5. Design and conduct a macro-invertebrate study of the river to assess ecological health, species richness, and detect impaired segments.

A1. Create and compile a GIS database repository to support data acquisition and analysis.

Task 1. Appoint a lead staff person from Greenwich Conservation Commission to work with TOG GIS staff to create a GIS warehouse for Byram watershed coverages.

The Conservation Commission staff will serve as the principal point of GIS contact for any BWC committee members who need GIS assistance. Having a principal point of contact through Conservation Commission staff will be important to make the most efficient use of GIS department staff time, to prevent cross communication problems by streamlining GIS request procedures, and to prevent duplications of effort.

Task 2. Set up a working relationship between Conservation Commission staff and GIS department staff.

The TOG GIS staff will be charged with creating and maintaining data quality standards for the depository, and to work out any technical issues regarding data transfer. The TOG GIS staff and Conservation Commission staff will both be charged with coordinating with relevant GIS professionals from other organizations and governments.

Task 3. Analyze draft intermediate plan to determine what coverages will be needed. Prioritize what can be generated immediately, and what can be generated after further investigation and analysis. Develop a working relationship with other BWC GIS representatives. Develop a work plan. Develop policies for public data sharing.

Responsible Parties: TOG Conservation Commission staff and TOG GIS staff
Milestones: Creation of the work plan, development of standards, creation of the repository, codification of public data sharing policies, use of the repository.
Timeline: 1 year
BMPs: GIS
Evaluation Criteria: Functional GIS database, GIS analysis products, a public data sharing policy that is acceptable to BWC members and the public. A duplicate set of GIS files will be made available as downloads from a website or as a CDROM.

A2. Delineate Watershed Assessment Units for use in data acquisition and analysis.

Task 1. Obtain the DEP basin map and identify the basin units within the Byram (7411) and East Branch Byram (7410) subregional basins in coordination with the stream walk assessment.

Task 2. Reconcile units with the proposed stream units cited in the introduction of the report.

Task 3. Identify any areas that are no longer in the topographic watersheds due to storm sewer system withdrawals or because of surface water diversions.

Task 4. Identify Streamwalk sampling sites

Task 5. Prepare GIS coverage to be also used for data management.

Responsible Parties:
Milestones: Creation of the map, creation of a GIS coverage that can be used for data collection and management.
Timeline:
BMPs: GIS
Evaluation Criteria: Functional GIS coverage

A3. Compile baseline data for a basin to basin assessment of land use patterns.

Task 1. Characterize each basin and compare to whole watershed

Obtain for each basin, and then the whole watershed, the following:
Size, impervious area, % cover types, zoning, septic – sewer – water status, qualitative description of land use patterns, hot spots and problems (from streamwalk data)

Responsible Parties: Municipalities
Milestones: GIS analysis, data summary statistics in report
Timeline:
BMPs: GIS
Evaluation Criteria: Production of summary statistics to be incorporated in final plan

A4. Perform a comparative subwatershed analysis to determine the basins with the greatest vulnerability/conservation needs and the basins with the greatest restoration potential.

Task 1. Determine the basins with the greatest vulnerability/conservation needs and the basins with the greatest restoration potential.

The analysis should use a methodological approach similar to that used in the North Branch Park River Plan, Brookfield, CT (Appendix 2)

The method used in the North Branch Park River Plan involves the following:

a. Identify subwatershed basin
b. Select and calculate metrics to measure vulnerability
c. Select and calculate metrics to measure restoration potential
d. Develop weighing and scoring rules to assign values to each metric
e. Compute aggregate scores and develop basin rankings

Subwatershed basins with high vulnerability scores are more sensitive to future development and may have high quality resources worth protecting. Subwatershed basins with high restoration potential scores are more likely to be impacted but good candidates for restoration based upon existing conditions.

Responsible Parties: technical BWC member or consultant
Milestones: selection of metrics, compilation of needed data, analysis, produce ranking lists, issue report
Timeline: Contingent on funding.
BMPs: Quantitative analysis
Evaluation Criteria: Prioritization report of basins most sensitive to development, and basins that are good restoration candidates.

A5. Design and conduct a macro-invertebrate study of the river to assess ecological health, species richness, and detect impaired segments.

Task 1: Design and conduct a macro-invertebrate study of the river to assess ecological health, species richness, and detect impaired segments. Focus on selected basins or survey all basins, depending on labor and funding constraints.

Task 2: Evaluate results to determine sources and locations of pollutants.

Task 3: Identify solutions and recommendations for pollutant source reductions.

Responsible Parties:
Milestones: Study design, field work, analysis of field work results, source analysis, identification of solutions, implementation of solutions, and observation of improvement in macro-invertebrate study findings.
Timeline: Ongoing
BMPs: Sampling
Evaluation Criteria: Number of macro-invertebrate studies and site visits conducted, summary reports with analysis, number of field sites determined to be "improving" based on sampling studies.
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CATEGORY B: Nonpoint Source Reduction.

Diminish or eliminate nonpoint sources of pollution into the Byram including (but not limited to) pathogens, nutrients, sediment, floatables, metals, pesticides (including herbicides), temperature, and sodium.

Objectives

B1. Identify and implement stormwater outfall retrofits.

B2. Identify and treat existing and potential sources of contamination from septic systems.

B3. Identify and treat existing and potential sources of contamination from parking lot discharges.

B4. Identify and treat existing and potential sources of contamination from river and stream crossings.

B5. Identify and treat existing and potential sources of contamination from inadequately sized river buffers.

B6. Identify existing and potential sources of nutrients from large areas of managed turf located adjacent to the river and its tributaries.

B7. Identify existing and potential sources of nutrient contamination from horse farms.

B8. Conduct pollutant load modeling for the Byram under existing and build-out scenarios, to identify future trends and potential issues.

B9. Conduct Investigation and Elimination of Illicit Sanitary Connections.

B1. Identify and implement stormwater outfall retrofits:

Task 1: Prioritize locations and basins in which retrofits are most feasible, and most likely to have significant impact on water quality. Obtain and examine existing Public Works maps, use local knowledge, confer with Conservation District, and analyze forthcoming Streamwalk data to select and identify sites.

Task 2: Estimate pollutant load reductions and costs for retrofits

Task 3: Secure funding and implement retrofits

Responsible Parties: Municipal, County and State MS4 NPDES Stormwater permitees and BWC.
Milestones: Obtain outfall maps, evaluation of sites, recommend retrofits, listing/ranking of candidate sites, secure funding, implementation.
Timeline:
BMPs: See Appendix 4 for examples of stormwater outfall retrofits**.**
Evaluation Criteria: Prioritized listing of candidate sites, recommended retrofits, and estimated load reductions. Number of stormwater BMP retrofits completed.

B2. Identify and treat existing and potential sources of contamination from septic systems.

Task 1: Locate areas within the watershed that are served by septic. Confer with local (Greenwich) and county (NY) agencies for available mapping. Create/compile a GIS map.

Task 2: Evaluate the areas to determine the scope of potential contamination. List susceptible areas. Identify problematic sites through research and discussions with Health departments. Formulate management and control measures as appropriate for areas and candidate sites.

Task 3: Work with appropriate Health authorities to enable enforcement action to correct failing septic systems discovered.

Task 4: Evaluate current local regulations regarding maintenance and formulate recommendations to strengthen river protection.

Task 5: Identify public outreach needs as appropriate.

Responsible Parties:
Milestones: Creation of map, identification of problem areas, identification of problem sites, formulation of improvement measures, issuance of recommendations to improve regulations, development and implementation of public outreach
Timelines:
BMPs: See Appendix 5 for an example of a Non-Point Source Assessment of Septic Systems.
Evaluation Criteria: Creation of map, number of sites identified or improved, issuance of regulation recommendations, # of people reached by public outreach

B3. Identify and treat existing and potential sources of contamination from parking lot discharges.

Task 1: Identify all parking lots that discharge directly into the river. Create a map.

Task 2: Identify candidates for BMP improvements. Select appropriate BMPs, estimate load reduction.

Task 3: Evaluate current local regulations regarding discharge mitigation requirements and formulate recommendations to strengthen river protection.

Responsible Parties:
Milestones: Creation of map, identification of candidates and BMPs, issuance of regulation recommendations
Timeline:
BMPs: See Appendix 4 for examples of BMPs for parking lots.
Evaluation Criteria: Creation of map, number of sites selected and improved, issuance of recommendations.

B4. Identify and treat existing and potential sources of contamination from river and stream crossings.

Task 1: Identify all road and bridge crossings over the Byram that discharge directly into the river. Create a map.

Task 2: Identify candidates for BMP improvements. Select appropriate BMPs, estimate load reduction.

Task 3: Expand Tasks 1 and 2 for major tributaries to the river.

Task 4: Evaluate current local regulations regarding discharge mitigation requirements and formulate recommendations to strengthen river protection.

Task 5: Evaluate current local Public Works and state DOT plans for maintenance of existing structures, and formulate recommendations for improvement.

Responsible Parties: Municipal and County DPW and GIS staff with coordination by BWC.
Milestones: Creation of map, identification of candidates and BMPs, issuance of regulation recommendations, issuance of maintenance plan recommendations
Timeline:
BMPs: See Appendix 4 for examples of BMPs for river and stream crossings.
Evaluation Criteria: Creation of map, number of sites selected and improved, issuance of two recommendation reports.

B5. Identify and treat existing and potential sources of contamination from inadequately sized river buffers.

Task 1: Identify areas where vegetated buffer widths are inadequate, using GIS orthophotography and future streamwalk data. Create map.

Task 2: Select and prioritize sites for restoration.

Task 3: Identify sources of restoration funding.

Task 4: Implement restoration projects.

Task 5: Review existing local regulations and issuance recommendations to improve protection of the Byram.

Responsible Parties: Municipal, County and State MS4 NPDES Stormwater permitees and BWC.
Milestones: Creation of map, identification of candidates and BMPs, identify funding sources, issuance of regulation recommendations, project implementation.
Timeline:
BMPs: Volunteer stream walk assessments, vegetated buffers, and tree plantings. See Appendix 4 and 5 for examples of BMPs and initiatives to address river buffers.
Evaluation Criteria: Creation of map, number of sites selected, number of restoration projects implemented and load reductions, issuance of recommendation report.

B6. Identify existing and potential sources of nutrients from large areas of managed turf located adjacent to the river.

Task 1: Identify areas and property ownerships where large areas of managed turf occur next to the river, using GIS orthophotography and future streamwalk data. Define minimum size appropriate for identification. Create map.

Task 2: Estimate Pollutant load reductions under cover type conversion scenarios, and low fertilization BMPs.

Task 3: Identify any candidates for restoration, and seek funding as appropriate.

Task 4: Create a public outreach program to target property owners identified.

Responsible Parties:
Milestones: Creation of map, identification of candidates, estimation of load reductions, selection of sites, project implantation, creation of public outreach program
Timeline:
BMPs: Vegetated buffers, tree plantings, and wet ponds. See Appendix 4 – 7 for examples of BMPs and initiatives to address non-point sources.
Evaluation Criteria: Number of sites identified, number of sites altered/restored, number of landowners engaged in public outreach.

B7. Identify existing and potential sources of nutrient and sediment contamination from horse farms, horse trails, and horse shows.

Task 1: Identify all horse farms in the watershed that may potentially generate runoff into the Byram. Review ongoing efforts by NRCS. Create a map.

Task 2: Document number of horses per farm and select priority horse farms.

Task 3: Contact property owners and determine if a horse manure / site management plan has been created and implemented. Review plans and identify improvements.

Task 4: Develop a program to assist those farms without a management plan to create one, and/or to recommend site specific BMPs. Engage in an educational program and promote the Horse Farm of Environmental Distinction program. Utilize NRCS, SWCD, and NYCDEP work products, outreach efforts and techniques.

Task 5: Estimate load reductions due to tasks 3 and 4.

