Coginchaug River Watershed Based Plan

Prepared by the USDA – Natural Resources Conservation Service
July 2008

Acknowledgements

I would like to thank the members of the Advisory Committee for their contribution of time and effort to the development of this plan:
Jane Brawerman, Connecticut River Coastal Conservation District
Linda Charpentier, Xavier High School Educator/Town of Durham
Marianne Corona, Town of Middlefield
George Frick, Town of Durham
Jim Gibbons, Connecticut Cooperative Extension
Melissa Greenbacker, Town of Durham
John Hall, Jonah Center
Meagan Hearne, Connecticut River Watershed Council
John Lyman, Town of Middlefield, Lyman Orchards
Ron Matyjas, Town of Middlefield
Bob Melvin, Town of Durham
Kate Miller, Conservation Commission, City of Middletown
Adam Moore, Town of Durham/CT. Forest and Parks
Tim Myjak, Middlesex Chamber of Commerce

I would like to thank the following NRCS Staff and others for their invaluable assistance:
All of the Streamwalk Volunteers and participants in outreach activities
Todd Bobowick, USDA-Natural Resources Conservation Service, Connecticut
Carol Donzella, USDA-Natural Resources Conservation Service, Connecticut
Jule Dybdahl, USDA-Natural Resources Conservation Service, Connecticut
MaryAnn Haverstock, CT Department of Environmental Protection
Carol Jaworowski, USDA-Natural Resources Conservation Service, Connecticut
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Sally Snyder, CT Department of Environmental Protection
Lesley Sweeney, USDA-Natural Resources Conservation Service, Connecticut
Lee Vito, Town of Middlefield
Margo Wallace, State Conservationist, USDA-Natural Resources Conservation Service, Connecticut (Retired)
Stan Zaremba, CT Department of Environmental Protection

This project was funded through a partnership between the USDA—Natural Resources Conservation Service in Connecticut, and the Connecticut Department of Environmental Protection, Section 319 Clean Water Act funds.

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TABLE OF C0NTENTS

List of Maps

List of Tables

EXECUTIVE SUMMARY

The Coginchaug River watershed is roughly 39 square miles (24,928 acres) in size and covers seven towns. Located in the central lowlands of Connecticut, the Coginchaug River main stem is approximately 15 miles long, and flows northward through a relatively broad, flat valley bounded to the east and west with rolling hills until it meets with the Mattabesset River. In 2004, the State included the Coginchaug River in its April 28 final 303(d) Impaired Waterbody Listings. Bacterium was cited as the principal water quality concern to be treated with BMPs, with nitrogen inputs from storm water as a secondary targeted pollutant. In early 2005 the Connecticut USDA – Natural Resources Conservation Service (NRCS) and the Connecticut Department of Environmental Protection (CT DEP) began discussing a cooperative effort to develop a watershed based plan to address the pollutants of concern. Using funding provided in part from Section 319 of the Clean Water Act, NRCS began, in April 2006, a watershed based planning effort for the Coginchaug River. Working in partnership, the NRCS and CT DEP established two primary goals for the project.

First, the project analyzed the watershed using a modified NRCS rapid watershed assessment model. Based on the analyses, NRCS identified Best Management Practices (BMPs) that could be implemented to address water quality concerns. The recommendations presented in this Watershed Based Plan (WBP) are made on two levels: BMPs suitable for implementation throughout the watershed, and BMPs for particular sites within the watershed, identified as "place based" in the report. The "place-based" sites are considered potentially significant sources of pollutant loading. The WBP provides an estimate of the technical and financial resources needed to implement the recommended practices.

The second goal is to develop an effective and replicable watershed assessment model for planning and analysis. This WBP describes the methods and processes used in evaluating the Coginchaug River watershed. Establishing this model offers local decision makers a template for detailed, focused watershed analysis – something not generally found today for local stakeholder groups or municipalities.

INTRODUCTION

The Coginchaug River is considered an impaired waterbody by the Connecticut DEP and has been included on the List of Connecticut Waterbodies Not Meeting Water Quality Standards since 1998. For more than a decade, from 1992 to 2004, the Connecticut River Watch (CRWP) program, a citizen monitoring program for the Connecticut River and tributaries supported by the CT DEP, collected water quality data on the Coginchaug River. The data revealed, among other things, that elevated levels of bacteria were present in the river. As required under Section 303(d) of the Federal Clean Water Act, the Connecticut DEP developed a Total Maximum Daily Load analysis (TMDL) for the Mattabesset River Regional Basin, which includes the Coginchaug River watershed, to address the high levels of bacteria.

According to the US Environmental Protection Agency, there is a statistical relationship between the levels of Escherichia Coli (E. coli), the indicator bacteria, and human illness rates. E. coli, like some other bacterium, originates from the intestinal tracts of humans as well as other warm blooded animals. The presence of these bacteria in the Coginchaug River indicates that human waste or animal manure is present. Though not necessarily harmful themselves, they are indicators of other disease-causing organisms, and are used as a general indicator of sanitary water quality conditions.
The Connecticut Water Quality Standards established the following criteria for E. coli bacteria in the State's surface waters:

- Not to exceed 235/100ml (for official bathing area) or 576/100ml (all other water contact recreation) for single samples;
- Not to exceed a geometric mean of 126 colonies/100ml for any group of samples.

These criteria are based on protecting recreational uses such as swimming, kayaking, wading, water skiing, fishing, boating, aesthetic enjoyment and others. When the bacteria counts exceed the criteria there may be an associated health risk from water contact.

The Mattabesset TMDL establishes the maximum loading of bacteria that Coginchaug River can receive without exceeding the water quality criteria adopted into the State Water Quality Standards. TMDLs in general establish the maximum amount of a pollutant that a waterbody can take in without an adverse impact to fish, wildlife, recreation, or other public uses. The end result is a quantitative goal to reduce pollutant loading to the waterbody, expressed as an average percent reduction from current loadings that must be achieved to meet water quality standards.

Potential sources of bacterial pollution in the Coginchaug River, as identified in the TMDL, include waterfowl, agriculture, crop-related sources, intensive animal feeding operations, natural sources, illicit discharges, and failed or inadequate septic systems. Other potential sources identified through this analysis include wildlife and domestic pet waste, stormwater runoff, leaking sewer lines, and swimming "accidents". (Please refer to A Total Maximum Daily Load Analysis for the Mattabesset River Regional Basin, and the Connecticut Department of Environmental Protection Water Quality Standards).

While currently listed for only for its problems associated with high levels of bacteria, other water quality concerns, including high levels of the nutrients nitrogen and phosphorus, are an issue in the Coginchaug River watershed. Nutrient loading in the Coginchaug River eventually makes its way to Long Island Sound. The Coginchaug River flows into the Mattabesset River which outlets into the Connecticut River which drains into the Sound. In an effort to minimize the impact of nutrient loading to the Sound, the State of Connecticut has developed a TMDL for Long Island Sound identifying nitrogen as the pollutant of concern. While nutrients, such as nitrogen and phosphorous, are essential elements for aquatic organisms, excessive amounts can cause water quality problems. Eutrophication, excessive plant and algae growth in a waterbody, is the most notable result. An overabundance of plants and algae may deplete a waterbody of dissolved oxygen, affect habitat for aquatic organisms, and alter the process of photosynthesis and nutrient cycling. These changes may affect the ability of a waterbody to support plant and animal life, interfere with water treatment, and decrease aesthetic and recreational values. In addition, some forms of nutrients can be toxic to humans and to animals. (Understanding the Science Behind Riparian Forest Buffers: Effects on Water Quality; Authors: Julia C. Klapproth, Faculty Assistant-Natural Resources, Maryland Cooperative Extension; James E. Johnson, Extension Forestry Specialist, College of Natural Resources, Virginia Tech, Publication Number 420-151, Posted October 2000)

Much of the bacterial and nutrient pollutant loading and poor water quality conditions in the Coginchaug River and its tributaries can be attributed to nonpoint source (NPS) pollution. Nonpoint source pollution, simply stated, is polluted runoff. Surface runoff from rainfall or snowmelt moves over or through the ground carrying natural and human-made pollutants into waterbodies such as lakes, rivers, streams, wetlands, and estuaries. In contrast, point source pollution comes from a specific location, such as discharge pipes or outfalls. Point sources can be easily identified, monitored, and regulated. Nonpoint sources are hard to identify, and therefore difficult to monitor and regulate.

What is NPS Pollution?
Common and widespread, NPS pollution is considered by the Environmental Protection Agency to be a leading cause of water quality impairment nationwide. NPS pollution results when rainfall and snowmelt carry accumulated pollutants into nearby water resources (vs. point source pollution, such as that coming from sewage treatment plants). Since these sources are so diffuse, addressing them is a considerable challenge.

Common NPS Pollutants
Nutrients (from fertilizers, yard waste, animal manure)
Sediments (e.g. road sand)
Pathogens (in bacteria)
Toxics (e.g. heavy metals, pesticides, herbicides)
Debris or Litter

Common Sources
Construction Sites
Roads
Parking Lots
Roofs
Lawns
Farms
Failing Septic Systems

In 2005 the United States Department of Agriculture – Connecticut Natural Resources Conservation Service (NRCS) and the CT DEP began discussions on how the two agencies in cooperation with local watershed stakeholders could develop a watershed based plan describing implementation measures to help attain the TMDL loading reductions. The NRCS and CT DEP signed a formal agreement in April 2006 and NRCS began working on this project. Funding from Section 319 of the Clean Water Act is being used to fund part of the work being conducted for this effort.

PURPOSE

Because land planning decisions are made at a local municipal level in Connecticut, this plan is intended to help watershed residents and decision makers understand the impact of nonpoint source pollution on the Coginchaug River. Towards that end, this planning effort has three distinct, yet related key purposes. The first purpose is to provide local, state, and federal entities with recommendations for the implementation of specific Best Management Practices (BMPs) intended to address identified water quality concerns in the Coginchaug River watershed. Second, the report describes a replicable approach to watershed based planning. Third, this plan satisfies the guidance set out by the EPA in Section 319 of the Clean Water Act regarding the development of a watershed based plan.

Through the identification of BMPs, this report, at its most basic, serves as a non point source water quality management plan. The plan presents local stakeholders with a number of alternatives and a variety of options to reduce bacterial loading to the Coginchaug River using structural and nonstructural practices. The recommendations for BMPs are made on both a watershed wide basis and "place-based" basis (for site specific locations within the watershed). Providing both watershed wide and place-based BMPs achieves two objectives. Suggesting watershed wide practices highlights the relationship between existing land use conditions and water quality. At this level, the recommended practices represent basic measures that can be put in place anywhere in the watershed to help reduce the impact of pollutant loading.

Place-based recommendations, on the other hand, focus attention on the impact an individual site may have on water quality. The individual sites identified through this study represent locations where there is a high potential for bacterial loading. It is important to understand that the place based locations are not necessarily contributing bacteria to the system, nor are they contributing more than other specific sites in the watershed. This determination of a "high potential" is based on the existing conditions at the site at the time of the investigation. Land use, land cover, soils types, among other factors, are some of the elements that were used to evaluate which sites might be more likely contributors of bacteria to the Coginchaug River and its tributaries. In order to assess the actual contribution of any of these sites more detailed and site specific analysis is required.

Implementing the measures outlined in this report, in whole or in part, will help to improve and maintain the health of the Coginchaug River and the surrounding landscape. Improving the health of the Coginchaug River has been a long term goal of local stakeholders. Moreover, the identification of specific BMPs assists the CT DEP with its stated goal of removing the Coginchaug River from its 303(d) impaired waterbodies list, and addresses the objectives of the TMDL that was written for meeting water quality standards for bacteria.

The TMDL, however, does not describe the appropriate measures that may be implemented within the watershed nor does it outline a process to use in order to reduce the bacteria loading to the

Coginchaug River. The description of the process and methods used in this effort presents a model or template for an effective and replicable approach to watershed based planning, the second purpose of this plan. In recent years there has been a renewed interest in watershed management on the part of many people, entities, and organizations, many of whom may not have the same level of resources available to them as NRCS. By design and intent, this planning effort experimented with ways in which a of variety natural resources based factors, related to water quality, could be analyzed in combination with each other.

The various analyses, and technologies used to assess watershed conditions were each designed to be sophisticated enough to shed light on the watershed features and water quality conditions, yet simple enough to be replicated with relative ease and minimal technical and financial resources. Throughout the planning process the components were evaluated to determine three things: (1.) did the component provide any valuable analysis, (2.) what did the analysis suggest about the relationship between watershed conditions and water quality, and (3.) how easily can the component be replicated. The idea is to put forward a process and analyses that can be used by just about any group or entity.

Along with the process and analysis, this report summarizes the financial and technical scope of the recommended BMPs. This information helps the municipalities and local stakeholders understand the costs in time and money that may be required for implementation of the suggested practices. Based on the estimates the involved parties can explore various ways to obtain the necessary resources, including allocations in municipal budgets, applying for grant money, and fundraising activities among others.

The costs developed by NRCS for the implementation of the BMPs described in this report represent a best estimate based on a variety of sources. It should be understood that the estimates do not necessarily consider all of the site specific conditions that may influence the final cost for implementation. Additionally, the estimates used in this report are based on costs as researched in 2006. Costs may change in subsequent years. For a more detailed discussion of cost development please refer to the Watershed Wide Analysis section of this report.

The third purpose of this plan is to satisfy the guidelines established by the United States Environmental Protection Agency (EPA) for the development of watershed based plans. EPA administers the Section 319 Nonpoint Source Management Program of the Clean Water Act. The stated goals of Section 319 mandate that certain criteria be met in order for an implementation project to be considered for funding using Section 319 monies. Beginning in the federal fiscal year 2004, one such criterion required by EPA is that a watershed based plan exists and that the plan addresses nine specific criteria.

Writing this watershed based plan, therefore, is part of the formal agreement between CT DEP and NRCS. The need to include the nine criteria, in essence, established the structure of the plan. "These nine elements include explicit short- and long-term goals, objectives, and strategies to protect and restore water quality; ways to strengthen working partnerships …; balance approaches that emphasize both State-wide programs and on-the-ground management of individual watersheds where waters are impaired or threatened; focus on both abating existing problems and preventing new ones; and use a periodic feedback loop to evaluate progress and make appropriate program revisions." (From EPA Section 319 website: http://www.epa.gov/fedrgstr/EPA-WATER/2003/October/Day-23/w26755.htm). Other entities interested in applying for Section 319 funds can use this plan as a template.

This WBP builds from the earlier studies and reports conducted of the Coginchaug River watershed. The Coginchaug River Greenway, Proposed Management Plan (1992), the Coginchaug River Natural Resources Inventory (1992), the Coginchaug River Improvements Report (1990), the Cherry Hill Dam Study (1988) and the Connecticut River Watch monitoring program (1992 – 2004) represent the long standing concern of the local community in understanding, improving, and maintaining the health of the Coginchaug River and surrounding landscape.

SCOPE

As described above, the scope of this project was limited to the bacterial loading to the Coginchaug River and its tributaries, and structured to meet the goals and requirements of Section 319 of the Clean Water Act.

Section 319

Congress enacted Section 319 of the Clean Water Act in 1987, establishing a national program to control nonpoint sources of water pollution. During the last several years EPA has been working with the States to strengthen its support for watershed-based environmental protection by encouraging local stakeholders to work together to develop and implement watershed-based plans appropriate for the particular conditions found within their communities. In particular, EPA and the States have focused attention on waterbodies listed by States as impaired under Section 303(d) of the Clean Water Act. Toward this end States must use $100 million of Section 319 funds (referred to as "incremental funds") to develop and implement watershed-based plans that address nonpoint source impairments in watersheds that contain Section 303(d)-listed waters. These plans may also include activities that address waterbodies within the watershed that are not currently impaired where appropriate to prevent future impairments within the watershed.

According to EPA, attention to these impaired waterbodies is particularly critical because nonpoint source pollution is reported by States and others to be responsible for the majority of remaining water pollution in the United States. As outlined in the Section 319 guidelines, two key steps are needed to solve nonpoint source problems within a watershed context: the development of a watershed-based plan that addresses a waterbody's water quality needs (including the incorporation of any TMDLs that have been developed) and the actual implementation of the plan.

While stakeholders may have remarked upon other issues and concerns, such as habitat, biodiversity, and water quantity, this plan is not designed to address those matters directly. The implementation of the BMPs suggested in this report may, however, provide ancillary benefits to those concerns. An additional benefit of this planning effort is that consideration was given to nitrogen reduction as part of the analyses and BMP recommendations in order to help meet the TMDL for Long Island Sound.

NRCS – CT DEP Agreement

The agreement between NRCS and the CT DEP is predicated on the aforementioned nine key elements required by the EPA. These elements are

1. The identification of the non-point sources that will need to be controlled to achieve load reductions established in the state's nonpoint source TMDL or any other goals identified in the watershed-based plan.

2. An estimate of the load reductions expected from the management measures described.
3. A description of the nonpoint source management measures needed to achieve load reduction and identification of the critical areas in which the measures will need to be implemented to achieve the nonpoint source TMDL.
4. An estimate of the assistance (financial and technical) and authorities the state anticipates having to rely on to implement the plan.
5. An information/education component, which the state will use to enhance public understanding of the project and encourage public involvement in the nonpoint source management measures.
6. A schedule for implementing the nonpoint source management measures identified in the plan.
7. A schedule of interim, measurable milestones that can be used to determine whether nonpoint source management measures or other control actions are being implemented.
8. A set of criteria that can be used to determine whether substantial progress is being made toward the water quality standards and, if not, criteria that will help to determine whether the nonpoint source TMDL should be revised.
9. A monitoring component to evaluate how effective the implementation efforts are as measured against the set of criteria developed as described previously.

PROJECT DESCRIPTION

Who is this report for?

This plan provides information for two groups: stakeholders within the Coginchaug River watershed; and individuals, entities, or groups interested or involved in implementing watershed based planning. For the watershed stakeholders (e.g. municipal staff and officials, members of local land use commissions, landowners, individual interested in watershed natural resources issues) this plan offers

- general information about the Coginchaug River watershed and broad understanding of current watershed conditions;
- a management guide for reducing bacterial loading and addressing general nonpoint source pollution concerns;
- a starting point from which local stakeholders can prioritize implementation projects;
- a funding document – information that can be used to support requests for future funding of projects designed to improve the health of the Coginchaug River watershed.

The Coginchaug River study, for those interested or involved in watershed based planning, is an example of one approach to watershed planning that meets the Section 319 requirements.

An important part of developing this plan was the involvement of the public. Direct public involvement came through the development of an advisory committee. Comprised of a representative cross section of the community - local citizens, municipal representatives, chamber of commerce members, agricultural producers, local business owners, and state and federal personnel, this committee served as a mechanism for incorporating stakeholder or local input into the plan and as tool for disseminating information about the effort to the broader public. It also acted as a conduit for information to be brought into the planning process. This enabled the process to be transparent and fully open.

Public involvement and transparency proved to be effective for this study well before the plan was completed. It allowed for communication and generated opportunities to have productive discussions about the natural resources issues in the watershed. For example, one of the municipalities asked for assistance in addressing an eroding stream and the resulting water quality problems. In another case, one of the advisory committee members was able to talk to the owner of a site which was initially believed to be a potential source of bacteria. It was an opportunity to discover that the town sanitarian does not consider the site to be a problem, and provided the opportunity to put the landowner in contact with the local conservation district to discuss the possibility to install enhanced vegetative riparian buffers. Another municipality requested assistance on water quality and flooding problems for a tributary to the Coginchaug.

In addition, several outreach activities were organized throughout the process. These activities were designed to generate awareness of the watershed based planning effort, educate local residents about the watershed's natural resources, and engage people in activities that directly connected them with the river and its surroundings. These activities included:

- Public meeting to present the study,
- Macro-invertebrate sampling,
- Boggy Meadows Hike to investigate water quality and ecological issues
- River Paddle down the Coginchaug River to the Connecticut River,
- "Source to Sea" River cleanup,
- Streamwalk

Map 1: Location of Coginchaug River Watershed

WATERSHED DESCRIPTION

The Coginchaug River watershed is approximately 39 square miles in size (24,927.6 acres) and includes portions of eight towns: 48.7 percent of the watershed is in Durham, 28.5 percent in Middlefield, 12.9 percent in Middletown, 6.7 percent in Guilford, 1.6 percent in Madison, and the remainder in the towns of Meriden, Wallingford, and North Branford (see Table 1). The watershed also includes the local basins of Allyn Brook, and Sawmill Brook– these, along with the Coginchaug River, are considered sub-regional basins of the Mattabesset River Regional Basin. The Mattabesset watershed is within the Connecticut River Major Basin (4). (Map 1: Coginchaug River Watershed)

Table 1: Towns in the Coginchaug Watershed

TOWN	total acres in town	acres in watershed	% of town in watershed	%of watershed in town
Durham	15,217.6	12,133.6	79.7%	48.7%
Guilford	30,356.3	1,664.0	5.5%	6.7%
Madison	23,425.7	399.1	1.7%	1.6%
Meriden	15,325.4	34.33	0.2%	0.1%
Middlefield	8,402.4	7,106.6	84.6%	28.5%
Middletown	27,403.6	3,212.3	11.7%	12.9%
North Branford	17,233.1	177.9	1.0%	0.7%
Wallingford	25,822.7	199.8	0.8%	0.8%
Total Acres in Watershed:		24,927.6		100%

Unlike most rivers in Connecticut, the Coginchaug River flows in a northerly direction. The headwaters are located in the Town of Guilford, at Myer Huber Pond. The upper reaches of the watershed are less densely developed, with the watershed becoming progressively more developed as one moves downstream. Though sections of the river running through the City of Middletown are heavily developed, the last mile of the river is more buffered than others and better protected from direct stormwater runoff from the urban environment. The Coginchaug River flows into the Mattabesset River at the North End Peninsula, which is comprised, in part, of a closed landfill that is known to contain hazardous waste and has no leachate collection system. Despite the potential hazards presented by the closed landfill, the area of the confluence, known as Boggy Meadows, contains a diverse, healthy, and unique ecosystem.

Water Quality Summary and Monitoring Data

According to State Surface Water Quality Classifications from (year?), the Coginchaug River is designated a Class A watercourse from its headwaters in Guilford to its confluence with Allyn Brook in Durham. Downstream from there, to its confluence with the Mattabesset River, it is designated Class B. The vast majority of tributaries in the watershed are Class A or AA, with several stream segments classified as B/A. (See Map 2).

Connecticut's Water Quality Standards

Connecticut's Water Quality Standards classify all the waters of the state, specify the designated uses and values that must be supported, and specify criteria that define the water quality necessary to support those uses. Surface waters are designated as either Class AA, A, B, C or D. Uses include:

- AA – Drinking water supply, fish and wildlife habitat, recreational (may be restricted), agricultural and industrial supply
- A – Potential drinking water supply, fish and wildlife habitat, recreational use, agricultural supply, navigation
- B – Recreational, fish and wildlife habitat, agricultural and industrial supply, navigation

Surface waters designated as Class C or D are not attaining designated uses or meeting water quality criteria.

Classifications are often expressed as an existing designation, with a water quality goal, for example as B/A. This means that the goal is "A", but current conditions support a classification of "B".

The CT DEP had targeted the Mattabesset and Coginchaug rivers for improved NPS pollution management due to problems associated with land development, agricultural and urban runoff and removal of streamside vegetation. Monitoring activities were undertaken to learn more about the rivers' health, as well as raise public awareness about human impacts on rivers and encourage an active interest in their stewardship. CRWP monitoring documented chronically high levels of the indicator bacteria E. coli that exceeded the criteria in the State Water Quality Standards (see Table 2). It should be noted that high levels of bacteria were present in samples taken under dry conditions, particularly in 2001 and 2004. The high level in these samples indicates that urban runoff and stormwater runoff are not the only source of significant bacterial loading, and suggest the presence of a local persistent source contributing to bacterial loading.

Map 2: Surface and Ground Water Quality

Table 2 CRWP Coginchaug River E. coli Results Summary

Sites are listed upstream to downstream. Results are reported for the sampling season as a geometric mean, an average value that reduces the influence of very high and low values.

2004 results are listed first, and then 2003, 2002, 2001 and 2000 results (see notes1).

Site #	Location	E. coli Results Colonies/100mL
CoR070	Bluff Head Road crossing in Guilford	2003 1017 2002 238
CoR060	Creamery Road crossing in Durham	2004 923 2003 1529 2002 523 2001 1004 2000 918
CoR030	Upper Wadsworth Falls in Middlefield	2004 590 2003 418 2002 680 2001 228 2000 96
CoR010	Veteran's Park in Middletown	2004 517 2003 502 2002 573 2001 355 2000 135

1Water quality results are often affected by rainfall. To help in interpreting the differences from year to year, rainfall records for each year are summarized as follows.

- 2004—5 of 9 days were rainy, though only 2 days were rainy enough to qualify as "wet condition" by the DEP: more than 0.1" precipitation in 24 hours before sampling, 0.25" in 48 hours before sampling, or 2.0" in 96 hours before sampling. Rainfall on those days in the 48 hours before sampling was 0.34 and 1.94 inches.
- 2003—3 of 4 days were rainy. In the 48 hours before sampling rain fell as follows: 0.05 inches, 0.84 inches, and
- 1.03 inches.
- 2002—Sampling coincided with rain events of varying degrees on 3 of 4 days; in the 48 hours before sampling
- rain fell in the following amounts: 0.54 inches, 0.87 inches, 0.33 inches. ☐☐2001—Only 1 of 4 days had any rain at all in the 48 hours preceding sampling, though it was an insignificant
- amount (0.04 inches).
  2000—2 of 4 days had rainfall in the 48 hours before sampling (0.08 inches & 0.22 inches).

Based upon these findings, the CT DEP completed the TMDL for the Mattabesset River Regional basin. The impaired use and cause listed in the CT DEP TMDL analysis for all Coginchaug River segments are contact recreation and indicator bacteria. The Connecticut River Coastal Conservation District worked in partnership with DEP to collect and provide monitoring data for the TMDL. Connecticut River Watch Program E. coli data from 2001-2003 was used, and volunteers and DEP staff collected the remaining samples needed to complete the data requirements for the TMDL in 2004.

For the purposes of analysis and assessment reporting, the CT DEP divides the mainstem of the Coginchaug River into six segments (see Map 3). A segment is the stretch of river between two TMDL monitoring points. Four of the six segments of the Coginchaug River main stem were listed on the CT DEP 2004 List of Connecticut Waterbodies Not Meeting Water Quality Standards (303(d) Impaired Waterbodies List). Segments CT 4607-00_01 and CT4607-00_03 were not included. Five of the six segments are now included in the TMDL analysis and subsequent 2006 impaired waters list because available data indicated exceedences of indicator bacteria (CT DEP, A Total Maximum Daily Load Analysis for the Mattabesset River Regional Basin, 2005). Only segment 4607-00_01, the most downstream segment, is not part of the TMDL. Monitoring data used for the TMDL analysis for segments 4607-00_02, 4607-00_04, and 4607-00_06 was collected between 2001 and 2004. For segments 4607-00_03 and 4607-00_05 only data collected during 2004 were used. The average percent total reductions range from 62% to 84%.

In addition, data were reviewed from six ancillary monitoring sites. As was the case with the TMDL sites, elevated levels of bacteria were found at each of the ancillary locations. The additional Coginchaug River main stem sites are at Bluff Head Road in Guilford, on the downstream side of Route 68 in Durham, and just upstream of the confluence with Hans Brook in Middlefield. Three tributaries were monitored, all in Middlefield: Lyman Meadow Brook on the upstream side of Route 147, Ellen Doyle Brook just downstream from Powder Hill Road, and Hans Brook just upstream of the confluence with the Coginchaug River.

High levels of the nutrient phosphorus were also documented by CRWP and DEP monitoring. Phosphorus, an essential plant and animal nutrient, is the limiting factor in aquatic plant growth in fresh water since it occurs naturally in very low concentrations. Connecticut's Water Quality Standards do not have numerical criteria for nutrients. Guidelines for phosphorus from the State of Vermont were used to evaluate these data (>0.05 mg/l, warning flag; >0.10 mg/l, impacts are certain). As can be seen in Table 3 below, in 2004, at all sites but the upstream Creamery Road site, levels of phosphorus were measured that were a cause for concern. This was especially the case at the Miller Road and Wadsworth Falls sites, where levels measured indicated "certain impacts."

Map 3: Analysis Areas and Water Quality Monitoring Points

Table 3 CRWP/DEP Coginchaug River Phosphorus Results Summary—2004
Sites are listed upstream to downstream. Results are reported for the sampling season as a geometric mean, an average value that reduces the influence of very high and low values. Only the 2004 results from the CRWP/DEP collaborative monitoring program are included.

Site #	Location	Phosphorus Results (mg/l)
CoR060	Creamery Road crossing in Durham	0.010
CoR045	Miller Road crossing in Durham	0.127
CoR030	Upper Wadsworth Falls in Middlefield	0.105
CoR015	Route 66 crossing in Middletown	0.092
CoR010	Veteran's Park in Middletown	0.080

Biological assessment of the benthic macroinvertebrate community of the Coginchaug River has also been conducted by CRWP and others, including, the Chernoff Lab at Wesleyan University. Benthic macroinvertebrates are aquatic organisms—insects, worms, mollusks and crustaceans—that live in the stream bottom. They are good indicators of water quality because many are sensitive to pollution; the composition of the community is a good reflection of long-term water quality because they live in the stream year-round; they cannot easily escape pollution; and they are relatively easy to collect.

In fall 2004, CRWP assessed a site on the Coginchaug River, downstream of the Route 66 crossing in Middletown. Two replicate samples were collected and preserved for later processing and identification by CRWP volunteers. Lab work was done at Xavier High School with assistance from biology teacher Linda Charpentier. Organisms were identified to the Family level, results were compiled, and a number of standard indices were used to analyze the results. Results for several of these indices are presented below.

Organism Density: The number of organisms in the sample.

Standard: 150 minimum for a healthy site
Result: 444--Meets criterion for a healthy site

EPT Richness: The number of different types of organisms in the Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) orders, all of which are sensitive to water quality changes.

Standard: 10 minimum for a healthy site
Result: 10--Meets criterion for a healthy site
Percent Contribution of Dominant Family: The percentage of the sample made up of the family containing the most organisms.

Standard: <30%, non to slightly impaired; 30-50%, moderately impaired; >50%, severely impaired.
Result: 38%--Indicates moderate impairment

Percent Model Affinity: The percent similarity with a reference community.
Standard: >64%, no impact; 50-64%, slight impact; 34-49%, moderate impact; <34%, severe impact.
Result: 62%--Indicates slight impact
.

Results for this site indicate that it has a relatively healthy community. While some of the metrics indicate slight to moderate impairment, others signify the site is healthy. In addition to the metrics reported on here, the presence of six types of very sensitive organisms (0-2 on the pollution tolerance scale) at the site is a sign of very good water quality. They include Ephemerellidae, Capniidae, Perlidae, Glossosomatidae, Lepidostomatidae, and Odontoceridae.

The Chernoff Lab at Wesleyan University conducted its benthic macroinvertebrate sampling at two sites on the Coginchaug River. CR is the upstream site close to the headwaters of the River; it is surrounded by agricultural fields, and has a riparian corridor of mainly herbaceous vegetation. LCR is the downstream site, close to its confluence with the Mattabesset River; its watershed includes a much larger proportion of developed land cover. The LCR sampling site is at a location of extremely high silt and sand build up, presumably from road run-off throughout the developed portion of the watershed.

Upstream sampling was done from the spring of 2004 to the fall of 2007; downstream from spring 2005 through summer 2007. The purpose of this sampling was to monitor temporal changes within and between river sites, and as such generally goes from May/June through October/November.

However, most sampling done by the State and Riverwatch programs for the purpose of monitoring water quality are done only in the fall. All data are included in the table (see Table 4); fall months are highlighted.

