MianusPlan_ Action plan.pdf

Byram River plan_ Action plan.pdf

Table 12. Subwatershed Targeting Metrics

Targeting Score	1	2	3
Drinking Water Source	Does not drain to a drinking water source	Drains indirectly to a drinking water source	Drains directly to a drinking water source
Stream Order	Less than 50 percent of the stream length is 1st order	50 to 99 percent of the stream length is 1st order	100 percent of the stream length is 1st order
Impervious Cover Score	Good	Fair	Poor
NO_3 Loading	Less than 1.3 lb/ac/yr	1.3 to 10.0 lb/ac/yr	Greater than 10.0 lb/ac/yr
Particulate P Loading	Less than 1.5 lb/ac/yr	1.5 to 3.0 lb/ac/yr	Greater than 3.0 lb/ac/yr
TSS Loading	Less than 300 lb/ac/yr	300 to 550 lb/ac/yr	Greater than 550 lb/ac/yr
Indicator Bacteria Loading	Less than 120 billion cfu/ac/yr	120 to 200 billion cfu/ac/yr	Greater than 200 billion cfu/ac/yr

IDENTIFIED TARGET SUBWATERSHEDS

The thirteen identified target subwatershed are depicted in Figure 10. These represent the subwatersheds with the highest combined sensitivity and impairment scores (1, 5, 7, 8, 10, 12, 14, 17, 19 [Strickland Brook], and the Main Stem [61, 62, 63, and 64]). The headwaters of subwatershed 18 were also included based on visual assessment results and stakeholder input.

IDENTIFIED MANAGEMENT ACTIONS

The Plan proposes a series of management actions, which include the development of structural and non-structural BMPs (discussed in the following pages), implemented through a variety of monitoring and education/outreach programs, as well as broader policy initiatives. Management actions (Table 14) are associated with each management strategy proposed in Chapter 5. In some cases, similar management actions apply to multiple strategies; these instances are cross-referenced in the table text. Many management actions identified by the Plan support multiple goals. This integrated approach acknowledges that the management goals identified in the Plan are related to one another and that implementation actions often have multiple benefits. In addition to providing a brief description of the management action, Table 14 provides a suggested schedule, implementation milestones, and quantitative or qualitative performance criteria for each management action.

Successful implementation will rely on a collaborative effort that brings together the shared knowledge and experience of the participating organizations. Accordingly, Table 14 also recommends organizations that would be well suited to implement each of the management actions, including a range of state, municipal, and nonprofit partners. Organizations were identified for implementation activities based on their legal authority, mission, and/or prior work in similar areas.

Table 13. Subwatershed Targeting Scores

Metric Ranking							
Importance rank*	1	2	3	5.5	5.5	5.5	5.5
Normalized rank**	0.25	0.21	0.18	0.09	0.09	0.09	0.09

Subwatershed Scoring

Subwatershed	Drinking Water Source	Stream Order	Impervious Cover Score	NO_3 Contribution	Particulate P Contribution	TSS Contribution	Indicator Bacteria Contribution	Overall Score
17	0.75	0.428	0.358	0.178	0.267	0.267	0.178	2.426
62 (Below Bargh Reservoir)	0.5	0.428	0.358	0.267	0.267	0.267	0.267	2.354
14	0.5	0.642	0.358	0.178	0.178	0.267	0.178	2.301
8	0.5	0.428	0.358	0.178	0.267	0.267	0.267	2.265
64 (Upper Main Stem)	0.5	0.428	0.358	0.178	0.267	0.267	0.267	2.265
61 (Lower Main Stem)	0.75	0.214	0.537	0.267	0.089	0.089	0.267	2.213
7	0.5	0.642	0.179	0.178	0.267	0.267	0.178	2.211
5 (Piping Brook)	0.75	0.428	0.179	0.178	0.178	0.267	0.178	2.158
12	0.5	0.642	0.358	0.089	0.178	0.178	0.178	2.123
19 (Strickland Brook)	0.25	0.428	0.358	0.267	0.267	0.267	0.267	2.104
63 (Main Stem/Bargh Reservoir)	0.75	0.428	0.179	0.178	0.178	0.178	0.178	2.069
1	0.5	0.642	0.358	0.178	0.178	0.089	0.089	2.034
10	0.5	0.428	0.358	0.178	0.178	0.178	0.178	1.998
18 (East Branch)	0.5	0.428	0.358	0.178	0.178	0.178	0.178	1.998
9	0.5	0.214	0.358	0.178	0.267	0.178	0.267	1.962
15	0.5	0.642	0.358	0.089	0.178	0.089	0.089	1.945
13	0.5	0.428	0.358	0.178	0.178	0.178	0.089	1.909
16	0.5	0.428	0.179	0.178	0.089	0.267	0.178	1.819
2	0.5	0.642	0.179	0.089	0.089	0.178	0.089	1.766
11	0.5	0.428	0.358	0.089	0.089	0.178	0.089	1.731
4	0.75	0.428	0.179	0.089	0.089	0.089	0.089	1.713
3	0.5	0.428	0.179	0.089	0.089	0.089	0.089	1.463

*IR of 1 is highest priority and the IR for metrics of equal priority are averaged; metrics with equivalent importance are assigned an average importance rank