Responsible Parties: Municipalities, County and BWC.
Milestones: Creation of map, determination of status of all properties identified, improvement and/or creation of plans
Timeline: 5 years.
BMPs: See Appendix 4 and 6 for examples of BMPs and initiatives to address non-point sources from equestrian activities.

Evaluation Criteria: Number of sites identified, number of landowners and user organizations participating in public outreach, number of BMPs designed and implemented, estimated reductions of nutrient loads, and number of educational/outreach events.

B8. Conduct pollutant load modeling for the Byram under existing and build-out scenarios, to identify future trends and potential issues.

Task 1: Collect baseline data

Task 2: Formulate pollutant load model and calibrate

Task 3: Identify baseline data gaps

Task 4: Formulate build-out conditions

Task 5: Compare existing pollutant loads to the build-out scenarios

Task 6: Use results to identify, prioritize, and evaluate specific basin or segment pollution control strategies.

Responsible Parties: IEC and Columbia University (modeling in process), BWC advisors
Milestones: Collection of baseline data, model formulation and calibration, build-out analysis, comparative analysis, application of results to formulate strategies, integrate the findings into the watershed management plan.
Timeline: Model is to be completed in early 2012. 1 year for integration of findings into watershed management plan.
BMPs: See Appendix 4 – 7 for examples of BMPs and initiatives to address non-point sources.
Evaluation Criteria: Acceptance of IEC/Columbia University model by grantees and regulatory agencies, modifications of watershed management plan with recommended strategies, implementation, and estimates of pollutant load reductions.

B9. Conduct Investigation and Elimination of Illicit Sanitary Connections

Task 1: Monitor progress of the Village of Port Chester, NY on the implementation and completion of their EPA Region 2 ordered program to track down and eliminate illicit sanitary connections.

Task 2: Examine the progress and accomplishments of all Byram River watershed municipalities regarding their illicit sanitary connection identification and required by their NPDES Storm Water General Permits

Task 3: Identify successful and deficient programs.

Task 4: Advocate for sharing knowledge, experience and resources to improve efforts within the watershed and regionally.

Task 5: Conduct surveys and sampling of stormwater outfalls to identify bacteriological quality of stormwater.

Task 6: Use results to identify, prioritize, and recommend sub basin initiatives and illicit sanitary connection control strategies.

Responsible Parties: Municipal entities responsible for compliance with the NPDES Stormwater General Permit.
Milestones: Region 2 Administrative Order deadlines for the Village of Port Chester to address their illicit sanitary connections (2012). Completion of evaluations of municipalities. Surveys of stormwater outfalls.
Timeline: 5 years.
BMPs: GIS, volunteer and professional stream walk assessments and inspections and sampling.
Evaluation Criteria: Sampling results of local State and Federal Agencies conclude that bacteriological quality of the Byram River is normal for an urban area. Number of stormwater outfall surveys conducted, number of outfalls determined to have excessive concentrations of bacteria, number of illicit connections eliminated. Number of audits of municipalities conducted. Number of workshops held to share knowledge, experience and resources for elimination of illicit connections.

CATEGORY C: Improve Base Flow and Minimize Peak Flow

Encourage appropriate studies to determine why the Byram River floods and what alternatives should be considered to improve base flow and minimize peak flow.

Objectives:

C1. Investigate surface water and ground withdrawals and their effect on base flow.

C2. Encourage appropriate studies to determine why the Byram River floods, and what alternatives should be considered to improve base flow and minimize peak flow.

C1. Investigate surface water and ground water withdrawals and their effect on base flow.

Task 1: Identify from regulatory agency databases all stream diversion permits granted and implemented.

Task 2: Identify any additional significant withdrawals or significant imports.

Task 3: Identify areas of the watershed serviced by private or public wells.

Task 4: Conduct an import/export analysis to evaluate the effect of existing surface and groundwater withdrawal on baseflow and aquatic or riparian habitat and life. Use gagging station and recent storm and drought events to evaluate conditions. Create a hydrologic budget for the watershed. Prepare recommendations.

C2. Encourage appropriate studies to determine why the Byram River floods, and what alternatives should be considered to improve base flow and minimize peak flow.

Responsible Parties: Army Corp of Engineers and municipal and County departments.
Milestones: List and locations of diversions, withdrawals, and imports, preparation of report summarizing impacts on baseflow and aquatic or riparian habitat and life, completion of flood studies.
Timeline: 5 years
BMPs: Studies recommended projects to improve peak and low flow.
Evaluation Criteria: Completion of ACOE flood control study with recommendations that address flooding, hydrology, hydraulics, sediment transport, channel stability, channel modifications, dams, stormwater management, the water budget for the watershed (diversions, withdrawals, imports and exports of water) and baseflow on aquatic and riparian habitat and life..

CATEGORY D: Promote Sustainable Land-Use

Encourage land-use practices and planning that contribute to the ecological health of the river.

Objectives:

D1. Identify and locate all large properties that may have a significant impact on the river through their land management practices.

D2. Analyze existing land-use regulations, jurisdictions, and planning documents for protection gaps and potential improvements with regard to Low Impact Development (LID) practices.

D3. Review all catchbasin maintenance practices within the watershed.

D4. Review all road maintenance and improvement practices within the watershed.

D5. Identify and locate all municipal, county, or state road maintenance facilities.

D6. Design a storm drain stenciling program for priority areas.

D7. Identify and locate all NY & CT NPDES permitted sites (commercial and industrial), other regulated waste streams, and permitted discharges.

D1. Identify and locate all large properties that may have a significant impact on the river through their land management practices.

Task 1: Identify and locate all golf courses, institutions (campuses, schools, corporations, hospitals, etc), and other major land owners that may have an impact on the river through their land management practices. Create map.

Task 2: Use this database to design a review of land management practices. Determine if each facility has a stormwater management plan or other environmental land management plan. Review all plans for implementation and adequacy.

Task 3: Design an outreach program to improve land management practices.

Responsible Parties: BWC**.**
Milestones: Creation of map, review of practices and plans, implementation of public outreach program
Timeline: 5 years.
BMPs: GIS, data collection, outreach and education.
Evaluation Criteria: Creation of map, number of properties identified and targeted, number of properties reviewed, number of properties outreached**.**

D2. Analyze existing land-use regulations, jurisdictions, and planning documents for protection gaps and potential improvements with regard to Low Impact Development (LID) practices.

Task 1: Compile all relevant land-use regulations, regulatory jurisdictions, and planning documents to determine site-specific level of environmental protection and strength of policies, including current Low Impact Development practices.

Task 2: Identify any gaps in environmental protection, barriers to LID implementation, and make recommendations to improve protection especially in regard to Low Impact Development practices.

Responsible Parties: Municipalities and County.
Milestones: Compilation of regulations, jurisdictions, and planning documents; preparation of analysis and recommendations
Timeline: 5 years.
BMPs: research, analysis and recommendations.
Evaluation Criteria: Issuance of analysis report with recommendations, number of recommendations implemented.

D3. Review all catchbasin maintenance practices within the watershed.

Task 1: Perform a review across all municipalities and State DOTs with regard to catchbasin inspection and maintenance schedules.

Task 2: Identify catchbasins in critical locations that need to be monitored. Create map.

Task 3: Issue a summary report with recommendations as appropriate.

Responsible Parties: Municipal, County and State MS4 NPDES Stormwater permitees and BWC.
Milestones: Compilation of inspection policies and maintenance schedules, identification of critical catchbasins, issuance of report
Timeline: 5 years.
BMPs: GIS, outreach, meetings
Evaluation Criteria: issuance of report, Number of practices/catchbasins improved/implemented

D4. Review all road maintenance and improvement practices within the watershed.

Task 1: Perform a review across all municipalities and state DOTs with regard to road maintenance and improvement practices, including right-of-way vegetation management.

Task 2: Identify river crossings in critical locations that need to be monitored. Create map.

Task 3: Issue a summary report with recommendations as appropriate.

Responsible Parties: Municipal, County and State MS4 NPDES Stormwater permitees and BWC.
Milestones: Compilation of maintenance policies, identification of critical road crossings, issuance of report
Timeline: 5 years.
BMPs: Research, field inspections, volunteer and professional stream walk assessments, and report preparation.
Evaluation Criteria: issuance of report, number of practices improved/implemented.

D5. Identify and locate all municipal, county, or state road maintenance facilities.

Task 1: Identify and locate all municipal, county, or state road maintenance facilities including storage facilities and vehicle maintenance facilities. Create data layer.

Task 2: Evaluate the effectiveness of stormwater protection plans for each facility.

Task 3: Issue a summary report with recommendations as appropriate.

Responsible Parties: Municipal, County and State MS4 NPDES Stormwater permitees and BWC.
Milestones: Creation of data layer, evaluation of practices, issuance of report
Timeline: 5 years.
BMPs: Research, field inspections, volunteer and professional stream walk assessments, and report preparation.
Evaluation Criteria: creation of map, issuance of report, number of practices improved/implemented and/or facilities improved.

D6. Design a storm drain stenciling program for priority areas.

Task 1: Design a storm drain stenciling program for prioritized areas.

Responsible Parties: Municipal, County and State MS4 NPDES Stormwater permitees and BWC.
Milestones: designation of prioritized areas, implementation of program
Timeline: 1 year.
BMPs: Public education and outreach.
Evaluation Criteria: number of storm drains stenciled

D7. Identify and locate all NY & CT NPDES permitted sites (commercial and industrial), other regulated waste streams, and permitted discharges.

Task 1: Identify and locate all NY & CT NPDES permitted sites (commercial and industrial), other regulated waste streams and permitted discharges. Create map.

Task 2: Identify pollutants of concern, potential for pollutants to release into the surface and ground water, and analyze impact as appropriate.

Responsible Parties:
Milestones: List and map of sites, pollutants identified
Timeline: 4 years
BMPs: CT DEEP and NY DEC permit research; field inspections, volunteer and professional stream walk assessments, and report preparation.
Evaluation Criteria: creation of map

CATEGORY E: Protect Riverine Habitat

Protect, restore, and enhance habitat for fish, aquatic life, and wildlife within the channel and riparian corridor.

Objectives:

E1. Identify channel alterations that may significantly affect the habitat value of the river, and evaluate the restoration potential for these alterations.

E1. Identify channel alterations that may significantly affect the habitat value of the river, and evaluate the restoration potential for these alterations.

Task 1. Identify dams, major culverts, impoundments, and channel modifications using aerial photography, public works mapping, streamwalk data, and ground survey. Create a map.

Task 2: Evaluate sites to determine if restoration or mitigation is conceivable to improve habitat for fish, aquatic life, and wildlife.

Task 3. List and prioritize locations in which restoration or mitigation is most feasible, and most likely to have significant impact on water quality and habitat.

Task 4. Identify funding sources, secure funding, design project, and implement.

Responsible Parties: BWC, Municipalities and Private Landowners along with volunteers.
Milestones: Creation of map, creation of prioritized list of sites, project design, project implementation, outreach and education events held.
Timeline: 3 years.
BMPs: See Appendix 4 for examples of fish barriers, and BMP opportunities. See Appendix 5 for an example of an assessment and education project for stream walk surveys using volunteers and a workshop to educate landowners of fish barriers on removal and modification opportunities. Appendix 8 is an example of Activities of Concern in the lower reach of the Byram River based on a stream survey assessment.
Evaluation Criteria: Creation of map, creation of prioritized list of sites, number of projects designed, funded, and implemented, number of linear feet or acreage of restored or enhanced habitat, passageway for specific species.

CATEGORY F: Protect Upland and Non-Riverine Landscape

Conserve, protect, restore, and enhance critical landscape located in the upland watershed that contributes to the health, stability, and value of the river.

Objectives:

F1. Identify and locate all sizable and notable parcels of open space within the watershed.