Table 4 shows the application of various biometrics. The Chernoff lab modified the CT DEP's rapid bio-assessment protocol to consider only those families with a narrow range of low tolerances (within species of the family). This might be considered the best indicator of water quality since it is only of organisms with low tolerance (for conditions found in degraded streams). The DEP considers those samples with 5 or more to be indicative of high water quality. While a lower than "minimum" density may signify impacts to water quality, a very high number can also be indicative of human impacts, such as from nutrient inputs. To some extent, this can also be reflected in % dominant family.

Conclusions:

- Biometrics: These sites are different from one another and from the Veteran's Park sample.
- Temporal Variability: Biometrics vary widely between and within sites over time, with impacts for some changing from none to severe. These variations do not appear to be seasonal.
- Impact: There is a scarcity of "most wanted" taxa at either site, indicating that neither could be considered high quality. Both are lower (averages of 2 for CR and .5 for LCR) than at other sites that we sampled, located in the Eight Mile River watershed (average 4.3).
- Average Abundance: This is significantly higher at CR than LCR, perhaps due to increased nutrients from local run-off. The lower abundances at LCR may be due to the high degree of substrate embeddedness there (the degree to which rocks on the river bottom are surrounded or covered in silt and/or sand).
- Water Chemistry: Average pH and average conductivity are very similar between sites when both years are summed. However, looking at the years individually, conductivity at CR rose from 1.8 in 2006 to 2.7 in 2007. Conductivity is a measurement of the ions in the water, which can increase with salts and other particles commonly in high quantity in street run-off. (See Table 5)

Table 4: Biometrics for CR and LCR for all years.

Coginchaug River Benthic Macroinvertebrate Biometrics											
Year	Month	Site	EPT Tax	Abundance	% EPT	MW Tax	# Taxa	% MA	% MA Adj.	% D	% D Imp.
2004	8	CR	2	192	40.10	2	11	moderate	moderate	0.33	moderate
2004	9	CR	2	1049	76.84	0	6	moderate	moderate	0.70	severe
2004	9	CR	3	499	80.16	1	7	moderate	moderate	0.77	severe
2004	10	CR	4	548	32.48	1	11	moderate	slight	0.49	moderate
2004	11	CR	5	303	74.26	4	12	moderate	no	0.29	no-slight
2005	6	CR	6	898	58.13	4	15	moderate	slight	0.52	severe
2005	7	CR	6	1332	37.39	3	19	moderate	slight	0.27	no-slight
2005	9	CR	7	3932	30.52	4	24	moderate	moderate	0.58	severe
2005	9	CR	6	2154	18.48	3	19	severe	moderate	0.47	moderate
2006	6	CR	5	127	23.62	3	10	moderate	moderate	0.32	moderate
2006	7	CR	4	191	23.56	2	14	moderate	moderate	0.31	moderate
2006	9	CR	1	822	52.80	1	14	moderate	slight	0.46	moderate
2006	11	CR	2	183	7.10	1	11	severe	severe	0.48	moderate
2007	5	CR	2	197	78.17	1	13	moderate	slight	0.76	severe
2007	7	CR	4	492	26.63	3	18	moderate	slight	0.18	no-slight
2007	8	CR	7	1680	46.61	3	25	moderate	moderate	0.40	moderate
2007	9	CR	5	2245	18.08	1	15	severe	severe	0.46	moderate
2007	11	CR	8	3269	15.23	3	22	severe	severe	0.69	severe
		AVE.	**4.39**	**1117**	**41.12**	**2**	**15**	**slight**	**slight**	**0.47**	**moderate**
2005	6	LCR	3	480	2.50	0	12	severe	severe	0.77	severe
2005	7	LCR	6	172	42.44	0	14	slight	slight	0.36	moderate
2005	7	LCR	5	746	31.50	1	16	moderate	moderate	0.40	moderate
2005	9	LCR	9	435	53.10	1	21	no	no	0.34	moderate
2006	6	LCR	2	57	3.51	0	9	severe	severe	0.47	moderate
2006	7	LCR	3	96	8.33	0	10	severe	severe	0.49	moderate
2006	8	LCR	5	831	80.02	1	12	slight	slight	0.71	severe
2006	9	LCR	4	94	28.72	0	9	moderate	moderate	0.40	moderate
2007	6	LCR	6	70	12.86	0	13	moderate	moderate	0.27	no-slight
2007	7	LCR	7	491	9.16	0	20	severe	severe	0.49	moderate
2007	8	LCR	6	190	41.05	0	15	slight	slight	0.38	moderate
2007	9	LCR	11	595	34.29	1	32	slight	slight	0.14	no-slight
2007	10	LCR	9	200	32.00	1	25	slight	slight	0.18	no-slight
		AVE.	**5.79**	**343**	**29.19**	**0.27**	**16**	**moderate**	**moderate**	**0.42**	**moderate**

Table 5: Water Chemistry at CR and LCR; averages to 2006 and 2007 averages.

Water Chemistry - averages 2006-2007			
Site	DO mg/L	Cond.	pH
CR	10.93	0.22	7.94
LCR	7.59	0.22	7.96

METHODOLOGY

The watershed analysis was divided into two parts: data collection and data analysis. Both of the collection and analysis components were split into two phases.

During phase one of data collection NRCS gathered existing data, and developed various studies that would help to characterize and assess accurately the current physical condition of the Coginchaug watershed. The NRCS

1. generated a detailed GIS based land use/land cover map based on interpretation of aerial photography;
2. produced a set of maps describing appropriate stormwater runoff management techniques based on soil types;
3. developed a wetland evaluation criteria tool and used it to assess each local watershed based upon its wetland complexes;
4. performed a municipal regulations review focused on water quality and water quantity issues;
5. organized a volunteer based streamwalk;
6. conducted a geomorphic and fisheries assessment of the watershed;

In addition, an advisory committee comprised of local citizens, municipal representatives, and state and federal agency representatives was created. The committee serves as a mechanism for incorporating stakeholder input into planning process, into the plan itself, and as a method for disseminating information about the effort to the public.

Under phase two of the project, NRCS examined the findings from the studies described above by examining the ways in which watershed conditions and characteristics relate to each other and to water quality conditions. Variables under consideration included land use/land cover, soil characteristics, stream types, pervious and impervious area, wetland functionality, existing local municipal regulations, and proximity of potential pollutant sources to waterbodies. The relationships among the different variables were explored through a variety of different analyses.

The level one analysis examines the Coginchaug River watershed in its entirety. Watershed conditions are examined on a broad scale, and, based on existing conditions, BMPs that may be appropriate and effective for use throughout the watershed are recommended in this report.

Through the second level of analysis, the watershed is subdivided into Analysis Areas. The Analysis Areas are delineated based on the location of the five (5) DEP water quality monitoring point. (Refer to Map 3: Analysis Areas and Water Quality Monitoring Points). The monitoring point is considered to be the outlet of the Analysis Area. All of the local watersheds contributing to that point were grouped together as part of the Analysis Area. It should be noted that Analysis Area 1 contains two of the monitoring points because both of the sites are located in one watershed. The local watersheds in each Analysis Area were then grouped according to similar land use/land cover characteristics.

All of the Analysis Areas are assessed to determine specific locations that might be potential or likely sources of pollutant loading primarily for bacteria and secondarily, nitrogen. Factors included in the analyses include land use and land cover, unbuffered sections of stream, soil suitability for subsurface sewage disposal systems, and impervious and pervious cover, among others. Appropriate "place-based" (site specific BMPs) are recommended for the sites.

Creating the Analysis Areas establishes a way to correlate the documented monitoring data with the associated contributing watershed conditions. While this method does not eliminate consideration of potential pollutant loading resulting from upstream contributions, it provides a mechanism to look more closely at what may be the potential local sources for pollutant loading. This detailed and comprehensive tiered assessment of watershed conditions creates a way for local decision-makers to comprehend the existing and potential impairments to water quality, and to examine more closely the potential sources of those impairments. This information, in turn, informs NRCS's recommendations for the BMPs that would be most suitable and provide the greatest impact for the watershed. Moreover, it enables NRCS and planners to identify specific locations for implementation of priority BMPs to achieve the most benefit. Using this "place-based" approach gives the local municipalities a focused, strategically developed, and relevant plan. This is significant because municipalities are the key to managing nonpoint source pollution in Connecticut.

In addition to the review of existing data, NRCS developed a set of components to evaluate existing watershed characteristics. Each component represents an individual study focusing on a particular aspect of watershed conditions. The studies are designed to provide data that can be used independently, in conjunction with the other watershed studies, and with other outside databases in order to distill the relationship between water quality and watershed conditions. The components included the following:

- a detailed Land Use/Land Cover (LULC) for the watershed,
- a set of maps providing soil based recommendations for storm water management practices,
- an evaluation of the watershed's wetland systems,
- an analysis of pervious/impervious cover,
- a municipal regulations review as related to water resources,
- a streamwalk,
- a level 1 geomorphic stream assessment, and
- a watershed fisheries resources assessment.

Land Use/Land Cover GIS Data Set

What is it and why did we do it?

The primary objective of the LULC data set is to provide a picture of Coginchaug watershed landscape. With this in mind, the NRCS LULC classification scheme is designed to separate out classes of land cover by their potential impacts on the levels of pollutants (specifically bacteria and nitrogen) entering into surface water and/or ground water. Using 2005 aerial photo imagery, a total of 34 classes of land use and land cover were established. A minimum mapping unit of one (1) acre was used in order to create a detailed map of the watershed landscape. Small waterbodies, less than 1 acre in size, have been mapped in cases where they may have an influence on water quality conditions. Creating such a detailed, large-scale land use/land cover map sets up a foundation for understanding the relationship between landscape patterns and water quality conditions.

NRCS mapped the watershed land use and land cover types at three levels of classification. The Level 1 classification shows the watershed land use and land cover types consolidated into seven

(7) broad categories (see Map 4: Level 1 Land Use/Land Cover Classification). Level II subdivides the seven broad categories into 29 detailed land use/land cover classifications. The detailed level of analysis, as shown on Map 5: Detailed Land Use/Land Cover Classification consists of 34 categories of land use and land cover in the watershed. (See Appendix A for additional details on the LULC).

Creating a contemporary land use land cover layer is critical to understanding the relationship between water quality and the watershed landscape. The three levels of classification enable analysis at different watershed scales. Reducing 34 classifications to seven allows general interpretations about broad scale, watershed wide patterns and helps inform recommendations for watershed wide BMPs. Alternatively, mapping the watershed using one acre as a minimum mapping unit allows for site specific analysis and the recommendation of BMPs that may address water quality concerns at specific locations.

LULC Findings

The LULC findings support the perception of the Coginchaug River watershed as a complex landscape with a mix of land uses. As can be seen from the totals in Table 6 (see below), forested land cover comprises nearly fifty percent of the watershed, while slightly less than one-third of the watershed is classified as developed, and just under 14 percent is in agriculture. The table substantiates that the level of development in the watershed tends to increase as one moves downstream in the watershed and that the largest area of agriculture is in the center of the watershed. The majority of this agricultural land is located along the mainstem of the Coginchaug River or along its major tributaries.

Map 4: Broad Land Use/Land Cover

Map 5: Detailed Land Use/Land Cover

Table 6: Level 1 Watershed Land Use/Land Cover Summary

Analysis Area	Data	Forest	Developed	Agriculture	Other	Transitional	Water	Barren	Grand Total
1	Acres of Cover	1,661.50	1,838.55	394.54	171.37	110.63	123.44	1.68	4,301.71
	% of Analysis Area	38.62%	42.74%	9.17%	3.98%	2.57%	2.87%	0.04%	100.00%
2	Acres of Cover	1,565.64	1,773.67	917.16	239.07	111.29	131.86	0	4,738.69
	% of Analysis Area	33.04%	37.43%	19.35%	5.05%	2.35%	2.78%	0.00%	100.00%
3	Acres of Cover	6,578.65	3,710.28	1,783.44	481.02	333.78	42.60	121.83	13,051.60
	% of Analysis Area	50.40%	28.43%	13.66%	3.69%	2.56%	0.33%	0.93%	100.00%
4	Acres of Cover	2,019.62	409.00	351.67	5.29	12.37	25.18	12.50	2,835.63
	% of Analysis Area	71.22%	14.42%	12.40%	0.19%	0.44%	0.89%	0.44%	100.00%
Total Acres in Coginchaug Watershed		11,825.42	7,731.49	3,446.81	896.75	568.07	323.08	136.02	24,927.63
Total % of the Coginchaug Watershed		47.44%	31.02%	13.83%	3.60%	2.28%	1.30%	0.55%	100.00%

LULC mapping also showed that although half of the watershed is forested, the larger contiguous tracts of forest are in the upper portion in the watershed, nearer the headwaters. As one moves downstream, the forestland becomes more fragmented, and makes up a smaller percentage of the landscape. It is important to note that the headwaters of most of the tributaries are in a forested landscape. Forested conditions generally have a high potential for infiltration and low potential for runoff. (Refer to the Pervious/Impervious section for more detail regarding runoff potentials). These are areas that might benefit from protection or implementation of low impact development measures/stormwater management techniques to preserve the natural infiltration/runoff relationship.

The LULC data, in conjunction with the USGS hydrology layer, was used to determine the location and extent of unbuffered areas. When these data layers were analyzed for the adjacency of polygons of development or agriculture to perennial water, stretches of streambank and shoreline were highlighted that were in need of increased buffering.

The LULC data was analyzed with a variety of soil interpretations. The interpretations relating to stormwater management and subsurface sewage systems (septic) were evaluated, in part, based upon the kinds of land uses that occurred at the site. Being able to visualize the land use on top of the potential limitations of the soil provided a context for discerning potential and likely sources of pollutant loading.

<u>Soil Based Recommendations for Storm Water Management Practices</u>

Soils information is used by professionals as one screening tool to assist with a variety of land use planning decisions (e.g. septic suitability, slope stability, etc.). As part of this project, NRCS generated a series of maps based on soil characteristics that influence the functioning of BMPs for stormwater runoff in the watershed. Soils were rated to indicate the extent to which each may be limited by their properties for specific stormwater management systems. Three maps were generated for the watershed: one stormwater basins, one for infiltration systems, and one for stormwater wetland systems. Maps 6, 7, and 8 show the suitability for these three systems of stormwater management. These maps are based on the National Cooperative Soil Survey for the state of Connecticut which was mapped at a 1:12,000 scale. Areas of soils less than about three acres in size cannot be delineated at this scale so map units may contain areas of soils differing from those named. The maps provide an excellent general planning tool to successfully select and implement appropriate BMPs within the watershed. They can be used to help guide the selection of storm water practices that best fit the soil conditions in comprehensive planning, site plan review, or for preliminary site selection and design. Survey based soil interpretations are meant to be used for planning or review and do not replace an on-site soil evaluation for site development (Refer to Appendix B for more detailed discussion of soil based recommendations for storm water management practices).

Findings

The majority of the soils in the watershed will accommodate some type of stormwater basin to manage stormwater runoff. This is also true of small practices such as rain gardens and swales for single home use. Map 6 shows the position of soils that are rated least limited and somewhat limited for these practices. The pink areas are unsuitable generally due to steep slopes, shallow bedrock, or soil saturation. Conversely, relatively few areas in the watershed lend themselves to infiltrations systems. These ratings are meant to apply to large scale engineered infiltration systems that deliver considerable additional runoff into the soil. Many areas marked somewhat or most limited are capable of infiltration of smaller amounts of runoff using filtering practices or low impact development practices. The ratings for stormwater wetland systems are based on a soil's

Map 6: Stormwater Runoff Management: Soil Suitability for Stormwater Basins

Map 7: Stormwater Runoff Management: Soil Suitability for Stormwater Infiltration Systems

Map 8: Stormwater Runoff Management: Soil Suitability for Stormwater Wetland Systems

ability to support hydrophytic vegetation and most are Connecticut wetlands. The total area of these soils is relatively small and located primarily along the main stem. Degraded sites within these areas may offer opportunities for restoration. In addition, many soils that are suitable for stormwater basins can also be used for some type of constructed wetland.

Wetland Evaluation

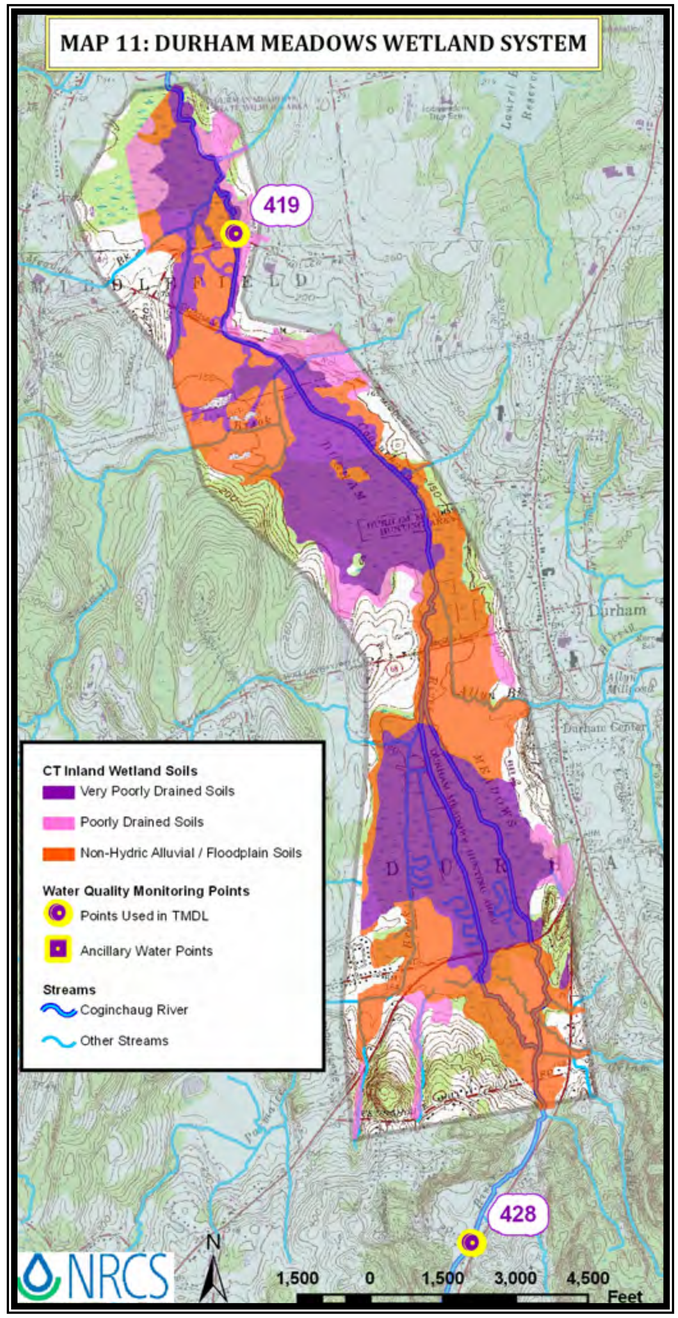
Wetlands provide numerous functions, including filtration and moderation of stormwater flows. The ability of a wetland area to protect surface and groundwater is influenced by the quantity and quality of inflow from the contributing watershed as well as the ability and capacity of the wetland itself to contain and treat the inflow before discharging into water bodies or aquifers. This wetland evaluation is designed to rate each local watershed based upon the acres of wetland and their capacities, the acres of various land cover types, and the soils and slopes that affect the runoff and infiltration in the watershed. Individual wetland complexes were not evaluated based upon their specific inputs or capacity.

By considering the quantity and quality of inflow within the local watersheds and the capacity of the wetlands in each of those local watersheds it is possible to draw some general conclusions about the wetlands' ability to moderate stormwater flows and protect watercourses from potential pollutants present in surface water and ground water flows. Map 9 shows the rating of each local watershed based upon the quality and quantity of inflow in the basin. Map 10 represents the rating of the local basins based upon capacity of all the wetlands in each local basin. (Refer to Appendix C for more detailed discussion of the Wetlands Evaluation).


Parmalee Brook, Durham

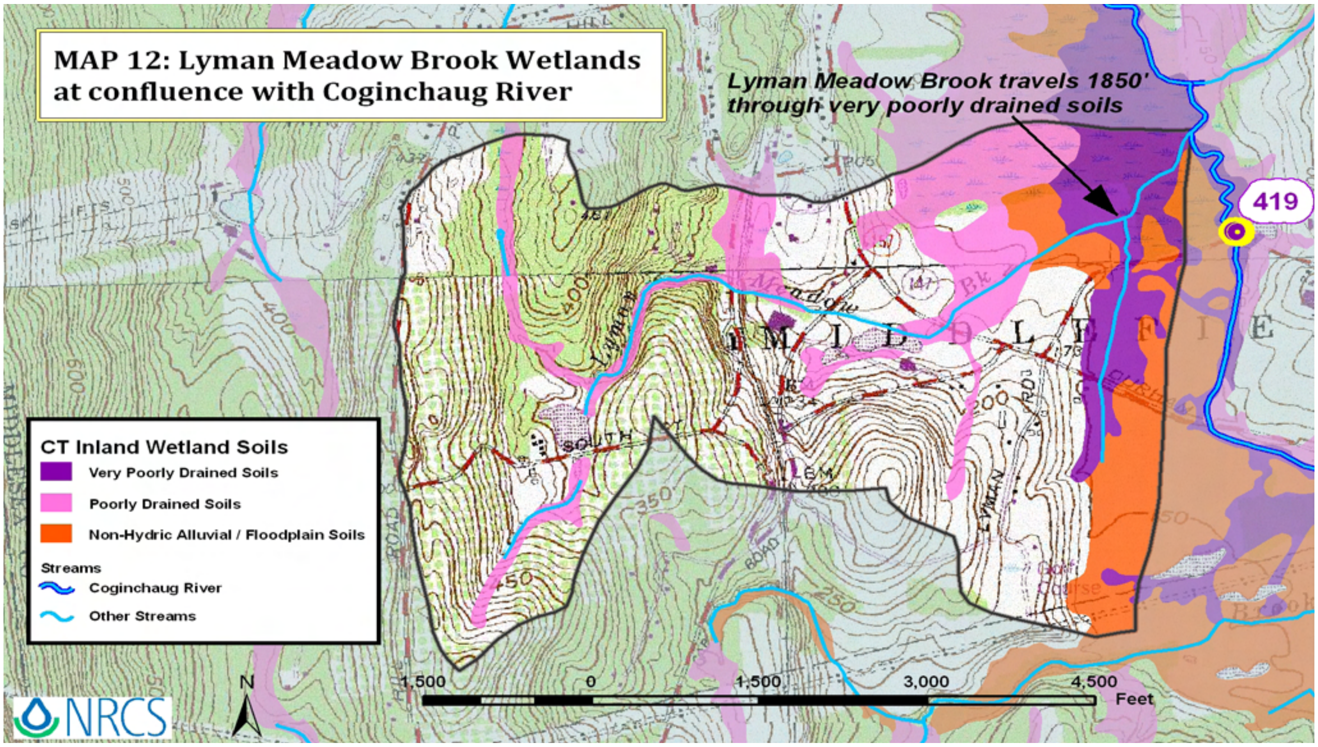
Non-hydric, alluvium and floodplain soils are regulated as wetlands, but have none of the hydric characteristics of the other soils. They may be dry for most or all of the year, flooding only intermittently. They may, in some places, be 'developed' (e.g. as ball fields, parks etc.). The non-hydric soils have little to no organic matter buildup, and are the least effective for filtering.

The large wetland at Durham Meadows, comprised of very poorly drained soils (as illustrated in Map 11: Durham Meadows Wetland System), appears to be effective in treating the TMDL indicator bacteria. As reported in the TMDL data, the levels of bacteria, though still elevated, decrease from Creamery Road (point 428) to the downstream side of Miller Road (point 419). These two points are located roughly at the upstream and downstream limits of Analysis Area III. This decrease in indicator bacteria levels occurs even with all of the inputs from this analysis area. Data derived from the LULC map shows that 52 percent of the agricultural land in the entire Coginchaug River watershed is situated in Analysis Area III. Similarly, 48 percent of all developed land in the watershed is located in Analysis Area III. (Refer to Table 6 for LULC percentages) In this analysis area, the Coginchaug River is a relatively, flat, slow moving marshy section of river. The low gradient and well developed floodplain increases residence time for water flows, thus allowing potential pollutants to be treated over a longer period of time. (See Stream Type section below for more detail). The combination of the large, very poorly drained wetland and a low gradient, slow moving stream creates an effective natural filter. The downstream extent of the filter along the mainstem is at Strickland Road. North of this point there is limited wetland filtration along the mainstem of the Coginchaug River.



Map 9: Wetland Evaluation – Inflow rating

Map 10: Wetland Evaluation – Capacity Rating

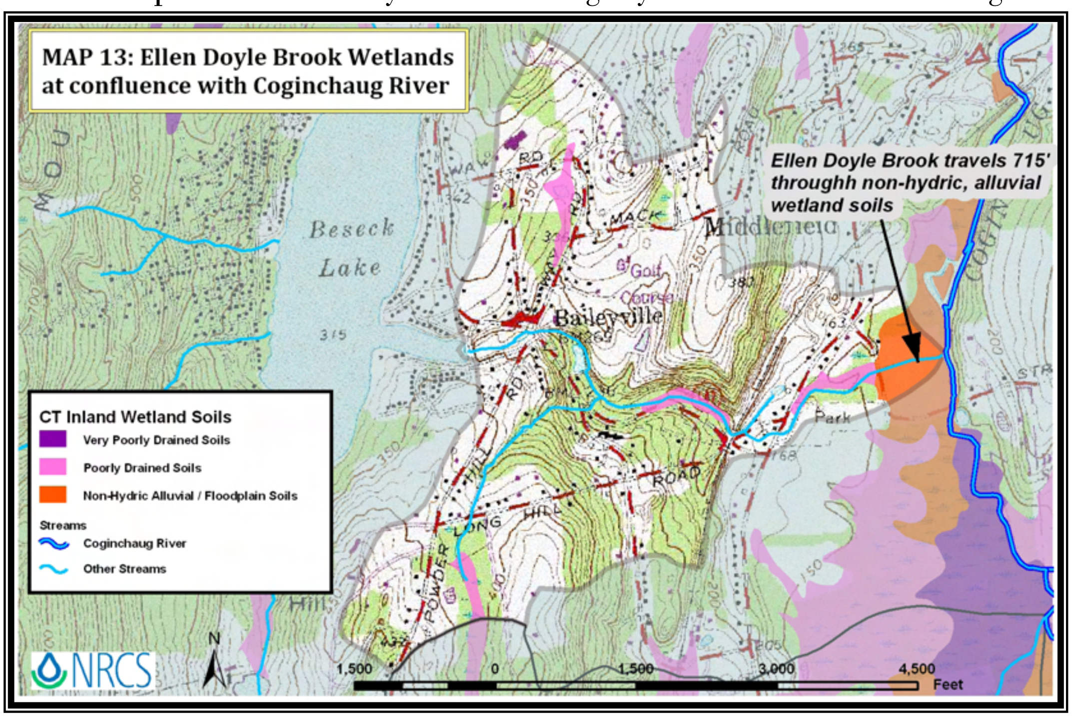


A wetland similar to Durham Meadows exists at the mouth of Lyman Meadow Brook (see Map 12). Based on our understanding of land use around Lyman Brook there is a potential for a high level of discharge of bacteria into the brook. However, a wetland comprised of very poorly drained soils is located at the confluence of Lyman Brook and the Coginchaug River. The presumption is that this wetland complex is acting as a biofilter. At this time, no data exists to demonstrate the absolute efficiency of the wetland's filtering capacity.

In contrast, there are only small areas of wetlands along Ellen Doyle Brook (See Map 13). Classified as poorly drained and non-hydric alluvium, these small wetland complexes provide minimal treatment.

Monitoring data, collected at the outflow of Lake Beseck, shows that Ellen Doyle Brook has high levels of bacteria. As the brook has a steeper gradient and shorter resident time then the mainstem, as well as minimal wetlands, the treatment of potential pollutants is limited. It is most likely that the indicator bacteria found in Ellen Doyle Brook is transported directly to the Coginchaug River with little natural treatment or filtration. In most cases, the capacity of the wetland is not easily increased. Some wetland systems may be degraded and require restoration. However the basic nature and type of wetland is not generally changed. Controlling the inflows into a system is the primary method of maintaining the balance between inflow and capacity. Human activity may affect the way a wetland functions by directly influencing the quality and quantity of inflow into a system. For example, catch basins are installed to capture stormwater surface runoff. The runoff is transported through a system of pipes, and the untreated water is often directly discharged into a stream. These systems bypass wetlands and eliminate any possibility for wetlands to treat this water. Not only do these systems eliminate effective treatment, they also put more water, more quickly into a stream than would normally get there, without allowing for infiltration and ground water recharge.

Impervious surfaces, areas where water cannot infiltrate, also contribute to the concentration of stormwater runoff and increased stream flows. In addition to decreasing infiltration capacity, overland runoff from impervious surfaces has the potential to pick up heavier concentrations of bacteria and nutrients and to transport them directly into a drainage system rather than allowing for infiltration into the ground.



Durham Meadows, Lyman Brook and Ellen Doyle Brook are examples of the importance of the type of wetland, the relationship between capacity and inflow, and the affect of stream type on water quality in both tributaries and the mainstem.

Pervious / Impervious Surface Analysis

Using soil type, land use, and land cover information, it is possible to predict areas in the watershed that have the highest potential for runoff as well as those areas with the greatest potential for infiltration and recharge.

Soil runoff classes are generated based on the slope and saturated hydraulic conductivity of a soil map unit. Slope refers to the overall steepness of the soil map unit. The saturated hydraulic conductivity is a measure of the rate of water movement in the soil. The value for saturated hydraulic conductivity assigned to a soil series is an average of its normal range throughout the area. The actual saturated hydraulic conductivity on a specific site may be influenced by land use, cover, and management. A grassy area used for seasonal parking, for example, would have a much lower hydraulic conductivity than an undisturbed woodland on the same soil.

Land use / land cover classes are divided into 3 categories of runoff potential: high, moderate, and low. A soil compaction meter was used to evaluate several land uses with grass cover. They included ball fields; high and low traffic recreational areas, abandoned areas, parking, golf courses, and cemeteries (both active and pre-1920).

The highest runoff potential is assigned to highly urbanized, commercial, and industrial areas. In addition, ball fields, picnic areas and grassed parking areas were found to be very compact at the surface. Moderate potential is assigned to most agricultural lands, most recreational areas, and low density development. Woodland is assumed to have the lowest runoff potential. In addition, abandoned areas previously used for agriculture have increased saturated conductivity with time.

A sense of the overall balance in the watershed and how much of the area remains in a pervious state can be interpreted by combining soil runoff potential with land use and land cover. This information will be most applicable for planning purposes. The potential for an area to pose a runoff hazard or to allow infiltration will also depend on its position on the landscape and adjacent soils and land uses. Site visits will be necessary to verify conditions.

Areas with low runoff potential, based on soils and land use, are providing the most protection to the Coginchaug from runoff and the greatest potential for recharge in the watershed. Some of those areas in key positions in the watershed may be considered for protection from development, enhancement for treatment, or as candidates for low impact development techniques. See map 16 for the areas that have both low potential for land use/land cover and soil. When these areas are developed, the impact on the overall watershed condition may be more significant than in less pervious locations.

In areas where the soil runoff potential is low or moderate but the land use / land cover potential is moderate or high, practices may be employed to increase the on-site infiltration. Depending on location, areas of high runoff potential may be posing a threat to overall water quality in the watershed. On-site investigations and runoff management plans are recommended.

Findings:

Runoff potential based on soil: (See Map 14)

Watershed wide, 43% of the acreage has low soil runoff potential, 43% has moderate soil runoff potential, and 13% has high soil runoff potential. An additional 1% of the acreage is made up of urban complexes which include soils with low or medium runoff potential. The primary reasons for high soil runoff potential in the watershed are shallow bedrock, steep slopes, and urbanization. Analysis area 4 has the highest soil-based runoff potential, with 32% of the area rated high, due to steep slopes and shallow soils.