**Normalized rank = (7 - IR + 1) / 28

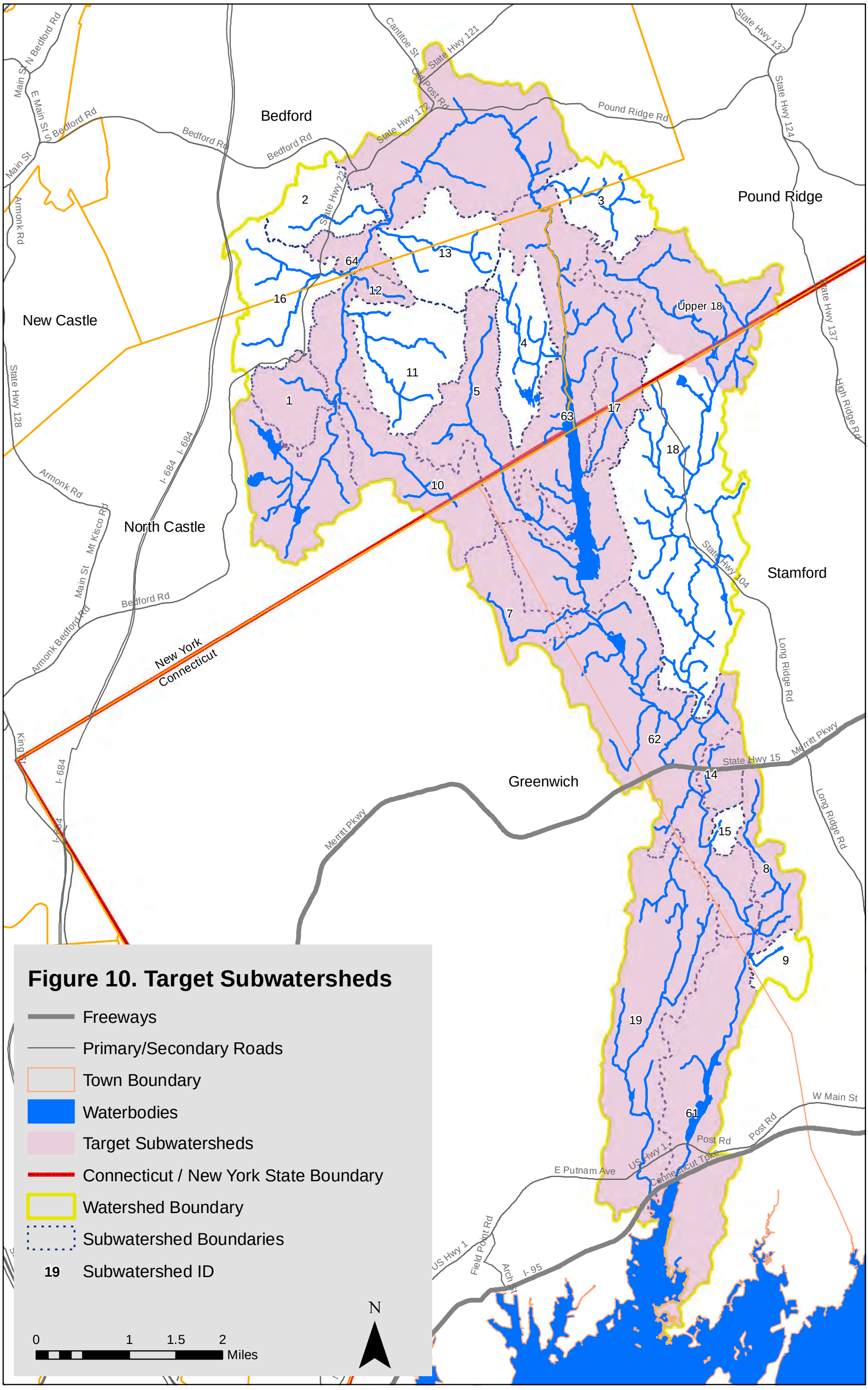

Figure 10. Target Subwatersheds

- Freeways
- Primary/Secondary Roads
- Town Boundary
- Waterbodies
- Target Subwatersheds
- Connecticut / New York State Boundary
- Watershed Boundary
- Subwatershed Boundaries
- 19 Subwatershed ID

0 1 1.5 2 Miles

N

Table 14. Implementation of Management Goals, Strategies, and Actions

STRATEGIES	GOALS				PARTICIPATING ORGANIZATIONS														SCHEDULE	INTERIM MILESTONES	PERFORMANCE CRITERIA
	Enhance stormwater runoff management	Protect and enhance drinking water quality	Restore impaired biological communities	Maintain and enhance recreational opportunities	Mianus River Watershed Council	Mianus River Gorge Preserve	Friends of Mianus River Park	NYSDEC	CTDEEP	NYSDOT/CTDOT	Southwest CT Conservation District	Mianus Municipalities	Mianus Land Trusts	Trout Unlimited	UConn Cooperative Forestry Extension	UConn CLEAR and NEMO	Aquarion Water Company				
1. Promote the use of BMPs to reduce nutrient and sediment loading																					
1.1 Implement identified structural BMPs in the Windmill Lakes neighborhood (subwatersheds 64 and 1)	x	x	x	x	x			x				x							Pilot (1-5 yrs)	Year 1: Define goals and obtain letters of support from private landowners and NYSDOT where applicable; obtain funding; Year 2: Select consultant and complete detailed design; Year 3: Complete construction; Year 4-5: Conduct monitoring at basin inflow and outflow points, and evaluate functionality.	Modeled N, P, TSS, and bacteria load reductions; Treated impervious acres
1.2 Implement identified structural BMPs in Banksville Center	x	x	x	x	x	x		x				x							Pilot (1-5 yrs)	Year 1: Define goals and obtain letters of support from private landowners, public agencies, and CTDOT where applicable; obtain funding; Year 2: Select consultant and complete detailed design; Year 3: Complete construction; Year 4-5: Conduct monitoring at basin inflow and outflow points, and evaluate functionality.	Modeled N, P, TSS, and bacteria load reductions; Treated impervious acres
1.3 Develop rain barrel/rain garden incentive program for homeowners and commercial properties	x	x	x	x	x						x	x	x						Pilot (1-5 yrs)	Year 1: Define goals and strategies of rain barrel program, and obtain funding; Year 2: Purchase pilot rain barrels, and initiate outreach; Year 2-4: Create incentive program and expand outreach to homeowners and commercial properties within target subwatersheds; Year 5: Install 50 or more rain barrels or similar devices for rainwater harvesting watershed-wide.	Numbers of residential rain barrels installed; Treated impervious acres
1.4 Develop nutrient management incentive program for homeowners		x	x	x	x						x	x	x			x			Pilot (1-5 yrs)	Year 1: Define goals and strategies of nutrient management program; Year 2: Initiate outreach to streamside homeowners; Year 2-4: Create incentive program and expand outreach to all homeowners in pilot area; Year 5: Recruit 50 or more homeowners to commit to sustainable nutrient management practices.	Number of homeowners committed to sustainable nutrient management; Estimated N, P, TSS, and bacteria load reductions
1.5 Support the installation of structural BMPs to mitigate runoff, erosion and sedimentation from the Mianus River Park Parking Lot	x	x			x							x							Pilot (1-5 yrs)	Year 1: Define project scope and identify funding; Year 2-4: Project design and installation; Year 5: evaluate successes related to reduced sedimentation and erosion adjacent to the parking lot.	Modeled TSS load reductions; Treated impervious acres

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1.6	Develop an inventory of publicly owned lands suitable for implementation of specific structural BMPs	x	x			x						x						Pilot (1-5 yrs)	Year 1: Obtain property records and conduct desktop assessments of all public properties within the watershed for drainage direction and available open space; Year 2: Prioritize sites based on feasibility, and conduct field assessments to determine drainage areas and need for additional piping; Year 3: Develop costs for each proposed BMP, and prioritize by cost per square foot of impervious managed.	Number of properties assessed; feasibility of proposed BMPs
1.7	Implement approriate structural BMPs to treat stormwater unoff from I-95 prior to discharge into Strictland Brook	x		x	x	x				x	x		x						Pilot (1-5 yrs)	Year 1: Identify appropriate structural BMP based on site contrainsts and potential costs; Year 2: Define goals and obtain letters of support from private landowner and public agencies where applicable; obtain funding; Year 3: Select consultant and complete detailed design; Year 4: Complete construction; Year 5: Conduct monitoring at basin inflow and outflow points, and evaluate functionality.	Modeled N, P, TSS, and bacteria load reductions; Treated impervious acres
1.8	Work with municipalities and local business owners to address problem areas associated with construction yards adjacent to the river, particularly in the Banksville area		x	x	x	x	x	x				x		x					Mid-term (5-10 yrs)	Using aerial imagery, identify all barren parcels adjacent to the river; Obtain contact information for property owners and reach out via local community members and business leaders; Develop non-regulatory solution to manage erosion and pollution sources.	Parcels identified; Property owners contacted; Number of owners committed to sustainable land management
1.9	Promote the use of bioretention along state and local roads	x	x						x	x	x		x						Mid-term (5-10 yrs)	Create an inventory of degraded roadside wetlands in the watershed, and present to DOTs and municipalities; Conduct a drive-through assessment of roadside sites for proposed bioretention (aerials may not be useful); Partner with DOTs and municipalities to establish guidelines for new roads and maintenance/repair of existing roads.	Acres of the watershed assessed for new bioretention; Number of roadside wetlands surveyed.
1.10	Implement remaining identified structural BMPs (Appendix A), and identify additional sites for BMPs	x	x	x	x	x	x					x	x						Long term (5-20 yrs)	Obtain additional funding; Implement BMPs sequentially in subwatershed 19, subwatershed 62, subwatershed 7, and subwatershed 18; Conduct survey for additional BMPs and continue to implement as funding allows.	Modeled N, P, TSS, and bacteria load reductions; Treated impervious acres