F2. Identify and locate areas of critical habitat and significant natural resources.

F1. Identify and locate all sizable and notable parcels of open space within the watershed.

Task 1: Identify and locate all sizable and notable parcels of open space and their respective owners, using GIS and existing maps. Create an open space inventory on GIS.

Task 2: Investigate the potential for the designation of a greenway and prepare recommendations.

Task 3: Identify any avenues of assistance and strategies to encourage continued preservation of open space in general, with particular emphasis on large vacant priority properties.

Responsible Parties: Greenwich Land Trust, Westchester Land Trust and BWC.
Milestones: Creation of open space map, recommendations regarding open space acquisition strategy, identification of avenues of assistance to encourage continued preservation
Timeline:
BMPs: Open space education and protection
Evaluation Criteria: Creation of an open space map, creation of a State recognized greenway, formulation of an acquisition feasibility and strategy report, development of assistance program, number of acres preserved or protected due to efforts.

F2. Identify and locate areas of critical habitat and significant natural resources.

Task 1: Identify and locate areas of critical habitat and significant natural resources including large bodies of waters, large extents of wetlands, locations of DEP listed species, reservoirs and other public drinking supplies, public drinking water subwatersheds, unique fish habitat, and any others area deemed environmentally significant or sensitive, using the “critical review areas” designated by Westchester County as a starting point.

Task 2: Categorize wetlands according to relatively undisturbed wetlands, headwaters, or potentially urbanizing/impacted wetlands.

Task 3: Prepare and/or summarize existing recommendations and/or strategies ensuring for the continued protection of these areas.

Responsible Parties:
Milestones: Creation of map(s), preparation of recommendations regarding continued preservation
Timeline: 5 years.
BMPs: GIS research.
Evaluation Criteria: Creation of map(s), preparation of recommendations regarding continued preservation, number of acres protected**.**

CATEGORY G: Protect and Promote Compatible Recreational Uses

Protect, restore, promote, and enhance portions of the river to resource related recreational uses as appropriate.

Objectives:

G1. Identify areas of the river that have recreational potential.

G1. Identify areas of the river that have recreational potential.

Task 1: Identify segments of the river that are appropriate for primary contact recreation, secondary contact recreation, and for fishing. Evaluate safeguards to prevent over use. Create a map.

Task 2: Identify areas of easy public access, evaluate safeguards to prevent over use, and create a map to encourage public access for designated spots.

Task 3: Identify segments that are impaired with regard to ideal recreational use, and determine feasibility of correcting the impairments while balancing. Evaluate safeguards to prevent over use.

Responsible Parties: BWC with support from municipalities and County.
Milestones: Recreational use map, public access map, recommendations regarding improvements and safeguards.
Timeline: 5 years.
BMPs: GIS and field surveys.
Evaluation Criteria: maps, issuance of report with recommendations regarding improvements, number of segments identified and improved.

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Appendix 1

Summary of Data on Causes and Sources of Pollutants in the Byram River Watershed

The following are individual summaries of the data sources from which the causes and sources of pollutants to the Byram River were identified and compiled.

Interstate Environmental Commission:

The IEC compiled assessment data for a 2008 report titled "305(b) State Water Quality Assessment and Methodology Report of the Interstate Environmental Commission." Data and metadata was compiled from a variety of NY, CT, and federal agencies as well as from their own sampling efforts.

- The assessment report summarized data collected from assessment units located within the interior of the Long Island Sound Estuary. There were two assessment areas broadly relevant to the Byram focus; a "Long Island Sound-West" unit AU10 consisting of the Sound from the Throgs Neck Bridge to Byram Harbor, and a "Long Island Sound-CT" unit AU11 consisting of the Sound from Byram harbor to New Haven Harbor.
- The waters within the assessment units are classified with regard to future uses as Class A: Suitable for all forms of primary and secondary contact recreation and for fish propagation. In designated areas, they are also suitable for shellfish harvesting.
- The waters within the assessment units were categorically assessed into Category 2: "Available data and/or information indicate that some, but not all of the designated uses are supported."
- Both AU10 and AU11 were specifically assessed as Not Supporting for Aquatic Life and Primary Contact Recreation, and Fully Supporting but Threatened for Fish Consumption.
- AU10 was specifically assessed as Not Supporting for Shellfish Consumption, while AU11 was specifically assessed as Fully Supportive but Threatened.
- Both AU10 and AU11 were specifically assessed as Fully Supporting for Secondary Contact Recreation.

New York State Department of Environmental Conservation:

The NYSDEC prepared a draft 2010 303(d) list of impaired waterways. Port Chester Harbor is listed, as well as the Lower Byram River.

- Port Chester Harbor is classified with regard to future uses as a Class SB saline surface water: "…The best uses of Class SB waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival..."

- Lower Byram River is classified with regard to future uses as a Class SC saline surface water: "…The best usage of Class SC waters is fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival.
- The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes..."
- Pollutants of concern in the harbor include floatables and pathogens.
- Pollutants of concern in the lower river include pathogens.

The Connecticut Department of Environmental Protection:

The CTDEP prepared a 303(d) list published in 2008. Several segments of the Byram are listed. It should be noted that large portions of the river within the mid- and upper-watershed were not sampled. Major portions of the upper main stem, the East Branch, the lower main stem, and Converse Brook were not sampled.

- Five DEP delineated segments are listed on the 303(d) list.
- Two segments are directly within the Byram River itself, and three segments are in the Long Island Sound area.
- The Byram River segments include the 1) "Byram River" (from just above Route 1 up to confluence with Pemberwick Brook), and 2) "LIS WB Inner-Byram River" consisting of the mouth of the Byram river to the saltwater limit just above route 1.
- The Byram River unit is impaired for Habitat for Fish, Other Aquatic Life and Wildlife. It is also impaired for Recreation.
- LIS WB-Inner Byram River is impaired for Commercial Shellfish Harvesting Where Authorized. It is also impaired for Recreation.
- Three segments are located downstream to the river itself within the Long Island Sound area. They include 1) "LIS WB Offshore", consisting of the offshore area of the Sound out to the NY border, 2) the "LIS WB Shore-Byram Harbor (West)"area, consisting of the offshore area of the Sound out to 1000 ft offshore from the CT/NY border to just west of Shore Island, and 3) the "LIS WB Shore-Byram Harbor" area consisting of the offshore area of the Sound out to 1000 ft from just west of Shore Island east to Field Point.
- LIS WB Offshore is impaired for Habitat for Fish, Other Aquatic Life and Wildlife.
- LIS WB Shore-Byram Harbor (West) is impaired for Shellfish Harvesting For Direct Consumption Where Authorized.
- LIS WB Shore- Byram Harbor is impaired for Recreation. It is also impaired for Shellfish Harvesting For Direct Consumption Where Authorized.

The Greenwich Health Department:

The Greenwich Health Department routinely conducts water quality surveys along several reaches of the river. Water quality parameters relevant to this plan include measurements of Total Coliform, Fecal Coliform, Fecal Streptococcus, Enterococcus, pH, turbidity, Nitrate, and Nitrite.

- There are fifteen assessment units used for sampling. Six are in the lower tidal section of the river from Route 1 to the Sound. Six sampling units are in the main stem of the river. Two sampling units are on the West Branch, one above Tollgate Pond and one off of John St. One sampling unit is on the East Branch, off of Porchuck Road. There are no sampling units on the Converse Brook branch.
- Total Coliform is routinely elevated from the Mill Street Bridge (below the railroad on the lower saline portion of the river below Route 1) on down to the Byram Shore end of the sampling.
- Nitrate is routinely elevated from the Greenwich Bay Marina site on down to Byram Shore.
- Turbidity is elevated within all of the sampling points.

Greenwich Planning and Zoning:

The Town of Greenwich Planning and Zoning Department received a grant from CT DEP in 2003 to conduct a water quality study of selected watershed in the town, including the Byram. Parameters measured were DO, temperature, pH, Specific Conductivity, TSS, Fecal Coliform, TN, Total Nitrite, and Total Orthophosphate.

- Two reaches were sampled – an upstream location southwest of Riversville Road in the upper portion of the lower main stem, and a location down stream near the corner of Riversville Road and Glenville Rd in the central portion of the lower main stem.
- Temperature increases were noted from upstream to downstream. Temperature exceeded the 25 degree EPA recommended maximum temperature though it was noted that this threshold was an average threshold.
- Specific Conductivity (dissolved mineral content) increased from 10 to 60% between upstream and downstream.
- Fecal Coliform exceeded DEP criteria. Mean Fecal Coliform upstream was 437/100 ml. Downstream FC was 660/100 ml. This exceeded both CT DEP Fecal Coliform (200/100 ml for average, no single sample > 400 /100 ml) and Total Coliform (500 /100 ml) criteria. No spike was measured during rain events.
- The likely sources of Fecal Coliform were suggested as aquatic and terrestrial animals (deer, horses, waterfowl), failing septic systems and leaking sewer mains.

Appendix 2

Comparative Subwatershed Analysis Plan

revised

Byram River Comparative Subwatershed Analysis

A comparative subwatershed analysis will be performed for the Byram River Watershed in order to identify and prioritize the subwatersheds with the greatest vulnerability and restoration potential. A series of metrics will be used to quantify watershed attributes that characterize the relative vulnerability and restoration potential of a subwatershed. The metrics will be compiled into an index and based on their index scores the subwatersheds will be ranked according to their relative vulnerabilities and restoration potential.

In order to calculate a number of the metrics, a watershed build out scenario will be necessary to estimate future development and associated impacts to the watershed. The Town of Greenwich Planning and Zoning Commission has already prepared a town wide buildout that could readily be adapted to the confines of the Byram watershed. For the portions of the watershed in NY the BWC will need to coordinate with the other municipalities and account for their respective zoning regulations. In the event that buildout scenarios are not available from the other towns, another option would be to use data from the Westchester County GIS data repository to conduct a buildout analysis.

Subwatersheds with *higher* Vulnerability Index scores are *more sensitive* to future development and should be the focus of watershed conservation efforts that maintain existing high-quality resources and conditions.

Subwatersheds with *higher* Restoration Potential Index scores are *more likely* to have been impacted and have a *greater potential for restoration* to improve upon existing conditions. A subwatershed's restoration potential can be limited if it is "too impacted" and so degraded that a restoration activity would have a negligible impact.

Vulnerability Metrics: Used to assess the subwatersheds vulnerability to future development impacts.

Metric	**Units**	**Logic**	**Metric Scoring**
Percent Impervious Cover Change under maximum buildout scenario.	% Increase	Subwatersheds that would gain the most impervious cover under maximum buildout would face the greatest impacts.	1 point for each 2 percent increase in IC. Up to 10 points.
Subwatershed Development Potential	% of subwatershed that is developable	Low development potential indicates stability of future conditions with limited additional impacts.	2 points for each 10 percent above zero.
Percent developable forest cover	% of developable lands that are forested	Forested land is important to a properly functioning watershed. Forest cover on developable land is the most vulnerable to loss to future development.	2 points for each 10 percent above zero.
Ratio of current IC to threshold value	Current IC % divided by 12 % impairment threshold	Subwatersheds that are below the impairment threshold are vulnerable to impairment with additional impervious cover. Subwatersheds with very high levels of IC are already impaired and thus considered less vulnerable.	≥5: 1 point ≥3: 3 points ≥2: 5 points ≥1: 7 points ≤1: 9 points ≤.5:10 points
Privately owned buffer	% of 150 ft stream buffer on private property.	Stream buffers on private property are frequently modified and degraded. It is also difficult to monitor and implement conservation actions on private properties, especially those that are single family residential.	1 point for each 10 percent above zero.
Percent Undeveloped buffer	% of 150 ft stream buffer that are forested and wetland.	Undeveloped buffers consist of forest, wetlands, or other natural cover types. These areas have intact riparian zones and are critical to stream health. If these areas are developed and degraded stream health will be negatively impacted.	1 point for each 10 percent above zero.
Septic vs Sewer	% of properties with septic systems	Sewer systems are easier to regulate with point source controls. There are a greater number of individual septic systems that can contribute to nonpoint pollution and make monitoring and mitigation of impacts challenging.	1 point for each 10 percent above zero.