Runoff potential based on land use / land cover: (See Map 15)

Watershed wide, 25% of the acreage rates high for runoff potential based on land use / land cover. Over 80% of this area is in high density residential development. An additional 20% is rated moderate (more than half occupied by low density residential development and cultivated agricultural land), and 53% low, mostly in woodland.

Based solely on land use / land cover, runoff potential steadily decreases from the mouth to the headwaters. Analysis area 1 has the highest potential due to urbanization and analysis area 2 the next highest, with a combination of residential, agricultural, and recreational land uses.

Map 14: Potential for Runoff Based on Soil Properties

Map 15: Potential for Runoff Based on Land Use/Land Cover Classification

Map 16: Potential for Runoff Based on the Combination of Soil Properties and LULC

Combined runoff potential: Soils and land use / land cover: (See Map 16)

Only a small percentage of the acreage with high soil based runoff potential is occupied by high run-off potential land uses (about 2% of the watershed) or moderate run-off potential land uses (<1%).

This is to be expected based on the steep slopes and shallow bedrock associated with most soils rated high for runoff in the watershed. An additional 15% of the watershed has a high runoff land use / land cover occupying a soil with moderate runoff potential, mostly high density residential. Of the 13,290 acres of woodland, transitional, and shrub/scrub and herbaceous areas with low runoff potential, 19% have high soil runoff potential, 35% moderate, and 46% low.

Some possible recommendations based on these findings:

- Visit areas rated high for both soils and land use and design BMP if needed.
- High density residential areas, especially those occupying areas with high and moderate soil-based runoff potential, are good candidates for street sweeping, pet waste management, new or improved stormwater management practices, and possibly low impact development stormwater management practices.
- Evaluate low density residential areas for off-site impacts. Design small practices such as rain gardens to retain more runoff on-site. In areas located on soils with high or moderate runoff potential, be sure to site and size practices so they can handle inflow.
- Evaluate areas with a high rating for land use/land cover and low rating for soils to determine if local site conditions permit use of infiltration BMPs.
- Regulations should address development of wooded areas with high runoff potential. Standards for minimizing off-site impacts should be set and enforced.
- Consider land preservation in areas where both land use / land cover and soils have low runoff potential to maintain their recharge and flood protection services.
- Incorporate low impact development practices into municipal regulations.

(Refer to Appendix D for a more detailed discussion of the pervious and impervious surfaces analysis).

Municipal Regulations Review

In Connecticut, each of the 169 municipalities develops and implements its own local land use regulations. Consequently, local land use regulations create the framework for managing growth and balancing the social and ecological needs of a community without requiring a consideration of the neighboring municipalities.

The purpose of this review is to examine the existing municipal regulations in order to identify the existing controls, policies, and plans in place to protect and enhance the natural resources in the watershed. The regulations assessed included Zoning, Inland Wetlands, and Subdivison. Because this plan concentrates on water quality, specific information was attained by developing a set of questions about the local regulations that have a direct or indirect relationship to water quality and water quantity concerns. The questions were reviewed by the Advisory Committee. Only the regulations for Durham, Middlefield, and Middletown were reviewed because together these three municipalities comprise 90.1 percent of the watershed. A regulations review for Guilford, the town with the next largest area in the watershed at 6.7 percent, was conducted in 2004 as part of a separate project.

The local municipalities can use the regulations review to consider modifications to their regulations or the establishment of new regulations in order to strengthen environmental and natural resources considerations. Recognizing that growth is likely to continue, the communities can use this review to evaluate the similarities and differences between their plans, policies, and regulations. Knowing what regulations neighboring communities have in place further enhances the understanding of the regional nature of the issues. It creates a way for towns to communicate and share ideas, thus encouraging a watershed based approach to planning across town boundaries. (Refer to Appendix E for a more detailed discussion of the municipal regulations review).

Findings

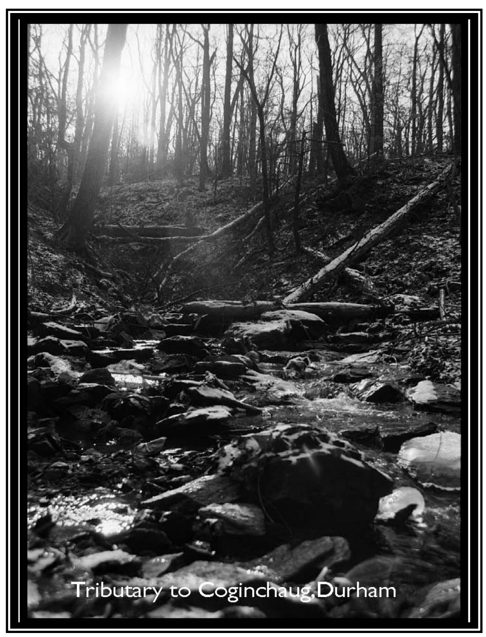
Durham, Middlefield, and Middletown have all adopted regulations that provide nominal protection and consideration of natural resources in the land use decision making process. The regulations tend to be basic and conventional in nature. For example, all three communities have incorporated standard language State model regulations to address erosion and sediment control measures. Each town uses the State model wetland regulations (though with differing setback limits), and all require the typical procedures for siting and engineering septic systems.

Some of the regulations suggest that the communities are addressing the potential impacts that development may have on water quality. Incorporation of these regulations demonstrates that the municipalities are taking additional steps to balance growth with ecological integrity. By adopting regulations that set limits on impervious surface, that include aquifer protection, and that recommend the use of retention and detention systems, the towns show recognition of the relationship between development and water quality and quantity. Similarly, each town has instituted regulations controlling stormwater runoff rates created by development.

Although the towns have embraced some regulations to manage stormwater runoff, the review revealed that there is a notable absence of regulations for more advanced protection of water quality. None of the towns, for example, recommend the use of the 2004 Connecticut Stormwater Quality Manual for the development of stormwater management plans. Nor do any regulations exist in the towns for consideration of groundwater hydrology as part of resource extraction operations.

Streamwalk

A streamwalk is a volunteer based assessment of the physical conditions of in-stream and streamside characteristics of the perennial streams within a river basin. It serves two purposes: resource evaluation through data collection and community involvement and education. The watershed was delineated into 33 survey areas (see Map 17: Streamwalk Survey Areas). The individual survey areas were selected by a trained volunteer team of two or more persons. The volunteer team was responsible for conducting the physical stream corridor assessment, gathering and recording their observations. The data gathered through the survey is a first step toward understanding the physical condition of a stream corridor. Although the streamwalk information may be used independently, using the data in


Tributary to Coginchaug, Durham

combination with other studies and analyses is often more beneficial and effective in identifying watershed areas with specific resource needs as well as potential sources of pollutant loading.

Factors or conditions evaluated in the streamwalk and considered as indicators of potential water quality concerns for a segment or stream include the presence of algae, the presence of vascular aquatic plants, areas with greater than 25% of fines (sand and silt) comprising the substrate, stream sections with a riparian buffer width on average of less than 25 feet, in-channel impoundments, and the presence of discharge pipes.

As part of the assessments, the people conducting the surveys identified and described specific areas of concern. Information about these areas was recorded on the Areas of Concern sheet that is part of the Stream Segment Survey form. Recording this information is a way to identify specific spots in the watershed that pose a potential threat to the chemical, biological, and/or physical condition of a watercourse. Such concerns include dams (or impoundments), algae growth, sediment deltas, trash, and changes to the visual conditions of the water. A query of the streamwalk database was run for each of these categories and for the Areas of Concern. (Query information is contained in Appendix F). The majority of data was collected in fall 2006.

Findings

- Only 3 of the 91 stream survey segments were noted to have algae present everywhere. Two of the three segments where algae were noted everywhere on Asmun Brook and the third was on Ellen Doyle Brook. The two stream segments on Asmun Brook identified with the presence of algae can be classified as a 2nd order, “C” stream type. The segment on Ellen Doyle Brook identified with algae can be classified as a 2nd order, “B” stream type. All three of these stream types are considered periphyton (brown algae on rock) dominated small streams. These types of stream are highly sensitive to nutrient loading, specifically nitrogen and phosphorous. Nutrient retention time in these types of streams is limited. Consequently, the presence of algae in Asmun Brook (Survey Area 4606-02-1) and Ellen Doyle Brook (Survey Area 4607-10-1) indicates that there is an ongoing loading of nutrients into the respective stream systems.

Map 17: Streamwalk Survey Areas

The presence of algae was observed in 26 additional stream segments on 11 different streams. The alga was described to be found only in spots along the segment. Seven of the 11 streams had algae observed on multiple segments. Though spotty occurrence of algae is considered normal, all of the sights may warrant further investigation, particularly the streams with multiple segments.

- Excessive growth of vascular aquatic plants (macrophytes), like that of algae, can be problematic. Fifteen segments were recorded with instances of aquatic plants observed in spots. There were no cases where plants were observed everywhere along a segment.
- Streambed materials, or substrate, have numerous direct and indirect effects on the living organisms of running waters. In some cases, a high percentage of fines can have a detrimental affect on stream biology and morphology. (For more detail on substrate materials refer to Appendix F).

Streamwalk volunteers recorded 30 segments on 11 streams with 25% or more of the substrate comprised of fines. It should be understood that the substrate for some stream types is naturally comprised of a high percentage of fines. The Coginchaug River and some of its tributaries can be classified as stream types that naturally have higher percentages of fines. These types include "E" and some times "C" stream types. In part, the 'normalcy' of the presence of a high percentage of fines is dependent on stream order. (For more information on stream type and stream order, refer to the Geomorphic Assessment section of this Plan).

Thirty segments on eleven streams were described to have greater than 25 percent of the substrate comprised of fines. Of the 30 segments, only 13 are in stream types where the presence of high levels of fines may be indicative of a water quality concern or may represent an unnatural contribution of fines to the river from overland runoff. These 13 segments should be studied more closely to determine whether or not the fines represent a potential problem. (The streamwalk data can be found in Appendix F).

- Riparian vegetation is important because it provides shading, a source of organic material, flood attenuation, nutrient cycling, overland stormwater runoff filtration, and stream bank stabilization through root structure. Twelve segments on six streams were identified to have less than an average of 25 feet of riparian vegetation on either the left or right bank. Only two of the 12 segments were recorded to have less than 25 feet of riparian buffer on both the right and left banks. The Coginchaug River and Hersig Brook were the only two watercourses to have multiple segments listed.

- A total of 36 in-channel impoundments were observed on seventeen streams in the watershed. Five of the streams had multiple impoundments, with the Coginchaug River and Ellen Doyle Brook having the most. Impoundments present potential problems for stream fisheries; they alter the natural hydrology of a stream system, and change the sediment transport regime. In certain instances, larger dams may create backwater that offers attractive habitat to wildlife, such as geese, which may contribute bacteria directly into the watercourse.

- A total of 90 discharge pipes, on 48 segments, were found in 28 streams in the watershed. All of the named watercourses were observed to have more than one discharge pipe. Discharge pipes were found on more than half of the unnamed tributaries.

Areas of Concern

The streamwalk data contains 68 specific sites identified as areas of concern. Eleven different types of concern were identified by the volunteers (see Table 7). While the areas of concern represent a potential physical, chemical, or biological problem, they may not necessarily be related, directly or indirectly, to the bacterial or nutrient issues associated with the Coginchaug River. Regardless, additional investigation of the areas of concern should be undertaken to ascertain the degree of the problem and what measures, if any, should be implemented.

Table 7: Number of Instances for Areas of Concern

Streamwalk Data: Types of Concern Found											
	Lack of Buffer	Erosion	Runoff	Channel Manipulation	Dams/ Impoundments	Invasive Plants	Outlets	Sediment	Ag Waste /Nutrients	Dead Fish	Piped
Total	13	9	2	8	26	2	12	6	1	1	2

Conclusions

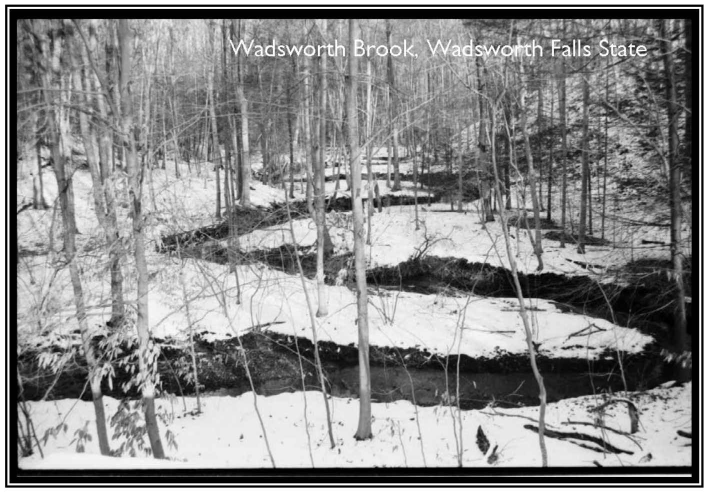
The streamwalk data represents a snapshot in time of the stream corridor conditions in the watershed. It should be understood that the ideal timeframe for data collection is between June and mid-September. This is when worst case stream conditions are most easily observed. A combination of factors, from volunteer involvement to timing of storm events, delayed data collection for the Coginchaug River streamwalk. Although the fall and winter of 2006 were milder than usual, the data may not entirely reflect conditions in the watershed as they were during the summer months. With cooler temperatures in fall/winter months the presence of either algae or vascular aquatic plants is greatly reduced or non-existent. Seasonal precipitation and local weather patterns for that time period may have affected average water width and depth. With cooler temperatures evaporation also tends to decrease, and with seasonal increases in precipitation, stream levels rise.

As a quality control measure, field spot checks were conducted by NRCS staff during 2006. Stream segments were visited and the data collected for those segments were checked. Additionally, during field work in spring 2007, algae were observed along some stream sites that were not identified in the 2006 streamwalk data. An informal follow-up field survey was conducted to determine whether or not algae were present at other locations as well. Approximately 8 sites that did not have algae noted on the stream segment survey sheets were revisited and a short section of stream observed to assess the condition. In approximately 5 of those areas algae was noted, at least in spots.

While the data collected through the streamwalk process is valuable to understanding watershed conditions and engaging local stakeholders, as a volunteer based effort there is variability and inconsistencies in the data collection process. As described above, the number of in-stream channel impoundments recorded on the stream segment survey sheets was 36. Only six of those 36 impoundments were identified as Areas of Concern. According to The Fisheries Resource Assessment of the of the Coginchaug River mainstem, conducted as part of this project, there are five major impoundments downstream of Wadsworth Falls, alone. This discrepancy in the data reinforces that fact that the streamwalk can only be considered a "first cut" assessment and further field work should be conducted to verify the extent and scope of the resource concerns and make subsequent land management decisions.

In 2005 the Connecticut River Coastal Conservation District conducted a streamwalk of the Coginchaug River mainstem. The data from these two streamwalk efforts supports the notion that a variety of potential water quality concerns exist on a range of scales. Examining this information in context and relationship to the other analyses will help to better understand the potential sources of pollution and present some potential opportunities for implementation of solutions. Despite the discrepancies, the streamwalk data provides physical locations to initiate further field investigation, in an effort to address the water quality related resource concerns within a particular drainage basin.

Level 1 Geomorphic Assessment



The objective of the NRCS Level I Geomorphic Assessment is to provide a base level classification of the fluvial network within the basin, including both stream type (Rosgen Methodology) and stream order. The base level classification then allows for the prediction of a river's behavior, based on morphological attributes, and enables the comparison and/or extrapolation of site-specific data or stream tendencies from a particular stream reach to other stream reaches with similar morphological characteristics. It should be noted that a Level 1 geomorphic assessment is derived from an investigation and analysis only of channel slope, shape and patterns. As such, the presented information is useful for broad-scale planning purposes and not site specific design. (More information about the Geomorphic Assessment is contained in Appendix G).

Findings

Stream Order

The Coginchaug River watershed exhibits a dendritic drainage pattern. Stream order is a method of classifying the hierarchy of natural channels in a watershed based on the degree of branching in this dendritic pattern. For example, a first order stream is unbranched (it has no tributaries). A second order stream is formed by the confluence of two first order streams. With approximately 98 linear miles of stream comprising the fluvial network, the drainage basin density or stream density is 2.4 mi/sq. mi. The Coginchaug River is a 5th order tributary to the Mattabesset River. The confluence of the Coginchaug River and the Mattabesset River is approximately 1.35 miles upstream of the confluence of the Mattabesset River and the Connecticut River.

The Coginchaug River becomes a 5th order stream after the confluence of Allyn Brook, a 4th order tributary. Sawmill Brook is the only 3rd order tributary in the watershed, with all other tributary streams entering the Coginchaug River being either 1st or 2nd order streams. The delineation of stream order for the entire watershed is shown on Map 18: Stream Orders.

Stream Type

Level I stream classification is a geomorphic characterization of a stream (Rosgen methodology) based on channel slope, channel shape and channel patterns. Stream types can be seen on Map 19: Stream Type. The Coginchaug River transitions primarily between a C and E stream type from it's headwaters to the confluence with the Mattabesset. There is evidence of significant stream channel modifications in many reaches, including channelization, floodplain filling and dams. As a result, the modified reaches of channel are often classified as an F stream type, such as the reach through Veterans Memorial Park in Middletown. In some cases the modified stream reaches are unclassified, such as the ¾ mile section downstream of Wadsworth falls, because the frequency of dams and associated backwater do not allow for adequate channel development.

The sections of stream identified as C stream type can be described as moderate to low gradient, slightly entrenched streams with well developed floodplains and a meandering, riffle/pool channel morphology of moderate sinuosity. Typical channel gradients for a C stream type range between 0.1% and 2%. The E stream types can be described as a low gradient stream with a well developed floodplain. Although, the E stream type is still a riffle/pool dominated channel, it tends to be more sinuous and has a lower width/depth ratio than the C stream type. Typical channel gradients for an E stream type are less than 2%. Conversely, the F stream types are both incised and entrenched with limited if any access to a floodplain. The F stream types have a homogeneous channel with a high width/depth ratio, and very low sinuosity. Typical channel gradients for an F stream type are also less than 2%.

While the above referenced stream types were observed in the tributaries, many sections of the tributaries were also classified as either an A or B stream type. An A stream type can be described as a steep, entrenched stream, with a very low sinuosity, dominated by a cascade or step/pool morphology. These are high energy streams with virtually no floodplain. Typical channel gradients for an A stream type range between 4% and 10%. The B stream type has a moderate gradient, mostly dominated by riffle, with some irregularly spaced pools. The "B" streams are moderately entrenched with access to a limited floodplain, with a typical channel gradient between 2% and 4%.

Map 18: Stream Order

Map 19: Stream Type

Fisheries Resources Assessment

The objective of the NRCS Fisheries Resources Assessment is to compile and summarize existing data on the distribution of diadromous fish species and resident stream fish in the Coginchaug River. Additional information is provided on fish migration barriers. The assessment includes only the main stem of Allyn Brook, Sawmill Brook, and the Coginchaug. Table 8 presents data gathered from the DEP stream survey report as well as data taken from the sampling efforts of Dr. Barry Chernoff and his students at Wesleyan University. Though there is not a direct correlation between the watershed's fisheries populations and pollutant loading, the health and sustainability of the watershed's aquatic organisms is connected to water quality conditions.

Diadromous Fish Data:

Diadromous fish migrate between fresh water and salt water, and include the anadromous and catadromous fish of Connecticut. Anadromous fish spend the majority of their life cycle in salt water, and then migrate from salt water to fresh water to spawn. Conversely, catadromous fish spend the majority of their life cycle in fresh water and then migrate to salt water to spawn.

The DEP has documented the presence of the American eel (Anguilla rostrata), the only catadromous fish in Connecticut, in the mainstem of the Coginchaug River. DEP has also documented the presence of the following anadromous fish in the mainstem of the Coginchaug River: American Shad (Alosa sapidissima), alewife (Alosa pseudoharengus), blueback herring (Alosa aestivalis), gizzard shad (Dorosoma cepedianum), sea lamprey (Petromyzon marinus), sea-run brown trout (Salmo trutta), and white perch (Morone americana).

Resident Fish:

In addition to the eight (8) diadromous fish species identified, the Coginchaug is also home to several resident fish species. The Connecticut DEP Inland Fisheries Division has conducted fish sampling surveys to determine species abundance and composition. Based on the 1990 report "A Survey of Connecticut Streams and Rivers – Connecticut River Tributaries, Scantic River, Mattabesset River, Salmon River, Coginchaug River and Eightmile River Drainages", two surveys were conducted on the mainstem of the Coginchaug River, one on Allyn Brook, and two on Sawmill Brook. The accuracy of the fisheries data is based on the accuracy of the stream sampling conducted by the CT Department of Environmental Protection –Inland Fisheries Division, and the sampling conducted by Dr. Chernoff and his students. No additional sampling was conducted to verify the published results.

The first fish sampling site on the mainstem of the Coginchaug River, site number 1093, is located just off of Fisher Road in the town of Middletown. The survey (492 foot sample length) documented the presence of thirteen different fish species, with American eel, redbreast sunfish, bluegill and rock bass being the most abundant. The second site on the Coginchaug River, site number 1044, is located at the lower Wadsworth Falls State Park, in the town of Middletown. The survey (150 meter sample length) documented the presence of thirteen different fish species, with the American eel and longnose dace being the most abundant.

On Allyn Brook, just downstream of Route 17 in the town of Durham is site number 1046 in the CT DEP survey. The survey (328 foot sample length) documented the presence of eleven different fish species, with the tessellated darter and common shiner being the most prevalent.

Two surveys were conducted on Sawmill Brook, one in Durham and the other in Middletown. The survey area in Durham (site number 1045), located just below Trimountain Brook Road, had a sample length of 164 feet and documented the presence of seven different fish species, with white sucker being the most abundant. The survey area in Middletown (site number 1043) is located along Bell Street. The survey (328 foot sample length) documented the presence of nine different fish species with common shiner and fallfish being the most abundant. See Table 8 for details.

Table 8: DEP and Wesleyan Fisheries Assessment

Sample Site:	Coginchaug River DEP Site #1093		Coginchaug River DEP Site #1044		Allyn Brook DEP Site #1046		Sawmill Brook DEP Site #1043		Sawmill Brook DEP Site #1045	
Fish Species:	**Presence**	**Est. Pop.**	**Presence**	**Est. Pop.**	**Presence**	**Est. Pop.**	**Presence**	**Est. Pop.**	**Presence**	**Est. Pop.**
American Eel (*Anguill rostrata*)	Y	144	Y	423	Y	9	Y	10		
American Shad (*Alosa sapidissima*)	Y	12								
blugill (*lepomis macroshirus*)	Y	56	Y	8	Y	2	Y	2	Y	13
blacknose dace (*Rhinichthys atratulus*)			Y	24	Y	69	Y	33		
brook trout (*Salvelinus fontinalis*)			Y	3	Y	3				
brown bullhead (*Ameiurus nebulosus*)									Y	4
brown trout (*Slamo trutta*)	Y	1	Y	4	Y	1				
common shiner (*Notropis cornutus*)					Y	143	Y	91	Y	3
fallfish (*Semotius corporalis*)	Y	7	Y	42	Y	92	Y	73	Y	15
largemouth bass (*Micopterus salmoides*)	Y	4	Y	3			Y	5	Y	3
longnose dace (*Rhinichthys cataractae*)			Y	361			Y	5		
pumpkinseed (*Lepomis gibbosus*)	Y	6	Y	23	Y	2			Y	4
rainbow trout (*Oncorhychus mykiss*)			Y	35						
redfin pickerel (*Esox americanus*)					Y	34				
rock bass (*Ambloplites rupestris*)	Y	38								
redbreast sunfish (*Lepomis auritus*)	Y	68	Y	35						
sea lamprey (*Petromyzon marinus*)	Y	9								
tessellated darter (*Etheostoma olmstedi*)	Y	5	Y	43	Y	341	Y	9		
white sucker (*Catastomuss commersoni*)	Y	10	Y	6	Y	82	Y	34	Y	41
yellow perch (*Pera flavescens*)	Y	1								

The Chernoff Lab at Wesleyan University has taken fish samples using single pass electroshock sampling methods at three sites on the Coginchaug River. This information it summarized in Table 9. Sampling is typically done monthly, from May/June to October/November, and was on done at CR from 2004-2007; at LCR from 2005-2007 and at the mouth from 2004-2007.

Two of these sites – CR (upper Coginchaug) and LCR (lower Coginchaug, but not the mouth) have also been sampled for benthic macroinvertebrates (please see site information in Benthic Macroinvertebrate section).

Table 9: Presence/absence of fish species at three sites on the Coginchaug

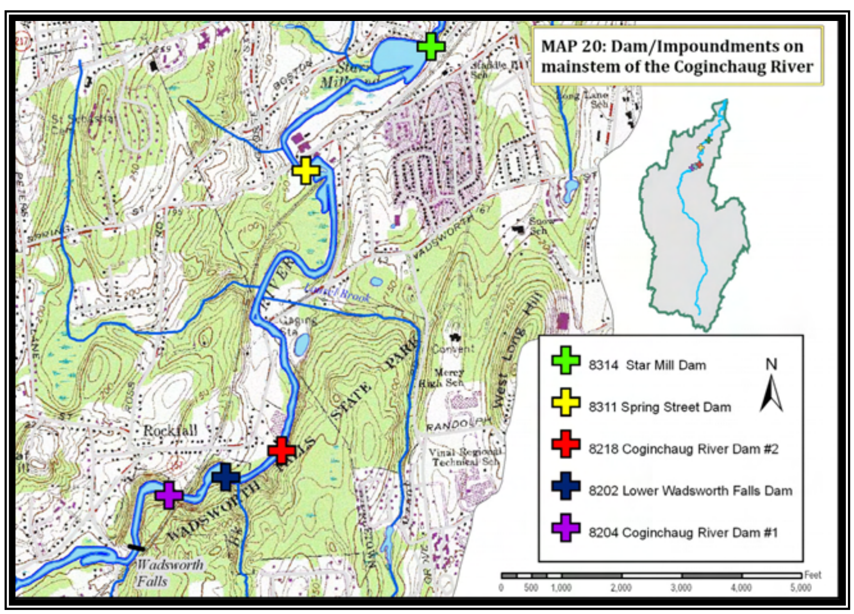
Fish species presence/absence 2006-2007			
Species	**CR UPPER**	**LCR CEMETARY**	**LCR MOUTH**
Petromyzon marinus		X	X
Anguilla rostrata	X	X	X
Salmo trutta	X		
Salvelinus fontinalis	X		
Alosa aestivalis			X
Alsoa psuedoharengus			X
Cyprinus carpio			X
Erimyzon oblongatus	X		
Luxilus cornutus	X		
Notemigonus chrysoleucas	X		X
Notropis hudsonius			X
Rhinichthys atratulus	X		
Rhinichthys cataractae	X		
Semotilus atromaculatus	X	X	
Semotilus corporalis	X		
Catostomus commersoni	X	X	X
Ictalurus nebulosus			X
Esox lucius			X
Esox niger	X		X
Umbra limi			X
Fundulus diaphanus	X		X
Apeltes quadricus		X	X
Morone saxatilis			X
Lepomis auritus		X	X
Ambloplites rupestris		X	X
Lepomis gibbosus	X	X	X
Lepomis macrochirus	X		X
Micropterus salmoides		X	X
Pomoxis nigromaculatus			X
Etheostoma olmsteadi	X	X	X
Perca flavescens	X	X	X
total species	**17**	**11**	**23**

Conclusions:

- The LCR site is species poor. Except for eels, the total for all species is less than 20 individuals per species, and many, such as rock bass, large-mouth bass, red-breast sunfish and lamprey are known only from 1 or 2 individuals.
- Most species at LCR have only been seen in recently, from above or below the heavily silted riffle where macroinvertebrate sampling is done.
- CR and the mouth are consistently species rich.

In addition, a rapid assessment of existing fish migration barriers (dams and impoundments) within the historic range of anadromous fish is presented. Along with presenting a migration barrier, impoundments present potential problems for stream fisheries. They alter the natural hydrology of a stream system, and change the sediment transport regime. In certain instances, larger dams may create backwater that offers attractive habitat to wildlife, such as geese, which may contribute bacteria directly into the watercourse. (More information about the Fisheries Assessment is in Appendix H)

<u>Dam/Impoundment Assessment</u>



Five major dams were identified on the mainstem of the Coginchaug River. (**See Map 20**). Each of these dams presents a barrier to upstream anadromous fish passage. It should be noted that approximately 2.41 miles upstream from the confluence with the Mattabesset is a natural bedrock outcrop that has the potential to impede the upstream migration of some fish under certain flow conditions. Because this bedrock outcrop is only an impediment under certain flow conditions, it should not be considered a barrier.

Wadsworth Falls is a natural barrier to the upstream migration of anadromous fish, and therefore the limit to the historic range of anadromous fish within the Coginchaug River. It should be noted that the falls is not a barrier to American eel, as they are found within the watershed upstream of the falls. The falls are roughly 45 feet high and are located about six (6) miles upstream of the confluence of the Coginchaug River with the Mattabessett River. The site is just downstream of Cherry Hill Road in the town of Middlefield.

Below is a brief inventory of the five dams located downstream from Wadsworth Falls. Details regarding hazard class, dam size, construction materials, and options for fish passage can be found in Table 10.

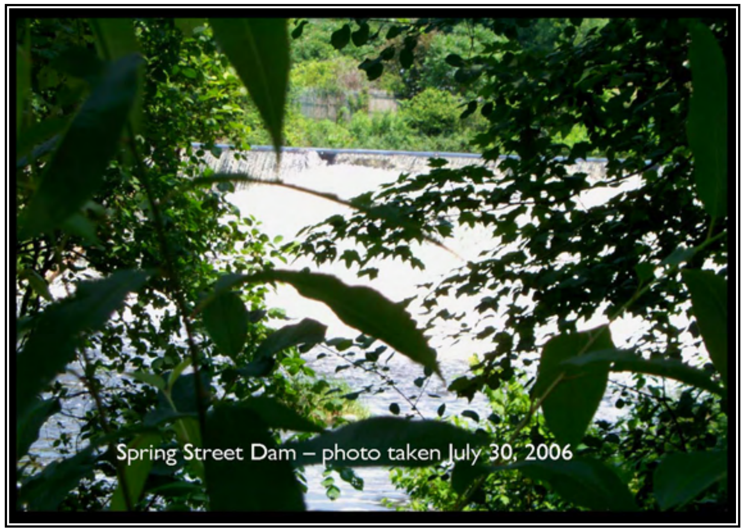
Table 10: Dam and Impoundment Assessment

Dam Name	DEP Database #	Hazard Class	Construction Materials	Weir Crest Height (ft)	Weir Crest Width (ft)	Fish Passage Options
Starmill Pond Dam	8134	BB	cut stone and concrete	9	98.4	Denil Fishway (Alaskan Steeppass)
Spring Street Dam	8311	BB	cut stone and concrete	13	111.5	Denil Fishway (Alaskan Steeppass)
Coginchaug Dam #2	8218	A	stone and concrete	7.5	113.2	Removal of dam; construction of rock ramp
Lower Wadsworth Falls Dam	8202	B	cut stone and concrete	7.5	85.3	Fish Bypass Channel
Coginchaug Dam #1	8204	B	cut stone and concrete	13	109.9	Denil Fishway (Alaskan Steeppass)

The Starmill Pond Dam is a run-of-river dam located in the Town of Middletown approximately 3.18 miles upstream (measured along the centerline of the channel) from the confluence of the Coginchaug River with the Mattabessett River. The dam is currently the upstream migratory barrier for all of the above listed anadromous fish. Electrofishing studies conduced by DEP indicate that at least a portion of the American eel run is able to pass the Starmill Pond Dam, as well as numerous other upstream barriers. The concrete cap is in disrepair, as are the millworks on the left abutment. The sediment-filled eutrophic impoundment upstream of the dam provides good spawning habitat for alewife. A small portion of the pond could be considered marginal spawning habitat for American shad, gizzard shad and white perch.