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2. Avoid future increases in stormwater-related impacts through LID based policies and stormwater ordinances																					
2.1 Conduct a conservation audit of existing municipal regulations and standards to identify barriers to implementation of LID elements (Bedford, North Castle, Pound Ridge, Stamford, Greenwich)	x	x			x	x	x				x	x	x					Pilot (1-5 yrs)	Year 1: Determine code sections for comparison (setbacks, buffers, lot size/density, street width, parking, stormwater management, LID provisions, etc.; Year 2: Review code; Year 3-5: Complete evaluation.	Number of watershed municipalities evaluated (target = 5)
2.2 Work with headwater municipalities (Bedford, Pound Ridge, and North Castle) to develop and adopt progressive LID based land use, stormwater and zoning regulations as identified in the conservation audit (see 2.1)	x	x			x	x					x							Pilot (1-5 yrs)	Year 1: Establish minimum stormwater controls, including controls for water quality and channel protection for new development and redevelopment (see 2.6); Year 2: Develop planning-level LID guidelines for new development, to include incentives for clustered development and limiting sprawl, narrower road widths, and smaller parking spaces; Year 3: Strengthen residential regulations/incentives related to riparian buffers and setbacks, and near-stream construction; Year 4-5: Enforce ordinances as needed.	Number of watershed municipalities implementing controls (target = 5)
2.3 Promote reduction of rooftop runoff with residential LID program	x	x			x	x			x		x	x				x	x	Pilot (1-5 yrs)	Year 1: Define goals and strategies of residential LID program and secure funding; Year 2: Purchase pilot rain barrels, or other simple BMP tools, and initiate outreach to owners of the 100 largest homes (by footprint); Year 2-4: Create incentive program and expand outreach to all homeowners in a single subwatershed; Year 5: Establish 50 or more LID sites within a target subwatershed, and begin to expand the program to additional target subwatersheds.	Numbers of residential sites committed to an LID approach to managing rooftops
2.4 Incorporate LID approaches into municipal improvement projects/construction	x	x								x	x	x						Mid-term (5-10 yrs)	Where pavement improvements are needed in low-traffic areas, replace traditional pavement with a porous alternative; Encourage external roof leaders for new buildings; Redirect pipes/outfall structures to bioretention areas.	Number of maintenance/construction projects incorporating LID techniques
2.5 Encourage LID approaches for all new development initiatives and major renovations to ensure no net increase in runoff	x	x	x	x						x		x				x		Mid-term (5-10 yrs)	Establish volume and minimum disturbance criteria for residential and non-residential projects; Establish design criteria water quality and channel protection using CTDEEP's Stormwater Design Manual as a starting point; Build support for increased regulations at the municipal level.	Number of watershed municipalities implementing controls (target = 4)

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2.6	Create watershed overlay district with consistent regulations and guidelines among the watershed municipalities	x	x	x	x	x	x					x	x					Long term (5-20 yrs)	Outline consistent approach to MS4 compliance for watershed municipalities; Establish minimum stormwater and LID controls, and achieve consensus among municipalities.	% MS4 compliance; % adoption of overlay
3. Define and remediate potential bacterial impairments within the Mianus River Watershed and improve riparian habitat																				
3.1	Identify and map the sources of potential bacterial impairments in the watershed.		x		x	x						x	x					Pilot (1-5 yrs)	Year 1-3: Beginning in subwatersheds with high bacteria load reduction targets (particularly 18, 19, 61, and 62), conduct detailed water quality sampling; Year 4-5: Evaluate potential remediation measures and develop an implementation plan.	Total area assessed; number of sites samples; number of impairments identified
3.2	Establish identified buffers in the Pine Ridge neighborhood in Greenwich (subwatershed 19), and at Riverbank Road in Stamford (subwatershed 62)	x	x	x	x	x		x				x						Pilot (1-5 yrs)	Year 1: Obtain letters of support from landowners, and establish permitting/design needs; Sample downstream water quality for bacteria; Year 2: Select consultant, as necessary, and complete design; Year 3: Complete construction; Year 4-5: Monitor water quality and goose populations, and complete analysis.	Total area of buffers established; before and after monitoring; Treated impervious acres; Estimated bacteria load reduction
3.3	Assess contribution, if any, of leaking septics to overall bacteria load, and develop a mitigation plan as needed		x		x	x	x				x	x						Pilot (1-5 yrs)	Year 1: Target properties for assessment based on spatial analysis of sewer type, soil type, depth to bedrock, proximity to stream, age of development, and additional municipal records as applicable; Year 2-3: Conduct visual assessment during stream walks; Year 4-5: Conduct targeted water quality monitoring based on visual/spatial assessment results, and develop a mitigation plan based on results.	Number of parcels assessed
3.4	Significantly reduce nesting populations of non-migratory geese		x		x				x	x		x	x					x	Pilot (1-5 yrs)	Year 1: Implement stream buffers wherever possible to limit access to open water habitat; Year 2: Define additional acceptable strategies for management as needed (controversial options include hunting, harassment by dogs, and limiting the viability of eggs);	number of sites addressed; estimated number of geese

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3.5	Conduct a detailed riparian buffer assessment and prioritize additional areas for restoration	x	x	x		x		x				x		x				Pilot (1-5 yrs)	Year 1: Create GIS database with all known unbuffered segments; Year 2: Prioritize buffers based on potential indicator bacteria load reductions; Year 3-5: Implement outreach campaign for streamside homeowners to encourage volunteer work and identify potential buffer areas on private land.	Square feet of additional unbuffered areas identified; Square feet of buffers constructed; Estimated bacteria load reduction
3.6	Update mandatory minimum setback requirements for septic systems in the Town of Greenwich and the City of Stamford		x		x							x						Pilot (1-5 yrs)	Year 1: Review applicable state health code and other county or municipal regulations for septic system setbacks from streams; Year 2: Update regulations as needed to establish stringent minimum separating distances of septic systems from streams	Regulations updated (yes/no)
3.7	Evaluate results of task 3.1 and, as needed, prevent or reduce incidence of leaking septics on private property		x		x						x	x						Mid term (5-10 yrs)	Implement leaking septic mitigation plan established during pilot phase through outreach, enhanced inspections, and/or incentive/cost share programs; Establish a municipal monitoring program for residential and commercial properties.	Number of failing systems identified and replaced
3.8	Maximize adoption of minimum buffers on remaining private properties (see task 8.1)		x		x		x					x	x			x		Mid term (5-10 yrs)	Create GIS database with all known unbuffered segments and prioritize buffers based on indicator bacteria load reductions; Implement outreach campaign for streamside homeowners to encourage volunteer work; Modify development code if necessary, to create minimum buffer requirements, and create incentive/stewardship program to encourage buffers.	Square feet of additional unbuffered areas identified; Square feet of buffers constructed
3.9	Develop pet waste management program for public recreation sites		x		x	x		x			x	x		x				Mid term (5-10 yrs)	Outline goals and strategies of program, and inventory existing outreach/incentives; Select public sites, and define solutions (signage, baggies, etc.); Deploy outreach/incentive strategies at selected sites, and establish enforcement measures.	Estimated number of dog owners reached; Number of sites selected for management; Estimated bacteria load reduction
3.10	Conduct long-term monitoring for indicator bacteria below the S.J. Bargh Reservoir (see also 4.3)		x		x	x		x		x				x			x	Long term (5-20 yrs)	Establish methodology and select additional parameters if necessary; Select monitoring sites and schedule; Establish partnership to conduct data collection	Number of sites monitored; Consistency of method