Subwatershed Restoration Potential:

Metric	**Units**	**Logic**	**Metric Scoring**
Stream Density	Stream Miles per square mile	Greater potential for stream corridor practices where multiple streams are influenced by same land.	1 point per half mile of stream per square mile.
Number of municipalities	Number of municipalities in subwatershed	Simpler jurisdictional structure will facilitate implementation of restoration actions.	1 :10 points 2: 5 points 3: 2 points
Ratio of current IC to threshold value	Current IC percent / 12 percent impairment threshold	Subwatersheds that are approaching or just past the impairment threshold and can benefit from a minimal amount of restoration. Too much IC can limit the impact of a potential restoration action.	>5: 1 point >3: 3 points >2: 5 points ≥1: 10 points <1: 9 points <.5: 5 points
Subwatershed Development Potential	Percent of subwatershed that is developable	Low potential for development indicates stability of future conditions.	1 point for each 10 percent below 100.
Percent Subwatershed that is publically owned	Percent of subwatershed that is publically owned	Publicly owned land reduces land acquisition fees and facilitates the permitting and implementation process.	1 pt for each 2 percent above zero. Up to 10 points.
Number of Stormwater outfalls per stream mile	Outfalls per stream mile	If there are relatively few outfalls it may be possible to implement BMPs and retrofits to minimize the impacts of Stormwater.	0-2: 10 points 5-10: 5 points >10: 1 point
Dams per stream mile	Number of dams stream mile.	Indicates the amount of contiguous stream habitat that can be opened up if a dam is removed. Too many dams can limit restoration potential.	0-1: 10 points 1-3: 7 points 3-5: 5 points 5-10: 3 points >10: 1 point

Road crossings per stream mile	Number of road crossings per stream mile.	Road crossings and their culverts are direct sources of stormwater, block fish passage, cause erosion and flooding. Roads also represent a long term investment in a subwatershed and can limit restoration potential by causing resistance to land use change.	0-1: 10 points 1-3: 7 points 3-5: 5 points 5-10: 3 points >10: 1 point
Percent undeveloped buffer	Percentage of 150 foot buffer that is forested, wetland, or other undeveloped land.	An intact vegetated buffer improves water and habitat quality. Areas that are intermittently missing a riparian zone would greatly benefit from restoration where as a restoration action on areas that are very heavily impacted would not make a significant difference.	2 points for each 10 percent above 0 up to 50 percent. Then 1 point per each 10 percent up to 100. .
Number of regulated sites.	Permits per square mile	Environmental Permits issued by the State. Currently regulated sites allow for the implementation of enhanced source controls, discharge prevention and on site retrofits.	0-1:1 point 1-2:3 points 2-5:5 points 5-10:7 points >10:10 points

Appendix 3 – Impervious Cover (IC) Analysis of the Byram River Watershed 2011

The impervious cover for each of the 55 hydrologic sub basins located within the Byram watershed was calculated using Geographic Information System (GIS) mapping software. Percent Impervious Cover (IC) was calculated by delineating impervious area from existing map coverages and then dividing the impervious area by the sub basin area and multiplying by 100.

The data was then summarized by combining sub basins into their major stream tributary watersheds.

Methods for Impervious Cover Analysis

The Byram River Watershed is in both CT and NY and found in multiple municipalities; as a result GIS Data will come from a number of sources.

Data Sources

- Columbia University
    - Byram River Watershed
    - Sub basins Byram River Watershed

- Town of Greenwich GIS Department
    - Roads
    - Driveways
    - Parking Lots
    - Buildings
    - Impervious features from land cover

The land cover data from the Town of Greenwich is extremely detailed and includes even small bits of impervious cover such as patios and residential sidewalks.

- Westchester GIS Data Warehouse: http://giswww.westchestergov.com/
    - Data from Base Map Planimetrics for each town were used
    - Structures
    - Roads
    - Transportation Features
    - Transportation Structures

ArcCatalog was used to match the coordinate systems of the NY and CT data. Features in different coordinate systems will not align properly on the map. The NY and CT data were in NY and CT state plane coordinate systems respectively. The NY features were converted to CT state plane.

The clip tool in Arc Toolbox was used to clip the shapefiles to the boundaries of the Byram River Watershed. To eliminate redundancies in the data the shapefiles were combined into one dataset using the Merge tool in Arc Toolbox.

The impervious features were then clipped to each sub basin. Sub basins are differentiated by an 8 digit Hydrologic Unit Code (HUC). Once clipped the CalcArea tool was used to calculate an accurate area value for the new clipped features. While the clip tool eliminates unnecessary impervious features outside of the desired sub basin it does not calculate new area values for the features in the output. This can be problematic for larger features not entirely contained by the subasins. For example a portion of the Merritt Parkway may be represented by a large polygon that crosses multiple subasins. When clipped to the desired sub basin, the large polygon will still maintain its original area value even though the clipped feature is a fraction of the original size. The overstated area values lead to inaccurate estimates of impervious cover. The CalcArea tool remedies this problem providing new accurate area values.

To calculate the Percent Impervious Cover for each sub basin, divide the Impervious Area / Sub basin Area and multiply by 100. Enter the resulting percent impervious cover into the attribute table of each sub basin, these values can be used to create a variety of visual displays.

Table 1 depicts the percent impervious area for the individual sub basins, which contribute to each major stream segment.

Table 1. Byram Watershed Percent Impervious Area in Individual Sub Basins

Stream Segment	Basin Number	Acres	Percent Impervious
Converse Pond Brook	7410-02-1	173.66	7.87
Converse Pond Brook	7410-02-1-L1	714.07	8.35
Converse Pond Brook	7410-02-1-L2	579.94	8.08
Converse Pond Brook	7410-02-2-L3	392.00	11.33
Converse Pond Brook	7410-02-2-L4	161.75	15.50
Converse Pond Brook	7410-02-2-R1	183.09	14.21
Converse Pond Brook	7410-02-2-R2	132.89	13.85
Converse Pond Brook	7410-02-2-R3	42.85	7.18
Converse Pond Brook	7410-03-1	146.65	13.92
Converse Pond Brook	7410-03-1-L1	474.44	15.62
Converse Pond Brook	7410-03-1-L2	260.17	11.28
Converse Pond Brook	7410-04-1	135.21	12.86
Converse Pond Brook	7410-06-1	546.93	8.82
Converse Pond Brook/ Upper Main Stem	7410-00-3-L4	36.89	12.66
East Branch	7410-00-1	87.07	2.82

Table 1. Byram Watershed Percent Impervious Area in Individual Sub Basins

Stream Segment	Basin Number	Acres	Percent Impervious
East Branch	7410-00-1-L2	953.40	9.52
East Branch	7410-00-2-L3	862.58	7.64
East Branch	7410-00-2-R1	140.91	9.13
East Branch	7410-01-1	43.07	13.31
East Branch	7410-01-1-L1	81.97	10.79
East Branch	7410-01-1-L2	42.03	12.42
East Branch	7410-01-1-L3	315.57	9.07
East Branch	7410-04-1-L1	167.12	12.84
East Branch	7410-05-1	75.67	8.17
East Branch	7410-05-1-L1	246.02	12.96
East Branch	7410-05-1-L2	30.00	6.40
East Branch	7410-05-1-L3	31.09	3.95
Lower Main Stem	7411-00-3-L5	115.10	25.76
Lower Main Stem	7411-00-3-L6	192.91	12.55
Lower Main Stem	7411-00-3-L7	60.05	18.14
Lower Main Stem	7411-00-3-R2	615.07	32.5
Lower Main Stem	7411-08-1	140.86	8.95
Pemberwick	7411-09-1	293.33	17.00
Pemberwick	7411-09-1-L1	617.20	11.47
Tidal/Lower Main Stem	7411-00-3-R3	1720.79	70.92
Upper Main Stem	7410-00-1-L1	46.47	7.16
Upper Main Stem	7410-00-3-R1	122.75	13.92
Upper Main Stem	7411-00-1	182.13	6.91
Upper Main Stem	7411-00-1-L1	854.51	8.51
Upper Main Stem	7411-00-2-L2	196.04	13.54
Upper Main Stem	7411-00-2-R1	26.09	8.34
Upper Main Stem	7411-00-2-R2	282.35	12.12
Upper Main Stem	7411-00-2-R3	404.70	35.31
Upper Main Stem	7411-00-3-L3	205.36	4.51
Upper Main Stem	7411-00-3-L4	1469.68	13.16
Upper Main Stem	7411-00-3-R1	770.71	11.08
Upper Main Stem	7411-01-1	244.89	5.11
Upper Main Stem	7411-02-1	339.60	9.38
Upper Main Stem	7411-03-1	516.13	23.64
Upper Main Stem	7411-04-1	472.05	14.22

Table 1. Byram Watershed Percent Impervious Area in Individual Sub Basins

Stream Segment	Basin Number	Acres	Percent Impervious
Upper Main Stem	7411-04-1-L1	294.72	11.31
Upper Main Stem	7411-04-2-R1	367.26	24.83
Upper Main Stem	7411-04-2-R2	173.41	42.87
Upper Main Stem	7411-05-1	490.64	10.20
Upper Main Stem	7411-06-1	492.97	19.79
Upper Main Stem	7411-07-1	408.51	9.55

Appendix 4

Byram River Watershed Management Plan Implementation Projects

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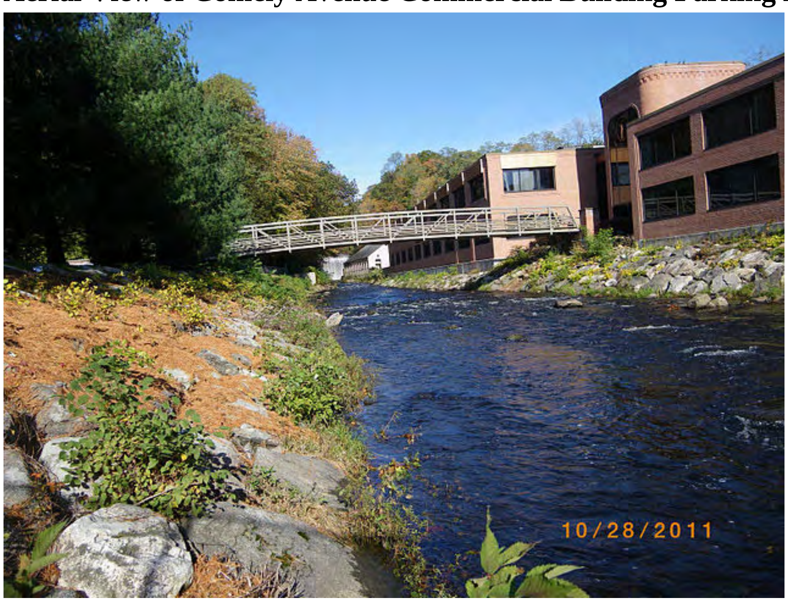
The following projects illustrate how the action plans proposed in the Byram Watershed Management Plan can begin to be implemented. These projects are the result of stream walk assessments, GIS map review and site visits. The projects listed focus on the lower portion of the Byram River as it is on the list of impaired waterbodies. Many other implementation projects can be identified throughout the watershed as stream surveys results are mapped and evaluated. Significantly more technical analysis, collaboration and cooperation of private and public organizations is needed to vet these projects for design, approval, construction and evaluation. These projects provide real life examples for stakeholders to consider and fosters creative analysis, group problem solving, identification of additional location-specific implementation projects for the implement the Byram watershed management plan.