Starmill Pond Dam – photo taken June 30, 2006

Spring Street Dam, the next upstream barrier, is located immediately upstream of Marszalek Park, a small open space are in the Town of Middletown, just south of Spring Street. This is approximately 0.77 miles upstream of Starmill Pond Dam. NRCS was unable to obtain safe access to the site, and therefore the dam was viewed at a distance, and all measurements are estimates. Under current conditions, access to this run-of-river dam is extremely limited; however, an access road from Marszalek Park could be constructed to facilitate the installation of a fishway. There is a sediment-filled eutrophic impoundment upstream of the dam.


Spring Street Dam – photo taken July 30, 2006

Located approximately 1.28 miles upstream from the Spring Street Dam, in the town of Middlefield, is another run-of-river dam, identified in the DEP dam inventory as "Coginchaug Dam #2". The site can be accessed through an industrial


Coginchaug Dam #2 – photo taken June 30, 2006

site located immediately adjacent to the stream on the western streambank. The impoundment behind the dam is sediment filled and provides limited habitat for the targeted species.

The next barrier is located approximately 0.22 miles upstream of Coginchaug Dam #2. This run-of-river dam, identified in the DEP dam inventory as "Lower Wadsworth Falls Dam", is a sediment filled eutrophic impoundment that could provide favorable spawning habitat for alewife. Although access to the site is limited, and would be through private property, the construction of a fish bypass channel is possible through both the left and right earthen abutments.


Lower Wadsworth Falls Dam – photo taken June 30, 2006

The fifth and final barrier, preventing the upstream migration of anadromous fish to the base of Wadsworth Falls, is located approximately 0.25 miles upstream of the Lower Wadsworth Falls Dam. Identified in the DEP dam inventory as "Coginchaug Dam #1", this run-of-river dam has an old mill building on the left abutment, which appears to have been converted to a residential dwelling. The eutrophic impoundment has extensive sediment deposits, some of which extend above the elevation of the weir crest allowing for the establishment of emergent vegetation.


Coginchaug Dam #1 – photo taken July 6, 2006

DISCUSSION OF WATERSHED COMPONENTS - THINGS TO KEEP IN MIND

The following section outlines the value of the various analyses. It also describes some of the obstacles and challenges faced in the use of the analyses, as well as suggestions for modifications that may improve the utility of the specific analysis.

Detailed Land Use/Land Cover

The creation of a current, detailed land use/ land cover is highly recommended for the development of a watershed based plan. A detailed land use/land cover provides planners and stakeholders with an up-to-date picture of the existing landscape. In a GIS, one can quantify and query the existing landscape mosaic, which may help planners and stakeholders to make informed decisions about land management techniques to address current conditions.

Several challenges may exist when creating a LULC. First, it must be determined if contemporary imagery at an appropriate scale is available. In some instances the only available imagery may be several years old, it may be an incomplete data set, or it may be at a scale that does not allow for the creation of a detailed LULC classification. If the imagery is deficient for some reason, it needs to be determined whether it is worthwhile using the imagery to create a LULC map.

In most instances, imagery needs to be purchased. A cost-benefit ratio needs to be established for the acquisition of the imagery. Depending on financial resources and budget limitations, it may not be possible to acquire useful imagery. If imagery is available and can be obtained, the land classification needs to be done by someone skilled in interpreting imagery and classifying land use and land cover types.

A classification system must be developed and agreed upon prior to classifying the land use and land cover types. Preliminary research on classification systems should be conducted. A decision must also be reached on how best to handle changing LULC conditions. It is likely that some land use and land cover types will change by the time the classification is completed. It is a recommendation of this study that the classification should be based on the year the imagery was taken. Changes on the land that occur during the classification should not be integrated. By following this process the inconsistency from mixing LULC classifications from different time periods is eliminated. Site specific investigation is part of the process of BMP implementation. Should a land use or land cover change be found, modifications can be made to ensure the implementation of the most appropriate BMP.

Similarly, the classification of agricultural land can be problematic. At different times of a year farm fields may be used for different purposes. For example, during part of a year a field may be planted with a crop, and once harvested, the field may be left uncultivated for the remainder of the year. Classification will be based on the use of the field at the time the imagery was taken; consequently, it is important to work with agricultural producers to learn in what capacity, or capacities, the land is used. A protocol should be developed for deciding what land use/land cover will be selected for agricultural land that has multiple or changing uses. Classifying the land based on the use or cover type that poses a greater potential impact on water quality will enhance the ability of planners to make decisions to select suitable BMPs.

Field verification ("ground truthing" the classification) is an essential element to the process. In this study, as outlined in Appendix A, five percent of the total number of LULC polygons were field verified. This enabled us to determine the accuracy of the classification, and to evaluate what modifications, if any, were necessary to make. Supplementing the "ground truthing" was a critical review of a draft version of the LULC by the Advisory Committee. Advisory Committee members were able to revise land use and land cover types that were either misclassified or were undetermined.

During the development of this Plan it was determined that use of parcel data should be avoided. By doing so the potential for targeting individual property owners is minimized. Ownership does not directly affect the land use/land cover determination. This information is far less useful, and potentially more intrusive, than the town's zoning information. A comprehensive and current zoning layer will provide information to determine what uses are allowed and what uses are most likely to be found on the land

Wetlands Evaluation

The wetland evaluation was originally intended to assess the existing ability of the wetlands within the watershed to function as a filtration mechanism. Early in the process of developing the rating system, it was decided that for purposes of replicability and ease, it would not be feasible to evaluate each individual wetland. As a result, the wetland rating is general in nature and gives a broad sense of the level of stress wetland complexes might be under, as well as the degree to which the wetland is capable of filtering potential NPS pollutants. In its current form, the rating system has limited functionality. It provides a simplified picture of local watersheds based upon the ability of the contained wetland complexes to potentially act as natural filters.

In working to create a replicable process, no field verification or "ground truthing" was conducted. The rating exercise and findings, in some cases, may present a different picture than what is occurring in the field. The rating system as developed does not look at the spatial relationship between the wetland complexes and perennial water and/or land uses. It just examines the gross acres of wetland and gross acreage of the local basin. Modifying the rating system to evaluate the spatial relationships would strengthen its usefulness.

Municipal Regulations Review

The municipal regulations review is a useful tool for offering insight about what is and what is not currently being regulated in a town. Many commission members and others involved in the land planning decision making process may be familiar with certain regulations, but not with all regulations. The regulations review compiles the solicited information into a concise table that makes for easy reference and serves as a quick guide. This helps decision makers evaluate how regulations may be modified or what additional regulations may need to be adopted so that the regulations themselves can serve as a BMP or advance the implementation of other BMPs.

If the review is being conducted for multiple towns, an additional benefit is that the review facilitates a better understanding of regional approaches to a variety of environmental considerations. Municipalities can use the document to assess ways to create more regional consistency through regulations. Similarly, towns may compare regulations and use a neighboring town's regulation as a model to adopt or as an example of how to modify an existing regulation.

Some factors will strengthen the development of the review and enhance the use of the document. A set of specific questions related to the particular issue under consideration should be developed early on in the process. Though there are many local regulations associated with environmental considerations, the questions should be focused and have a discernable relationship to the issue. A good way to develop the questions is to work with a variety of people who are involved in the municipal regulatory process. These people might include professional staff (DPW, Planning Department, DPH, etc…), commission members, and local stakeholders. Bringing together a diverse group of people will add perspective and depth to the questions being asked.

The review should provide clear definitions and explanations of the regulations and the language that is being used. For example, if the terms setback and buffer are being used interchangeably that needs to be made evident in order to avoid any potential misunderstandings. Though the table offers a concise format, a narrative summarizing the findings and presenting some basic analysis improves the usefulness of the review and decreases the potential ambiguity some may associate with the table.

Streamwalk

Conducting a streamwalk is an effective way to increase public awareness and understanding of water resources and the relationship between water resources and human activity. Involving local stakeholders as data collection volunteers is a good way to acquaint or reacquaint people with the natural resources in their watershed and collect large amounts of data in a short timeframe.

Using a local entity to coordinate and organize the streamwalk, and recruit volunteers is most effective. Organization should begin early in the process. It takes time to produce the materials needed for data collection, advertise the program, and recruit volunteers. A database should be used, preferably one that can be easily linked to a GIS. In conjunction with this, a method for identifying survey areas should be instituted. This will facilitate integration of the collected data with other data.

During the organization and coordination effort, a decision should be made about the data that is important to collect, how it will be used, and how the streamwalk information will be tied to the other data being used for the study. The generic data collection survey sheets are designed to gather a broad range of information. They may need to be modified to meet the specific needs of the program, or during the training session volunteers can be instructed to pay more attention to certain aspects of data collection than to others.

It should be understood that the streamwalk data collection process has some subjectivity built into it. Volunteers have varied experience and knowledge. The data collection sheets are general in nature in order to capture a lot of information in a basic format. Training is condensed into a half day session. Discrepancies between volunteer collected data and other data sources may arise. While problematic in one sense, it also highlights some of the opportunities for further site investigation, more education and outreach, and deeper analysis.

Geomorphic Assessment

The geomorphic assessment was designed to determine what value characterizing stream order and stream type might provide in assessing water quality conditions. Stream order provides basic information about the physical order of the stream network. There may be some value in giving a higher priority to lower order streams (first order and headwater streams) when installing BMP's. Protecting lower order streams decreases potential downstream pollutant loading.

Stream type was found to be useful when evaluating the streamwalk data. The general characteristics of stream type may help to put the streamwalk data into context. For example, stream segments with a high percentage of fines reported in the substrate may not be problematic if the stream type typically has finer substrate materials. Someone trained in geomorphic assessment is required in order to incorporate this data into a watershed based plan. Establishing a methodology for linking the data to a GIS is beneficial because the data can be cross-queried and analyzed in conjunction with other data sources.

Fisheries information offers insight into a segment of a watershed's biological community. Depending on the presence or absence of species it may be possible to draw some conclusions about the connection between water quality and the watershed's fisheries. However, there is not necessarily a direct relationship between water quality and fisheries. Fisheries data may not be relevant for a given study.

The value of fisheries data will also be dependent on the age of the data. Old data may not reflect current populations. In fact, it may misrepresent the existing conditions in the watershed. Caution should be used if using older information. If current information is not available the cost and time associated with collecting data needs to be considered.

BEST MANAGEMENT PRACTICES

Objective

As described above, the watershed analyses were conducted on two levels – watershed-wide and place-based. The intent of providing recommendations on a watershed-wide basis is to offer basic measures that can be implemented relatively easily anywhere within the Coginchaug River basin. Given the complexity of the landscape in the watershed, a variety of watershed-wide BMPs are considered suitable for implementation on a watershed wide basis. While not focused on specific locations that may be more direct contributors to water quality concerns, these measures, when put into place, will help to control inputs from stormwater runoff and minimize potential site specific and cumulative impacts within the basin. Along with addressing possible bacterial concerns, these practices may help to reduce the non-point source pollution contributions of nitrogen entering the stream system. Reducing nitrogen loads in the Coginchaug River will, in turn, decrease the pollutant loading of the Connecticut River and assist in achieving the nitrogen TMDL established for the Long Island Sound.

Place-based BMPs are site specific practices that may include one or more options and may work in conjunction with watershed-wide practices. These sites were selected based on a combination of factors: land use/land cover, proximity to a waterbody or watercourse, water quality data at or near the location, and recommendations from the Advisory Committee. Based on available information these sites appeared to have the highest potential for contributing to bacterial loading. Additional investigation should be conducted for each site to determine the most suitable BMP or BMPs for those specific sites. Place based BMPs under consideration include wetland creation/enhancement, UV filtration, buffer enhancement/creation (tree/shrub establishment), settling basin installation, catch basin filters, structural stormwater management practices (e.g. filtration, infiltration, runoff control, ponds, wetlands, manufactured technical devices, etc…), Low Impact Development techniques (e.g. rain gardens, porous pavement, infiltration swales, etc…), property purchase, septic system maintenance/repair, goose/water fowl management, and dog waste management systems and education.

Cost estimates for BMPs are required in 319 watershed based plans. NRCS developed cost estimates for each place-based BMP recommendation that specifically addresses bacteria. The cost estimates also help local stakeholder evaluate the financial resources necessary to install and maintain recommended BMPs. Below is an explanation of the methods used to develop the cost estimates.

Structural Stormwater BMPs:


Coginchaug River at Miller Road

The cost estimates for structural BMPs are made up of two basic parts: the cost of the BMP itself and the operation and maintenance (O&M) cost for the BMP. In order to compare BMPs, the cost of the BMP was capitalized over its lifespan at an interest rate of 7% (resulting in $/year). The capitalized cost is added to the annual O&M cost to obtain the total annual cost of the BMP. The lifespan of the BMP for this study is what may reasonably be expected with adequate maintenance and is within the range of the "Effective Life" listed by the U.S. Federal Highway Administration (FHWA) (Shoemaker et al., 2002, Table 5). The cost of the BMP includes the construction cost, design, permitting, and other contingency costs. In the cost tables developed by NRCS, the cost for design, permitting, and other contingency costs are calculated as percentage of the total construction cost. In most cases this amount is 25 percent. The percentage for manufactured devices was lower because some of the design has already been completed. These costs are in 2006 dollars and are exclusive of land costs. General cost estimates for stormwater retrofits are not included since the costs are site specific.

Most construction costs were obtained by comparing several different references (such as R.S. Means). Meriden, CT was the locality for each estimate, as this is the city closest to the Coginchaug River watershed. The construction costs for the structural stormwater BMPs were typically dependent on the water volume or watershed area. All dollar amounts were adjusted to 2006 dollars. . The references include several different sources within U.S.EPA documents (U.S.EPA, 2004 & U.S.EPA, 1999) and the on-line Menu of BMPs (U.S.EPA, 2007), the U.S. FHWA (Shoemaker et al., 2002), and the University of New Hampshire Stormwater Center 2005 Data

Report. Some construction costs were obtained from manufacturers estimates and/or using *RSMeans Building Construction Cost Data 2006*. Annual O&M costs were calculated as a percentage of the construction cost. The percentage was taken from within the ranges listed by the U.S.EPA.

Catch basin (CB) Inserts, Street Sweeping, and UV Treatment

CB inserts that target bacteria and street sweeping cost estimates use the same basic method described above. The general cost estimates are done on a per unit basis (per each and per curb mile, respectively. The cost estimates for the UV filtration treatment were based on a per unit cost relative to the expected outflow of the targeted waterbody.

Buffers, Agricultural Practices, and other source control and management practices

The cost estimates for buffers, agricultural practices and other source control and management practices are on a total cost per unit basis. The cost estimates for buffers, agricultural practices, and wetland restoration came from Connecticut NRCS in-house cost data based on practices done through NRCS programs.

Overall Efficiencies of BMPs

The overall possible efficiency of the recommended place-based and watershed wide BMPs has been estimated for each Analysis Area. By estimating BMP efficiencies, the potential reduction of bacterial loads to the Coginchaug River was determined. This information provides a sense of the effectiveness of implementing the various BMPs. The percent contribution of different sources was estimated within each Analysis Area and then used to weight the efficiencies of the applicable BMPs within that Analysis Area. Finally, the load reductions set forth in the Mattabesset TMDL have been compared to the expected potential reductions at each monitoring point.

Estimated Efficiencies of Place-Based BMPs

The tables below summarize the efficiencies of the BMPs. In all cases, the efficiencies of the BMPs represent best-case scenarios. Table # shows, by Analysis Area, the percent contribution of each site identified as a potential source of pollutant loading, the efficiency of the place-based BMP or BMPs for that site, and the weighted efficiency of the BMP(s). The weighed efficiency is the calculation of the percent contribution multiplied by the efficiency of the treatment BMP.

The total efficiency of the place-based BMPs in each analysis area assumes that all of the place-based BMPs identified in Table 11 are implemented; that they are as efficient as indicated; and that the sources are contributing at the estimated levels.

Table 11: Place-Based BMP's

Place-based BMP	% Contribution	BMP Efficiency	Weighted Efficiency	Remarks
ANALYSIS AREA 1				
Veteran's Park Snow Pile	5 %	90%	4.5%	Catch basin inserts targeting bacteria, bioretention basin, or manufactured biofilter
Ross Road - Small Ag.	25%	75%	18.75	Nutrient management
Wadsworth SP – Along Laurel Brook	20%	75%	15%	Pet waste management and buffers
Wadsworth SP – Water in pond	40%	90%	36%	UV treatment, bioretention basin or manufactured biofilter
Route 66 Commercial Districts	10%	70%	7%	Regular sweeping, low impact development practices, catch basin maintenance
		Total Efficiency:	**81.3%**	
ANALYSIS AREA 2				
Lake Beseck - Street Sweeping/Catch Basins	50%	60%	30%	Street sweeping/catch basin inserts, low impact development practices & pet waste brochures/program
Triangle A Farm	25%	75%	18.75%	Nutrient management
Lyman's Orchard	25%	90%	22.5%	Apple Barrel pond – biofilters or media filters targeting bacteria @ outlet, buffer upstream ponds
		Total Efficiency:	**71.3%**	
ANALYSIS AREA 3				
White's Farm	25%	75%	18.75%	Pet waste management/education
Deerfield Farm	15%	75%	11.25%	Nutrient Management
Greenbacker's Farm	60%	90%	54%	Buffers, fencing and wetland establishment
		Total Efficiency:	**84%**	
ANALYSIS AREA 4				
Animal waste management (all farms)	60%	75%	45%	Nutrient Management
Wimler's Farm	40%	88%	35%	Nutrient management, fencing, buffer & land purchase
		Total Efficiency:	**80%**	

Estimated Contribution of Additional Sources of Bacterial Loading

Based on the calculations in Table 11, the total efficiency of the place-based BMPs for each analysis area is sufficient to meet the goals established by the TMDL. However, it was estimated that the sources which could be addressed with place-based BMPs contribute only 60% of the total pollutant loading for each of the Analysis Areas. The remaining 40% of pollutant loading is presumed to come from a variety of non-point sources. The following is a list of these additional potential sources of bacteria:

- Residue, sediment, and waste on streets
- Material in catch basins
- Pet waste
- Small agriculture
- Failed septic/ illicit discharge
- Sources not treated by buffers
- Wildlife/others

The estimation of contribution from each of these sources accounted for the fact that there may be some overlap between and among sources, (e.g. pet waste may contribute to street sweeping/ catch basin sources). Also, place–based sources were not included in the estimated contribution of any other sources. For example, the contribution attributed to wildlife sources does not include the potential contribution from resident geese as they were identified in place-based recommendations. The estimates of contribution were calculated as a percentage of the bacterial load in each Analysis Area, and are shown in Table 13.

<u>Basis for Estimates of the Contribution from Non-point Sources</u>

- The contribution of street and catch basin sources was based on the amount of developed acres in each Analysis Area as determined in Table 6: Level 1 Watershed Land use/Land Cover Summary. AA-2 estimation for street and catch basin sources was lowered by 1% because the Lake Beseck area is addressed in the place-based sources.
- The pet waste contribution was based on the number of town-licensed dogs in each Analysis Area. Table 11: Number of Licensed Dogs shows the proportionate number of dogs from each town, in each Analysis Area.
- The contribution from small agricultural enterprises was estimated based on the amount of agricultural land identified in Table 6, the types of operations shown in Map 22, and the number of small agricultural operations shown on the maps of each Analysis Area (Maps 25-28). This estimate was modified because of those agricultural operations which were

already specifically identified for place-based BMP's. The following potential sources are included in the small agriculture contributions: horse farms, sheep farm(s), and chicken farm(s) (the latter in AA-4).

- The estimate contribution from failed septic/illicit discharge was based on the number of acres mapped as "residential areas of potential septic failure" (See Map 23). The method for delineating these areas is described in the Soil potential for subsurface sewage disposal systems section of the Analysis Area 1 report. The number of acres of which could potentially be contributing bacteria is identified in the place-based section of each Analysis Area. These areas are also shown on the corresponding Analysis Area Map. The City of Middletown has sanitary sewer systems. Consequently, there are neighborhoods in Analysis Area 1 which are not mapped as potential contributors, so the potential for septic failures in AA-1 has been lowered. However, since AA-1 is highly developed, the potential for illicit discharges is increased and the total estimate for this source was increased by 1%.
- The estimated contribution from sources not treated by buffers was based on the linear feet of un-buffered stream, as identified in the place-based BMP recommendations for each Analysis Area. The method for delineating these areas is described in the Buffer implementation sites section of the AA-1 report.

Each of these types of non-point sources has had recommendations developed and described in the Watershed Wide BMP section of the report. As seen in Table 12, the treatment of the non-point sources is considerably less efficient at reducing bacterial loading then BMPs which are place-based.

Table 12: Estimated Efficiencies of Watershed–Wide BMPs

Estimated Efficiencies of Watershed-Wide BMPs		
BMP	**Efficiency**	**Reference**
Street Sweeping/ Catch Basin Cleanout	70%	Watershed Protection Techniques Vol. 3 No. 1 - April 1999 by Center for Watershed Protection
Pet Waste Pickup	50%	Watershed Protection Techniques Vol. 3 No. 1 - April 1999 by Center for Watershed Protection 66% comply, and it is 75% effective (animal waste management)
Small Agriculture Animal Waste Management	60%	Virginia DEQ Guidance Manual for TMDL plans
Elimination of Septic System Failures/Illicit Discharges	90%	
Sources that could be Treated by Buffers	50%	Virginia DEQ Guidance Manual for TMDL plans
Wildlife/ Other *	0 %	
* Since most of the goose issues were covered as place-based BMP's, they are not considered under wildlife. Other kinds of wildlife are contributing bacteria to the watershed, especially beaver, but no management practices were considered for them so the efficiency of wildlife BMP is 0%. This estimate also includes other, unknown, sources of bacteria.		

Consequently, as shown in Table 13, the overall BMP efficiency for each Analysis Area is substantially decreased when the weighted efficiency of both the place-based and the non-point sources are considered. The efficiency of treatment for the areas draining to monitoring points 428, 414, 28, and 429 are at levels below or just meeting the target goals established by the TMDL. (See Table 14). Monitoring point 419 is the only location where BMP efficiencies exceed the stated goal.

Table 13: Contribution and Efficiency of All BMPs, by Analysis Area

BMP Type	**% Contribution**				**BMP % Efficiency**				**Proportional Efficiency**			
	Analysis Area				**Analysis Area**				**Analysis Area**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Place Based Sources	60	60	60	60	81	71	84	80	48.6	42.6	50.4	48
Street Sweeping / Catch Basin Sources	12.5	9.5	8	4	70	70	70	70	8.75	6.65	5.6	2.8
Pet Waste	7	5,5	6.5	5	50	50	50	50	3.5	2.75	3.25	2.5
Small Agriculture	3.5	2.5	6	7.5	60	60	60	60	2.1	1.5	3.6	4.5
Failed Septic/ Illicit Discharge	2	10	5	5	90	90	90	90	1.8	9	4.5	4.5
Sources that Could be Treated by Buffers	5	5.5	4.5	5.5	50	50	50	50	2.5	2.75	2.25	2.75
Wildlife	10	7	10	13	0	0	0	0	0	0	0	0
Total	**100%**	**100%**	**100%**	**100%**					**67%**	**65%**	**70%**	**65%**

The estimations of BMP efficiency are based on local site conditions and existing studies of BMP efficiencies. Inherent in each of these estimates is a range of efficiency. As a result, a margin of error should be associated with the potential efficiencies presented in this report. The margin of error may range from plus or minus 10 percent to as much as plus or minus 50 percent. The total percent reduction that may be potentially achieved is also based on a weighted calculation. The TMDL goals for percent reduction are based upon the upstream contribution to the monitoring points. The total percent reduction potentially achieved for each monitoring point, as shown in Table 14, has been weighted based on the acreage of the contributing areas.

Table 14: TMDL goals for Reduction of Bacteria and the Total Reduction Potentially Achieved

Monitoring Data		TMDL Goal: Percent Reduction	Contributing Area(s)	Contributing Area (acres)	Total % Reduction Potentially Achieved *
Point #	Location				
428	At Creamery Rd.	84 %	AA-4	2,835.63	65 %
419	Downstream Miller Rd.	62 %	AA-3&4	15,887.23	69 %
414	Above Wadsworth Falls	69 %	AA-2,3,&4	20,625.92	68 %
28	Downstream Rt. 66	79 %	AA-1to rt66 &2,3&4	23,827.63	68 %
429	Veterans Park	68 %	AA-1,2,3&4	24,927.63	68 %

* Based on Analysis Area Percent Reduction & Contributing Acres

The best way to determine the efficiencies of the implemented BMPs and the total percent reduction achieved is to establish a monitoring program. Data would be collected pre- and post-implementation. This would allow people to assess the effectiveness of the individual BMPs and to evaluate the overall impact on bacterial loading to the Coginchaug River. Based on the findings, modifications could be made to the BMPs to more aptly address pollutant loading concerns, and the TMDL could be revised as deemed necessary

WATERSHED WIDE BMP RECOMMENDATIONS

Listed below are the watershed wide BMP recommendations. (Refer to Appendix I for a table outlining the costs associated with the watershed wide practices).

Vacuum-assisted street sweeping:

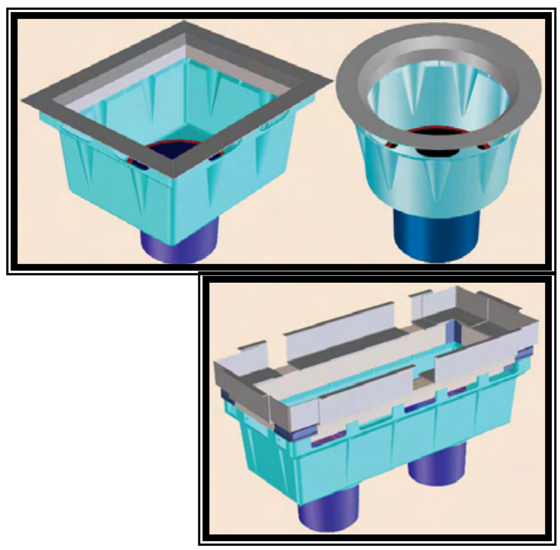
Old-fashioned street sweeper

We recommend conducting regular street sweeping. Street sweeping reduces the potential loading of sediment and debris into waterbodies, as well as any associated pollutants that may be adsorbed or absorbed by the sediments. While the efficiency of street sweeping has been debated and differing results have been achieved through various simulation models, any removal of sediment load and potential associated pollutants is better than leaving the sediment in the streets. According to Sartor and Gaboury (1984) (cited from USGS publication, The Potential Effects of Structural Controls and Street Sweeping on Stormwater Loads to the Lower Charles River, Massachusetts, Water Resources Investigation Report 02-4220, Zarriello, Breault, Weiskell) on average one kilogram of street dirt contains 3 million colony forming units (CFU) of fecal coliform bacteria. Furthermore, the USGS report indicates that the majority of fecal coliform bacteria load originates from residential streets as opposed to industrial or commercial. Vacuum-assisted street sweeping offers an alternative method for stormwater management to areas that may have limitations for the installation of structural practices to control stormwater runoff. Research indicates that weekly street sweeping is most effective, with efficiency decreasing as the time between sweeping events increases. Because cost and availability of equipment may be limiting factors, particular areas within the watershed could be targeted for more frequent sweeping. All streets in the basin should be swept at least twice each year.

Regular Maintenance of Catch Basins:

Catch basins are the entry point for stormwater into a storm sewer system. Typically, catch basins have a sump area designed to trap sediment and limit its direct transport and discharge into a watercourse or waterbody. Over time the sump area fills with sediment and must be cleaned out. Without regular maintenance, inflows into a catch basin may flush the trapped sediment and any associated pollutants into the receiving waters. Studies have shown that catch basins are effective until they have reached 40-60% of their capacity. After that, inflows may bypass treatment and sediments may be resuspended. Studies have indicated that increasing the frequency of maintenance and cleanout can improve performance, particularly in industrial or commercial areas. A study conducted in Alameda County, California, showed that increasing the cleaning frequency from once per year to twice per year could increase the total sediment removal from catch basins (Mineart and Singh, 1994) from 54 pounds for annual cleaning, to 70 pounds for semi-annual and quarterly cleaning, and 160 pounds for monthly cleaning. Using the estimate of 3 million CFU of fecal coliform (as described under the street sweeping section above), 54 pounds of sediment contain roughly 73.6 million CFU. With increased maintenance comes increased cost. The benefit of improved pollutant removal needs to be weighed against the increased cost of maintenance.

Catch Basin Filters



Images from www.transp.com

Catch basin inserts are devices installed in an existing catch basin, under the storm grate. The inserts treat stormwater through filtration, settling, or adsorption. A variety of manufacturers have commercially available products that are designed to remove a variety of pollutants, including bacteria, sediment, oil, litter and debris. Units need to be maintained routinely and filters need to be replaced on a regular basis to attain maximum removal efficiency. Replacement rates will depend on the type of pollutants being treated, the amount of sediment Images from www.transp.com loading, and the regularity of street sweeping. Research indicated that costs for inserts range from $650 per filter to $1,300 per filter. Cost for inserts that targeted bacteria in a pilot project in Norwalk, CT ranged from $800 - $1,000. Installation of filter inserts throughout the watershed would provide a degree of effectiveness without the use of any other measures or BMPs. Improved efficiency would be achieved by instituting a regular schedule of street sweeping. While the initial capital cost may be high, it should be weighed against maintenance of catch basins and the long-term impact and costs associated with water quality renovation.

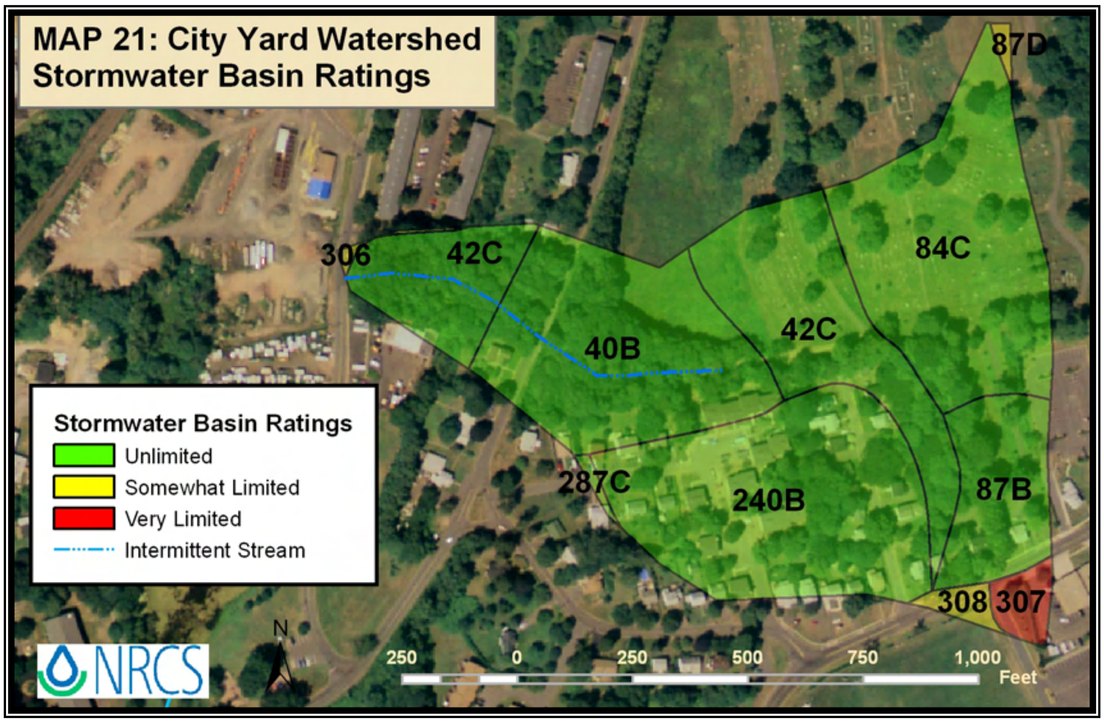
The City Yard watershed, located in Middletown, is an example of an area where the implementation of BMPs including street sweeping, catch basin maintenance, the use of catch basin filters, and the installation of stormwater detention basins or stormwater wetland systems could serve as a demonstration project. (See Map 21) Implementation of these measures at the site could be used to show the benefits derived from the general management of stormwater runoff and evaluate the efficiencies of the various techniques that are implemented.