Table 14. Implementation of Management Goals, Strategies, and Actions

STRATEGIES	GOALS				PARTICIPATING ORGANIZATIONS														SCHEDULE	INTERIM MILESTONES	PERFORMANCE CRITERIA
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4. Establish a long term water quality monitoring program																				
4.1 Develop a monitoring program for select headwater streams, and identify funding (see also 8.9 and Chapter 9)		x			x	x		x					x	x			x		Pilot (1-5 yrs)	Year 1: Develop a 5-year plan for monitoring, and work with municipalities and NGOs to incorporate funding for water quality monitoring into annual budgets; Year 2: Select sites and constituents; Years 3-5: Engage laboratory, consultants, and volunteer groups and establish monitoring for selected headwater streams; Year 5: Analyze program results and determine further needs.	Number of sites monitored for bacteria, N, P, TSS, and additional constituents if necessary; Consistency of method.
4.2 Work with municipalities and NGOs to incorporate funding for water quality monitoring into annual budgets		x			x	x	x				x	x	x						Mid-term (5-10 yrs)	Review available funding sources and apply for grants (see appendix B); consider allocating an annual sum as part of general municipal operations	Amount of funding secured
4.3 Expand monitoring to include additional sites as needed; maintain data online via a live-streaming map application (see also 3.10 and Chapter 9)		x			x	x	x					x	x				x		Long term (5-20 yrs)	Select additional headwater streams and segments lower in the watershed for monitoring, as needed; Extend headwater monitoring program to incorporate additional segments; Provide data online using interactive mapping tools.	Number of sites monitored for bacteria, N, P, TSS, and additional constituents if necessary; Consistency of method; Numbers of volunteers engaged.
5. Maintain & improve in-stream flows																				
5.1 Adopt and implement CT streamflow standards			x	x		x			x		x		x				x		Pilot (1-5 yrs)	Year 1: Classify the river per CT streamflow standards and establish baseline habitat conditions below the S.J. Bargh Reservoir; Year 2: Adopt standards through a public participation process; Year 3: Implement standards and update reservoir release schedule as needed; Year 4-5: Monitor downstream habitat and record changes from baseline (see 5.4 and 5.5).	Standards are adopted and implemented (yes/no)
5.2 Conduct an in-stream flow assessment above the S.J. Bargh Reservoir to better understand impacts related to private well withdrawals, and establish consumptive use targets as necessary			x	x		x					x		x				x		Pilot (1-5 yrs)	Year 1-2: Review withdrawal permits, and estimate private well consumption; Year 3: Install stream gages; Year 4: Model system to determine extent of habitat impairment and flow required to improve conditions; Year 5: Establish flow criteria and develop plan for meeting future goals.	Acres of watershed area modeled; Miles of infrastructure assessed.

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5.3	Conduct a feasibility study to quantify the degree and causes of impairments to the Mianus Mill Pond and evaluate restoration and mitigation options		x	x	x					x			x					x	Pilot (1-5 yrs)	Year 1: Convene stakeholders and technical experts, including Aquarion Water Company, CT Department of Public Health, CTDEEP, the Town of Greenwich, the U.S. Army Corps of Engineers, and adjoining property owners; Year 2: Collect water quality samples under wet-weather and dry-weather conditions, and evaluate bacteria and dissolved oxygen constituents against state standards; Year 3: Conduct a biotic assessment of indicator species to determine the effect of sediment and nutrient loading on aquatic life; evaluate cost/feasibility of potential management actions.	Water quality parameters sampled; Number and variety of management options assessed
5.4	Conduct an in-stream flow assessment below the S.J. Bargh Reservoir to determine if adoption of CT streamflow standards has improved in-stream habitat conditions (see 5.1)			x	x		x						x		x			x	Mid term (5-10 yrs)	Assess habitat below the S.J. Bargh Reservoir both before and after CT streamflow standards have been implemented; Complete hydraulic and hydrologic study of the reservoir system, and install stream gages.	Acres of watershed area modeled; Miles of infrastructure assessed.
5.5	Address in-stream flow conditions through adaptive management of drinking water resources			x	x	x	x	x		x			x		x			x	Mid term (5-10 yrs)	Tie withdrawal permits to consumptive use limits; Implement changes to the reservoir release program in accordance with in-stream flow targets; Monitor downstream habitat features and target species populations and continue to revise/refine release regime and withdrawal limits accordingly.	Flow (cfs) and timing of release schedule; miles of in-stream habitat improved; number of target individuals counted
6. Reduce the impact of small dams and impoundments through barrier mitigation																				
6.1	Develop barrier mitigation master plan to evaluate and prioritize barrier removals/retrofits in terms of migration barriers, river flow/flooding, and impacts to water quality			x	x	x	x		x	x					x				Pilot (1-5 yrs)	Year 1: Enter known culvert and dam locations into GIS, and establish further needs; Year 2: Collect remaining data through streamwalk assessments; Year 3: Develop mitigation plan and establish monitoring program/criteria; Year 4-5: Remove or retrofit 1-2 high priority structures (i.e. fishways and other bypass structures).	Number of barrier sites assessed; number of removals or retrofits conducted
6.2	Retrofit raised culverts, install fish passage structures, and remove small dams where feasible			x	x	x	x		x	x	x		x		x			x	Mid term (5-10 yrs)	Obtain additional funding; Conduct owner outreach to residential and commercial properties adjacent to target barriers identified in the mitigation plan; Obtain fish ladders/counters; Partner with CTDOT to address eventual replacement of culverts and small dams under their control.	Fish counted on an annual basis; Miles of potential connected habitat