1. Comely Avenue Commercial Building Parking Lot, Greenwich, CT

At the intersection of Comely Avenue and Pemberwick Road in Greenwich, CT is a commercial parking on the west side of the Byram River opposite a commercial office building at 200 Pemberwick Road, Greenwich, CT 06831-4236 occupied the Infogroup (203) 532-1000. The parking lot is two acres of asphalt with two catch basin on the east side of the parking lot, near the river. There are two outfalls to the river. There is no treatment of the runoff except for catch basin sumps. There appears to be adequate space to design a sand or biofiltration treatment unit to improve water qualtiy in the south east corner of the parking lot. capture. Ownership of the parking is unknown but is likely to be the owner of the

Infogroup Building. The installation of a stormwater BMP at this lot would treat a significant volume of stormwater and depending on the design could reduce pathogen concentrations along with sediment.

Aerial View of Comely Avenue Commercial Building Parking Lot, Greenwich, CT.



**View of Byram River adjacent to Comely Avenue Commercial Parking Lot.
Two stormwater outfall from parking lot. One is in the foreground
and the other on the far side of the pedestrian bridge.**

South stormwater outfall and headwall of Comely Avenue parking Lot.

2. Stormwater Outfall BMP near 26 Caroline Place, Greenwich, CT

Install a secondary treatment practice on the outfall located at 26 Caroline Place, which has a contributory drainage area of approximately 9.1-acres and a land use primarily of medium density residential and roadways. The outfall exhibited a build up of sediments directly deposited along the shoreline. Due to its small footprint, the installation of a larger pretreatment measure is not possible. The proposed stormwater retrofit for this site trends towards deepening the standard catch basin sump enhanced with a hooded outlet that would increase its capacity to sequester solids and floatables. Receiving waterbody is Caroline Pond and Byram River.

Aerial View of Stormwater Outfall near 26 Caroline Place, Greenwich, CT.

Stormwater Outfall for BMP near 26 Caroline Place, Greenwich, CT.

3. Stormwater Outfall BMP near 67 Caroline Place, Greenwich, CT

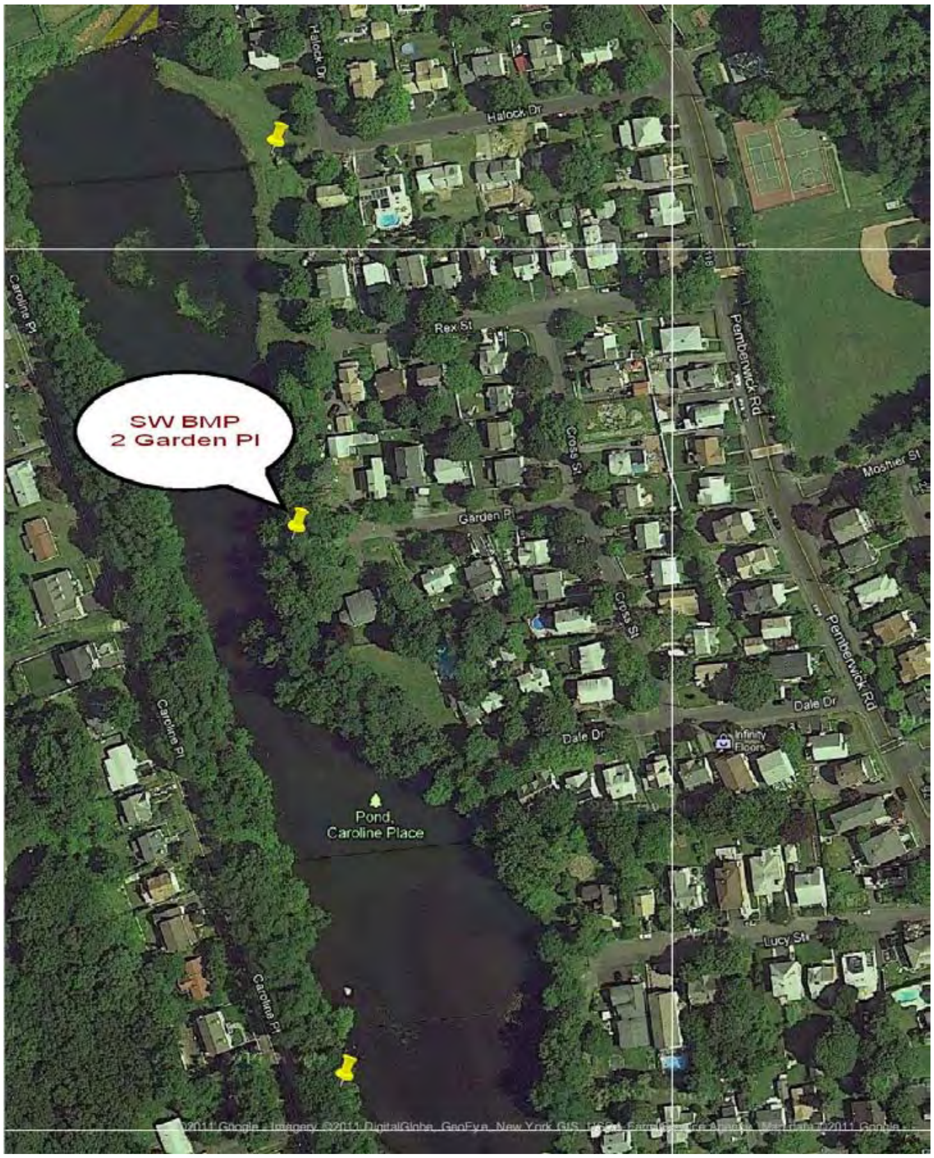
The 30 inch RCP located at 67 Caroline Place directly discharges to Caroline Pond and pollutants associated with medium & high-density residential uses plus the roadway system impact the water quality. The site has enough area to accommodate the installation of a forebay and created wetland system to settle solids and perform nutrient uptake. This site lends itself to a primary treatment practice such as the ones found in the 2004 CT SWQM pages 11-P3-1
thru 9.

Aerial View of Stormwater Outfall near 67 Caroline Place, Greenwich, CT.

Stormwater Outfall for Proposed BMP near 67 Caroline Place, Greenwich, CT.

4. Stormwater Outfall BMP near 2 Garden Place, Greenwich, CT

Located at 2 Garden Place this 12 inch RCP direct stormwater outfall has a contributory area of 2.7-acres, which receives runoff from an area of medium and high density residential plus the roadway system. This site lends itself to a primary treatment practice for bioretention similar to the practice found in section 11-P4-1 thru 7 in the 2004 CT SWQM.



Aerial View of Stormwater Outfall near 2 Garden Place, Greenwich, CT.

Stormwater Outfall for BMP near 2 Garden Place, Greenwich, CT.

5. Stormwater Outfall BMP near 99 Moncia Road, Greenwich, CT

Located at 99 Monica Road this direct discharge to Caroline Pond would benefit by the installation of a primary treatment practice to settle solids in the form of at gabion forebay similar to the one described in the 2004 CT SWQM on pages 11-P2-5 & 6.

Aerial View of Stormwater Outfall near 99 Monica Rd, Greenwich, CT.

Stormwater Outfall for BMP near 99 Monica Rd, Greenwich, CT.

6. Parking Lot at 777 Putnam Avenue West, Greenwich, CT

A commercial office building near Rt.1 on the east side of the Byram River is an asphalt parking lot of about 3 acres with catch basins along its perimeter. All flow from the parking lot appears to drain to one outfall at the southwestern end of the parking lot. There is adequate land available between the parking lot and the river for the installation of a stormwater treatment facility of bioretention or sand filtration to address sediment and pathogens. The parking lot has raised beds of concrete in which trees have been planted. Modifications of these planting beds into below grade bioretention rain gardens in conjuction with a centralized stormwater treatment unit would substantially improve water quality.

Aerial View of Stormwater Outfall at 777 W. Putnam Ave., Greenwich, CT.

Parking Lot at 777 W. Putnam Ave., Greenwich, CT. Facing south. Note buffer between parking lot and the Byram River.

Stormwater Outfall at Parking Lot for 777 W. Putnam Ave., Greenwich, CT.

7. SW BMP for Outfall at North End of Parking Lot for 777 W. Putnam Avenue, Greenwich, CT

Near Rt. 1 at a commercial office building's northwest corner of the parking lot - there is a stormwater outfall at this location that drains a residential neighborhood just east of the parking lot through a stormwater pipe along the northern edge of the parking lot for the 777 W. Putnam Avenue. There is adequate land available between the parking lot and the river for the installation of a stormwater treatment facility of bioretention or sand filtration to address sediment and pathogens.

8. Concrete Dock in Byram River, Port Chester, NY

On the west bank of the Byram River, opposite the 777 W. Putnam Avenue commercial office building parking Lot near Rt. 1 is what appears to be a concrete dock projecting into the river channel. An evaluation of the structure with considerations to modifications of the structure to eliminate excessive backwater during floods should be evaluated.

9. Pocket Park on South Water Street, Byram, CT

a recently installed pocket park on the bank of the Byram River presents an opportunity for a stormwater retrofit project. There is a large catch basin with a deep sump just before the pocket park that drains an adjacent commercial parking lot and drainage from a steep road just east and across the street from South Water Street. The flow of water could be modified to direct first flush runoff into the vegetated beds of the park to achieve some biodetention and filtration. There is some evidence of this concept at the pocket park in the way of a small curb cut for water flow over a stone and sand channel toward the river for a distance of about 20 feet. The exact purpose of the design is unclear. However, it did not appear to be receiving any runoff flow when inspected during a rain event on Octobe 27, 2011. The retrofit of the pocket park to enable biofiltration of stormwater runoff would enable both sediment and pathogens to be removed. At this pocket park there are six outfalls in the bulkhead at the river. It is unclear why there are so many outfalls. The largest outfall (estimated to be a 36 inch RCP) had flow coming out on November 1, 2011 but also had flow coming out around the pipe suggesting a problem with the pipe or groundwater/sanitary wastewater piping under the park. The structural stability of the bulkhead should be assessed with the ongoing flow around the stormwater outfall pipe. The pocket park was completed in about 2010.

10. Den Road Stormwater BMP, Greenwich, CT

Near the Byram River at this location are two outfalls. There appears to be an easement from Den Road to the River at this location that would enable the installation of a biodetention or first flush filtration treatment for stormwater.

11. Seton Boy Scout Stream Channel Modification

Along a tributary to the Byram River in the Seton Boy Scout property is a substantial channel modification that consists of a stone wall along the bank of the river, now standing in the center of the stream channel due to lateral shifts in the stream channel. The lenth of this stone lined channel and freestanding stone wall in the stream channel is estimated to be about 1 to 1.5 miles long. Natural design of the stream channel to provide a stable channel and improve habitat should be considered and evaluated as part of a larger Army Corp of Engineers flood assessment of the Byram River proposed in 2011. Throughout the entire Byram River watershed there are many miles of stream channel modifications similar to this are present along with fish barriers and dams. The channel modifications need to be professionally evaluated to determine if modifications can address flood control, river flashiness, channel stability and improve aquatic habitat.

Channel Modification at Seton Boy Scout Propterty, Greenwich, CT.

12. Fish Barrier - Pemberwick Dam, Greenwich, CT

Consideration should be given to the installation of a fishway for migratory fish or the modification or removal of this dam.

Aerial View of Fish Barrier at Pemberwick Dam, Greenwich, CT.

13. Caroline Pond Sedimentation

The pond is shallow, about 3 to 4 feet deep and heavily vegetated with a combination of attached aquatic weeds and attached algae. It is reported that this pond was a borrow pit for the construction of the Merritt Parkwaywith a depth in places of 50 feet at one time. In order to alleviate flooding, the dredging of this pond should be evaluated. It is recommended that the evaluation be included in the ACOE flood risk study of the Byram proposed in 2011. The dredging of the pond along with other sediment managment alternatives for natural and stable channel design. Improvements to Caroline pond should be evaluated within the goals of improving access to the river, managing flood water and flashiness of the river and improving aquatic habitat. A pedestrian pathway should be considered in pond and channel improvements at Caroline Pond. A local organization has proposed conceptual designs for a naturalized stream channel design with a flood plain serving as a pedestrian park along the river. Additonal details and images can be found at http://96.56.48.67/index_caroline.html.