City Yard is municipally owned parcel housing equipment and materials for the Department of Public Works. The stream that runs through City Yard is a tributary to the Coginchaug River. It is fed by Butternut Pond and an unnamed stream that originates in Indian Hill Cemetery (subwatershed AA-1.B). Water quality monitoring data for the stream shows degraded water quality. Comparatively the site is a low priority for bacteria and nutrients. The unnamed stream is currently experiencing erosions problems that are, at least, in part a result of stormwater runoff from the site.

The cemetery grounds may be prone to increased surface stormwater runoff. Though the upper portion of the grounds are vegetated, the manicured grass is not as effective at slowing runoff as other vegetative covers. Moreover, soil compaction at the cemetery may be greater than expected because of the use of heavy equipment. Soil compaction decreases soil infiltration capacity of runoff. As a result, overland flow through the cemetery may be higher in quantity and velocity than might be expected. The cemetery is an example of the way that land use and land cover effect how pervious a site might be.

A stormwater wetland could be constructed at the headwaters of the stream to moderate the amount of runoff entering the channel over time. The bottom of the slope in the cemetery appeared to be unmanaged and less likely to be used for burial plots and a possible location for a stormwater wetland basin. The intent with this option is to collect, treat and slowly release the runoff in the upper watershed. Managing the volume of water in the stream and the speed with which it enters the stream channel will decrease the flow and lessen the potential erosive force of the water. Further investigation of this area, along with the wooded area surrounding the headwaters would be necessary to determine its suitability for the construction of a stormwater wetland. The placement of a wetland in this location could potentially address the runoff coming from the cemetery as well as the concentrated pipe flow from Sunset Terrace. The stormwater wetland should be inspected and maintained on a regular basis to assure proper function.

Additionally, installing catch basin filters in the catch basins on Butternut Street and Thomas Street would be a means of reducing pollutant loading to the unnamed tributary. A controlled street sweeping schedule could be implemented on both streets to evaluate overall effectiveness of sweeping methods and timing, as could a catch basin maintenance schedule.



Domestic Pet Waste Management (including dog walking areas and kennels):

Research indicates that non-human waste comprises a significant source of bacterial contamination in all watersheds. Studies by Alderiso et al. (1996) and Trial et al (1993) suggested that 95 percent of the fecal coliform found in urban stormwater was of non-human origin. Research around the Seattle, Washington area showed that nearly 20 percent of the bacteria that could be matched with it host animal were matched with dogs. According to some studies, one gram of dog feces contains 23 million fecal coliform. Some estimates suggest that two to three days of dog droppings from a population of roughly 100 dogs could contribute enough bacteria and nutrients to temporarily close a bay in a coastal watershed of up to 20 square miles in size to swimming and shellfishing. (EPA, 1993) In comparison, the Coginchaug Watershed is approximately 39 square miles, and has an estimated 1536 licensed dogs. (See Table 15).

Table 15: Number of Licensed Dogs

Town	Total Acres in Town	Total Town Acres in Watershed	Percent of town in Watershed	# Licensed Dogs in Town	Proportional # 0f Town Dogs in Watershed
Durham	14,912	12,130.80	81.3%	986	802
Guilford	30,464	1,663.04	5.5%	1500	82
Madison	23,232	399.10	1.7%	N/A	N/A
Meriden	30,720	34.30	0.1%	N/A	N/A
Middlefield	8,512	7,104.60	83.5%	468	391
Middletown	27,456	3,214.00	11.7%	2177	255
North Branford	17,152	177.90	1.0%	595	6
Wallingford	127,360	199.80	0.2%	N/A	N/A
			Total Number of Dogs:	**In Towns**	**In Watershed**
				5726	**1536**

variety of pet waste management systems could be used to limit the amount of fecal matter left on the ground. In-ground pet waste "septic systems" could be installed.

- Bacteria degrading enzyme is often used to aid in the decomposition of the waste. Minimal maintenance is required. Each system can service between 1 and 4 dogs depending on the size of the dog and the size of the system.
- A second option is pet waste stations. Plastic bags are provided for pet owners to pick up waste, and a garbage can is convenient to deposit the waste. Numerous stations can be set up at known dog walking locations. Periodic collection of the waste is required.
- The "long grass principle" is a third option. Dogs are attracted to areas with long grass, (approximately 4-5 inches high), to defecate. This area of tall grass should be situated such that it minimizes the potential for waste to enter into the water system, e.g. kept away

from steep slopes, drainage ditches, streams, etc. Regular pick-up of waste for this alternative would be required.

The most suitable waste collection system will depend on the size, location, and land cover of the dog walking area. All dog kennels that we spoke with are conducting waste management practices. Waste at the kennels located within the watershed is picked up either daily or every few days. The waste is bagged and placed into dumpster on site for collection.

Agricultural Nutrient Management Plans (for all agricultural operations, and including horse farms):

Numerous livestock agricultural operations exist in the Coginchaug River watershed. (See Map 22). Livestock waste contains dissolved nutrients (especially nitrogen, phosphorus, and potassium), organic matter (biochemical oxygen demand or BOD_5), solids, bacteria, including fecal coliform, and other infectious. Without appropriate management measures, storm water runoff and leaching can transport livestock waste and pollutants into wetlands, watercourses, waterbodies and associated groundwater and result in a significant risk of pollutant loading. In some cases, livestock may have direct access to a watercourse which increases the chances for animal feces to be deposited in the stream.

Comprehensive nutrient management plans (CNMPs) should be developed for agricultural livestock operations of all sizes. Measures may include waste collection, handling, storage, treatment, and transfer facilities, evaluation and treatment of sites proposed for land application of waste, land application methods (waste utilization and nutrient management), record keeping activities, and companion practices such as livestock exclusion along streams to restrict access, establishment of streamside buffers to trap sediment, and implementation of prescribed grazing systems which involves pasture management and installation of stock watering systems located away from wetlands and waterbodies. Cost for these practices will vary depending on the size of the operation and number of animals because these factors influence the sizing of structural measures.

Map 22: Agricultural Operations

Educational Materials for Agricultural Operations:

Providing educational materials for agricultural operations enhances the producer's understanding of the relationship between their practices and farm management plan and water quality. Information would include practices that could be implemented to improve control of stormwater runoff, protection of watercourses, pasture management, and waste management. Technical and financial resources information would also be made available to facilitate efforts on the part of the producer to implement conservation practices on their land. Cost for education and outreach efforts will depend on the exact nature of the materials being produced (e.g. flyers, brochures, booklets, workshops, etc…), and the numbers being produced.

Subsurface Sewage Disposal System Maintenance and Repair:

Failing private septic systems may potentially contribute to pollutant loading. Many factors will directly influence the degree to which a failing system may add to pollutant loading: proximity to a waterbody, type of soils, and the degree to which the system is failing. Watershed residents with private systems should be made aware of the potential problems associated with a failing system and should be encouraged to provide regular maintenance of their system along with timely repair when necessary. Costs for maintenance and repair may vary depending on the size of the system, the type of maintenance being done, or the type of repair necessary. Regular maintenance will minimize the likelihood for future, more expensive repairs. Failing systems located closer to waterbodies are more likely to be problematic, particularly if the soils have a higher hydraulic conductivity, (fluids move through them faster), if the soils are less suitable for effective septic system operation, or if the waste material is already observable (visibly or through odor) above ground. (See Map 23)

Vegetated Buffers Along Streams:

The presence of vegetation along a watercourse or waterbody provides numerous services. Vegetated buffers help decrease pollutant loading by slowing sediment transport, and through nutrient uptake and storage. Though the overall effectiveness of vegetated buffers is debated, the presence of a buffer, like street sweeping, is generally accepted to be better than no buffer. In addition, vegetated buffers create a visual barrier for geese, and have been found to be effective in discouraging the birds from using a waterbody. Given that a typical goose dropping has approximately 130,000 fecal coliform, keeping geese from the water through the use of buffers may offer a significant improvement in fecal coliform loading.

Table 16 shows the number of acres that lacked a riparian buffer at the time of investigation. Map 24 shows the approximate location of these sites. These sites were located using GIS. Each stream or waterbody that was immediately adjacent to a land cover in the Developed or Agricultural categories was selected. Only segments greater than 75' long were included. Each of the individual sites would require additional assessment to determine the feasibility of installing a buffer, the potential effectiveness based on local inflows, the appropriate type of vegetation and the associated cost.

Table 16: Buffer Acreage by Analysis Area

Analysis Area	Criteria	Acres
AA-1	35' Buffer on each side	37.91466
	50' Buffer on each side	54.16379
	100' Buffer on each side	108.3276
AA-2	35' Buffer on each side	44.90421
	50' Buffer on each side	64.14886
	100' Buffer on each side	128.2977
AA-3	35' Buffer on each side	98.45424
	50' Buffer on each side	140.649
	100' Buffer on each side	281.2979
AA-4	35' Buffer on each side	32.36283
	50' Buffer on each side	46.23258
	100' Buffer on each side	92.46518
Watershed-wide: 35' Buffer on each side		**213.6359**
Watershed-wide: 50' Buffer on each side		**305.1942**
Watershed-wide: 100' Buffer on each side		**610.3884**

Typical cost for a grass/herbaceous buffer will range from $450 to $850 per acre. A tree and shrub establishment costs approximately $2400 per acre. These costs will vary depending on the specific plants selected, the degree of site preparation that is required, and the recommended density for planting

Map 23: Soil Potential Rating Subsurface Sewage Disposal Systems for Single Family

Map 24: Locations of Missing Streamside Vegetated Buffer on Broad LULC Classification

Municipal Regulations:

In Connecticut, each of the 169 municipalities is empowered by the State with the authority to establish local land use planning regulations and policies. Under the current land use planning system, municipalities have responsibility for addressing nonpoint source pollution, while the State has responsibility for addressing point source pollution. Municipalities can use their regulations to create effective ways to manage the potential adverse affects on water quality that may arise as a result of growth and land planning decisions.

A wide range of practices can be incorporated into municipal regulations to address these potential impacts. Preservation of open space or the use of cluster subdivisions are methods designed to protect natural resources by limiting development. Other techniques specifically address stormwater runoff. These techniques are designed to increase infiltration (e.g. rain gardens, curbless roads, increased use of pervious surfaces, etc…), improve treatment of stormwater before it enters a watercourse, decrease the potential for erosion and sedimentation, and minimize impact from associated land uses (e.g. through buffers, setbacks, impervious/pervious surface, etc…). Many of these techniques are part of broader concept of Low Impact Development

At a minimum, stormwater management regulations can be used to strongly encourage and, at a maximum, require measures or practices that attend to water quality and/or water quantity issues. The towns in the Coginchaug River watershed can use the 2004 Connecticut Stormwater Quality Manual to "provide guidance on the measures necessary to protect the waters of the State of Connecticut from the adverse impacts of post–construction stormwater runoff" (Connecticut Stormwater Quality Manual). By identifying mutually acceptable solutions for stormwater management in a given area, municipalities, developers, and engineers can find ways to effectively manage stormwater.

The decreased use of bituminous curbing is an example of a regulatory modification that could be made in all three towns. In some cases, concentrating stormwater runoff and directing it to a catch basin system is appropriate. In other instances, curbing prevents runoff from reaching a pervious surface where infiltration can occur. Limited infiltration diminishes the potential for stormwater to be filtered as it travels over and through the soil and it increases the chances for pollutants to be discharged directly into watercourses and waterbodies.

The filtering capacity of soils is one of the factors influencing the requirements for siting and installation of septic systems. Permitting engineered septic systems, as each of the three towns do, is an understandable approach to developing a parcel of land constrained by soil limitations. Numerous areas throughout the Coginchaug River watershed have soils rated as low to extremely low potential for septic suitability, (Map 23 Soil Potential Rating: Subsurface Sewage Disposal Systems for Single Family Residences). Using this information the towns can reconsider the way private septic systems are currently regulated. General consideration can be given to the allowances for engineered systems. Regulations regarding the maintenance of septic systems can be reexamined. Towns may consider establishing stricter requirements for maintenance and proof of maintenance for areas with soils rated from low to extremely low potential.

Site specific investigation should be conducted in order to ensure that appropriate land planning techniques are implemented. The cost for a regulations review is associated with the time required to review and modify the regulations.

ANALYSIS AREA PLACE-BASED RECOMMENDATIONS:

The Analysis Areas are delineated based on the location of the five (5) DEP water quality monitoring points. (Refer to Map 3: Analysis Areas and Water Quality Monitoring Points). The downstream monitoring point is considered to be the outlet of the Analysis Area. All of the local watersheds contributing to that point were grouped together as part of the Analysis Area. It should be noted that Analysis Area 1 contains two of the monitoring points because both of the sites are located in one watershed. The local watersheds in each Analysis Area were then grouped according to similar land use/land cover characteristics.

Place-based recommendations focus attention on the impact an individual site may have on water quality. The individual sites identified below represent locations where there is a high potential for bacterial loading. It is important to understand that the place-based locations are not necessarily contributing bacteria to the system, nor are they contributing more than other specific sites in the watershed. This determination of a "high potential" is based on the existing conditions at the site at the time of the investigation. Land use, land cover, soils types, among other factors, are some of the elements that were used to evaluate which sites might be more likely contributors of bacteria to the Coginchaug River and its tributaries. In order to assess the actual contribution of any of these sites more detailed and site specific analysis is required.

Analysis Area 1 (AA-1)

Analysis Area 1 (AA-1) is 4,302.1 acres in size. The area was divided into two subwatershed areas: AA-1.A and AA-1.B. AA-1.A is the southern half of the area and AA-1.B makes up the northern half of the area. Approximately 9.17 percent of the watershed is categorized as agricultural land, 42.74 percent is developed land, and 38.62 percent is forested (refer to Table 6). The remainder is comprised of a combination of land classified as transitional, barren, other, or water. Urbanization and denser developments patterns predominate in the northern portion of this area. Proceeding south and west the analysis area becomes progressively more forested and agricultural. The suggested place-based BMPs are identified for this analysis area on Map 25.

1) Buffer implementation sites

As outlined in the watershed-wide recommendations, the establishment of vegetated buffers may help to reduce pollutant loading. Analysis of the entire watershed was conducted to determine what specific sites along the Coginchaug River and its tributaries would be most suitable for riparian plantings. These areas have been identified in each Analysis Area.

A preliminary selection of sites was based on two basic factors: land use/land cover, and length of segment. Using GIS, stream segments were identified as potentially unbuffered by selecting those segments of stream (from the USGS hydrography layer) that intersected land use/land cover areas classified as agricultural or developed. It was decided to use a minimum linear length of 75 feet of stream segment to be considered for a potential planting. Using these criteria allowed prioritization of the unbuffered stream reaches that are most prone to allowing runoff into watercourses.

Additional criteria that could be used to further prioritize sites include the following:

a. Soil characteristics – hydraulic conductivity (how rapidly water moves through the soil), and suitability for different types of planting (trees, shrubs, herbaceous),
b. Looking at a more detailed level of land use/land cover classification (e.g. industrial, commercial, residential, pasture, orchard, cultivated cropland), may provide greater insight about runoff and buffer establishment.
c. Size of delineated land use/land cover polygon. 51 segments of unbuffered stream were identified in Analysis Area 1. This constitutes a total of 23,084 linear feet.

2) Soil potential for subsurface sewage disposal systems Watershed soils were reviewed for their potential use for private septic systems. The range of ratings included high, medium, low, very low, and extremely low potential. The soils mapped with a high potential rating have the best characteristics for standard installation of septic systems and any limitations that exist are easily overcome. At the other end of the spectrum, soils with extremely low potential have multiple major limitations and it is unlikely that the soils can be sufficiently improved to meet state health code regulations. For more information refer to Map 23: Soil Potential Rating: Subsurface Sewage Disposal Systems for Singe Family Residences. The NRCS used soils data and GIS to evaluate areas of residential development containing soils with extremely low to medium potential for septic systems. The least suitable locations were further narrowed by selecting sites within the residential areas that are 75 feet or less from a watercourse or waterbody. This assessment was conducted for each Analysis Area. These areas should be considered as priorities to investigate and confirm that no septic failures or illicit discharges are taking place.

Analysis Area 1 contained 8.8 acres (43 delineated polygons) mapped as medium to extremely low potential for septic

3) Middletown Sewage Line under Coginchaug River.

Members of the Advisory Committee stated a concern about a City of Middletown municipal sewage line which travels under the Coginchaug River behind Saint John's Cemetery, roughly ½ mile from the confluence of the Coginchaug and Mattabesset Rivers. The line runs under the river at two points. During a meeting with staff at the Middletown Sewer and Water Authority, it was

Map 25: Analysis Area 1

indicated that protective measures are in place to prevent against any effluent discharge or leakage from the pipe entering the stream. Engineer's drawings were reviewed to see the design and construction measures in place. Both sections of pipe are encased in a concrete. The southern section is encased for 90 linear feet and the northern section for 100 linear feet. In addition, concrete cutoff collars are in place at both locations on the upstream and downstream sections of pipe. The collars would cause any leaking effluent to travel around them and away from the river. Based on this information, any bacteria loading from the sewer line is highly unlikely.

4) Veteran's Park Snow Pile (subwatershed AA-1.B)

This site was identified by the local advisory committee as a potential source of pollutant loading. The City of Middletown deposits the excess snow from plowing operations onto a parking lot located on Walnut Grove Road in Veteran's Park. The parking lot, approximately ¼ acre in size (100'x100') and covered with a mix of asphalt, stone, and bare soil, is located at the top of a hill. A network of three catch basins captures the runoff from parking lot. Two catch basins are located at the base of the hill: one on the north side of Walnut Grove Road and the other on the south side of the road. The third catch basin is situated at the southwest corner of the parking lot. A portion of runoff from the parking area enters the catch basin at the southeast corner of the lot, and a portion of runoff flows down the Walnut Grove Road. The stormwater discharges from a pipe located at the base of the hill, approximately 100 feet from the west bank of the Coginchaug River, and passes through a small floodplain wetland before entering the Coginchaug River. The size of the snow pile varies from year to year as well as within a single season depending upon snowfall. No data was found that characterized the constituents in the snow and runoff, quantified the amount of runoff, quantified pollutant levels or types in the snow. Though data is unavailable, the site offers an opportunity to demonstrate practices that reduce sediment loading, and control snowmelt and stormwater runoff. Options to address potential issues associated with the runoff from the snow pile include the following:

a. Install catch basin filters in each of the three catch basins located at the site. At a minimum an insert could be installed in the catch basin at the corner of the parking lot and the catch basin on the north side of Walnut Grove Road. This would likely capture the majority of the runoff. Street sweeping in this area is not an option to complement the catch basin inserts because the road and parking area are only partially paved.

b. Stormwater runoff can be treated by installing a structural BMP such as a stormwater pond or wetland, or a filtration system. Runoff should be directed off of Maple Grove Road to the selected structural BMP. By grading the road and surrounding area, runoff could be directed to the vegetated area along the road. Moving runoff through the vegetated area eliminates the need to pipe the runoff directly to the structural BMP. Use of the vegetated area also acts as a pre-filter and thus improves the efficiency of the structural BMP. The runoff could then be discharged to the catch basin. Additional treatment could be achieved with the installation of a catch basin insert. Regular maintenance of the sediment basin would be required. Various types of settling basins are presented in the table below along with the associated costs.

Costs for these two options are outlined in the table below.

Table 17: Veteran's Park Cost Estimates

Option 1	**Structural BMP's**								
		Design & Contingency				Annual Cost Over Lifespan Interest Rate = 7%	O & M % Cost	O & M $ / yr	Total Capitalized Cost /yr over Lifespan
	Construction Cost	% Const.	Cost	Total	Life-span (yrs)				
Ponds/Wetlands									
Stormwater Ponds	$ 8,800.00	25%	$,200.00	$ 1,000.00	30	$886.49	6%	$528.00	**$1,414.49**
Stormwater Wetlands	$ 12,000.00	25%	$3,000.00	$ 5,000.00	30	$1,208.85	6%	$720.00	**$1,928.85**
Gravel Wetland	$21,600.00	25%	$5,400.00	$27,000.00	20	$2,548.53	7%	$1,512.00	**$4,060.53**
Filtration									
Surface Sand Filter	$16,000.00	25%	$4,000.00	$20,000.00	15	$2,195.80	13%	$2,080.00	**$4,275.80**
Underground Sand Filter	$21,600.00	25%	$5,400.00	$ 27,000.00	15	$2,964.33	13%	$2,808.00	**$5,772.33**
Bioretention	$24,000.00	25%	$6,000.00	$30,000.00	15	$3,293.70	8%	$1,920.00	**$5,213.70**
Manufactured Tech Devices									
Biofilters (e.g. StormTreat)	$23,000.00	15%	$3,450.00	$26,450.00	15	$2,903.95	7%	$1,610.00	**$4,513.95**

Option 2: Catch Basin Insert									
		Initial cost ($)	Lifespan (yrs) ^	Capitalized cost over Lifespan^		Operation & Maintenance		Total	
				($/yr)	units	($/yr)	units	($/yr)	units
Average Cost of Operation	Catch basin insert for bacteria (e.g. AbTech Ultra Urban Filter with Smart Sponge)	$1,100	1 to 3	$420 - $1,100	ea.	$230*	ea.	**$650 - $1100**	ea.
^ Little / no maintenance; insert replaced every year; monthly maintenance will extend the life of insert to 3 years									
* Operation and Maintenance: $230 - heavy sand load may require more maintenance in the spring									

5) Laurel Brook Reservoir.

The reservoir is a public drinking water supply reservoir for Middletown, and is located primarily in Middlefield. Though the majority of the land around the reservoir is forested, several pockets of developed land with a high runoff potential rating are located in relatively close proximity to the reservoir. A more thorough investigation of those areas should be conducted to ensure that runoff is being captured, treated, filtered, or detained before reaching the reservoir.

6) Ross Road Small Agricultural Operation located in Middlefield, CT

Streamwalk information revealed that a small agricultural operation exists at a residential location on Ross Road. Four to five head of cattle were observed along with several types of domesticated birds. An unnamed tributary to the Coginchaug River flows along the southern boundary of the parcel, turns slightly northward and continues to flow through the back portion of the property. At the time of the streamwalk assessment no fencing was present and the livestock had access to the stream. It is recommended that the producer work with the appropriate agencies to develop a farm management plan, which includes waste management and pasture management plans. Exclusionary fencing and establishment of a riparian vegetated buffer would provide protection for the stream and decrease the possibility of pollutant loading. A stock watering system should be installed away from the stream.

The site has approximately 200 feet of linear feet along the stream that would require fencing. The average cost for woven wire fencing is $10/foot. Cost fencing the site would be $2,000.

7) Wadsworth Falls State Park

The park is a State run facility, located on 267 acres in Middletown. Permitted activities at the park include hiking, swimming in a man-made pond, mountain biking, picnicking, and fishing. Walking pets and horseback riding are also allowed. Wadsworth Brook and Laurel Brook, along with other smaller intermittent streams, flow through the property and feed the Coginchaug River, which flows along the western and northern boundary of the park. Potential sources of bacterial contamination include domestic pet waste, and wildlife waste, and possibly human waste.

As described on the CT DEP park website, the swimming pool is a saucer-shaped basin hollowed out of the level plain south of Route 157 that is paved with a soil cement to prevent water from leaching out. Water is pumped from the Coginchaug River through a series of inter-connected wells into the pool creating a circulating effect. The pond water is discharged through a controlled outlet structure and pipe back into the Coginchaug River, just downstream from where it is pumped. The pond is drawn down after the Labor Day holiday. Water quality testing is conducted weekly from just prior to Memorial Day through Labor Day because it is a State swimming area. Testing has revealed elevated and unsafe levels of E. coli bacteria resulting in the pond's closure on numerous occasions over several years. The State has targeted the site as a water quality concern to be addressed.

Bacterial contamination in the pond can occur from human as well as wildlife waste sources, Geese, deer, raccoons, and other animals are all possible sources of bacteria. Short of establishing a vegetated buffer around the portion of the pond currently unbuffered and closing the pond to swimming, it is unlikely that the bacterial loading from wildlife or humans can be easily controlled. The State, therefore, has a number of post contamination treatment options available. It should be understood that these measures can be used in tandem with each other.

a. Install an ultraviolet treatment system in the pond's discharge pipe. As the water is released back to the Coginchaug River it can be treated. Ultraviolet disinfection is based on exposure of a certain wavelength for a certain length of time. The UV-C spectrum (200-280 nm) is considered the germicidal spectrum and is therefore used most often in UV disinfection systems. The basic premise of the UV system is that when the microorganism is traveling through the UV chamber, it must be exposed to enough disruptive UV for a long enough period of time to either kill it or at least keep if from being able to reproduce. The preference is to kill the bacteria.

b. UV dosage is a function of UV lamp output, flow rate, and UV transmittance through the water. Therefore if the water is very turbid the UV system will be ineffective, and/or you will need a much higher exposure rate and a longer exposure time to achieve a desirable kill rate on the targeted organism.

Table 18: Ultraviolet Treatment Cost Estimates

Option 2:	**Ultraviolet (UV) treatment of water in swimming pond**				
Water will be treated in the pond or at the outlet of the pond					
System Size - Wattage	Construction / Installation Cost	Inlet / Outlet Size	Flow Rate @ 30,000 uWs/cm2	Unit Cost	NOTES:
450	$3,000 - $5,000	4"	225 gpm	**$4,500**	Yearly O&M $2,200 - $4,000
750	$3,000 - $5,000	6"	399 gpm	**$5,900**	
1200	$3,000 - $5,000	8"	608 gpm	**$9,300**	

The estimates assume that water clarity is relatively high. Turbidity levels along the Coginchaug River itself or associated watercourses and waterbodies may be affected by storm events and by recreational uses. If water clarity is low, a higher UV rate and a prolonged exposure time may be required to achieve the desired kill rate. A commercial grade UV system is most likely required.


Laurel Brook – Wadsworth Falls State Park

Construction and installation costs include provision of power to the site, connection of the pipe outlet, and building a shelter to house and protect the unit. On all of these units the bulbs need to be replaced about every 9,000 hours, as they drop down to 60% effectiveness after that amount of usage. Bulbs range in price from $150 - $200 each. The bulbs are housed in quartz sleeves which insulate the bulb from the water. Those sleeves need to be cleaned on a regular basis, depending on the water conditions.

b. Design and construct a wetland or other stormwater BMP that would serve to filter the pond water before it reenters the Coginchaug River. The BMP could be sited where the outlet of the discharge pipe is currently located. (See Table 19 for costs).

Table 19: Stormwater Management – Wadsworth Falls

Option 1:	**Stormwater BMP's**								
		Design & Contingency				Annual Cost Over Lifespan Interest Rate = 7%	Operations & Maintenance		Total Capitalized Cost /yr over Lifespan
	Construction Cost	% Const.	Cost	Total	Lifespan (yrs)		% Const	$ / yr	
Constructed Wetlands									
SW Wetland	$12,000	25%	$3,000	$15,000	30	$1,209	4.5%	$540	**$1,749**
Gravel Wetland	$21,600	25%	$5,400	$27,000	20	$2,549	5.0%	$1,080	**$3,629**
Filtration									
Surface Sand Filter	$20,800	25%	$5,200	$26,000	15	$2,855	12.0%	$2,496	**$5,351**
Underground Sand Filter	$21,600	25%	$5,400	$27,000	15	$2,964	12.0%	$2,592	**$5,556**
Bioretention	$24,000	25%	$6,000	$30,000	15	$3,294	6.0%	$1,440	**$4,734**
Manufactured Tech Devices									
Biofilters (e.g. StormTreat)	$24,000	15%	$3,600	$27,600	15	$3,030	5.0%	$1,200	**$4,230**

c. Additional water quality testing of the Coginchaug River just upstream from the pumping station and the series of dry wells to verify the source of the bacteria. Testing at these locations would help to find out how much bacteria, if any, in the pond is arriving from the Coginchaug River.

d. Laurel Brook. The 225 to 250 foot reach of Laurel Brook extending upstream from the confluence with the Coginchaug River lacks riparian vegetation and is channelized. The lack of riparian vegetation and channelization increases the brook's vulnerability to pollutant loading from both the parking lot and the grassed area between the brook and pond. Feces from wildlife or domesticated pets can easily enter the stream. The channelized condition of the stream means that material is transported more rapidly into the Coginchaug River. It is suggested that riparian buffer be established along both sides of

Laurel Brook. Ideally buffer width should be twenty (20) feet on each side of the stream, with a minimum width of ten (10) feet on each side being acceptable. Planting materials should consist of native grasses, herbaceous vegetation, and shrubs. (See Table 20 for cost).

Table 20: Laurel Brook Buffers

Buffers along Laurel Brook		
20' on both sides, 250' long = 0.23 Ac.		
	100% Grasses	75% grasses & 25% shrubs / trees
	$450 / ac.	$1912.5 / acre
buffer	$104	$440
20% contingency	$21	$88
Total	**$125**	**$528**

e. Establishment of pet waste stations. Pet waste, as described above, contains large levels of bacteria. Strategically placing pet waste collection systems on trails or the sections of trail increases the chance that pet owners will dispose of their pet waste and thus lessens the potential for bacterial contamination of the Park's watercourses. The trails along Wadsworth Brook and Laurel Brook should be considered priorities because they are in close proximity to water, as should the picnicking areas located at the main entrance to the park, the swimming pond, and those adjacent to the Coginchaug River. Associated signage explaining the reason for the waste station would be a cost effective way to educate the public about the impact of pet waste on water quality.

Table 21: Wadsworth Falls State park Pet Waste Stations

	Pet Waste Stations
	$500/ea.

f. Public Restrooms

The CT DEP should assess the septic management system for the public restroom facilities located at the Park's main entrance to confirm that the facility is functioning properly and no illicit discharges are occurring. If any problems exist, appropriate measures should be


Laurel Brook - Wadsworth Falls State Park

taken to rectify the condition.

g. Picnic Area

A number of picnicking areas, with grilling facilities, are located around the main entrance to the park and in close proximity to the swimming pond and the Coginchaug River. Those areas should be properly maintained to eliminate any food waste from the site. Doing so will reduce the likelihood that wildlife will come to the area, which, in turn, will lessen the chance that wildlife feces will be in close proximity to the waterbodies in this area (i.e. the swimming pond, Laurel Brook, and the Coginchaug River). Maintenance of the areas can be achieved through educational means (e.g. signage in the picnicking area), reliance on park users, and seasonal DEP staff. The longer-term more beneficial approach would be to educate the public and park users about the implications of leaving food waste, having visits from wildlife, and the associated water quality concerns.

Given the public's use of the site, the park is a splendid location to implement a variety of water quality practices. The work would serve as a model to the public and demonstrate the State's role as and desire to be a leader in water quality protection.