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	Enhance stormwater runoff management	Protect and enhance drinking water quality	Restore impaired biological communities	Maintain and enhance recreational opportunities	Mianus River Watershed Council	Mianus River Gorge Preserve	Friends of Mianus River Park	NYSDEC	CTDEEP	NYSDOT/CTDOT	Southwest CT Conservation District	Mianus Municipalities	Mianus Land Trusts	Trout Unlimited	UConn Cooperative Forestry Extension	UConn CLEAR and NEMO	Aquarion Water Company				
7. Manage the impacts of recreational activity on natural lands and aquatic resources along the Mianus River Greenway and the Mianus River Gorge																					
7.1 Create a monitoring-driven adaptive management plan for all parks, conservation areas, and preserved open spaces, to include trail master planning		x	x	x	x	x	x		x				x		x				Pilot (1-5 yrs)	Year 1: Convene task force to include recreational users, pet owners, and environmental advocates and identify a phased approach to address all potential lands; Year 2: Develop monitoring plan to quantify how recreational use is impacting environmental resources; Year 3: Establish multi-use goals and strategies for implementation, building on the 2006 *Mianus River Park Action Plan* ; Year 4-5: Implement preliminary management actions and initiate follow-on monitoring.	Variety of interests represented by task force; Number and specificity of monitoring criteria; consistency of monitoring methodology
7.2 Work to have the designations of the three northern parcels of Mianus State Park (Blake Coleman, Upper Mianus, Lower Mianus) changed to implement conservation efforts and minimize recreational uses in sensitive habitats		x		x	x	x			x										Pilot (1-5 yrs)	Year 1-3: Build residential and municipal support via education and outreach campaigns geared toward communicating the non-recreational value of sensitive areas.	Number of parcels re-designated (target = 3)
7.3 Modify trail system to maximize habitat and recreational value using a regenerative design approach		x	x	x	x	x	x						x						Pilot (1-5 yrs)	Year 1: Identify ecological and recreational resources, and define design agenda to allow for multiple uses; Year 2: Select landscape architect to mediate a community-driven design process; Year 3-4: Complete design and build structural features; Year 5: Establish plan for volunteer maintenance and monitoring.	Number of stakeholders supporting plan; Number of attendees at community meetings; Multiple uses addressed by design
7.4 Address problem areas at the River Road parking lot, including bank erosion, loss of riparian vegetation, and sedimentation	x	x	x		x		x												Pilot (1-5 yrs)	Year 1: Evaluate options to stabilize riparian zone; Year 2: Select measures and complete design/engineering plan, if necessary; Year 3-5: Install stabilization measures.	Length of bank protected/stabilized
7.5 Continue to support implementation activities identified in the 2006 *Mianus River Park Action Plan* ; in the *Mianus River Park Management Plan* (under development 2012); and additional targeted restoration throughout the watershed		x		x			x			x			x						Mid-term (5-10 yrs)	Track status of recommendations and monitor outcomes; Recruit volunteers for management activities; Publicize activities via multiple media outlets (see Chapter 8).	Number of identified activities implemented/supported

Table 14. Implementation of Management Goals, Strategies, and Actions

STRATEGIES		GOALS				PARTICIPATING ORGANIZATIONS													SCHEDULE	INTERIM MILESTONES	PERFORMANCE CRITERIA
		Enhance stormwater runoff management	Protect and enhance drinking water quality	Restore impaired biological communities	Maintain and enhance recreational opportunities	Mianus River Watershed Council	Mianus River Gorge Preserve	Friends of Mianus River Park	NYSDEC	CTDEEP	NYSDOT/CTDOT	Southwest CT Conservation District	Mianus Municipalities	Mianus Land Trusts	Trout Unlimited	UConn Cooperative Forestry Extension	UConn CLEAR and NEMO	Aquarion Water Company			
7.6	Establish long-term management policies, and implement additional structural features as needed to achieve identified goals for the greenway				x	x	x	x											Long term (5-20 yrs)	Continue and expand outreach activities such as stewardship events, ambassador program, and signage improvements (see *Mianus River Park Action Plan*); Enforce correct use policies.	Number of events and audience reached; number of complaints regarding improper use
8. Encourage better stewardship of public and private lands by implementing education and outreach programs for landowners and municipal officials																					
8.1	Develop a series of workshops for developers, engineers, land use attorneys and property owners to encourage watershed-friendly yard design and management		x			x	x					x	x		x	x	x		Pilot (1-5 yrs)	Year 1: Establish goals, target audience, content, and schedule; Year 2: Hold first workshop with attendance by 20-30 members of the target audience; Year 3-5: Reach additional audience through partnerships with local neighborhood organizations and civic groups (two workshops per year with similar attendance).	Number of events and audience reached
8.2	Develop a training series for municipal officials, boards, and commissions to encourage LID and other strategies facilitating MS4 compliance		x			x	x					x					x		Pilot (1-5 yrs)	Year 1: Establish goals, target audience, content, and schedule; Year 2: Hold first LID workshop with attendance by municipal officials (Stamford, Greenwich, North Castle, Pound Ridge, and Bedford municipalities represented); Year 3-5: Develop additional workshop content and continue to schedule events (2 per year).	Number of events and audience reached
8.3	Conduct email & social media campaigns to encourage stewardship of private property		x			x	x					x	x						Pilot (1-5 yrs)	Year 1: Define message and target audience/s and obtain contact information; Year 2: Obtain web/social marketing consultant to develop graphics, refine message, and deploy campaigns (may be useful to deploy in conjunction with public service announcements)	Number of watershed citizens reached
8.4	Promote roadway and parking lot "good housekeeping" practices to Public Works, Parks Departments, and Boards of Education to maintain watershed friendly operations and practices		x			x	x					x	x		x				Pilot (1-5 yrs)	Year 1: Establish interdepartmental municipal task force; Year 2: Develop employee training modules for fleet and building maintenance, sand usage and cleanup, catchbasin cleaning and retrofitting, landscape maintenance, and proper waste disposal; Year 3-5: Conduct training sessions.	Number and completeness of training modules (see EPA guidelines for Good Housekeeping); Number of events and audience reached

Table 14. Implementation of Management Goals, Strategies, and Actions

STRATEGIES		GOALS				PARTICIPATING ORGANIZATIONS													SCHEDULE	INTERIM MILESTONES	PERFORMANCE CRITERIA
		Enhance stormwater runoff management	Protect and enhance drinking water quality	Restore impaired biological communities	Maintain and enhance recreational opportunities	Mianus River Watershed Council	Mianus River Gorge Preserve	Friends of Mianus River Park	NYSDEC	CTDEEP	NYSDOT/CTDOT	Southwest CT Conservation District	Mianus Municipalities	Mianus Land Trusts	Trout Unlimited	UConn Cooperative Forestry Extension	UConn CLEAR and NEMO	Aquarion Water Company			
8.5	Organize and promote priority stream-side clean up efforts			x	x	x	x	x						x	x				Pilot (1-5 yrs)	Year 1: Select cleanup sites in conjunction with multiple other activities (gateways, ribbon cuttings, demonstration sites); Year 2: Partner with corporate human resource departments to obtain volunteers, and schedule multiple events within a single subwatershed.	Number of events conducted; Number of volunteers recruited
8.6	Develop programs to encourage better management of small ponds and impoundments.		x	x		x						x			x				Mid-term (5-10 yrs)	Select target sites; Advocate for stream buffers, dam removal where appropriate, goose management, and reductions in fertilizer use; Offer training for property owners (see 8.1); Provide free labor in the form of volunteer work days/cleanups, etc.	Number of properties committed to improving management techniques; Number of dams removed; Estimated N, P, and bacteria load reductions.
8.7	Develop programs to promote sustainable management at golf courses, nurseries, and horse farms	x	x	x	x	x	x				x	x							Mid-term (5-10 yrs)	Select sites for outreach; Produce a brochure for golf course and nursery managers (information on stream buffers, soil testing, organic fertilizing practices, and goose management); Produce a brochure for managers of horse farms (information on stream buffers, grazing practices, manure removal/covering, and goose management); Partner with trusted community members to conduct personal outreach at select sites.	Number of properties committed to improving management techniques; Estimated N, P, and bacteria load reductions.
8.8	Implement a "neighborhood-by-neighborhood" approach for restoration of stream reaches	x	x	x	x						x								Mid-term (5-10 yrs)	Define target residential neighborhoods adjacent to the stream; Conduct outreach via social and recreational programs; Recruit homeowners to "sponsor" buffer restoration and plantings on their property; Schedule additional education and outreach events related to lawn care, pet waste, and septics.	Number of restorations implemented; Estimated N, P, and bacteria load reductions.
8.9	Engage volunteers in monitoring tasks (see also 4.1)		x			x	x			x		x			x				Long term (5-20 yrs)	Establish task force to oversee volunteer effort; Recruit volunteers for stream walks, septic monitoring, fish and benthic surveys, habitat assessment, and other tasks as appropriate.	Hours of volunteer service secured; Number of volunteers