Aerial View of Caroline Pond, Greenwich, CT.

14. Stormwater BMP Opportunity near Haleck Street, Greenwich, CT

Opportunity for installation of a biofiltration unit adjacent to the river. The design could be integrated into the Army Corp of Engineers berm and tide gate valve project constructed in the 1956. This is a residential neighborhood.

15. Comely Avenue and Pemberwick Road Leak Off

At the southeast corner of this intersection is surface runoff from the intersection through the curb that bypasses the catch basin. The leak off is a 4 ft wide asphalt gutter that has an accumulation of sediment and organic debris. The leak off is perched high above the river at about 20 ft. Flow cascades down boulder rip rap on the stream bank. There appears to be adequate space between the road and the river for the installation of a bioretention unit or sand filter to treat stormwater runoff for sediment and pathogens. There is a stormwater outfall below the leakoff in the concrete headwall of the Comely Avenue bridge (southeast corner) that drains stormwater from Pemberwick Road throught several catch basins. A larger stormwater treatment project to collect all runoff from the catchbasins should also be considered.

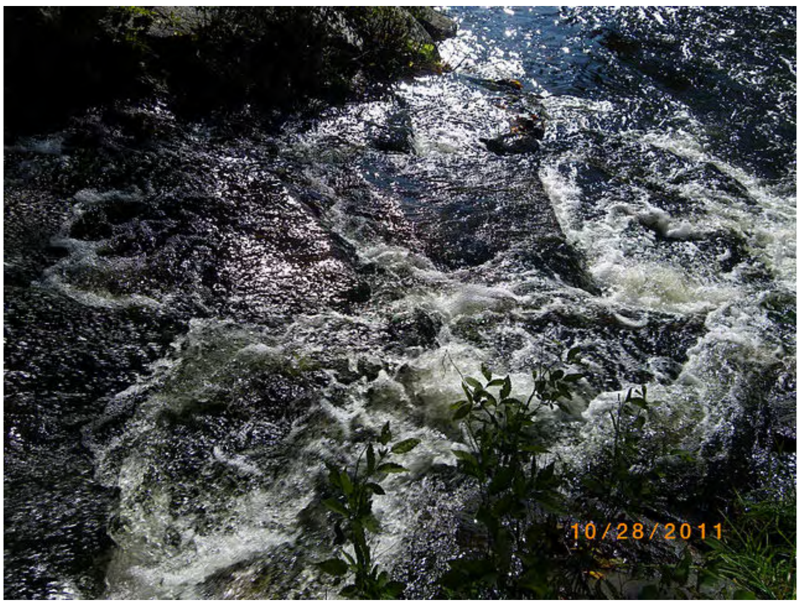
Pemberwick Road drainage leak off near Comely Avenue intersection, Greenwich, CT.

16. Fish Barrier at Tributary to Byram River

Just south of Comely Avenue on Pemberwick Road is an unnamed tributary to the Byram River. As part of the boulder rip rap armoring of the Byram River channel at this location, the confluence appears to have boulders in the stream bed that form a steep, high velocity water flow that is likely a barrier to migratory fish. At the time of the field visit, there was substantial flow from storms on the previous day. The site should be evaluated by migratory fish experts to determine what modifcations are needed to reestablish successful fish passage and thereby open several miles of the tributary for migratory fish habitat.

Aerial View of Fish Barrier (blue icon) Located at Tributary to Byram River at Culvert on Pemberwick Road near Comely Avenue, Greenwich, CT.

Fish Barrier at Pemberwick Road Culvert near Comely Avenue, Greenwich, CT.



Fish Barrier at Pemberwick Road Culvert Steep Grade and Velocity near Comely Avenue, Greenwich, CT.

17. Rock Deposit on the West Side of the Byram River Channel at Haleck Street

On the west side to the river channel at Haleck Street is a substantial accumulation of 8-10 inch rocks along 200 feet of the river channel that have accumulated on the inside bend of the Byram River since the Army Corp of Engineer (ACOE) river improvement project in 1956. The rock deposit restricts river flow at this location and likely has an impact on the sediment transport and deposition immediately downstream in Caroline Pond. An analysis of the hydrologic, flood control, and aquatic habitat considerations and benefits of removing rock deposit at this location should be conducted. It is recommended that the evaluation be included in the ACOE flood risk study of the Byram proposed in 2011.

Aerial View of Rock Deposition in Channel near Haleck Drive, Greenwich, CT.

Rock Deposition in Byam River Channel near Haleck Drive, Greenwich, CT.

18. Goose Control Management to Minimize Pollution

Canada geese graze on grass during warm weather when they are mating, nesting, incubating, and raising young. Geese also require water such as a ponds, or rivers. Goose habitat is available throughout the Byram watershed especially where there are expanses of mowed turf. Grass is mostly indigestible fiber, so a goose must eat a lot of it to keep nourished. An adult Canada goose can produce as much as 2 pound of droppings in a day. The bacteria and nutrients deposited on the lawn are carried by storm water sheet flow into nearby streams and ponds. Goose droppings are a potential health hazard harboring parasites, viruses, and bacteria while overenriching streams and ponds and encouraging unsightly and smelly algal scum. It is recommended that goose control measures be implemented in the Byram watershed. The project would begin with an inventory and surveillance effort to identify significant populations of geese. The Town of Greenwich currently has an active goose control program that could be expanded to the Byram watershed, particularly the lower Byram River. Ideal locations are municipally owned land and private property that is easily accessible by municipal staff and volunteers. A preliminary review of maps suggests that the Toll Gate Pond area near Rt. 15 and Riversville Road, Caroline Pond near Pemberwick Road and the Western Greenwich Civic Center at Glenville Road should be evaluated for goose management opportunities. Control practices that should be considered include a) population stabilizationusing egg addling/oiling, b)hazing geese with dogs, c) education of the public on not feeding geese and habitat elimination, and d) fencing. Property owners, golf course managers, town health officials, conservation officers, park managers, and other interested individuals or groups throughout the watershed should be encouraged to participate. The Town of Greenwich Conservation Commission could provide the best source of information and experience on goose control and collaborate with other municipaliteis in the watershed. Background informaton on goose control management include:

Town of Greenwich 2005. Town Annouces New Goose Management Plan, Press Release, June. http://greenwichct.virtualtownhall.net/public_documents/GreenwichCT_Conserve/Archive2005/geesePRJune2005.pdf

Pittsfield Charter Township 2005. Goose Control Best Management Practices to Prevent Pollution of Ponds,Streams,and Rivers, Pittsfield Charter Township Phase II Storm Water Management Program—"Operation Goose Down" August 11, 2005. Inspired by "Weatherstone Wildlife," a column by the late Bill Mullendore, published in the Weatherstone Condominium Morning News. http://www.pittsfieldtwp.org/NRC_Goose_Control.pdf

Harold, Sally 2011. Goose Poop Problem: Spoiling lawns — and Rivers, The Nature Conservancy Wednesday, 16 March 2011. http://bit.ly/s9G6Bn

Appendix 5
Fish Barrier Assessment and Public Workshop Initiative

Byram Watershed Coalition

The following are excerpts from a grant proposal for assessment of streams in the Byram Watershed and the Development of a Workshop for Landowners of Stream Channel Modifications and Fish Barriers to Consider modification alternatives.

Project Abstract

An inventory of stream restoration opportunities to improve riverine habitat for both migratory and resident fish species will be prepared for the Byram River watershed using the Natural Resource Conservation Service (NRCS) stream walk assessment protocol and volunteer citizen scientists. Data will be input to GIS, representative stream restoration case study projects will be selected and conceptual restoration/retrofit designs will be prepared. A public workshop will be held to increase awareness of stream habitat impacts that result from channel modifications and inadequate stream buffers. The workshop will review stream restoration methods, costs, benefits and the selected case study projects in the Byram River watershed. A brochure on stream restoration will be prepared. The stream walk assessment to locate and inventory concerns is an action item in the Byram River watershed management plan. Project results will be used plan and implement habitat improvements in the Byram River watershed as well as address other concerns. The Byram River Watershed is a tributary to Long Island Sound that drains a 29 square mile urban area that includes communities in New York (Port Chester, Rye Brook, North Castle and Bedford) and the Town of Greenwich, CT. The streamwalk assessment from summer 2010 reveals a significant number of stream concerns such as fish barriers, channel modifications, inadequate stream buffers, water quality, erosion, degraded buffers and stormwater runoff.

The Glennville Mill Dam located 3.8 miles upstream from Long Island Sound on the Byram River.

Typical Fish Barrier in a Headwater Stream of the Byram River Watershed.

Urban modification of streams channels prevents fish passage, and inhibits their ability to survive extreme event conditions. For diadromous fish, their long-term survival is threatened when they are unable to swim upstream to gain access freshwater streams. Excessive channel modifications also contribute to hydrodynamic impacts on stream channels that can negatively impact aquatic habitat and contribute to more rapid runoff and concentrations of water, flood damage and energy downstream. The efforts funded by this grant will inventory stream channel modifications, select and plan stream restoration demonstration projects and improve community understanding of the current problem, the environmental consequences and techniques that can be used for stream restoration, the cost and value of stream restoration. This project will enhance community awareness and get citizens to explore and better understand the Byram River watershed and its relationship to the health of Long Island Sound.

The project will result in an inventory stream modifications that adversely impact aquatic habitat (dams, channel linings, culverts, poor storm water outfall pipe designs, illicit connections to stormwater sewer outfalls, inadequate stream buffers, eroding stream banks, etc.). The inventory will result in planning for increased fish passage, reduced sediment transport and deposition in stream beds, better tree canopy cover for streams and reductions in water temperatures, improved stream habitat, stormwater runoff quality, enhanced community awareness and understanding of the problems and restoration solutions. The project will identify stream restoration demonstration projects for restoration and retrofit and prepare the conceptual designs for restoration or retrofit (i.e. dam removal or modification to enable fish passage). A public workshop and brochure will heighten community understanding of impacts to streams (the problems and concerns) and promote community support for stream restoration projects.

Riverine migratory corridor fish habitat and resident fish habitat of the Byram River watershed that drains to Long Island Sound are the habitat addressed by this project. River quality for the lower, tidal portions of the Byram River at Port Chester, NY and Greenwich (Byram), CT is failing to meet water quality standards for consistently failing to meet bacteriological standards for contact recreation. Non-point sources of urban runoff and illicit connections to storm sewers in Port Chester have been identified as the cause and are being investigated and addressed by the Village of Port Chester in compliance with two Administrative Orders issued by US EPA Region 2 New York. The upper reaches of the River have not been assessed by CT DEP adequately or the data is insufficient in order for the CT DEP to assess compliance with water quality standards. As part of the Byram Watershed Coalition's efforts, wet and dry weather samples were collected during 2010 on the west branch of the Byram River in CT and NY by the Interstate Environmental Commission (IEC) as part of a larger effort to prepare a water quality load model for the watershed. Draft sampling results from ten locations show significant concentrations of fecal and total coliform bacteria and enterococcus after rainfall events at many sampling locations. IEC will be drawing conclusions from their sampling when additional sampling is completed in Spring 2011.