8) Commercial Districts – Route 66

a. Route 66 – This is a good location to implement more regular street sweeping, and possibly install Low Impact Development (LID) practices such as depressed vegetated islands and vegetated swales. This would serve as a way to minimize the amount of sediment entering the catch basin system and to increase stormwater infiltration. Priority locations that might be suitable include the Home Depot shopping plaza as well as the A&P shopping plaza. Both sites have large impervious parking areas. Slowing runoff from these areas and reducing the amount of sediment transported from the parking lots will decrease general non-point pollutant loading into the Coginchaug River. It would also help lessen the level of maintenance required for the associated catch basins, and extend the lifespan of any catch basin inserts that might be installed. Other commercial sites along Route 66 could be investigated for similar practices to treat parking lot runoff.

Additionally, a number of restaurants operate along Route 66. Work should be done with the business owners to ensure that food waste is dealt with properly. Raccoons, coyote, and gulls, among other animals, scavenge for food. Fecal matter from all of these animals contributes to bacterial loading in stormwater. An average gull dropping, for example, has approximately 184 million coliform colonies. Instituting a combination of food waste control practices with site cleanup could greatly reduce any wildlife waste contributions that might be occurring.

b. Catch basin maintenance. Given the high volume of stormwater runoff from the impervious surfaces in the commercial districts, the sites are ideal locations an increased level of catch basin maintenance. A schedule of regular maintenance would decrease the potential for resuspension of sediments.

Analysis Area 2 (AA-2)

Analysis area 2 contains the local watersheds in the northwestern portion of the Coginchaug drainage basin. The area, 4,739.4 acres in total, was subdivided into three subwatershed areas (AA-2.A, AA-2.B, AA-2.C). Area 2.A covers the southern tip of the Analysis area and is about 1/8 of the analysis area. AA-2.B and AA-2.C each make up an equal amount of the remaining 7/8 of the analysis area with 2.B being located in the middle and AA-2.C comprising the northern section of the analysis area. 19.35 percent of the watershed is classified as agricultural land, 37.42 percent developed, and 33.03 percent forested. Most of the development is situated in an east-west band through the center of the watershed, with relatively dense development around Lake Beseck. The remainder of the analysis area is comprised of land classified as barren, transitional, other, and water. Seven locations for place-based BMPs were identified in this analysis area. (See Map 26).

1. Buffer implementation sites

   For a full description see option one under Analysis Area 1. Fifty segments of unbuffered stream were identified. This constitutes a total of 27,651 linear feet.

2. Soil potential for subsurface sewage disposal systems

   As described under Analysis Area 1, soils were evaluated for their potential for installation of private septic systems. The areas identified with medium to extremely low potential should be considered as priorities to investigate and confirm that no septic failures or illicit discharges are taking place.

   Analysis Area 2 contained 77.2 acres (298 delineated polygons) mapped as medium to extremely low potential for septic.

3. Ellen Doyle Brook

   The residential properties around Lake Beseck, on its east and west sides, were connected to public sewer beginning in the late 1990's, with the project being completed in 2001. Despite the sewering project, monitoring data collected on Ellen Doyle Brook (one of the ancillary monitoring sites) show elevated levels of bacteria were present in the brook after 2001.

Map 26: Analysis Area 2

Testing of the lake at the public beach has been conducted since the completion of the sewer project. Elevated levels of bacteria have occurred infrequently and have not prompted any beach shut downs. However, remote sensing data suggests that the water in the lake moves away from the beach. This may result in misleading information about the bacteria levels in the lake. Additional testing at the lake outlet is recommended to determine if elevated levels of bacteria are present in the lake. If elevated levels are present, more detailed analysis would be required to determine the specific source of the pollutant loading. Sources may include long-term resident bacteria in the system, possible illicit discharges to the lake, or inputs from the associated residential properties around the lake.

4. Lake Beseck Properties

   Although the overwhelming majority of homes surrounding Lake Beseck have been sewered (completed in 2002 under a grant from the USDA Rural Development), the residential properties remain as potential contributors to pollutant loading. Stormwater runoff transports pollutants that have been generated from automobile use and maintenance, fertilizer and herbicide applications, or pet waste left on the ground. Bare soil can be washed off site during a storm. The pollutants generated from these activities can enter the lake through overland flow or through pipe discharge. Several options exist to diminish these inputs. (See Table 22 for costs).

a. Low Impact Development (LID) practices can be implemented. These practices are designed to control stormwater runoff by increasing infiltration, decreasing the volume of runoff, and increasing the travel time for runoff to enter a watercourse. Such measures include, but are not limited to, the use of

   i. permeable paving material for driveways. These materials permit infiltration of stormwater runoff.
   ii. rain gardens. Stormwater is directed to appropriately sized landscaped gardens planted with vegetation that can withstand saturated conditions. These areas allow for increased stormwater infiltration and improved filtration of sediments.
   iii. lawn alternatives. Replant lawns with vegetation other than turf grass. Doing so increases infiltration capacity, decreases maintenance requirements, and lessens the use of gas powered lawnmowers and weed trimmers.

b. Installation of catch basin inserts at strategic locations. During a drive through survey of the area, sixty (60) catch basins were counted. This was an informal count conducted only on the western side of the lake, and did not include all of the streets in the development. Installation of inserts at strategic locations would minimize initial cost, limit maintenance requirements, and establish a level of control and management over stormwater runoff. Periodic street sweeping of the development would extend the lifespan of the inserts, decrease maintenance requirements, and maximize insert efficiency. At a minimum, inserts should be installed in the catch basins that are the final stop before water is discharged into the lake.

c. Additional water quality testing at selected sites around the lake would help to locate the source(s) of pollutant loading into the lake.

Table 22: Lake Beseck Cost Estimates

Option 1: Street Sweeping								
	Initial cost ($)	Lifespan (yrs)	Capitalized cost over Lifespan^		Operation & Maintenance		Total	
			($/yr)	units	($/yr)	units	($/yr)	units
Average Cost of Operation	$185,000	8	$3.80	curb mi.	$18.50	curb mi.	$22.30	curb mi.
Cost estimates are based on 8,160 curb miles/year *. The estimate for Lake Beseck is adjusted below for a low level of usage								
Assumptions:								
6 Miles of Road surrounding Lake Beseck = 12 linear miles of curb Sweeping done 2X per month for 9 months (18 times/year) X 12 curb miles per year = approximately 220 curb miles/year							**Annual Cost** **$4,906**	
Annual Cost Increased by 25% for low usage (or rental / fuel)							**$ 6,133**	

*Ref. from EPA 1999 EPA determination Sweeper can service 8160 curb miles per year

^Capitalized cost over the Lifespan = the initial cost, capitalized over its lifespan, at an interest rate of 7%.

Option 2: Catch Basin Insert									
		Initial cost ($)	Lifespan (yrs) **	Capitalized cost over Lifespan^ ($/yr)	units	Operation & Maintenance ($/yr)	units	Total ($/yr)	units
Average Cost of Operation	Catch basin insert for bacteria (e.g. AbTech Ultra Urban Filter with Smart Sponge)	$1,100	1 to 3	$420 to $1,100	ea.	$180	ea.	$600 to $1,100	ea.
Cost Specific to Lake Beseck area									
Assumptions: There are approximately 90 catch basins								**Annual Total Cost**	
If there is little/no maintenance; inserts are replaced every year:								**$99,000.00**	
If there is monthly maintenance costing $180 ea/year, this extends the life of insert to 3 years:								**$54,000.00**	

** Lifespan depends on maintenance & loading. Monthly maintenance can decrease the per unit annual cost as the lifespan increases
^ Capitalized cost over the Lifespan = the Initial cost, capitalized over its lifespan, at an interest rate of 7%.

Option 3: Combination of Options 1 and 2				
	Capitalized cost over Lifespan^	Operation & Maintenance	Total (Capital Cost + O&M)	Annual Cost
Catch Basin Annual Cost	$420 each – as in Option 2 above	$30 each - reduced due to decrease loading as result of street sweeping	$450 each	
Total # of Catch basins = 90				$40,500
Street Sweeping cost (12 curb miles, 18 times/year)	$3.80 /curb mile -as in Option 1 above	$18.50 / curb mile	$22.30/curb mile	$6,133
Total Annual Cost				**$46,633**

^ Capitalized cost over the Lifespan = the Initial cost, capitalized over its lifespan, at an interest rate of 7%.

Other recommendations
1. Cleanout of sediment chambers 2X per year (Spring and Fall)
2. Install Pet Waste Collection Station at the boat launch estimated cost=$500

5. Triangle A Farm (subwatershed AA-2.C)

The farm is situated at the headwaters of Hans Brook, a tributary to the Coginchaug River. One of the ancillary monitoring sites is located on Hans Brook just upstream from the confluence with the Coginchaug River. Data from the site indicates that elevated levels of bacteria are present. A number of agricultural BMPs are available to the Triangle A farm.

a. Though the farm pond does not directly discharge into the Coginchaug River or one of its tributaries, it does drain into a wetland which feeds Hans Brook. Potential pollutant loading could be reduced by establishing a vegetated buffer around the unvegetated portion of the pond and by installing fencing to exclude livestock from direct access to the pond. The vegetated buffers can help to trap sediment being transported by overland runoff. Trapping sediment reduces sediment loading and, therefore, provides an opportunity for improved filtration in the wetland. Improved filtration capacity of the wetland should help to naturally reduce bacteria and nutrient levels. As part of this practice, a stock watering system should be installed away from the wetlands.

b. With assistance from appropriate agencies, a comprehensive conservation plan, including pasture management, nutrient management, and waste management could be developed. These BMPs would enhance the fencing and vegetated buffer measures described above. Part of the waste management plan would include construction of a waste storage facility. By implementing these practices agricultural pollutant transport and potential pollutant loading into Hans Brook would be reduced.

6. Residential properties. There are two properties, located on the west side of Jackson Hill and the eastern side of the Triangle A farm, which are in an area with a combination of soils mapped as having high potential and low potential for septic suitability. Both properties are in very close proximity to the headwaters of Hans Brook. The septic systems at these properties should be inspected by the Town Sanitarian to confirm that they are functioning properly. If the systems are in disrepair, appropriate repairs or replacement should be made.

7. Cahill Environmental Services is located in the Town of Middlefield on property adjacent to the Coginchaug River and Hans Brook. One service the company provides is portable toilet rental. The toilet units are stored on the property adjacent to the river. The existing riparian buffer is of minimal width. As a result of this study, the Chamber of Commerce representative to the Advisory Committee contacted Cahill Environmental Services to discuss the concern about the potential for bacterial loading from the site.

   The company indicated that the Town Sanitarian had inspected the site in July 2007. At the time of the visit, the sanitarian determined that no health hazards were presented by the storage of the portable toilets on the property. Each toilet is cleaned and rinsed at the location of its use, the units are stored empty, any visible water observed was "clean" water, and “Toilet Deodorize Soap” is the only chemical used in the units and is non-toxic according to its Material Data Safety Sheet.

In subsequent conversations, Cahill has expressed an interest in working with the local conservation district to maintain and enhance the existing riparian buffer between the Coginchaug River and the storage area. Doing so will minimize any potential leaks or accidental spill of waste into the river.

8. Lyman’s Orchard Excluding the ponds and stream flowing through the golf course, there are three ponds and one stream associated with the property that are potentially affected by pollutant loading: the irrigation pond located in the orchards on the north side of South Street; a small pond on the east side of Route 157 roughly 0.10 miles south of the intersection of Routes 157 and 147; and the pond located in front of the Lyman’s Orchard Apple Barrel store. Treating the water from the Apple Barrel Store pond before it enters Lyman Meadow Brook for pollutant and nutrient reduction would be the ideal. (See Table 23 for costs).
    a. Option 1: Establish a vegetated buffer around the irrigation pond and the Apple Barrel Store pond and eliminate the waterfowl from the area. A supplemental practice would be to establish a buffer around the orchard pond. This pond feeds into the brook and waterfowl have been observed at the pond.
    b. Option 2: The small pond on the east side of Route 157 outlets into the Apple Barrel Store pond. By storing and controlling the flow from this pond, it would create a clean supply of water for the Apple Barrel Store pond. One or two structural BMP filtration systems could be installed, in combination with the buffers, to treat the discharge from the Apple Barrel Store pond. This option creates a method to manage pond levels and allows water to be treated for pollutant removal.
    c. Option 3: Install five or six structural filtration systems for the larger pond if no additional treatment methods are implemented for the other areas/waterbodies around the store.
    d. Option 4: Install a filtration unit in the existing outlet pipe from the large pond so that pollutants would be treated prior to discharge into Lyman Meadow Brook.

e. Option 5: Construct an appropriately designed wetland on the north side of 147 to treat the water from the pond and the stream. Based on preliminary analysis, considering watershed size and estimated flows, such a system would require a large amount of the land area currently in production. (See discussion on Durham Meadows wetland system under the wetland evaluation finding section, p. 48)

f. Supplemental Practice 2: Install low impact development techniques on the parking areas around the store – these may include permeable pavement, catch basin filters, vegetated buffer/swale off of the parking area, bioretention systems to treat stormwater runoff.

Table 23: Lyman Orchard's Cost Estimates

Option 1: Buffer Pond at Apple Barrel Store and eliminate water fowl: 1625' x 15' buffer (0.6 ac) : 25% shrubs/trees & 75% Warm Season Grasses (not mowed)			
	Warm Season Grass ($850/ac)	Shrubs / Trees ($2400/ac)	Total Cost
Buffer cost	0.45 ac = $383	0.15 ac = $360	$743
Seeding (0.25 ac existing bare soil)	$113	-	$113
20 % contingency	-	-	$171
Total			**$1027**

Option 2: Control flow from upper adjacent small pond to the Apple Barrel Pond and retain/divert (through a swale directly to Lyman Brook) higher storm flow. Add a small structural filtration system for Apple Barrel pond. Construction costs for each include the cost for diversion.									
		Design & Contingency			Lifespan (yrs)	Annual Cost Over Lifespan Interest Rate = 7%	Operations & Maintenance		Total Capitalized Cost /yr over Lifespan
	Construction Cost	% Const.	Cost	Total			% Const	Cost / yr	
Surface Sand Filter	$25,100	25%	$6,275	$31,375	15	$3,445	12.0%	$3,012	**$6,457**
Underground Sand Filter	$25,900	25%	$6,475	$32,375	15	$3,554	12.0%	$3,108	**$6,662**
Biofilters (e.g. 2 StormTreat)	$28,300	17%	$4,811	$33,111	15	$3,635	5.0%	$1,415	**$5,050**

Option 3: Large filtration system for outlet of the Apple Barrel Pond (perhaps on northwest side of pond)									
		Design & Contingency				Annual Cost Over Lifespan Interest Rate = 7%	Operation & Maintenance		Total Capitalized Cost /yr over Lifespan
	Construction Cost	% Const.	Cost	Total	Lifespan (yrs)		% Const.	Cost / yr	
Surface Sand Filter	$62,400	25%	$15,600	$78,000	15	$8,564	12.0%	$7,488	**$16,052**
Underground Sand Filter	$64,800	25%	$16,200	$81,000	15	$8,893	12.0%	$7,776	**$16,669**
Biofilters (e.g. 6 StormTreat)	$72,000	15%	$10,800	$82,800	15	$9,091	5.0%	$3,600	**$12,691**

Option 4: Installation of a media filter that targets bacteria at existing pond outflow pipe.									
		Design & Contingency				Annual Cost Over Lifespan Interest Rate = 7%	Operation & Maintenance (O&M)		Total Capitalized Cost /yr over Lifespan
	Construction Cost *	% Const.	Cost	Total	Lifespan (yrs)		% Const. + replace media filter every 2 yrs	Cost / yr	
Media Filter	$4,901.50	25%	$1,225.38	$6,127	30	$494	2% + $1,100	$731	**$1,225**

*Construction cost includes $3801.5 for construction and $1,100 for cost of media filter.

Option 5: Stormwater wetland on North side of Route 147 (which includes water from Lyman's Brook)									
		Design & Contingency				Annual Cost Over Lifespan Interest Rate = 7%	Operation & Maintenance (O&M)		Total Cost /yr over Lifespan
	Construction Cost	% Const.	Cost	Total	Lifespan (yrs)		% Const.	Cost / yr	
Constructed Wetland	$ 224,000.00	25%	$56,000	$280,000	30	$22,565	4.5%	$10,080	**$33,254**
Estimated CT water quality volume (WQV)=205,000 cf									

Supplemental Practice 1: Buffer 1500' perimeter of Orchard pond in upper watershed of Lyman's Brook				
	Warm Season Grass ($850/ac)	Shrubs / Trees ($2400/ac)	20 % Contingency	**Total Cost**
1500' x 15' (0.5 ac) buffer for goose exclusion: 100% warm season grasses	$425	-	$85	**$510**
1500' x 35' (1.2 ac) buffer for water quality and goose exclusion: 75% warm season grass (0.9 ac) , 25% shrubs/trees (0.3 ac)	$768	$120	$178	**$1,066**

Supplemental Practice 2: Low Impact Development for parking area - catch basin insert, porous pavement							
	Initial Cost	Lifespan* (yrs)	Capitalized cost over Lifespan		Operation & Maintenance (O&M)		**Total Cost / yr**
			Cost / yr	units	Cost / yr	units	
Catch basin insert for bacteria (e.g. AbTech Ultra Urban Filter with Smart Sponge)	$1,100	1 to 3	$420 to $1,100	ea.	$180.00	ea.	**$600 to $1,100**

* lifespan depends on maintenance & loading

Porous pavement	$ 4.10 per sq. ft.

Analysis Area 3 (AA-3)

With 13047.6 acres, Analysis Area 3 covers just over ½ of the total area of the Coginchaug River watershed. Eleven subwatersheds (AA-3.A – AA-3.K) were delineated. The majority of the watershed was classified as forested (50.42%). At 28.40 % development comprised the next largest land use/land cover category, while agricultural lands covered 13.67% of the analysis area. The remaining lands were classified as transitional, other, barren, and water. Suggested place-based BMPs were identified for this analysis area on Map 27.

1. Buffer implementation sites

   For a full description see option one under Analysis Area 1. 141 segments of unbuffered stream were identified. This constitutes a total of 60,208 linear feet.

2. Soil potential for subsurface sewage disposal systems

   As described under Analysis Area 1, soils were evaluated for their potential for installation of private septic systems. The areas identified with medium to extremely low potential should be considered as priorities to investigate and confirm that no septic failures or illicit discharges are taking place. Analysis Area 3 contained 105 acres (407 delineated polygons) mapped as medium to extremely low potential for septic.

3. White's Farm (Dog waste) (subwatershed AA-3.D, AA-3.G)

   White's Farm is an open space parcel, 94 acres in size, in the Town of Durham. The area is used for passive recreation including dog walking. The northern boundary of the parcel abuts Allyn Brook, while the western and southwestern edges of the parcel are adjacent to the wetland complex around Cream Pot Brook. Most of the area where dog walking occurs is located in subwatershed AA-3.G. Implementation of a dog waste collection program could help to decrease the amount of dog waste from entering the brook. The options for dog waste collection systems have been outlined within the watershed-wide BMP section. Based on existing use patterns at the site, any of the methods previously described could be used. From a public education standpoint, conducting a town meeting with dog walkers to discuss BMP options would be helpful to determine which option(s) would be most effective and acceptable. An interactive public meeting would be beneficial also to explain the water quality issues that justify the need for dog waste collection. Ideally multiple collection areas would be set up around the property to facilitate waste collection for dog owners, thus

Map 27: Analysis Area 3

increasing effectiveness. At least one collection site should be located in close proximity to Allyn Brook, as this area is heavily used by dog walkers and it is most prone to pollutant loading. (See Table 21; Wadsworth Pet Waste Stations for associated costs)

4. Equine Operations (5 located in this analysis area)

   Five horse farms are located in this analysis area and a comprehensive farm management plan is recommended for each of these operations, (see Map 27 for the location of each horse operation). With assistance from appropriate agencies, a comprehensive conservation plan, including pasture management, nutrient management and waste management could be developed. For detailed information about specific BMPs that may be implemented please refer to *Agricultural Management Practices for Commercial Equine Operations*, produced by Rutgers University Cooperative Extension. The document may be found on line at www.esc.rutgers.edu. Also, the Horse Environmental Awareness Program (HEAP) may be a source of information and technical support for horse owners. HEAP is a coalition of federal and states agencies, organizations and individuals interested in protecting the environment by educating horse owners on good horse management practices. It has no regulatory authority and its only interest is to help horse owners improve their management practices. Information can be found online at: http://www.ct.nrcs.usda.gov/programs/rc&d/km_heap-program.html

5. Deerfield Farm

   The farm, located on Parmalee Hill Road in Durham, produces raw milk from Jersey cows along with milk-based skin care products. Though the farm does not directly abut any watercourse, a comprehensive farm plan is recommended to address the water quality concerns associated with dairy operations, (see Map 27 for farm location). With assistance from appropriate agencies, a comprehensive conservation plan, including pasture management, nutrient management and waste management could be developed.

6. Greenbacker's Farm

   Greenbacker's Farm is a dairy operation located in Durham. The farm ponds located off of Route 68 are subject to stormwater runoff and contamination from farm livestock and wildlife. Several options exist for addressing water quality concerns associated with the ponds and stream located on the Greenbacker's Farm property.

   a. Goose control through a variety of possible techniques (egg addling, harassment –

dogs, fencing, vegetated buffer). The recommended method for control is the establishment of a vegetated buffer. With relatively low maintenance needs and long-term effectiveness, buffers are the most attractive alternative for the site. While studies have shown that grass and herbaceous buffers are effective on their own, the inclusion of some trees and shrubs may further deter geese from landing in a pond. A minimum buffer width of 15 foot is recommended, although a buffer 30-50' would be preferred because of the surrounding slopes and the amount of pollutant loading. While maintaining vegetation at a height of at least six to eight inches will reduce a goose's interest and ability to find food, taller vegetation decreases the likelihood that geese will use a waterbody at all. A minimum height of 18 to 24 inches would improve buffer effectiveness.

b. Fencing in conjunction with buffer (buffer would be combination of trees and shrubs). Fencing is to keep livestock out of pond. Installation of a livestock watering system, well away from the ponds and wetlands, is a part of this option.

c. Conversion of the existing pond, on the north side of Route 68, into a vegetated wetland complex and the installation of a watering system for the livestock. This option would eliminate use of the area by geese, and would create a mechanism for filtration that could help treat any bacterial contamination in runoff from the pasture. The dam would have to be breeched to a safe level.

d. With assistance from appropriate agencies, a comprehensive conservation plan, including pasture management, nutrient management and waste management could be developed.

Table 24: Greenbacker's Farm Cost Estimates

Option 1: Install a15' buffer around large pond to exclude geese (2,645' x 15' ~ 1 ac)				
	Warm Season Grass ($850/ac)	Shrubs / Trees ($2400/ac)	20 % Contingency	**Total Cost**
2645' x 15' (1 ac) buffer for water quality and goose exclusion: 75% warm season grass, 25% shrubs/trees	$638	$600	$248	**$1,486**
2645' x 30' (2 ac) buffer for water quality and goose exclusion: 75% warm season grass, 25% shrubs/trees	$1275	$1200	$495	**$2970**

Option 2: Install fencing around large and small ponds to keep out livestock. Install livestock watering facility			
Perimeter of small pond = 970 ft		Perimeter of large pond= 2645 ft (total 3615')	
Scenario A: Both ponds surrounded by barbed wire		**Scenario B: Woven wire fence used on large pond to assist in deterring geese, barbed wire around smaller pond**	
3615' of 4/5 strand barbed wire: $5.70/ft	$20,605	2645' of woven wire fence : $10 / ft	$26,450
watering facility	$525	970' of 4/5 strand barbed wire: $5.70/ft	$5,529
100' pipe ($7/ft)	$700	watering facility	$525
15% contingency	$3,275	100' pipe ($7/ft)	$700
Total	**$25,105**	15% contingency	$1013
		Total	**$34,217**
possible additional costs in both scenarios are a well ($6,300 avg.) or a Pumping Plant ($2,500)			

Option 3: Convert large pond into wetland (7ac wetland planting)			
	Wetland Plants ($2,600 / ac)	20% Design & Contingency	**Total**
Herbaceous / grasses planted: 7 ac	$18,200	$ 3,640	**$ 21,840.00**

Analysis Area 4 (AA-4)

Analysis Area 4 contains the land in the southern tip of the Coginchaug River watershed. Forested land, 71.2%, makes up the majority of this area, while development comprises 14.4 percent, and agricultural lands represent 12.4 percent of the area. Two subwatersheds were delineated, AA-4.A, andAA-4.B, splitting the analysis area in a more or less north-south division. Route 77 runs roughly through the center of the watershed in a north south direction. Suggested place-based BMPs were identified for this analysis area on Map 28.

1. Buffer implementation sites:

   For a full description see option one under Analysis Area 1. Forty three segments of unbuffered stream were identified. This constitutes a total of 19,891 linear feet.

2. Soil potential for subsurface sewage disposal systems:

   As described under Analysis Area 1, soils were evaluated for their potential for installation of private septic systems. The areas identified with medium to extremely low potential should be considered as priorities to investigate and confirm that no septic failures or illicit discharges are taking place. Analysis Area 4 contained 24 acres (95 delineated polygons) mapped as medium to extremely low potential for septic.

3. Myer Huber Pond:

   Myer Huber Pond is located at the headwaters of the Coginchaug River. Elevated levels of bacteria have been recorded near this location, as evidenced by the data from the ancillary monitoring station C0R070 located at Bluff Head Road, just down stream from the pond. The source of those bacteria remains undetermined. Residential properties located in Guilford on the east side of the Pond have historically had problems with failed septic systems. The soils for these residential properties are mapped as having a low potential for septic suitability, thus making them more susceptible to potential failure. These problems, according to Town of Guilford Sanitarian, have been addressed and corrected.

   a) Water quality testing at the outlet of the pond is recommended to determine if the bacteria is originating in the pond or entering into the watercourse from a downstream source. If elevated bacteria levels are present in the pond, possible sources may include wildlife such as transient geese or resident beavers.

   b) The adjacent residential septic systems should be dye-tested and monitored to ensure that no failures are occurring.

Map 28: Analysis Area 4

4. Durham Bluff Head Horse Farm With assistance from appropriate agencies, a comprehensive conservation plan, including pasture management, nutrient management and waste management could be developed. It should be noted that from aerial imagery it appears that there is some sort of channel or path connecting the area of the farm to the north end of Myer Huber Pond. Further assessment should be done to determine if any farm runoff is being conveyed to the pond along this pathway. If it is, appropriate measures should be taken to direct or prevent such flows.

5. Wimler's Farm Wimler's Farm is an active dairy agricultural operation. The farm is located at the Guilford/Durham town line. The Coginchaug River flows through the farm and runs along fields that are currently used for pasture as well as crop production. (See Table 25 for costs).
   a. With assistance from appropriate agencies, a comprehensive conservation plan, including pasture management, nutrient management and waste management could be developed.
   b. Without conducting a detailed assessment of the property, recommendations for the site based on observations include the establishment of exclusionary fencing along the Coginchaug River. This would prevent livestock from having direct access to the stream. A watering facility for the livestock should be installed away from the river.
   c. Establishment of a streamside vegetated buffer. Ideally the buffer would be a minimum of 35 feet and would include trees and shrubs. The buffer should extend for the full length of the portion river which abuts the farm. Vegetation should consist of at least 50% tree and shrubs with the remaining 50% in grasses and herbaceous cover. The planting of a buffer would complement the exclusionary fencing previously described.
   d. A parcel of land at the corner of Crooked Hill Road and Route 77 (Guilford Road) is currently used for pasturing livestock. A tributary to the Coginchaug River runs through this parcel. Significant algae were observed in the stream. Part of the stormwater runoff that feeds the stream originates from agricultural fields located on the east side of Route 77 at the end of Crooked Hill Road along with stormwater coming from the subdivisions along Ivy Way, Mica Hill, and Surrey Drive.

The parcel is too small for implementation of any buffering or fencing of the stream while continuing its use for pasture. Purchase of the parcel would be the most effective means for eliminating potential pollutant loading from livestock. Buffering of the stream could be conducted after purchase or the property could be left to re-vegetate naturally. Additional measures could be implemented to minimize loading. Assist the producer to encourage that appropriate agricultural practices and measures are being conducted on the fields to the east.

Table 25: Wimler's Farm Cost Estimates

Option 1: Install a 35' buffer on both sides of stream, 3025' in length				
	Cool Season Grass ($450 /ac)	Shrubs / Trees ($2400/ac)	20 % Contingency	**Total Cost**
3025' x 70' (4.8 ac): 50% grass (2.4 ac); 50% shrubs/trees (2.4 ac)	$1,080	$5,760	$1,368	**$8,208**

Option 2: Land purchase depends on the actual size of the lot(s) that encompass this area			
	Acres	Cost / ac*	**Total Cost**
Purchase of land around stream	4.2 ac	$60,000/ac	**$ 252,000**
Purchase of land around stream + remainder of lot (Lots 15, 16 and 17)	6.71 ac	$60,000/ac	**$ 402,600**

*Estimate based on land values from current town land records

6. Small agricultural operations

   a) Several sheep are penned and kept on a residential property located at the north end of Myer Huber Pond. The home is located on the west side of Route 77. With assistance from appropriate agencies, a comprehensive conservation plan, including pasture management, nutrient management and waste management could be developed.

   b) A small chicken farm operation is located on the east side of Route 77 just north of Myer Huber Pond. With assistance from appropriate agencies, a comprehensive conservation plan, including pasture management, nutrient management and waste management could be developed.

NEXT STEPS

Each component developed for this study was designed to be replicable. While there are advantages to using the components in conjunction with one and other, each can be used as a stand alone element. In some cases not all of the components will provide useful information about watershed conditions. In this sense, groups conducting watershed based planning can employ the applicable components from this study as a foundation for the work in their own watershed.

For the most part, each component uses readily available data. Only the Land Use/Land Cover required the acquisition and creation of additional data, in order to make the dataset as useful as possible. Most of the analyses using these components can be accomplished with minimal field work. Groundtruthing the findings is beneficial, however. The ability to conduct analyses this way decreases the need for a large volunteer corps or for extensive staff time in the field.

The availability of technical and financial resources does present an obstacle to making use of some of the components. Some of the components (e.g. geomorphic assessment and the LULC) do require trained individuals. This might require contracting with professional staff to perform the services or to provide training to staff or volunteers. Groups will need access to a Geographic Information System (refer to Appendix A for a discussion of the GIS used for this study). A significant amount of time, both for staff and volunteers, was required for this plan. It would be difficult to complete a watershed based plan, on this scale, on a strictly volunteer basis or with limited staffing. Finally, sufficient funding would be needed to cover the cost for paid staff as well as any necessary equipment.

At roughly 39 square miles, the Coginchaug study was a fairly ambitious undertaking for the scope of the work and the scale of the watershed. In considering future efforts, it may be more practical to work on a smaller geographic scale. Additional monitoring may make this more attainable. A clearer sense of potential sources will allow groups to focus on the specific contributing areas.

The measure of effectiveness of BMP's is contingent upon current and sufficient water quality data. One of the problems encountered with this watershed based planning effort is the age of the data. The most recent data available was collected in 2004 and portions of the data were collected in 2001.

The second limiting factor is the number of monitoring sites. Five monitoring sites, all along the Coginchaug River mainstem, were used as the basis for the determination of the TMDL that was developed for the river. While this information is invaluable in showing that the river's water quality is degraded, the number of monitoring sites is inadequate to accurately determine the sources of bacterial loading. Because all of the sites are located along the mainstem of the Coginchaug River, there is no way to determine the level of bacterial contribution from tributaries as opposed to the inputs directly into the mainstem.