Table 14. Implementation of Management Goals, Strategies, and Actions

STRATEGIES	GOALS				PARTICIPATING ORGANIZATIONS														SCHEDULE	INTERIM MILESTONES	PERFORMANCE CRITERIA
	Enhance stormwater runoff management	Protect and enhance drinking water quality	Restore impaired biological communities	Maintain and enhance recreational opportunities	Mianus River Watershed Council	Mianus River Gorge Preserve	Friends of Mianus River Park	NYSDEC	CTDEEP	NYSDOT/CTDOT	Southwest CT Conservation District	Mianus Municipalities	Mianus Land Trusts	Trout Unlimited	UConn Cooperative Forestry Extension	UConn CLEAR and NEMO	Aquarion Water Company			
9. Pursue strategic land acquisition to protect headwater streams and promote greenway expansion																				
9.1 Fund and support implementation of the Mianus River Greenway Priority Properties to Protect report		x		x	x	x	x					x	x					Pilot (1-5 yrs)	Year 1: Obtain funding; Year 2: Make contact with owners of all priority properties; Year 3: Further prioritize the list by feasibility/owner support; Year 4: Acquire properties where possible, and continue to monitor ownership.	Priority acres protected
9.2 Continue acquisition activities to support headwater and greenway protection		x		x	x	x	x					x	x				x	Mid-term (5-10 yrs)	Monitor sale properties, particularly those identified as conservation targets; Maintain contact with land owners; Continue to secure funding opportunities and acquire property as funding allows.	Priority acres protected
9.3 Building on existing regulation in several watershed municipalities (see also 2.2), develop a "conservation bank" program for new development in the watershed		x			x	x	x		x			x	x		x			Long term (5-20 yrs)	Create scoping document to assess financial feasibility and to define oversight and legal requirements; Modify code at the watershed scale to include bank offsets in permitting for new development; Establish incentives/assistance/recognition to encourage early adoption by developers.	Number of transactions conducted; Acres of land preserved
10. Implement the Plan and monitor outcomes																				
10.1 Identify funding for a program coordinator to aid in implementation of the Plan.	x	x	x	x	x	x			x			x						Pilot (1-5 yrs)	Year 1: Review available funding sources (Appendix B) and apply for grants; Year 2: Select coordinator and prioritize tasks; Year 3-4: implement programs and demonstrate successes; Year 5: obtain long-term financial support for the position from municipalities and NGOs.	Amount of funding awarded
10.2 Review the Plan every 5 years, evaluating successes and lessons learned. Revise and update the Plan as necessary	x	x	x	x	x	x			x			x						Long term (5-20 yrs)	Formally initiate a plan review and evaluation in year 4 of each 5-year cycle; At the end of the 5-year cycle, update and revise the Plan as necessary. If at any time based on monitoring data conditions of the watershed dramatically change the Plan should be adapted to current conditions.	All above

Emphasizing Best Management Practices

Whether it is building a stormwater rain garden that manages urban runoff, working with a hobby farm owner to install livestock fencing, or teaching a homeowner how to properly care for a septic system, the core approach to implementation involves putting in place BMPs that result in measurable reductions in or prevention of NPS pollution. BMPs include a range of project types that reduce NPS pollution and other negative effects of unmanaged stormwater runoff. For the purposes of this Plan, BMPs are categorized as either structural or non-structural BMPs. Structural BMPs refer to physical, site-specific pollution reduction projects that include rain gardens, porous pavement, livestock fencing, and constructed wetlands as well as stream restoration and riparian buffering. Equally important, non-structural BMPs are changes in behavior that result in NPS pollution reduction at its source, leading to protection and improvement of water resources. These include reductions in fertilizer use, proper septic system maintenance, and proper disposal of pet waste.

As part of an NPS reduction plan, the management actions presented in Table 14 rely heavily on a broad range of structural and non-structural BMPs. In addition, 13 site-specific structural BMPs are recommended and described in Chapter 7 (Table 19). Most of these BMPs were selected through a process of desktop identification and field vetting. Appendix A contains detailed site descriptions, costs, photos, and feasibility constraints associated with 11 of the identified site-specific structural BMPs. Two additional areas were identified by stakeholders for further analysis and potential structural BMPs (BMPs L and M in Table 19).

Plan Phasing

Although full Plan implementation will likely require 20 or more years, the Plan emphasizes the use of interim milestones, including an initial five year pilot phase, to ensure consistent progress. The first five year implementation period will lay the foundation for future success through a combination of strategic planning, outreach, and small-scale management actions designed to test and demonstrate a long-term approach. As early success is crucial, short-term programs with clearly defined objectives may have a higher likelihood of success. This pilot phase is intended to be a testing, incubation, and capacity-building period in which small, manageable activities are implemented. Such actions may be single structural BMPs, or outreach activities such as training events or marketing programs. Once these smaller actions have been completed, typically near the end of the five year term, monitoring and assessments will provide a better understanding of which approaches need to be repeated or expanded to achieve long-term goals, and which need to be refined.

Pilot phase implementation activities may focus on one of the target subwatersheds outlined earlier in this chapter. Implementation of multiple management actions in a single subwatershed during the pilot phase will likely yield the most measurable short-term resource improvements. Once opportunities in a particular subwatershed are exhausted and improvements have been documented, implementation activities can be replicated in other subwatersheds. This method is preferable to a more diffuse approach because it demonstrates a micro-scale version of the full implementation approach, allowing the approach to be tested and refined with limited funding. If a subwatershed-scale effort shows positive outcomes, it follows that similar methods will be successful at larger scales. In addition, this approach allows watershed partners to more powerfully demonstrate the early success that is so critical for building momentum and attracting long-term funding.

At the end of the pilot implementation period, watershed partners should engage in a brief, focused, strategic planning process to outline implementation for the next five-year period. During the 5-to-10-year, mid-term implementation period, successful management actions and approaches may be implemented on a broader scale, within other target subwatersheds. Major follow-on planning activities and pilot-scale implementation activities should be complete, and a clear path to achieving long-term goals may be established. Funding and monitoring goals should be clearly defined for the following 10 years, and refined metrics for measuring success should be put in place.

Long-term (10-to-20 years) planning incorporates the outcomes from the evaluation, planning, and preliminary implementation that occurs during the initial 10-year period. During the long-term implementation period, the pace of implementation is accelerated to reflect the gains in funding, capacity, technical "know how," and successful delivery during the first 10 years of implementation. Long-term management actions and strategies identified in the Plan are designed to be refined based on successes and lessons learned during the pilot and mid-term implementation periods. Accordingly, milestones and schedule are less precisely defined for the long-term implementation period.