The Byram River Watershed consists of 29 square miles. A rough estimate is that there are about 50 linear miles of stream within the watershed. Regarding the living resources that are the focus of this project, we are particularly interested in diadromous fish, American eels (Anguilla rostrata) documented by CT DEP to be present in the Byram River and river herring (Alosa pseudoharengus and/or Alosa aestivalis) and white perch (Morone Americana). Studies by CT DEP have identified 11 resident fish species with blacknose dace and creek chubs to be the most abundant species in the watershed. The CT DEP also stocks brown trout (Salmo trutta), brook trout (Salvelinium fontinalis), and rainbow trout (Oncorhynchus mykiss) for angling. All of these species will ultimately benefit from projects selected for stream restoration, retrofit or dam removal/modification from the foundation work created by this project.

The Byram River drains a watershed area of 29 square miles. The river flows through six towns located in the border region of southwestern Connecticut and southeastern New York. The majority of the watershed is located within the towns of Greenwich, Connecticut (62 % of the watershed), and North Castle, New York (29 % of the watershed). The remaining 9% portion of the watershed is spread within the Westchester County, New York towns of Port Chester, Bedford, New Castle, and Rye Brook. The main stem of the Byram River is approximately 20 miles in length. The river begins in New York at an elevation 750 feet, flows through Greenwich and along the lower Westchester NY boundary, and eventually flows to Long Island Sound in Port Chester Harbor. The surrounding watershed to the Byram is characterized by a mixture of urban and suburban residential parcels and densely populated commercial areas. The upper and mid portions of the river flow through a hilly forested landscape that is predominately residential. The lower portions of the river flow through a flatter, more urbanized landscape. There are four major urban transportation corridors (NY Route 684, Interstate 95, the Merritt Parkway, and CT Route 1) that transverse within the watershed, as well as a network of locally maintained roads. Maps of the Byram River watershed are attached that show the municipalities, an aerial view, and a topographic map of the watershed and streams. The watershed is a wedge shape from north to south with the point toward Long Island Sound. The following map coordinates border the watershed:

Southern Edge at Long Island Sound - 40°59'22.09"N 73°39'32.75"W
Northeast Corner - 41° 8'19.33"N 73°38'22.12"W
Northern Edge - 41°10'59.44"N 73°41'30.18"W
Northwest Corner - 41° 9'13.85"N 73°44'12.21"W

Although this is primarily a watershed-planning proposal, the project includes a focus on riverine migratory fish habitat corridors (one of the 12 high priority habitats identified by the Long Island Sound Study) along with resident fish habitat. This planning project is an action item in the draft watershed management plan for the Byram River, a work product of the Byram Watershed Coalition based on two years of meetings, data collection and ongoing assessments supported by SWCD with funding from CT DEP, Westchester Community Foundation, Fairfield County Community Foundation and Rivers Alliance. The watershed management plan focus is restoring and protecting water quality, and natural and wildlife resource management. The proposed project is part of a long-term project (assessing stream concerns, collecting restoration expertise and developing preliminary restoration/retrofit designs) that when implemented will help to restore and protect the watershed. The method of the proposed project addresses the following topics outlined in the LISFF RFP for "Stormwater and Nonpoint Source Pollution Control Planning" category projects:

• *Citizen and business engagement and collaborations between public and private entities* – the data collection aspects of this project (identification of stream corridor concerns such as dams, culver design, erosion problems etc.) is based on citizen science volunteers following an NRCS protocol of stream walk assessments. The volunteers include a wide variety of backgrounds and interests, some with professional training in environmental science, engineering and natural and wildlife resource management. Many different organizations and affiliations are represented in the Byram Watershed Coalition that is engaged in the implementation of the watershed management plan. To further engage a wide variety citizens, businesses, stakeholders and experts, a stream restoration workshop is planned.
• *Riparian buffer corridor protection and restoration* is the primary focus of the proposal.

The draft Byram River Watershed Management Plan was completed in November 2010. It has been submitted to CT DEP for comments. Mr. Chris Malik of CT DEP's watershed program has participated in most meetings and supported the Byram Watershed Council's preparation of the draft plan. Work is currently underway to finalize the plan in September 2011. Elements of the plan are being implemented as funding and resources are available and applications. The lower portions of the river are listed on CT DEP's 304 (l) list for failing to achieve bacteriological water quality standards and designated beneficial uses for contact recreation. Illicit connections (sanitary sewers connected to storm drains) and damaged sanitary sewers and storm sewers have been identified as the primary cause for the water quality problem. Two US EPA Region 2 Administrative Orders have been issued to the Village of Port Chester to identify and repair illicit storm sewer connections The *known and listed* impaired segments of the Byram River include from head of tide (upstream of Route 1 crossing, at inlet to the ponded portion of river, just downstream of Upland Street East area, upstream to Pemberwick outlet dam (upstream of Comly Avenue crossing, and upstream of the confluence with Pemberwick Brook. The segment length is 0.49 Miles. The impaired designated uses are "habitat for fish, other aquatic life and wildlife, and recreation". The sources of impairment are listed as "outside the CT State jurisdiction or borders, source unknown, highway/road/bridge runoff (non-construction related) unknown, and illicit connections/hook-ups to storm sewers and Escherichia coli.

The designated uses of the streams in the Byram River watershed are habitat for fish, other aquatic life and wildlife and recreation.

This project involves a stream walk assessment and inventory of problems in the Byram River Watershed (a tributary to Long Island Sound), the input of data into a GIS database for review and presentation of findings, the selection of stream restoration project case studies, the development of conceptual designs for the stream restoration work, the planning and delivery of a public workshop on stream restoration and the preparation of a brochure on stream restoration. A streamwalk assessment program began during the summer of 2010. The Natural Resource Conservation Service (NRCS) protocol for stream walk assessment was followed. NRCS trained over 40 volunteers in June 2010. Seventeen subbasins along the northwest portion of the watershed were surveyed. Over 250 hours of volunteer time was logged in the effort. The NRCS streamwalk protocol can be viewed at the following website along with data collection forms: http://goo.gl/PsPC2. The method consists of volunteer teams walking in or along streams and rivers in subbasins delineated by NRCS to collect data on basic stream characteristics, substrate, buffer condition, tree canopy and concerns or problems. Standardized forms are used to document stream characteristics and concerns including dams and culverts that inhibit fish passage, channel modifications, stormwater runoff outfall pipes, eroding stream banks, excessive sediment accumulation, inadequate stream buffers, excessive algae and aquatic vegetation, and water quality problems. Findings are entered into a spreadsheet and loaded into GIS. This proposal will fund the Byram River Watershed Coordinator to manage the streamwalk program during the summer of 2011 and a fisheries biologist/GIS specialist to prepare GIS maps. These individuals will be contracted to perform the streamwalk coordination and data management. In addition, the individuals will work with a stream restoration consultant to be hired by SWCD to select stream restoration case study projects and develop conceptual designs for stream restoration projects. To refine selections of stream restoration case studies, GIS land use data will be considered such as impervious cover, stream buffer size, tree canopy, and adjacent land use activities. We anticipate that the case study projects will likely include design modifications to dams and culverts that will enable fish passage and channel modifications to remove stone channels and allow for more natural flood plain energy dissipation during high flows. The consultant will work with the coordinator to plan and deliver a public workshop to engage the public, particularly private landowners that have dams and fish barriers present on their property and municipal conservation and land use decision-makers from within the Byram River watershed. Workshop topics will include typical restoration opportunities, consequences to aquatic life and fish, project selection methods, permitting requirements for restoration/retrofitting, cost estimates, benefits of stream restoration projects, sources of funding, examples of successful projects and a review of the selected case studies from the Byram River watershed. Landowners will be encouraged to consider stream restoration and retrofit projects that will have a beneficial impact on riverine habitat. A brochure will be prepared to reinforce the concepts presented in the workshop for distribution to landowners, environmental advocates and municipalities. The streamwalk assessment and concern identification inventory is an action item of the Byram River Watershed Management Plan.

Activity	Timeline
Enlist Volunteers for Stream Walk Assessments (SWA)	Mar 21 – May 15, 2011
Interview Qualified Stream Restoration (SR) Consultant	Mar 21 – May 1, 2011
Select SR Consultant and Sign Contract	May 1 – June 1, 2011
Refresher Training for SWA Volunteers	May 15 – May 31, 2011
Begin Stream Walk Assessments	June 1 – June 15, 2011
Begin Planning Stream Restoration Workshop	June 1 – July 1, 2011
Begin Data Entry of Assessment Data Sheets	July 1 – Sept 30, 2011
Complete Data Entry and Uploads to GIS	Sept 30 – Oct 1, 2011
Contract with Stream Restoration Consultant	Sept 30 – Oct 1, 2011
Draft Workshop Plan, Agenda and Presenters	Nov 1 – Nov 15, 2011
Preliminary Selection of Stream Restoration Projects	Nov 15 – Dec 15, 2011
Conceptual Designs for Restoration Projects Draft	Dec. 15 – Jan 15, 2012
Conceptual Designs for Restoration Projects Final	Jan 16 – Feb 1, 2012
Convene Stream Restoration Workshop	Feb 15 – Mar 15, 2012
Draft Brochure on Stream Restoration/Retrofit	Mar 15 – Apr 1, 2012
Final Brochure on Stream Restoration/Retrofit	Apr 1 – Apr 20, 2012

Budget Category	Total $s project budget by Budget Category	Nonfederal cash or inkind matching contributions Applied to Budget Category	LISFF $s Requested towards Budget Category
Salaries & Benefits	$16,100	$15,000	$1,100
Equipment	$0		
Contractual Services	$54,200		$54,200
Supplies/Materials	$2,200	$500	$1,700
Printing	$3,500	$2,000	$1,500
Travel	$2,000	$500	$1,500
Other	$0		
Totals	$78,000	$18,000	$60,000

Pemberwick Dam located about 3.1 miles upstream of Long Island Sound on the Byram River..

The project proposal is a continuation of a planning effort to finalize and begin implementation of the watershed management plan for the Byram River. The Byram Watershed Coalition (BWC) was formed in January 2008 and holds monthly meetings with its members. BWC held a public forum in March of 2009 to review the need for a watershed management plan, review the known issues and concerns within the watershed. In June 2011 BWC produced a brochure about the watershed and activities that citizens should consider. BWC began streamwalk assessments of the Byram River watershed during the summer of 2010. The preliminary findings show significant concentrations of channel modifications and fish barriers. (See BWC preliminary findings in an attached document). About 25% of the watershed was assessed. Work to input the data into spreadsheets and the Greenwich GIS system are ongoing. The draft watershed management plan was submitted to CT DEP in November 2010. Another Byram River watershed project in progress is the development of a water quality load model. The project is being conducted by the Interstate Environmental Commission (IEC) in coordination with Columbia University and funded with a NY DEC 604(b) grant. The project includes wet and dry weather sampling during 2010 - 2011 by the IEC. Preliminary sampling results from ten locations indicate significant concentrations of fecal and total coliform bacteria and enterococcus after rainfall events at most sample locations. The water quality load model will be available the Fall of 2011.

Results of the project will be a) published to the Byram Watershed Coalition (BWC) webpage (https://sites.google.com/site/byramwatershedcoalition/), b) published in the Southwest Conservation District's newsletter "Soil and Water" c) presented to participants at the Stream Restoration Workshop proposed for February - March 2012, d) given as a press release to the local newspapers, e) presented to homeowner associations in the watershed that accept BWC's offer to provide a status report at their annual meetings, f) summarized in the Stream Restoration Brochure for release in Spring 2012, g) shared with municipalities in the watershed as summary report.

The Town of Greenwich will be the organization collaborating closely with the SWCD on this project. The Town has been well represented at the monthly BWC planning meetings with individuals from the Conservation Commission, the Department of Environmental Health, and the Inland Wetlands and Waterways. Joe Cassone, an employee of the Conservation Commission will be supporting the project and providing inkind support via GIS data input and quality assurance of data. The GIS system of the Town of Greenwich will be the repository for watershed related data that result from this project. A letter from the Town of Greenwich characterizing their support for this grant proposal and quantifying their inkind support of the project is included in the uploaded files supporting this grant application. The members of the Byram Watershed Coalition (BWC) collaborate with SWCD via monthly meetings and the exchange of emails and reviews/comments on distributed minutes from meetings. The implementation of the tasks of this grant proposal will be a routine agenda item. The BWC includes citizens, State employees, Municipal employees, Commissions, non-profit organizations, and environmental consultants all interested in improving the quality of the Byram River Watershed. The membership list can be found on the BWC web page: https://sites.google.com/site/byramwatershedcoalition/how-we-are-organized.