Data from six ancillary monitoring sites was also available. Three of these sites were located on the Coginchaug mainstem and the other three were situated on tributaries: Ellen Doyle Brook, Lyman's Meadow Brook, and Hans Brook. Though limited in number, the information from the tributaries is significant in illustrating that elevated levels of bacteria are present in tributaries. By establishing a monitoring site for each tributary at the confluence with the Coginchaug, it will be possible to assess how much bacteria, as well as other pollutants, are being transported into the Coginchaug River through its tributary network. This will improve the understanding of the relationship between watershed water quality conditions and watershed land use and land cover conditions. It will enable planners to determine more precisely and with a greater level of confidence the source of pollutant loading down to the subwatershed level. Selection of appropriate place-based BMPs will be improved and potential pollutant removal efficiency enhanced. It is also strongly recommended that a monitoring component be established for each BMP that is implemented, regardless of its location in the watershed, so that the efficiency of the BMP can be determined. This information will be helpful to other watershed planning efforts.

The contributions of an involved and knowledgeable advisory committee can provide valuable local contacts and integrate crucial local knowledge. In addition, we found that the public outreach activities were beneficial. The events got the participants out and into the watershed – they literally got their feet wet. Positive press coverage created an opportunity to expand awareness of the effort, create a larger pool of volunteers for future watershed activities, and inform the public about water quality issues. While the public outreach component was effective, a way to strengthen it would be to organize a series of meetings each designed to focus on the needs of a target group (e.g. professional municipal staff, municipal commission chairs, local land trusts, agricultural producers, etc…).

Below is a proposed schedule of implementation. This schedule, one of the nine criteria required by EPA, can be considered to be a working document, the foundation upon which watershed stakeholders can modify or adapt as necessary. The objectives have not been prioritized.

Table 26: Proposed Schedule of Implementation

Goal	Improved water quality of the Coginchaug River watershed by reducing bacterial contamination and degradation from other non-point source pollutants, including nitrogen.
Objective 1	Identify potential sources of funding (1 year)
Actions/Milestones	Research funding organizations
	Incorporate funding source information into the WBP
	Grant application submitted for specific project
BMPs	N/A
Responsible Parties	CT DEP, NRCS, CRCCD, Municipalities, Private Land owners, NGO's…
Timeline	1 - 3 years
Anticipated Products	Section of WBP with funding potential sources identified.
Estimated Cost	N/A
Evaluation	N/A
Objective 2	Work with the agricultural community to enhance understanding of land stewardship and use of BMPs to protect water quality.
Actions/Milestones	Gather existing educational information for agricultural management, and develop new agricultural management educational materials as needed.
	Create new materials (includes both general information as well as information specific to particular types of agriculture [horse farming, greenhouse operations, etc…])
	Distribute written materials to agricultural operators in the watershed
	Provide materials explaining State (CT DOA, CT DEP) and Federal (USDA) programs
	Advertise the Horse Educations and Awareness Program (HEAP and work to involve horse farm operation in HEAP
	Conduct workshops dependent upon interest and need.
	Obtain funding to produce and distribute materials and to conduct workshops.
BMPs	Educational materials and workshops.
Responsible Parties	CRCCD, NRCS, RC&D, CT DOA, CT DEP, FSA, AFT, Farm Bureau
Timeline	1 - 10 years
Anticipated Products	Educational materials
Estimated Cost	N/A
Evaluation	Surveys regarding product effectiveness, participant feedback, surveys.
Timeline	1 - 10 years

Objective 3	Build awareness of nonpoint source management practices and reduce nonpoint source contributions from residential areas through development and distribution of educational materials.
Actions/Milestones	Collect existing educational materials
	Develop new and/or revise existing materials as needed.
	Distribute materials to residential and urban watershed residents
	Conduct workshops focusing on non-point source issues
	Obtain funding to produce and distribute materials and to conduct workshops.
BMPs	
Responsible Parties	CRCCD, NRCS, CT DEP, CT Forest and Parks Assoc., Jonah Center, Middlesex Land Trust, Municipalities
Timeline	1 - 10 years
Anticipated Products	Educational materials and workshops.
Estimated Cost	N/A
Evaluation	Surveys regarding product effectiveness, participant feedback, surveys.
Timeline	1 - 10 years

Objective 4	Establish riparian buffers in priority areas
Actions/Milestones	Identify priority sites for establishment of buffers Contact landowners to obtain determine level of interest, cooperation, and obtain permission
	Obtain funding for implementation of five (5) buffer sites
	Design the riparian plantings (develop a painting plan)
	Plant the buffers
	Water quality monitoring
BMPs	Established buffers
Responsible Parties	CRCCD, NRCS, CT DEP, land owners, Municipalities
Timeline	2 - 4 years
Anticipated Products	Planting/Buffer design plans, before-after photo documentation of sites
Estimated Cost	$450/ac - $2,400/ac (dependent on materials selected)
Evaluation	Photo documentation. Pre-post water quality monitoring of sites, documentation of number of sites and the linear feet buffered
Timeline	3 - 6 years

Objective 5	Address pollution from failing septic systems and illicit discharges in priority areas
Actions/Milestones	Work with Town sanitarians to evaluate the residential septic systems in the priority areas as defined by the WBP
	Provide educational materials regarding septic system maintenance and municipal ordinances
	Prioritize areas for assessment
	Asses the sites
	Report findings
	Select sites for repair or enforcement
	Work with landowners to implement repairs
	Select and hire contractors
	Repair systems
BMPs	Repaired septic systems and eliminated illicit discharges
Responsible Parties	Municipalities (Town Sanitarians), landowners
Timeline	5 - 10 years
Anticipated Products	Fixed septic systems, elimination of illicit discharges
Estimated Cost	N/A
Evaluation	Photo-documentation, sanitarian confirmation, municipal testing and monitoring
Timeline	1 - 3 years

Objective 6	Implement ongoing water quality monitoring program in the watershed to develop baseline conditions and measure changes pre and post BMP implementation.
Actions/Milestones	Identify specific locations for monitoring (10 - 15 sites). Sites should include at least one location (e.g. confluence) for each of the tributaries to the mainstem and some sites along the minister
	Obtain funding for monitoring program
	Develop monitoring parameters and program details
	Train volunteers (if necessary)
	Monitor sites
	Report results
BMPs	Report that improves knowledge of originating locations of bacteria and other nps pollutants
Responsible Parties	CT DEP, USGS, CRCCD, Local stakeholders, Municipalities
Timeline	1 - 5 years
Anticipated Products	Monitoring data, report describing data, recommendations for focus areas
Estimated Cost	
Evaluation	Review data with appropriate agencies
Timeline	1 year

Objective 7	Implement Place Based BMPs - structural and non-structural measures, to reduce bacteria loading along with nitrogen and other nps pollutants.
Actions/Milestones	Prioritize place-based sites
	Select sites and contact landowners to determine level of interest and cooperation
	Apply for grants and funding; obtain funding
	Develop design for structural BMP implementation
	Develop implementation plan for non-structural measures
	Obtain proper permits
	Construct structural measures; implement non-structural measures
	Monitoring program to assess practice effectiveness
BMPs	Construction of structural practices (e.g. stormwater wetlands, stormwater treatment units.) implementation of non structural practices (e.g. street sweeping, dog waste management, etc…)
Responsible Parties	Municipalities, CRCCD, NRCS, local stakeholders
Timeline	3 - 6 years
Anticipated Products	Monitoring report, Photo documentation, site design plans
Estimated Cost	See cost estimates in report.
Evaluation	Document number of sites, monitoring data to show effectiveness, quantify level of pollutants (e.g. sediment, animal feces, etc…) removed
Timeline	2 - 10 years

Objective 8	Strengthen municipal land use regulations and Plans of Conservation and Development to protect water quality and minimize future water quality degradation issues.
Actions/Milestones	Review the findings of the Regulations review (conducted as part of the WBP effort) with municipal officials and commissions (Examine regulations including but not limited to zoning, subdivision, wetlands, erosion and sedimentation, …)
	Gather existing model regulations to present to local officials and commission members
	Work with local staff and commissions to develop regulations and language that reflect the interests of the local communities
	Adoption of the new language, amendments, and regulations
BMPs	Provide information regarding water quality, implementation municipal control measures
Responsible Parties	Municipalities, CRCCD, NRCS, CT DEP
Timeline	2 - 10 years
Anticipated Products	Municipal regulations and language incorporated into municipal regulations
Estimated Cost	N/A
Evaluation	Work with municipal staff, commission members, and developers to ascertain effectiveness, challenges and opportunities.
Timeline	3 - 5 years

Funding Sources

A table of potential funding sources was developed by DEP, with assistance of NRCS. (See Table 27). The funding entities and grant programs listed in the table is not necessarily a complete list. Watershed stakeholders can use the table as a starting point to seek funding opportunities for implementation of the BMP recommendations in this report. The recommendations in this report will support future grant proposals by demonstrating a comprehensive analysis of watershed conditions and presenting options for addressing identified concerns. Moreover, the table can be considered a dynamic document. Modifications can be made to reflect changes to the availability of funding or changes to the funding cycle, and to include other funding entities or grant programs.

Table 27: Potential Funding Sources

Funding Source	Maximum Dollar amount	Minimum Dollar amount	Required match	Applications Open	Deadline
DEP Watershed Funding Website					
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=335494&depNav_GID=1654&pp=12&n=1 Index of many potential funding sources for funding watershed-based planning projects.					
DEP CT Landowner Incentive Program	up to $25,000	at least 25%			
http://www.ct.gov/dep/cwp/view.asp?a=2723&q=325734&depNav_GID=1655					
DEP Long Island Sound License Plate Program	$25,000			January	March
http://www.ct.gov/dep/cwp/view.asp?a=2705&q=323782&depNav_GID=1635					
DEP Open Space and Watershed Land Acquisition				March	June
860-424-3016 david.stygar@ct.gov http://www.ct.gov/dep/cwp/view.asp?a=2706&q=323834&depNav_GID=1641					
DEP Recreation and Natural Heritage Trust Program					
http://www.ct.gov/dep/cwp/view.asp?a=2706&q=323840&depNav_GID=1641					
Eastman Kodak / Nat'l Geographic American Greenways Awards optional Program	$2500	$500	Optional	April	June
jwhite@conservationfund.org, Jen White					
EPA Healthy Communities Grant Program	$35,000	$5,000	optional, up to 5%	March	May
617-918-1698 Padula.Jennifer@epa.gov					
Northeast Utilities Environmental Community Grant Program	$250	$1,000			15-Apr
http://www.nu.com/environmental/grant.asp Cash incentives for non-profit organizations					
EPA Targeted Watershed Grants Program			25% of total project costs (non-federal)		
http://www.epa.gov/twg/ Requires Governor nomination.					

Funding Source	Maximum Dollar amount	Minimum Dollar amount	Required match	Applications Open	Deadline
DEP CWA Section 319 NPS			40% of total project costs (non-federal)		October 15
Nonpoint Source Management http://www.ct.gov/dep/nps 20-25 projects targeting both priority watersheds and statewide issues.					
DEP Section 6217 Coastal NPS			N/A		
http://www.ct.gov/dep/cwp/view.asp?a=2705&q=323554&depNav_GID=1709 Section 6217 of the CZARA of 1990 requires the State of Connecticut to implement specific management measures to control NPS pollution in coastal waters. Management measures are economically achievable measures that reflect the best available technology for reducing nonpoint source pollution.					
DEP Hazard Mitigation Grant Program			75% Federal/25% Local		
http://www.ct.gov/dep/cwp/view.asp?a=2720&q=325654&depNav_GID=1654 Provides financial assistance to state and local governments for projects that reduce or eliminate the long-term risk to human life and property from the effects from natural hazards.					
American Rivers-NOAA Community-Based Restoration Program Partnership					
http://www.amrivers.org/feature/restorationgrants.htm These grants are designed to provide support for local communities that are utilizing dam removal or fish passage to restore and protect the ecological integrity of their rivers and improve freshwater habitats important to migratory fish.					
FishAmerica Foundation Conservation Grants	average $7,500				
703-519-9691 x247 fishamerica@asafishing.org					
Municipal Flood & Erosion Control Board	1/3 project cost	2/3 project costs			
NFWF Long Island Sound Futures Fund Small Grants	$6,000	$1,000	optional (non-federal)	Fall	February
631-289-0150 Lynn Dwyer LISFFAnfwf.org					
NFWF Long Island Sound Futures Fund Large Grants	$150,000	$10,000	optional(non-federal)	Fall	February
631-289-0150 Lynn Dwyer LISFFAnfwf.org					
NRCS Conservation Reserve Program					
Jan Dybdahl, (860) 871-4018 http://www.ct.nrcs.usda.gov					
NRCS Wildlife Habitat Incentives Program (WHIP)	$50,000/year	$1,000	25%		
Jan Dybdahl, (860) 871-4018 http://www.ct.nrcs.usda.gov For creation, enhancement, maintenance of wildlife habitat; for privately owned lands.					
NRCS Environmental Quality Incentives Program (EQIP)	$50,000/year		25 - 50%		
Jan Dybdahl, (860) 871-4018 http://www.ct.nrcs.usda.gov For implementation of conservation measures on agricultural lands.					
NRCS Healthy Forests Reserve Program					
For restoring and enhancing forest ecosystems http://www.nrcs.usda.gov/programs/HFRP/ProgInfo/Index.html					
NRCS Wetlands Reserve Program					
Nels Barrett, (860) 871-4015 http://www.ct.nrcs.usda.gov For protection, restoration and enhancement of wetlands					

Funding Source	**Maximum Dollar amount**	**Minimum Dollar amount**	**Required match**	**Applications Open**	**Deadline**
USFS Watershed and Clean Water Action and Forestry Innovation Grants					
http://www.na.fs.fed.us/watershed/gp_innovation.shtm This effort between USDA FS-Northeastern Area and State Foresters to implement a challenge grant program to promote watershed health through support of state and local restoration and protection efforts.					
Corporate Wetlands Restoration Partnership (CWRP)	typically $20,000	typically $5,000	3 to 1	April and August	
http://www.ctcwrp.org/9/ Can also apply for in-kind services, e.g. surveying, etc.					
DEP 319 NPS Watershed Assistance Small Grant			40% of total project costs (non-federal)		
860-361-9349 rivers@riversalliance.org					
Trout Unlimited EmbraceAStream	$5,000				
USFWS National Coastal Wetlands Conservation Grant Program	$1 million		50%		
Ken Burton 703-358-2229 Only states can apply.1					
YSI Foundation	$60,000		optional	March	April
937-767-7241 x406 Susan Miller Susan Miller smiller@ysi.com					
Grants Program	$2,500	$500			November
(860) 347-0340					
Other Financial Opportunities					
Private Foundation Grants and Awards					
http://www.rivernetwork.org Private foundations are potential sources of funding to support watershed management activities. Many private foundations post grant guidelines on websites. Two online resources for researching sources of potential funding are provided in the contact information.					
Congressional Appropriation - Direct Federal Funding					
Congressman Larson, Courtney, DeLauro, Shays, Murphy					
State Appropriations - Direct State Funding					
http://www.cga.ct.gov/					
Membership Drives					
Membership drives can provide a stable source of income to support watershed management programs.					
Donations					
Donations can be a major source of revenue for supporting watershed activities, and can be received in a variety of ways.					
User Fees, Taxes, and Assessments					
Taxes are used to fund activities that do not provide a specific benefit, but provide a more general benefit to the community.					
Rates and Charges					
Alabama law authorizes some public utilities to collect rates and charges for the services they provide.					
Stormwater Utility Districts					
A stormwater utility district is a legal construction that allows municipalities to designated management districts where storm sewers are maintained in order to the quality of local waters. Once the district is established, the municipality may assess a fee to all property owners.					
Impact Fees					
Impact fees are also known as capital contribution, facilities fees, or system development charges, among other names.					

Special Assessments	
Special assessments are created for the specific purpose of financing capital improvements, such as provisions, to serve a specific area.	
Sales Tax/Local Option Sales Tax	
Local governments, both cities and counties, have the authority to add additional taxes. Local governments can use tax revenues to provide funding for a variety of projects and activities.	
Property Tax	
These taxes generally support a significant portion of a county's or municipality's non-public enterprise activities.	
Excise Taxes	
These taxes require special legislation, and the funds generated through the tax are limited to specific uses: lodging, food, etc.	
Bonds and Loans	
Bonds and loans can be used to finance capital improvements. These programs are appropriate for local governments and utilities to support capital projects.	
Investment Income	
Some organizations have elected to establish their own foundations or endowment funds to provide long-term funding stability. Endowment funds can be established and managed by a single organization-specific foundation or an organization may elect to have a community foundation to hold and administer its endowment. With an endowment fund, the principal or actual cash raised is invested. The organization may elect to tap into the principal under certain established circumstances.	
Emerging Opportunities For Program Support	
Water Quality Trading	
Trading allows regulated entities to purchase credits for pollutant reductions in the watershed or a specified part of the watershed to meet or exceed regulatory or voluntary goals. There are a number of variations for water quality credit trading frameworks. Credits can be traded, or bought and sold, between point sources only, between NPSs only, or between point sources and NPSs.	
Mitigation and Conservation Banking	
Mitigation and Conservation banks are created by property owners who restore and/or preserve their land in its natural condition. Such banks have been developed by public, nonprofit, and private entities. In exchange for preserving the land, the "bankers" get permission from appropriate state and federal agencies to sell mitigation banking credits to developers wanting to mitigate the impacts of proposed development. By purchasing the mitigation bank credits, the developer avoids having to mitigate the impacts of their development on site. Public and nonprofit mitigation banks may use the funds generated from the sale of the credits to fund the purchase of additional land for preservation and/or for the restoration of the lands to a natural state.	

INTERIM MILESTONES

Described below are interim, measureable, milestones that may be used to ascertain the progress that the Coginchaug River watershed communities are making over time toward reducing bacteria and nitrogen loading. The primary goal of reducing the bacteria and nitrogen loading is to attain the water quality standards for the Coginchaug River Watershed as outlined in the Mattabesset TMDL. The milestones, and the progress marked, will also provide an indication of whether the TMDL should be revised. Working toward the goals of the TMDL will enable the communities to be eligible for future Section 319 grant funds.

It is not anticipated that each community will implement each of these measures. The intent of the milestones is to present attainable goals to the local communities that will help to increase awareness and understanding of potential pollution sources in the watershed. Through improved understanding, municipalities and individuals can focus on ways to minimize potential threats. The development of new policies and programs, and the amendment of local regulations can help municipalities proactively address potential water quality concerns that arise as part of the growth process in their community. Not every objective is expected to be met, with the exception of those that are required pursuant to State stormwater discharge permits. All efforts to restore, remediate, renovate or retrofit existing or potential threats are encouraged as resources and funding allow.

- Municipal compliance with the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4)
    - ♦ Six Minimum Control Measures:
        - Public Education and Outreach on stormwater impacts and Best Management Practices (BMPs)
        - Public Participation/Involvement
        - Detection and Elimination of Illicit Discharges
        - Construction Site Stormwater Runoff Control BMPs
        - Post-construction Stormwater Management BMPs for new development and redevelopment
    - ♦ Pollution Prevention/Good Housekeeping BMPs for municipal operations
- Stormwater Monitoring

- ♦ a total of six (6) outfalls, (two outfalls each), shall be monitored annually from areas of: industrial development, commercial development and residential development, according to the parameters identified in the MS4 General Permit
- Municipal compliance with the General Permit for the Discharge of Stormwater Associated with Industrial Activities ♦ Permit Coverage applies to public works facilities, transfer stations, and road salt storage sites
  - ♦ Preparation & Implementation of Pollution Prevention Plan to address sources of pollution ♦ Sample stormwater discharges annually
- Indication of pollutant load reductions of bacteria and nitrogen based on water quality monitoring. This is to be provided by either DEP; municipalities in accordance with the requirements of the MS4 General Permit; or other entities, e.g. U.S. Geological Survey, Connecticut River Coastal Conservation District, academic institutions, volunteer watershed organizations, etc..
- Municipal adoption of ordinances/regulations that allow for new, innovative or emerging technologies or construction techniques and other practices. The goal is to reduce and minimize nonpoint source pollution runoff and to preserve the predevelopment hydrology of a site. These techniques and technologies may include:
  - ♦ structural and non-structural measures such as stormwater treatment retrofits and secondary treatment practices
  - ♦ reduction of land disturbance to decrease compaction and runoff
  - ♦ infiltration measures
  - ♦ use of existing natural buffers, and establishment of vegetative plantings or preservation of open space (a.k.a. Low Impact Development).
- Municipal adoption of impervious surface ordinances/regulations. These ordinances/regulations would limit the amount of impervious cover allowed for new site development or redevelopment, and include site design requirements that promote infiltration (where appropriate) and decrease the amount of effective impervious surface (i.e. direct discharge of stormwater runoff into surface water bodies).
- Municipal adoption of zoning or planning & zoning ordinances/regulations requiring project construction design and post-construction operation in accordance with, or in reference to the 2004 Connecticut Stormwater Quality Manual

- Municipal adoption of illicit discharge and stormwater connection ordinance/regulation (see DEP's 2004 Connecticut Stormwater Quality Manual, Appendix C http://www.ct.gov/dep/lib/dep/water_regulating_and_discharges/stormwater/manual/Apx_C_Model_Ordinances.pdf)
- Municipal adoption of septic system inspection and maintenance ordinance/regulation/policy.
- Development and adoption of homeowner septic system educational management program.
- Municipal adoption of policy on the avoidance of fertilizer use in or near wetlands, riparian buffer areas and watercourses
- Municipal adoption of riparian buffer ordinance/regulation/policy to conserve or preserve natural vegetation along rivers and streams, especially in areas that have a high potential for pollution sources. Restoration of buffers should follow guidance given in DEP white paper on Hydraulic Impacts of Re-Vegetation Projects within Floodplains August 2002, for the appropriate choice of floodplain vegetation for hydraulic conveyance.
- Adoption or revision of municipal Plan of Conservation and Development to include a goal to protect water quality now and in the future.
- Municipal adoption and use of updated Land Use/Land Cover maps as reference for land use commissions and Plan of Conservation and Development.
- Municipal adoption of ordinance/regulation/policy to ban the feeding of nuisance wildlife (e.g. geese). This ordinance/regulation/policy should include a public education and outreach component.
- Municipal adoption of ordinance/regulation/policy to require proper disposal of pet waste. This ordinance/regulation/policy should include a public education and outreach component.
- Adoption/revision and implementation of a comprehensive farm management plan for all agricultural operations. This includes pasture management and waste management plans.
- Municipal adoption and implementation of a policy or program to preserve open space, including farmland.
- Consistency of land use ordinances/regulations/policies among Coginchaug River Watershed municipalities

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APPENDICES

Appendix A: Land use/ land cover

Methodology and LULC Tables

Objective

The main objective of the Coginchaug River Watershed Land Use / Land Cover data set developed by CT NRCS, (NRCS LULC), was to provide a foundation for the Watershed Based Plan for the Coginchaug River Watershed. The focus of the resulting plan is the design of Best Management Practices which address nonpoint source pollutants in the most efficient manner; specifically pathogens (bacteria) and nutrients (Nitrogen and Phosphorous). With this in mind, the NRCS LULC classification scheme was designed to separate out classes of land cover by their potential impacts on the levels of these pollutants entering into surface water and/or ground water. In cases where use of the land was determined to be an important variable, the classification scheme was expanded to include use as well as cover.

Imagery

The imagery used for remote sensing was of several years and differing resolution. The primary base imagery used was the 1990-1992 leaf-off b/w Orthophoto osaic for Middlesex County, Connecticut, 1 m resolution. The true-color, leaf-on, 2005 NAIP FSA-APFO compliance imagery, 2 m resolution was used to detect change in cover or use. Additionally, the 2004 Connecticut Statewide Digital Orthophoto Mosaic, 0.8 ft spatial resolution was used to discern specific use and cover. This imagery was not available to CT NRCS to use directly in GIS, so a multiple screen approach was used to compare this higher resolution imagery, available on a website, to the geo-referenced imagery and polygons in the GIS.

Quality Control

Approximately 4% of the polygons were field checked when cover or use could not be discerned through remote sensing. An additional 3% was verified through ground truthing of a random sample. The entire dataset was reviewed by an advisory committee made up of local landowners.

General Approach

The intended use of data controlled the structure of the classification scheme for the NRCS LULC. Data that could be captured in separate data sets, such as ownership of lands, easements, political boundaries, etc., were not classified in this one. Also, the classification of wetlands is not considered here, but the cover over the wetland, (e.g. forest, shrub or herbaceous), is the dominant consideration. The 34 classes in this data set will be used to consider land use/land cover by its potential affect on water quality issues. The classification scheme is loosely modeled upon the Anderson Classification System, with consideration given to definitions found in the National Resource Inventory glossary, USDA NRCS 2004; and the National Land Cover Dataset, U.S. Geological Survey 1999.

The University of Connecticut Center for Land Use Education and Research data set, 2002, (CLEAR 2002), was used as a resource base. We found that we were unable to use the CLEAR 2002 data set directly as the foundation land use / land cover data set for our analysis. The methodology of spectral reflectance used in the CLEAR 2002 processing creates a data set that classifies land based upon the color value of a 30 sq m pixel of satellite imagery. Thus, each pixel's value is based upon the spectral value that is dominant in a 0.22 acre square. In our initial analysis of the CLEAR data, we were able to see that the data was not only several years out of date, but it also did not have enough resolution to capture the diversity of land cover that is found on Connecticut's landscape at the scale at which we were working.

Also, the CLEAR 2002 data set was not designed to ascertain land use from land cover. In the NRCS LULC data set, detailed classes of land use were used to separate and recombine classes of CLEAR 2002 data. For example, land use categories such as "Developed: Other: - golf course", "Developed: Residential-low density", and "Agriculture: Non-cultivated" partially replace the CLEAR 2002 land cover category of "Turf and Grass". The CLEAR 2002 dataset was found to be particularly useful in determining forest type and as a quality control reference.

Specific Approach

The NRCS LULC was developed using ESRI ArcGIS 8.3. The base imagery was in UTM NAD 1983 zone 18, so all data layers were projected to match. Vector data sets were imported into a personal geodatabase in order to facilitate the calculation of acres. A simple field computation was used to calculate the field "Acres" from the field "Shape_Area" (Acres=[Shape_Area] *0.000247105381). A topology was used to eliminate polygon node errors.

The boundary of the watershed was defined by the dataset "Basins" maintained by the CT DEP on their website (http://dep.state.ct.us/gis/Data/data.asp). The seven digit basin codes were used to label the local basins for individual study. For the NRCS LULC, the polygons of the local basins contained within Allyn Brook (4605), Sawmill Brook (4606 only) and Coginchaug River (4607) were merged to form the outer boundary of the watershed. This single polygon was edited to classify the land use and land cover.

The Attribute table for the LULC was designed to contain three levels of classification, area measurement and a label. The definitions for these classifications can be found in Appendix A; an example of the attribute table can be seen below. All polygons were classified at least to Level II; some were further classified to Level III. The label field was calculated to be equal to the highest level of classification of each polygon. By attributing each polygon with levels of classification, it will be simple to display the data set at Level I, Level II or complete classification.

Attributes of Coginchaug LU/LC

OBJECTID*	Shape*	Id	Level_1_c	Level_II_c	Level_IIIc	Label	Acres	Shape_Area
3	Polygon	0	b	bm		bm	119.235190	482527.
4	Polygon	0	d	dc		dc	32.137983	130057.
13	Polygon	0	w	wl		wl	1.086255	4395.
16	Polygon	0	a	ap		ap	4.451177	18013.
18	Polygon	0	d	do	dob	dob	3.205866	12973.

Table 28: Attribute Table for Land Use / Land Cover Categories

Level I	Level II	Level III	Symbol	Definition
DEVELOPED			**D**	Developed Land includes areas where much of the land is covered by impervious or artificially compacted surfaces. Included in this category are residential developments, strip developments, shopping centers, industrial and commercial complexes, transportation corridors, active recreational areas and other artificial surfaces. There is a minimum density of 20% cover of constructed materials.
	Residential		**dr**	This unit includes property that has been removed from the rural land base through the erection of residential structures. The unit includes areas ranging from urban centers of multi-unit structures to suburban developments, to less dense, rural residential areas. Constructed materials account for at least 20% of the cover. The delineation includes associated land that is tied to the residential use through fencing, pavement or intensive landscaping. *Note: the 20% threshold was determined through a combination of sources: NLCD uses 30 -80%; NRI calls for 5 structures (each with a min. of .25ac) per 2,640' of road. Using a 100' lot depth, this is a density of 20%. There is no gradation between High and Low density in NRI*
		High density	**drh**	This unit is typically made up of multiple-unit structures of urban cores or residential areas that are between 75% and 100% constructed material cover type.
		Low density	**drl**	This unit is typically comprised of residences outside of urban centers that exceed the threshold of 20% cover of constructed material, but do not meet the requirement of High Density Residential.
	Commercial		**dc**	This unit includes urban central business districts, shopping centers, and commercial strip. Institutional land uses, such as educational, religious, health, correctional, and military facilities are also components of this category. Also included are the secondary structures and areas – such as warehouses, driveways, parking lots and landscape areas. Large associated recreation areas (ball fields, etc) will be classified under Other Urban. Pumping stations, electric substations, and areas used for radio, radar, or television antennas are included if they meet the minimum mapping size.
	Industrial		**di**	This unit includes land uses such as light manufacturing complexes, heavy manufacturing plants and their associated, adjacent areas such as parking lots, storage facilities and properties that have been removed from the rural land base through fencing or intensive landscaping.
DEVELOPED	Transportation		**dt**	This unit includes areas whose use is dedicated to transportation outside of developed areas. Along with roadways and railroad corridors, this includes rights-of-way, areas used for interchanges, and service and terminal facilities. Rail facilities include stations and parking lots. Airport facilities include the runways, intervening land, terminals, service buildings, navigation aids, fuel storage, and parking lots.
	Mixed Urban		**dm**	This unit captures areas with a mixture of uses, such as residential, commercial and/or industrial where more than a one-third intermixture of another use or uses occurs in a specific area. Also included are areas where the individual uses cannot be separated at the mapping scale.
	Other Urban		**do**	This unit typically consists of uses such as golf courses, urban parks, cemeteries, waste dumps, grassed water-control structures and spillways, ski areas, and undeveloped land within an urban setting that is greater than ### in size. The category does not require that there be structures in place if the land is in very intensive use and resulting compaction can be expected.
	Other Urban	Ball Fields	**dob**	Baseball, soccer, football and other heavily used active recreation areas
		Cemeteries	**doc**	Self-explanatory
		Golf Courses	**dog**	Self-explanatory
		Landfills/dumps	**dol**	Self-explanatory
		Playgrounds	**dop**	Self-explanatory
		Compacted grasses	**dok**	This includes open, unwooded areas of active recreational areas such as ski slopes, grassy areas in parks or other grassed areas without intensive use (such as grassed water control structures)
AGRICULTURE			**a**	Agricultural Land may be defined broadly, as land used primarily for production of food and fiber. When lands produce economic commodities as a function of their wild state such as wild rice or certain forest products they should be included in

Level I	Level II	Level III	Symbol	Definition
				the appropriate Land Cover category (e.g. Forestland).
	Cultivated		**ac**	Cultivated land includes areas in row crops or close-grown crops under annual tillage.
	Non-cultivated		**an**	Non-cultivated cropland is comprised primarily of hayland. The crop may be grasses, legumes, or a combination of both. Hayland also includes land that is in set-aside or other short-term agricultural programs, and is generally mowed annually.
	Pasture		**ap**	This unit is comprised of land associated with an agricultural use that is primarily in herbaceous cover – usually a grass mixture.
	Pasture-grazed		**ag**	This unit is comprised of land associated with an agricultural use that is primarily in herbaceous cover – usually a grass mixture. In this unit, there is a known use of animal grazing.
	Orchards, Berry Fruit, Vineyards		**ao**	This unit is comprised of fields used for the production of fruit grown on trees, shrubs or vines.
	Nurseries (fields)		**au**	This unit includes fields used for commercial production of shrubs, flowers, trees and other vegetation that is generally sold intact (not for the fruit/seed).
	Farmsteads, Greenhouses, Stables, Barns, Corrals		**af**	This unit includes areas with structures that are associated with an agricultural enterprise. This includes commercial greenhouse complexes as well as the houses, barns and outbuildings that are associated with an active farmstead.
TRANSITIONAL AREAS			**t**	A vegetated area that does not meet the definition of other vegetated cover (forest, agriculture). A clearly defined use cannot be ascribed through remote sensing. There is the potential for the land cover and or land use to change in the future.
	Mixed herbaceous and/or shrub		**tm**	This unit is typically former croplands or pastures that now have grown up in brush in transition back to forest. The land is no longer identifiable as cropland or pasture from imagery
	Recently logged, or partial canopy <25%		**tl**	This unit is typically either former cropland or pasture which have passed through the brush stage and is now sparsely treed (not meeting the 25% canopy cover); or it is forestland that has been recently logged. The land is no longer identifiable as forestland, cropland or pasture from imagery.
	Recently clear-cut		**tc**	This unit captures areas that were forested and are currently completely cleared – stumps may or may not be present.
FOREST LAND			**f**	Forest Lands have a tree-crown areal density of 25 percent or more, which equates to 10 percent stocked by single-stemmed woody species of any size that will be at least 4 meters (13 feet) tall at maturity. The area must be at least 100 feet to be classified as forestland.
	Deciduous		**fd**	Deciduous Forest Land includes all forested areas having a predominance of trees that lose their leaves at the end of the frost-free season or at the beginning of a dry season.
	Coniferous		**fc**	Evergreen Forest Land includes all forested areas in which the trees are predominantly those which remain green throughout the year.
	Mixed Deciduous/ Coniferous		**fm**	When more than one-third intermixture of either evergreen or deciduous species occurs in a specific area, it is classified as Mixed Forest Land.
WATER			**w**	Water includes all areas that are persistently water covered.
	Streams & canals		**ws**	The Streams and Canals category includes rivers, creeks, canals, and other linear water bodies. Where the watercourse is interrupted by a control structure, the impounded area will be placed in the Reservoirs category.
WATER	Lakes & ponds		**wl**	A natural inland body of water, fresh or salt, extending over 40 acres or more and occupying a basin or hollow on the earth's surface, which may or may not have a current or single direction of flow.
	Reservoirs – artificial waterbodies		**wr**	A pond, lake, basin, or other space, created in whole or in part by the building of engineering structures, which is used for the storage, regulation, and control of water.
BARREN			**b**	This unit is comprised of land with limited capacity to support life and having less than 5 percent vegetative cover. Vegetation, if present, is widely spaced.
	Beaches		**bb**	This unit includes the area adjacent to the shore of an ocean, sea, large river, or lake that is washed by the tide or waves.