Performance Criteria and Adaptive Management

Implementation of the Plan relies heavily on an adaptive management approach through which management actions are continuously refined and improved by evaluating past actions. In accordance with this approach, performance criteria were developed for each management action. In most cases, performance criteria do not represent prescriptive endpoints, but rather provide metrics with which to track outcomes over time. Water quality criteria are suggested generally for common NPS pollutant types (see Chapter 9 for a full discussion of water quality constituents and monitoring methods). In some cases, targets for performance criteria for the pilot phase have been defined (e.g., number of homes implementing rain barrels) though partners may feel free to adjust these targets based on their own resources and funding levels. Whether they adopt the targets set forth in the Plan or adjusted targets, during the pilot phase partners should set realistic goals that have a high likelihood of being achieved. Achieving even modest goals during the initial implementation phase will build momentum and enthusiasm, attract funding, and set the stage for wider implementation. At the end of the pilot phase, management actions implemented in the watershed may be evaluated and priorities for the mid-term phase should be established. Regular evaluations and updates of the Plan will focus efforts and encourage long-term success.

Cost-Effective Implementation

With limited funding available, it is important to select management actions that maximize pollution reduction and other desired benefits while minimizing cost. While simple in concept, cost/benefit analysis can be difficult because of the uncertainty in determining pollution reduction and other benefits, particularly broad initiatives such as outreach programs targeting widespread behavior changes. When selecting structural BMPs, an understanding of unit costs (that is, cost per unit of pollution or unit of stormwater managed) is useful for concept-level planning. Structural BMPs can vary widely in the cost per unit pollutant removed. For instance, highly engineered BMPs such as green roofs have extremely high unit pollutant reduction costs. On the other hand, simple BMPs such as riparian buffers, which require limited engineering and can be installed by volunteers without the use of heavy equipment, tend to have much lower unit costs. Appendix B presents a list of potential watershed funding sources.

Tables 15, 16, and 17 summarize pollutant load reductions associated with many of the management actions recommended in the Plan. Load reductions associated with management actions that remove pollutants at their source are typically presented as absolute values (amount of bacteria kept out of the stream per prevented septic failure, etc.) and are presented in Tables 15 and 16. Structural BMPs function by intercepting stormwater runoff and removing a percentage of pollution from the water captured. For these BMPs, pollution reduction potential is typically presented as a percent reduction, which represents the fraction of pollutants removed from the treated runoff. Pollutant reduction efficiencies for common structural BMP types are presented in Table 17. In addition, literature values are available for some source control activities, such as riparian access control for livestock, and are also presented as percent reductions in Table 17. General ranges for capital and operations and maintenance (O&M) costs for various BMP types are presented in Table 18.

Table 15. Unit Pollutant Load Reductions from Non-Structural Best Management Practices

	Annual Load Reduction[1]			
Pollution Source	**Total N (TN) (lb)**	**Total P (TP) (lb)**	**TSS (lb)**	**Indicator Bacteria (billion cfu)**
One (1) Canada goose	12.05	10.68	N/A	2,660
One (1) dog—	6.72	0.88	N/A	408,800
One (1) malfunctioning septic system—repaired or upgraded	7.48	0.58	23.03	2,611,000
One (1) acre lawn—fertilizer use reduced by 50 percent	18.80	0.38	N/A	N/A

[1]All reductions derived using methodology outlined in Caraco 2002

Table 16. Grouped Pollutant Load Reductions from Non-Structural Best Management Practices

	Annual Load Reduction[1]			
Pollution Source	**TN (lb)**	**TP (lb)**	**TSS (lb)**	**Indicator Bacteria (billion cfu)**
Small flock of geese (10 geese)	120.5	106.8	N/A	26,600
100 people cleaning up after their dogs	672	88	N/A	40,880,000
10 homes conducting annual septic maintenance and repair	74.8	5.8	230.3	26,110,000
10 homes using ½ their normal amount of lawn fertilizer	188	3.8	N/A	N/A

[1]All reductions derived using methodology outlined in Caraco 2002

Table 17. Pollutant Reduction Efficiencies of Structural Best Management Practices

(Norwalk River Watershed Initiative Committee [NRWIC] 2011; Table updated by AKRF in 2012)

		Water quality performance - Percent reductions			
BMP	**Source[2]**	**TSS**	**TN**	**TP**	**Bacteria**
Bioretention	CWP 2007	52	43	22	70
Constructed Wetland	CWP 2007	58	22	45	50
Dry Pond/Extended Detention	CWP 2007	61	25	17	30
Grassed Swale	CWP 2007	85	32	28	0
Riparian buffer	Modeled values (avg)	23	22[3]	23[4]	23
Infiltration	CWP 2007	89	42	65	not available
Livestock Riparian Access Control	Monaghan et al. (2007)	not available	not available	not available	22-35
Green Roof	CWP 2007	-	53	53	-
Porous Pavement	CWP 2007	90	70	48	70
Rain Barrel	CWP 2007	-	40	40	-
Wet Pond	CWP 2007	76	30	48	70

[1] Norwalk River Watershed Plan, 2011 (table 6-4)

[2]CWP (2007) National Pollutant Removal Performance Database (NRPRD): Version 3, 2007; median values. For permeable pavement, used infiltration practice data. Values are generally mass or load-based measurements of efficiency; NYSDEC Manual (2010): Just "phosphorus" and "nitrogen" are listed. Indicator bacteria is lumped; NYSDEC (2001) Table A.4 is from Appendix A of the 2001 manual. This appendix and table were removed in subsequent versions (2003 onward); CWP (2005) MD guide: A User's Guide to Watershed Planning in Maryland, CWP. Dry pond value assumes extended detention. For permeable pavement, used infiltration practice data; CWP (2008), Runoff Reduction Method (referred to as RR memo), CWP Runoff Reduction Method, 2008. Values are mean for Total Removal (considers change in concentration and volume).

[3]Values as NO_3, not TN

[4]Values as particulate P, not TP

Table 18. Capital and Operations and Maintenance Costs of Best Management Practices

(NRWIC 2011; Table updated by AKRF in 2012)

BMP	Unit	Capital Cost per unit ($)	O&M Cost per unit ($)
Wet Pond	Cubic Feet	5.1–8.5	0.9–1.5
Dry Pond	Cubic Feet	2.6–6.8	0.4–1.2
Bioretention	Cubic Feet	8–20	2–5
Riparian buffer[1] (grass)	Square Feet	0–.01	N/A
Infiltration[2]	Cubic Feet	5	2
Reforestation	Planted Tree	328	N/A
Rain Barrel	Gallon	7-8	-
Porous Pavement	Square Feet	6.2	0.8
Grassed Swale	Square Feet	0.56	0.2
Green Roof	Square Feet	20–28	5–7
Illicit Discharge Detection & Elimination	per program	$23,300-101,200 Initial Cost;	$43,000-126,500 Annual Cost;
Septic maintenance[3]	Per household	-	$1,500 to 4,000
Downspout disconnection[3]	Per household	$150 to 400	-
Livestock Riparian Access Control			
Education and outreach[3]	Per program	Cost will vary significantly--examples include: $2,000 for advertising campaigns to in excess of $500,000 for a full program involving brochures, advertising, surveys, etc.	-

All PlaNYC (2008)except where otherwise noted
[1] EPA 2004, Chapter 6
[2] Maryland Cooperative Extension, Fact Sheet 774
[3] NRWIC 2011

CHAPTER 7 STRUCTURAL BEST MANAGEMENT PRACTICES

The management actions presented in Chapter 6 describe discrete steps required to achieve the Plan's management goals. Several of these management actions involve the design and construction of structural BMPs. This chapter identifies 11 structural BMPs that were identified and field-vetted during Plan development as potential first steps toward meeting the Plan's pollution-reduction targets. Feasibility was evaluated for each BMP through a desktop and field assessment process, which is described later in the chapter. Estimated costs, load reductions, and engineering feasibility considerations associated with each BMP are presented in Appendix A. Two (2) additional sites were later identified by stakeholders for structural BMPs.