This project includes the recruitment of volunteers from the watershed community to conduct streamwalk assessments of streams and rivers in the Byram River watershed. Press releases will be prepared and issued to solicit participation that will also serve to inform the community about the Byram River watershed planning efforts. Additionally, a public workshop will be held to increase awareness among the community, municipal land use decision makers, as well as any interested parties on the problems and concerns that are present in the Byram River watershed, the consequences of those problems and the methods that can be employed to restore streams and retrofit dams, culverts and channels. The proposed project has the support of the Byram Watershed Coalition, the watershed planning organization composed of watershed stakeholders, environmental resource experts from the municipalities in the watershed, non-profit environmental organizations, homeowner associations as well as private businesses.

All private, public, State, municipal and Federal ownership types are present in the Byram River watershed.

Appendix 6

Non Point Source Horse Farm and Trail Inventory for Best Management Practice Initiative

To View this document online, go to: http://bit.ly/o7rTPC
Prepared by: Jack Stoecker - ctzipper@gmail.com

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Background

Mianus River Watershed Council (MRWC) conducted a GIS assessment of the Mianus River State Park near Howard Road, Stamford in 2006. The findings reveal that the density of horse trails is significant and in some locations are unnecessarily close to sensitive wetlands. Additional concerns were raised about the depth of treading and erosion potential of the trails. A draft watershed management plan has been prepared for the Mianus River by AKRF under a contract with Southwest Regional Planning Agency (SWRPA), Stamford, CT. A draft watershed management plan is has been prepared for the Byram River with support from the CT Southwest Conservation District (SWCD) and funding from CT DEP.

The Mianus River Watershed Management Plan can be viewed at: http://www.swrpa.org/Default.aspx?Regional=280. . Goals and strategies of the plan include programs to promote sustainable management at horse farms for nutrient loading reductions. The Byram Watershed Management Plan can be viewed at : http://bit.ly/psofvo. Task B7 of the plan calls for the identification existing and potential sources of nutrient contamination from horse farms.

MRWC plans to expand its GIS assessment of horse trails throughout the Mianus River Watershed and the Byram River Watershed, identify the number, size and location of horse farms, work with Greenwich Riding and Trails Association (GRTA) and other horse owner and riding associations to review best management practices (BMPs) and develop a dialog with horse farm owners, the GRTA and other agencies that will review horse manure management, grazing practices, riparian stream buffers, trail design and maintenance, and design and landscape practices to minimize storm water pollution and impacts of stream quality and habitat. MRWC would like to renew interest in the Horse Farms of Environmental

Distinction (HFOED) program wherein horse farm owners are awarded a HFOED award for adequately, implementing low impact practices. There has been one instance of enforcement action against a homeowner for stockpiling manure in the vicinity of the Bargh Reservoir that serves as the primary drinking water supply for the Town of Greenwich, Port Chester, NY and Rye, NY.

Data Sources

MRWC will seek the support and assistance of the GRTA and other riding and trail organizations to contact its membership and work with MRWC to collect information about the size and location of horse farms in the watersheds. MRWC will obtain public records from the State and Local Health Departments regarding available information on horses and any permits required of horse owners or horse farms. Interviews of subject matter experts will be conducted to prepare a literature review of similar efforts and an Internet-based search will be conducted. The GIS database developed by the Mianus River Gorge Preserve (MRGP) for the Mianus River will be used to store inventory information for the Mianus River while the Town of Greenwich will store inventory information for the Byram River watershed. The proximity of horse farms to sensitive bodies of water will be determined and evaluated for significance and possible outreach.

For the Byram River, the Town of Greenwich GIS system will be used with support from the Department of Conservation and GIS staff. Within the Byram watershed, a wet and dry weather sampling program at various location in the watershed has been done and will be repeated one more time to calibrate a non-point source load model being developed by Columbia University. The findings of that sampling and modeling will be used along with the geographic location information for horse farms to evaluate possible trends. Additional sampling locations will be recommended based on the findings to determine if there is a measurable impact from horse farms.

Horse Farm Inventory Data Sources

1. Dunn and Bradstreet
2. SIC Codes
3. Business License Registration
4. Real Estate Tax Codes for "farms"
5. Personal Property Taxes for Horse Ownership
6. License from Health Department like dog license
7. Internet website listings of "horse farms", breeders, equestrian instruction or horse stables.
8. Greenwich Riding and Trails Association - voluntary questionnaire.
9. GRTA coordination to enlist new members.
10. Horse vetrinarians for knowledge/listings.
11. Aerial Google images and address look up and follow with a letter/questionnaire. Look for visual signatures of horse farms.
12. Check with the “CT Horse Council” - http://www.cthorsecouncil.org/
13. Check with the “Just Horses” Directory - http://www.justhorses.com/c.html.

Work Products

1. Horse Farm and Trail Riding Organizations within the Mianus and Byram River watersheds.
2. Literature Review of BMPs for horse farms, horse trail design and maintenance.
3. GIS Inventory of the horse farms and trails on publicly owned land and possibly privately owned land.
4. GIS inventory of the location of horse farm and owners of horse farms and owners of horses. Where possible, the number of horses present will be tracked along with other significant farm livestock or zoo animals based in GIS.
5. A dialog with the GRAT and other riding clubs and user groups regarding the number and location of horse farm BMPs, and trail design and maintenance BMPs.

Preliminary Budget Estimate

The budget estimate for each task of this project is as follows:

1) Literature Review/Interviews

20 hours - reseach/interviews
10 hours - draft findings
5 hours - response to comments
$ 100 - miscellaneous

2) Inventory Development/Research

20 hours - research, interviews
10 hours - draft
10 hours - response to comments
$ 100 - miscellaneous

3) Data Collection and Data Input of Mianus River and Byram River

80 hours
40 hours - data input
20 hours - GIS refinement
$ 100 - miscellaneous

4) Education and Outreach

40 hours draft brochures
40 hours - edits and final
$ 1,000 design and print
20 hours - update websites
16 hours - preparation /presentations

5) Project Administration

20 hours - draft report
8 hours - final report

Budget Summary

	Labor	Expenses
1	35	100
2	40	100
3	140	500
4	145	2000
	360	2700

Total Budget: $ 12,000

Appendix 7

Non-Point Source Assessment of Septic Systems in the Byram River Watershed

This proposal seeks funding for the mapping of septic systems using GIS to assess possible loadings of pollutants of concern to nearby streams, the characterization of soils and geology as a possible influence on loadings, the prediction of hot spots and the distribution of information on appropriate septic system management frameworks and best management practices for the homeowner, the municipalities, homeowner associations and the Byram Watershed Coalition.

BWC proposes a literature review of septic system management practices for consideration by member municipalities, homeowner associations and BWC in its advocacy role for the implementation of the watershed management plan.

The Byram Watershed is 30 square miles in CT and NY. The watershed management for the Byram River is currently being drafted. The lower tidal portions of the River are failing to meet water quality standards for pathogens based on a long history of water quality sampling by the Interstate Environmental Commission and the Town of Greenwich. The upper reaches of the watershed are scheduled to be sampled by the IEC during the 2010-2011 calendar year. Dry and wet weather sampling events are planned for 7 locations. We anticipate that water quality testing will show pathogens. In an effort to document the location of septic systems (individual, multiple home and commercial), we propose to review municipal records, maps and collect and analyze GIS maps to evaluate the density of of septic systems, soil and geology characteristics as it relates to removal of pollutants. Of particular concern is the loading of nitrogen.

Data Collection - will consist of a review of municipal records for failing septic systems within the Byram River watershed in search of a pattern, the identification of soil and geologic formations as they relate to the performance of septic systems or contribute to their failure, GIS mapping of public sewers, and the density and proximity to tributaries of non-sewered homes and businesses to tributaries in the watershed. We propose to limit the assessment to 100 feet of streams.

Literature Review - will consist of an inventory examination of municipal code requirements related to septic system design and maintenance. The potential for expansion of sewer districts will be examined. The municipal management and inspection program for sanitary sewers will be reviewed. A review of literature for similar studies and a survey of successful and noteworthy management programs for septic systems will be summarized.

Data Analysis - will be conducted to identify areas of concern to recommend sampling and analysis of streams for pollutants indicative of sanitary waste water from septic systems. Municipal oversight of septic systems will be evaluated and compared for improvement opportunities with respect to findings in the literature review and any findings regarding the performance of soils and geology. Recommendations will be made to municipalities.

Public education - of the findings of the study will be presented to municipal land use decision-makers and interested citizens. The findings and recommendations of the study will be added to the action items for the Byram Watershed Management Plan.

Additional Studies and Investigations - will build on the findings of the Non-point Source Assessment of Septic Systems. The results of the project will be used to recommend sampling locations to assess water quality in the vicinity of high densities of septic systems and the examination of the health of the streams near those locations.

Budget Estimate -

Activity	**Labor**	**Expenses**	**Dollars**
Data Collection	2250	200	2450
Literature Review	2250	200	2450
Data Analysis	3000	400	3400
Report Preparation	3000	600	3600
			$ 11,900

Similar Projects - Projects with similar goals will be reviewed for background, ideas, collaboration and lessons learned. One nearby project is:

NFWF Grants Profile - Long Island Sound Futures Fund
Project Title: Septic System Management Education Campaign (CT)
Project Location: Town of Westport, Connecticut
Project ID No: 2009-0061-015
Description: Implement a town-wide educational campaign to educate homeowners about responsible septic system maintenance and management.
Project Location: Aspetuck River, Westport, Connecticut.

Appendix 8

Activities of Concern in Lower Byram River from Stream Survey

On November 1, 2011, a boat survey of stormwater outfalls was conducted from Caroline Pond to the Mill St. Bridge on the Byram River. The following concerns were observed. We suspect that some of these activities may be illegal but would require additional analysis from regulatory staff. Observations and photo were collected by Jack Stoecker, Mike Finkbeiner and Peter Alexander[1].

1. Dumping of Masonry into Byram River - just North of the Mill St. Bridge on east bank is a pile of masonry debris, sand, gravel, mortar and concrete that has been dumped directly into the river to create a pile of solids at least 6 feet high from the bottom of the river to several feet above the river surface.

2. Dumping of Vegetation into the Byram River - just North of the Mill St. Bridge on the east bank is a pile of cut landscaping flowers, purple chrysanthemums? in a large pile. The dumping was observed on November 1, 2011.

3. Drainage from a Home Heating Oil Truck Fleet - on the east (Greenwich) side of the Byram downstream of the Rt. 1 bridge. There is a suspicious looking outfall from an oil delivery truck fleet building. It should be investigated for oil.

4. Paint from Spray Booth - on the west bank of the River just north of the Mill St. Bridge in Port Chester. A cloud of overspray leaves a building along the the river and settles on the surface of the water. The paint particles float on the water.

5. Erosion of Streambank - just south of the Rt. 1 bridge on the east (Greenwich) bank is a severe erosion/hole formed by the free fall of stormwater from a ~12 inch outfall pipe perched about 20 feet above the riverbank. A large hole has formed at the toe of the masonry retaining wall in the river sediment (organic soil) and and caused the erosion of a large hole. Energy dissipation might be needed. The discoloration below outfall should be investigated for possible sanitary sewage or oil.


11/01/2011

6. Construction Project Underway with Stream Bank Retaining wall installed. Did this homeowner have a permit for this project?