The structural BMPs described in this chapter do not represent an exhaustive list of opportunities in the watershed. In fact, they probably represent a fairly small percentage of the total number of opportunities in the Mianus River Watershed. The structural BMPs identified do, however, represent some of the most compelling and cost effective opportunities that were identified during a formal desktop and field assessment process, and through input of the watershed community. In many cases, the structural BMPs identified represent a prototypical project type that could be replicated in other similar sites throughout the watershed.

Structural BMPs identified in this chapter are primarily geared toward achieving measurable pollution reduction goals. However, most BMPs can be designed to provide for multiple benefits. Meadow plantings in large extended detention areas can improve habitat for birds and small mammals. Rain gardens in public spaces can improve site aesthetics and, with some signage, become highly visible demonstration sites. BMPs constructed at or near schools can be planted and maintained by students, providing a unique extension of typical earth sciences coursework. In this way, the BMPs proposed here can be implemented in conjunction with multiple other management actions related to education and citizen science, habitat, and promoting LID in the watershed.

Descriptions for each structural BMP are presented in Appendix A, and include:

- BMP type;
- Subwatershed;
- Order-of-magnitude cost estimate;
- Potential benefits;
- Probable permitting requirements;
- Site access;
- Ownership;
- Other constraints;
- Context and rationale;
- Existing conditions; and
- Design approach and feasibility.

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 Eutrophication of LIS
Impairment	Limited Recreation Decrease in Aquatic Life	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.

Appendix 4

Byram River Watershed Management Plan Implementation Projects

Table of Contents

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

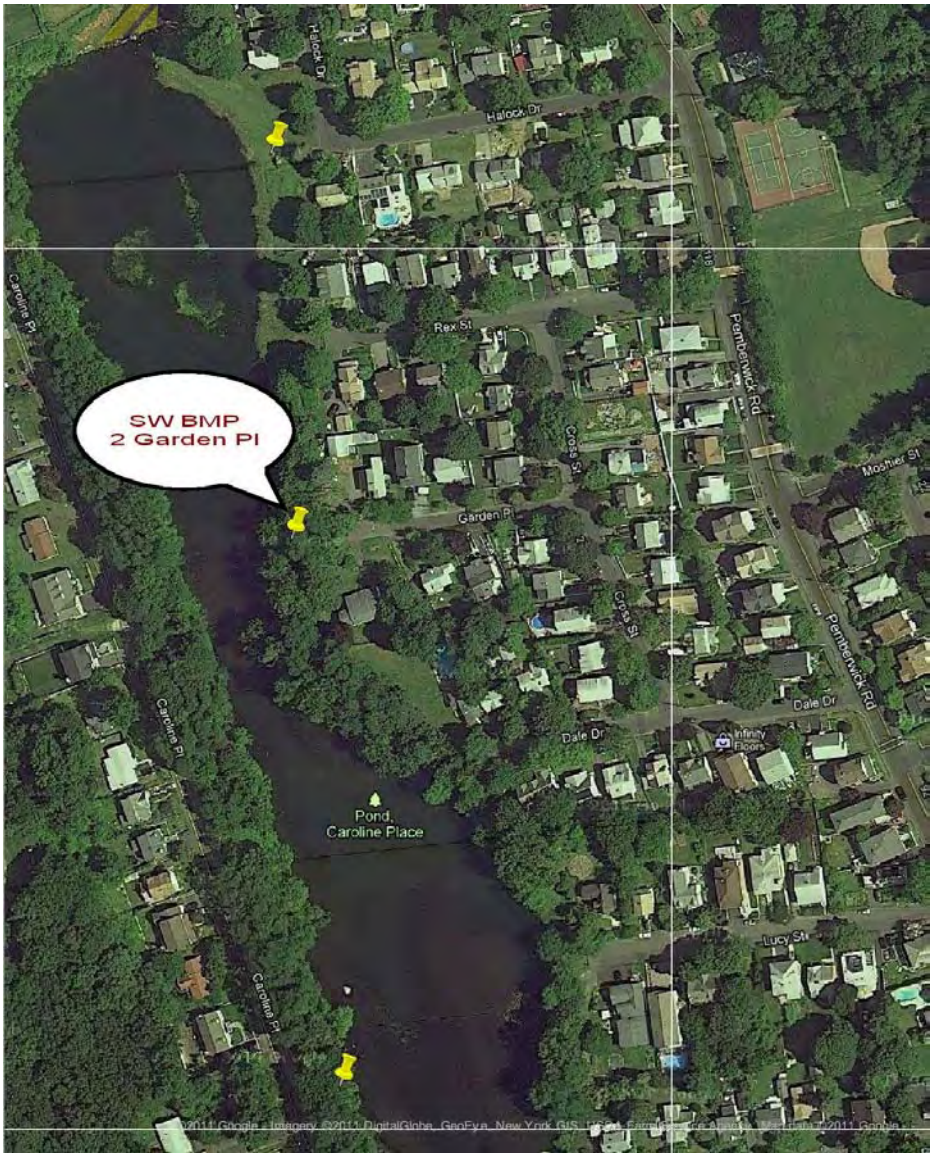
The 30 inch RCP located at 67 Caroline Place directly discharges to Caroline Pond and pollutants associated with medium & high-density residential uses plus the roadway system impact the water quality. The site has enough area to accommodate the installation of a forebay and created wetland system to 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.

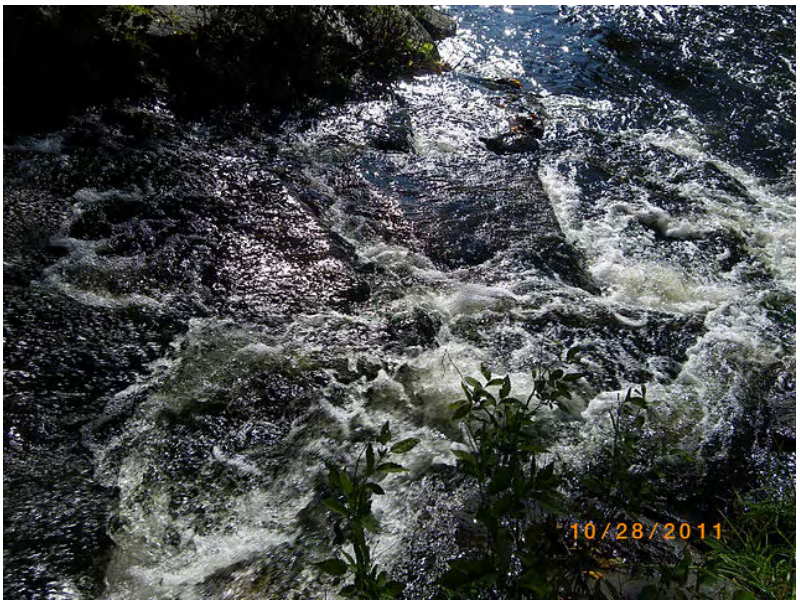
Pemberwick Road drainage leak off near Comely Avenue intersection, Greenwich, CT.

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