Level I	Level II	Level III	Symbol	Definition
BARREN	Strip mines, Quarries, Pits		**bm**	This unit includes land that is actively used for extraction of ores, minerals, and rock materials.
	Permanently bare soil/rock		**br**	This unit consists of areas that are large enough to meet size requirements, and that consist of permanently bare rock or soil.
OTHER			**o**	This category encompasses land that does not have a defined use under earlier classifications. It is not designed as a 'catch-all' and should be used to classify areas that are un-forested and rural (undeveloped) and likely to remain so – for instance: wetlands, areas known to be under conservation wildlife easement, etc.
	Herbaceous cover		**oh**	This unit is comprised of land that has an herbaceous cover, but is not directly associated with an agricultural enterprise. Some ancillary data (e.g. ownership, easements, etc) was used to differentiate this area from agricultural grasslands. This also includes wetland areas that are in herbaceous cover
	Scrub Shrub cover		**os**	This unit is comprised of land that has a mixed herbaceous/shrub cover, but is in a relatively permanent use category. The number of acres of any one use may not be significant so they will be mapped together. Examples include well fields, and scrub-shrub wetlands.
	Scrub-shrub, Right of Way		**osu**	This unit is comprised of land that has a mixed herbaceous/shrub cover, and is artificially maintained in the permanent-use category of utility right of way.

This set of definitions was developed for the watershed planning group with certain criteria in mind. The product that will ultimately be derived from the dataset collected will be addressing water quality issues – specifically NPS pollutants, N, P, sediment and bacteria. As such, the classification was designed to separate out land cover and land use by its potential affect on these issues. Data that could be captured in separate datasets was not classified in this one. Therefore, the classification of wetlands will come through a combination of the inland wetland soils database, the land cover types classified here and any ground-truthing or further information gathered through the wetland assessment protocol. General values for percentage impervious surface will likely be assigned based upon the artificial cover types classified under Developed Lands. The presence/absence of pollutants could be affected by the use of the land. Therefore, areas where fertilizers and nutrients may be applied were separated from areas where there are animals actively grazing and also from areas that are currently fallow or abandoned.

Throughout the data collection, a variety of resource materials were used to support the remote sensing of the imagery. Most of these data layers are available over the internet. A list of data sets used and available from the CT DEP GIS website is included in Appendix B. Data that is owned by government agencies, (e.g. the Common Land Unit data set, USDA FSA), may not be available to the general public. The information that is contained in this data can be very important. When classifying land uses such as farmsteads and greenhouses in areas where the land use is intertwined with other commercial or residential uses, the CLU data provided ownership information that tied land to an agricultural interest.

Some towns (such as Middletown) have online GIS utilities which provided additional information such as ownership and zoning information. Although the data could not be downloaded and imported into GIS, it was useful enough to warrant running multiple screens (more than one computer) in order to visually compare imagery and data. Some towns provided parcel information or zoning information in ".pdf" format. The town of Durham's parcel maps were printed and manually mosaicked, and they provided the data collector with the ability to further refine polygons based upon ownership.

Other data layers that provided invaluable information include layers that show municipally owned lands, state-owned lands and natural resource information. By loading the CT Soil Survey data layer, we were frequently able to improve interpretation of unusual sites such as bare rock, beaches, wet soils vs. coniferous forests, etc. Since the wetlands were not delineated in this data set, we did not have to worry about matching or conflicting with existing wetland data layers. However, during the classification, we were able to refer to wetland maps in the GIS. The category 'Other' was the classification used for herbaceous or scrub-shrub wetlands such as the meadows in Durham.

Topographic layers were useful to find rural residences and to pick out cultural features like cemeteries and public institutions like schools or hospitals. As with all data layers, the user must be careful to remember that the original mapping scale of the data set will control the level of accuracy at which it can be used. Therefore, the topographic maps which were generated at 1:100,000 may appear to be mis-aligned with the soils information that was mapped at 1:12,000. Likewise, zooming in beyond the scale of 1:12,000 may show soil lines to be out of place on the imagery. The NRCS LULC was mapped on-screen at approximately 1:6,000. A minimum mapping unit of 1 acre was adhered to except in cases of small water bodies which may have an impact on water quality or be affected by NPS.

Table 29: Resource Data Layers

An important consideration when starting out is to decide which coordinate system you will be working in. Below is a list of data layers used in NRCS GIS analysis of the Coginchaug Watershed. As stated in the text, all data was reprojected to UTM NAD 1983, zone 18. In this table, the Data Layer Source column shows where this data is available to the public. It may also be available in other places, and may have been projected into other coordinate systems. In general, the CT DEP website (http://www.ct.gov/dep/cwp/view.asp?a=2698&q=322898&depNav_GID=1707) is regularly updated and their data is in CT State Plane, NAD 83. Some of this data is also available from the NRCS Geospatial Gateway (http://datagateway.nrcs.usda.gov). This data is in UTM NAD 1983.

Name	Date of Update	File type	Scale / Ground Resolution	File Size	Coordinate System	Data Layer Source
Digital Orthophoto Quarter Quadrangles (b/w)	1990	MrSid	1 m	3.4 mb +/- ea.	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
USDA-FSA-APFO NAIP County Mosaic (true color)	2005	MrSid	2 m	117 mb	UTM Nad 1983, zone 18	http://datagateway.nrcs.usda.gov
USGS 7.5 Minute Topographic Maps	1969 - 1984	MrSid	1:24000	3.4 mb +/- ea.	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
Towns	1969 - 1984	Polygon .shp	1:24000	604 kb	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
Basin	1978 - 1988	Polygon .shp	1:24000	14.7 mb	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
Hydrography Lines	1969-1984	Polyline .shp	1:24000	20.9 mb	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
DEP Property	5/2006	Polygon .shp	1:24000	1.1 mb	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
Municipal and Private Open Space Property	1994	Polygon .shp	1:24000	2.3 mb	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
Wetland Soils	2005	Polygon .shp	1:12000	57.8 mb	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
County Soils	2005	Polygon .shp	1:12000	19.6 - 45.8 mb	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
Connecticut Routes	2003	Polyline .shp	1:100000	393 kb	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
Dams	1996	Point	1:24000	175 kb	Connecticut State Plane NAD 1983	http://dep.state.ct.us/gis/
CLEAR 2002 LULC	2002	Polygon .shp	30 m	49 mb	Connecticut State Plane NAD 1983	http://clear.uconn.edu/projects/landscape/statewide_landcover.htm

Appendix B: Soil Based Recommendations for Stormwater Management Practices

Objective

Planners and others use soil survey information as a screening tool for successful selection and implementation of best management practices for storm water runoff in the watershed.

Imagery / Data / Mapping

Certified Spatial and Tabular data from the National Cooperative Soil Survey (NCSS), State of Connecticut produced by USDA-NRCS, Connecticut.

Quality Control

NCSS maps and data meet all agency standards. Maps are produced based solely on these products. No field checking was performed. Map units have a three acre minimum and may include areas of dissimilar soils. These maps are meant to be used for planning and review and do not replace an on-site evaluation.

General Approach

Soil and landscape criteria used to rate soil suitability were identified using specifications in the **CT/RI-NRCS Runoff Management System Standard (570)** and through interviews with engineering staff.

The National Soil Information System (NASIS) was used to write queries that access the state's soil survey data and assign ratings and limitations to each map unit in the soil survey legend. Rating classes indicate the extent to which the soils are limited by the soil properties that affect the management system. A "least limited" or "suitable" rating indicates that the soil has features that are very favorable for the specified system. Good performance and relatively low installation and maintenance costs can be expected. A soil rated "somewhat limited" or "fair" has features that are moderately favorable for the system. The limitations can be overcome or minimized by special planning, design, installation, and maintenance. Increased installation costs and maintenance will be required to sustain performance. A "most limited" or "poor" rating indicates that one or more soil feature is unfavorable for the specified system. The limitation generally cannot be overcome. Sometimes expensive design, installation, and maintenance may be employed, but performance may still be poor.**

Specific Approach

Five maps were generated for the watershed: one for each of the four practices, (storm water basins, infiltration systems, intermittent wetland systems, and perennial wetland systems), showing areas of favorable, somewhat favorable, and unfavorable soils for. A fifth map shows areas that are favorable for one or more of the four practices. All maps have a topographic map background and supporting information and graphics along with a legend.

** For more information, see Soil Based Recommendations for Storm Water Management Practices, CT-TP-2005-3. To view or downloaded this publication, visit ftp://ftp-fc.sc.egov.usda.gov/CT/water/CT-TP-2005-3.pdf

Appendix C: Wetland Evaluation

Objective

Wetlands provide numerous services and functions, including filtration and moderation of stormwater flows. The intent of the wetland evaluation was to identify the wetland complexes located within the watershed and determine how effective those complexes might be in moderating stormwater flows and protecting watercourses from potential pollutants present in surface water and ground water flows.

Quality Control

As the intent of the wetland evaluation was to assess the renovation capacity of the wetlands on a broad scale, no site investigations were conducted.

General Approach

Connecticut inland wetlands are defined by soils, with the Connecticut Inland Wetlands and Watercourses Act defining wetlands soils as "any of the soil types designated as poorly drained, very poorly drained, alluvial, and floodplain by the National Cooperative Soil Survey, as may be amended from time to time of the Natural Resources Conservation Service of the United States Department of Agriculture."

The current soils information from the National Cooperative Soil Survey (NCSS), State of Connecticut produced by USDA-NRCS, Connecticut was used to delineate the inland wetlands complexes within the watershed. The 2004 aerial imagery was used to assess any significant discrepancies that might exist between the GIS based data and recent aerial imagery.

It is important to recognize that although map units may be dominated by Connecticut inland wetland soils, inclusions of non-wetland soils may be present. Similarly non-wetland map units may contain inclusions of Connecticut inland wetland soils. On site investigation is required to determine the presence or absence of wetland soils in a particular area.

Specific Approach

The effectiveness of a wetland is influenced in two ways: by the quantity and quality of the inflow, and by the capacity of the wetland to contain and treat the inflow. For the purposes of this evaluation, "wetlands" include marshes, swamps, and bogs. Open water such as ponds, lakes, rivers, and streams are not included. Each wetland complex was evaluated based on the characteristics of the local basin within which it is located.

Three factors were considered when evaluating the quantity and quality of inflow into the basin:

1. Dominant land uses in the basin;
2. Percent of sloping areas in the basin; and
3. Runoff potential

Dominant land uses were derived from the Land Use/ Land Cover map developed for the project. Detailed categories were grouped to create four (4) broad classifications. The first classification included woodland, open space and low density residential development. Impervious surface area for this category was equal to or less than 10 percent. Active agriculture, suburbs and golf courses comprised the second category, with impervious surface cover ranging between 10 to 25 percent. Land uses with impervious surface greater than 25 percent – urban, commercial, and industrial - were consolidated into the third category. A fourth category, mixed land use, was created to accommodate polygons containing all three land types. No one use occupied more than 50 percent of the mixed use areas.

While quantity and quality of flow significantly affect a wetland complex, the capacity of a wetland to handle flow also influences the functions and services provided by that wetland complex. For this project the capacity of wetlands was based on four criteria.

1. The size of the wetland as a percentage of the local basin within which it is located.
   According to Bulletin 9 5.7.2 "the effective storage of a wetland in relation to the drainage area is the single most important factor in flood control. As the amount of flood water stored in the wetland increases, immediate flood runoff is decreased, and is then released slowly over a longer period of time."

2. The percent of very poorly drained soils, open water, and standing water in the wetland.

   This is an indicator of water quality because wetlands with more open water or permanently saturated soils provide more treatment. This information was calculated using the GIS soils layer and/or the Web Soil Survey.

3. The amount of degradation in the watershed related to land use.

   This was ascertained using a combination of the land use/land cover layer developed for this project, orthographic photos, local knowledge, and field spot checks. The intent was to assess the potential impact that surrounding land uses might have on wetland conditions.

4. The percent of wetland located in a non-hydric floodplain.

   These areas may contribute less to the capture and treatment of runoff. On the other hand, they may be much less degraded by activities such as farming. If a significant proportion of the wetland is in this category, consider adjusting these ratings accordingly.

Appendix D: Pervious and Impervious Analysis

Potential runoff by soil type:

For more information about soil runoff classes, refer to the
Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18 Chapter 3, Part 3, pg. 113 – 115

http://soils.usda.gov/technical/manual/contents/chapter3_index.html

Potential runoff by land use / land cover
Land use / land cover types used for this project were divided into 3 groups reflecting their relative runoff potential.

Table 30: Land Use / Land Cover categories by runoff potential

Low	Medium	High
Forest / Coniferous	Agriculture / Cultivated	Agriculture / farmsteads
Forest / Deciduous	Agriculture / grazed pasture	Barren / Strip mines, Quarries, Pits
Forest / Mixed	am	Developed / Commercial
Other / Herbaceous	Agriculture / Pasture	Developed / Industrial
Other / Scrub Shrub	Agriculture / Orchards, Berry Fruit, Vineyards	Developed / Mixed Urban
Other / Scrub Shrub Right of Way	Agriculture / Non-cultivated	Other Urban / Ball Fields
Transitional / Recently logged, or partial canopy <25%	Agriculture / Nurseries / Fields	Other Urban / Compacted Grass
Transitional / Mixed herbaceous and/or shrub	Barren / Beaches	Residential / High Density
	Barren / Permanently bare soil and rock	Developed / Transportation
	Developed / Cemeteries	
	Developed / Golf Courses	
	Developed / Landfills, Dumps	
	Residential / Low Density	

An increasing amount of information is becoming available addressing runoff rates and land cover / land use. One study in Ocean County, NJ measured bulk density and permeability of soils under several land uses. Soils in woodland had nearly twice the permeability of those in pasture or single house lots. All highly disturbed soils in commercial, residential, and recreational areas had much lower permeability.

Table 31: Permeability Measurements in Ocean County, NJ

Permeability Measurements of Sampled Layers within 20 of Soil Surface		
Site	Bulk Density (g/cm^3)	Permeability (in/hr)
Woods	1.42	15
Pasture	1.47	9.9
Single House	1.67	7.1
Subdivision Lawn 1	1.79	0.14
Garage Lawn	1.82	0.04
Cleared Woods	1.83	0.13
Subdivision Lawn 2	2.03	0.03
Athletic Field	1.95	0.01

Impact of Soil Disturbance During Construction on Bulk Density and Infiltration in Ocean County, New Jersey By Ocean County Soil Conservation District, Schnabel Engineering Associates, Inc., USDA Natural Resources Conservation Service March 2001 (Rev. 06/01/01) http://www.ocscd.org/soil.pdf

An investigation was conducted using a penetrometer to assess field conditions under several land use and cover types in the watershed. Compacted soils are associated with low permeability, resulting in increased runoff. A Dickey-john soil compaction meter with a range of 0 – 500 pounds/sq.in (PSI) was used to take the measurements. At 0 – 200 PSI there is little resistance to root growth. At 200 – 300 there is moderate resistance. A measurement above 300 PSI indicates a compacted soil. The following results were obtained and were used to help in the selection of land use / land cover runoff potential categories.

Table 32: Compaction Measurements, Middlesex County, CT

Land Use	Land Cover	Mainte-nance Level	Compaction (PSI) Bottom depth in inches (Zero indicates surface compaction)		Soil moisture
			0 – 200	200 – 300 (or depth to compaction)	
Cemetery - newer 1920 - present. Tested at gravesites	grass, other broad leaf herbaceous	moderate	0	0	dry
Access roads	grass, other broad leaf herbaceous	low	0	0	dry
Picnic area	wooded, bare soil, no understory	high	0	0	somewhat moist
Baseball/softball field	sod	high	0	0	dry
Cemetery - older late 19th century	grass, other broad leaf herbaceous	moderate	1	3	dry
Grassed picnic area, general use	grass	moderate	1.5	2.5	dry
Cemetery - newer 1920 - present. Tested between gravesites	grass, other broad leaf herbaceous	moderate	1.5	4	dry
Cemetery: present day use	grass, other broad leaf herbaceous	moderate		3	dry

Land Use	Land Cover	Mainte-nance Level	Compaction (PSI) Bottom depth in inches (Zero indicates surface compaction)		Soil moisture
			0 – 200	200 – 300 (or depth to compaction)	
Golf Course -fairway	sod with sandy loam	high		1.5	moist
Golf Course -green	sod with sandy soils	high	2	3	moist
Golf Course -fairway	sod with sandy loam	high	2	3	moist
Golf Course -rough	sod with sandy loam	high	2	3	moist
Golf Course -green	sod with sandy soils	high	2	3	moist
Golf Course -rough	sod with sandy loam	high	2	3	moist
18th & 19th century cemetery remaining 1/3 of property	grass, other broad leaf herbaceous	low	4	6	dry
School property	wooded, no understory - 30 years + old	low	5	6	dry
Unused area in cemetery	meadow	low	15	18	moist
18th & 19th century cemetery - 2/3 of property	grass, other broad leaf herbaceous	low	27		dry
19th century cemetery	grass, other broad leaf herbaceous	moderate	27		dry
Park	mature forest, little understory	low	3 - 12	30+	dry

Next steps:

More comprehensive soil data collection is needed to assess runoff and infiltration in a watershed. All land uses should be tested on a variety of soils. The best measurements would be obtained using a constant head permeameter, such as the amoozemeter.

Appendix E: Municipal Regulations Review

Objective

In Connecticut, each of the 169 municipalities develops and implements its own local land use regulations. Consequently, local land use regulations create the framework for managing growth and balancing the social and ecological needs of a community without requiring a consideration of the neighboring municipalities.

In the Coginchaug watershed regulations review, the focus was on the three towns which made up the majority of the watershed: Middletown, Middlefield and Durham. The purpose of this review was to examine the existing municipal regulations in order to identify the controls, policies, and plans which are in place to protect and enhance the natural resources in the watershed. The local municipalities can use the regulations review process to evaluate modifications to existing regulations and/or the establishment of new regulations which may strengthen environmental and natural resources considerations. Recognizing that growth can and will continue, the communities can use this review to evaluate the similarities and differences between their plans, policies, and regulations. Awareness of the approaches which neighboring communities are taking to regulations enhances understanding of the regional nature of the issues and creates a means for sharing and communication among towns.

Materials Reviewed

The regulations reviewed for this study included Zoning, Inland Wetlands, and Subdivision, along with the Plan of Conservation and Development for the towns of Durham, Middlefield, and Middletown.

General Approach

Depending upon the specific goals of the regulations review, a variety of municipal planning documents can be considered. These documents may include, and are not limited to, the regulations for Zoning, Inland Wetland, and Subdivisions. Other pertinent material may include the Plan of Conservation and Development, Open Space studies, economic development studies, town build out studies, and natural resources inventories.

The findings are outlined in table format with information organized according to broad categories. Categories can include focus areas such as: water quality, erosion and sedimentation, aquifer protection, open space, floodplain management, cluster subdivisions. The categories which are chosen are dependant upon the goals and objectives of the review. A citation of the document in which the regulation is found is included in the table, as is a notation of the responsible commission. Brief comments about the regulations may be included in the table in order to clarify or describe unique details about the specific regulation.

The tabular data is summarized in text format to facilitate understanding of the information. For example, three of the five towns in the study have regulations for timber harvesting.

Specific Approach

Because the focus of the Coginchaug Watershed Based plan is water quality, the regulations review concentrated on water quality and water quantity. Specific information was attained by developing a set of questions about the local regulations and the ways in which they address water quality and water quantity concerns. The questions were reviewed by the Advisory Committee.

The questions which address land use practices, relevant to water quality and water quantity included:

- Does the town recommend the use of the State Stormwater Design manual for development of a stormwater management plan?
- Does the town recommend the use of the *CT Erosion and Sediment Control Guidelines* for stormwater management and control?
- Does the town have any limits for impervious surface?
- Are road widths defined? If yes, what are they?
- Are cul-de-sac specifications provided?
- Are grassed swales or curbing required?
- Is the sizing for commercial parking defined? If yes, what is the square footage per vehicle?
- Is the construction of an alternative development (e.g. open space subdivision, cluster housing) left to the discretion of the towns? Do the towns have the power to require an alternative development or is the ultimate choice left up to the applicant?

- Are any areas in town identified as "by right" areas for alternative developments?
- Are alternative developments identified as a way to maximize open space?
- Is minimizing impervious surface a stated goal in cluster subdivision regulations?
- Do buffers and or setback areas exist for wetlands and watercourses? If yes, what is the width?
- Are any aquifer protection regulations in place?
- Are E&S controls required for disturbed areas less than ½ acre cumulatively?
- Is there a specific distance between a septic system and wetlands or watercourses?
- Are engineered septic systems permitted?
- Are soil limitations cited as a limiting factor for septic placement and installation?
- Are *Net Buildable Area* regulations in place?
- Are slopes used as a limiting factor for development? If yes, what is the slope percentage?
- Does local regulation or guidance exist regarding timber cutting or clear cuts?
- Has the town established a limit on the net increase that can result in stormwater flow as a result of development? If yes, what is the net outflow permitted?
- Does the town use a certain sized storm for the design of its stormwater management practices? If yes, what sized storm?
- Are detention and or retention systems recommended in the regulations?
- Who is responsible for maintenance of stormwater management installations/structures?
- Are regulations in place preventing development in identified floodplains?
- Do the towns have jurisdiction over dams and diversions?
- Is groundwater hydrology a consideration in resource extraction regulations?

Appendix F: Streamwalk Data

A streamwalk is a volunteer based assessment of the physical conditions of in-stream and streamside characteristics of the perennial streams in a river basin. It serves two purposes: resource evaluation through data collection and community involvement and education.

The data gathered through the survey is a first step toward understanding the physical condition of a stream corridor. The information can be used to identify resources needs such as erosion and sedimentation, lack of adequate riparian (streamside) vegetation, and sources of direct discharges into the stream, among others. Although the streamwalk information may be used independently, using the data in combination with other studies and analyses is often more beneficial and effective. Communities can begin to plan and implement conservation measures and prioritize areas which may require more detailed evaluations to determine the most appropriate management measures which will meet specific resource needs.

The Coginchaug River streamwalk was conducted in 2006, and included the mainstem of the Coginchaug River as well as all of the perennial tributaries in the watershed. A training session for volunteers was held in was conducted at the Durham, Connecticut Public Library on June 8th, 2006. Twelve (12) volunteers attended the training. Volunteers selected 23 of the 33 survey areas. The remaining ten areas were surveyed by NRCS personnel. Assessments were carried out from June 2006 through December 2006. All of the data was entered into an access database. Specific queries were developed to quantify the information and assess the overall conditions of the perennial streams in the watershed.

Introduction

Thirty three survey areas were delineated for the watershed. Survey areas are generally based on local watershed boundaries with roughly 1 -3 linear miles of stream in the survey area. In cases where local watersheds were smaller in size or where stream lengths were shorter, watersheds were combined to make a survey area. For larger local watersheds with more than 3 miles of stream, or where access was limited, the watershed was divided into manageable survey areas. In these situations an effort was made to delineate the survey areas based on topography – an artificial sub-local watershed. Where that was not possible, roads or access points were typically used to divide the area.

From the 33 survey areas, 91 stream segments were delineated in the field by volunteers and NRCS staff. A stream segment is defined by the physical conditions of the in-stream and steam corridor conditions, such as slope, width, depth, substrate materials, streamside vegetation, etc. The minimum length of a stream segment is 1,000 linear feet. A separate survey sheet was completed every time a consistent change(s) in the physical characteristics of a stream was observed for a minimum length of 1,000 linear feet. In this sense, each of the segments represents a 'unique' section of stream.

Factors or conditions that might suggest potential water quality concerns for a segment or stream include the presence of algae, the presence of vascular aquatic plants, areas with greater than 25% of fines (sand and silt) comprising the substrate, stream sections with a riparian buffer width on average of less than 25 feet, in-channel impoundments, and the presence of discharge pipes. A query was run for each of these categories and the information is summarized below. (See Table below for detailed information).

As part of the assessments, the people conducting the surveys identified and described specific areas of concern. Information about these areas was recorded on the Areas of Concern sheet that is part of the Stream Segment Survey form. The intent is to identify specific spots in the watershed that pose a potential threat to the chemical, biological, and/or physical condition of a watercourse. Such concerns include dams, algae growth, sediment deltas, trash, and changes to the visual conditions of the water. An *Areas of Concern* report of these sites was generated (See Table ##).

Findings

- Algae was observed in 11 streams and recorded as present in 29 out of the 91 watershed segments. Algae are important food producers in the aquatic environment. In manufacturing food, algae release oxygen, increasing the amount of dissolved oxygen in the water. When overabundant, their decay may deplete the oxygen in the water and cause "summer kills" of aquatic organisms (fish and macroinvertebrates). Green and blue-green algae are indicators of nutrient rich waters. In 26 of the 29 segments, algae were noted in spots. For the remaining three segments algae was recorded to be present everywhere. Two of those three segments were on Asmun Brook and the third was on Ellen Doyle Brook. Seven of the 11 streams had algae observed on multiple segments.

- Vascular aquatic plants, also known as macrophytes, were observed in eight streams. Macrophytes are important for stream ecology because they convert sunlight to useable energy for other organisms, cycle nutrients, and provide shelter and habitat. While some plant growth is desirable, excessive growth is indicative of changes to the stream conditions including temperature, sediment, and light availability. Excessive growth of macrophytes can be problematic. When plants are not producing oxygen through photosynthesis, they are consuming the oxygen in the water column, resulting in decreased levels of dissolved oxygen. Prolonged exposure depressed levels of dissolved oxygen may adversely affect aquatic organisms. Fifteen segments were recorded with instances of aquatic plants observed in spots. There were no cases where plants were observed everywhere along a segment.
- Streambed materials, or substrate, have numerous direct and indirect effects on the living organisms of running waters. It provides a surface to cling to or to burrow into, shelter from current, material for use by macroinvertebrates in the construction of shelter, and refuge from predators. In shallow streams substrate materials can also influence water oxygenation. The type of streambed materials will vary depending on the geology and surficial materials throughout the watershed, as well as the size and slope of a given stream. An excessive amount of fine material: sand, silt or clay, may be an indication of erosion or transport of road sand into a stream by overland runoff. The fine material can degrade fish habitat, cause turbidity, transport toxic substances that have been adsorbed or absorbed by the sediments, or fill stream channels. Thirty segments on eleven streams were described to have greater than 25 percent of the substrate comprised of fines. In one half of the 30 segments, the fines represented at least 50 percent of the total substrate material. Twenty two segments had sand at greater than 25 percent, with the average percentage equaling 45.7%. Ten segments had silt and clay at greater than 25 percent with an average percentage of 57%. It should be noted that sand is the natural substrate material for the Coginchaug River mainstem. Consequently, the presence of high levels of fines in the Coginchaug mainstem may not be indicative of a water quality concern nor represent an unnatural contribution of fines to the river from overland runoff.
- Riparian vegetation is important because it provides shading, a source of organic material, flood attenuation, nutrient cycling, overland stormwater runoff filtration, and streambank

stabilization through root structure. Twelve segments on six streams were identified to have less than an average of 25 feet of riparian vegetation on either the left or right bank. Only two of the 12 segments were recorded to have less than 25 feet of riparian buffer on both the right and left banks. The Coginchaug River and Hersig Brook were the only two watercourses to have multiple segments listed.

- A total of 36 in-channel impoundments were observed on seventeen streams in the watershed. Five of the streams had multiple impoundments, with the Coginchaug River and Ellen Doyle Brook having the most. Impoundments present potential problems for stream fisheries; they alter the natural hydrology of a stream system, and change the sediment transport regime. In certain instances, larger dams may create backwater that offers attractive habitat to wildlife, such as geese, which may contribute bacteria directly into the watercourse.

  Impounding a stream usually alters the stream's temperature, flow patterns, and sediment transport capacity. Impounded areas have larger surface areas that are typically exposed to direct solar radiation. Elevated temperatures can lead to a loss of riverine species diversity due to decreased levels of dissolved oxygen and/or stream temperatures beyond the tolerance range for specific aquatic species. In addition to affecting stream temperatures, impoundments usually modify local hydrology. Diminished stream flow due to evaporation losses or consumptive uses may affect a stream dramatically. Modifications to the flow regime of a stream may disrupt normal stream scour patterns, vegetative growth, water quality, flood storage, and other natural processes. Changes to the vegetative communities along the streambank and alteration of the streambed will result in changes in the suitability of these areas to support aquatic species, terrestrial wildlife, and bird life. Impoundments may impede fish migration of both resident freshwater species as well as any diadromous species present in the basin.

- A total of 90 discharge pipes, on 48 segments, were found in 28 streams in the watershed. All of the named watercourses were observed to have more than one discharge pipe. Discharge pipes were found on more than half of the unnamed tributaries. Discharge pipes present several potential concerns associated with stream health. Piped flow is problematic because pollutants that may be contained in the runoff are concentrated and discharged directly into the stream. Discharge pipes also concentrate runoff which results in higher velocities of water flow. This means that the piped water arrives at the stream channel in a shorter period of time than if it had flowed over vegetated ground, and at higher velocities than it would if it were not piped. As a result there is a shift in the stream hydrograph resulting in higher peak flows.

Areas of Concern

The streamwalk data contained 34 specific sites identified as areas of concern. Of the 34 sites, eleven were noted to have a lack of riparian buffer; seven with erosion; two for runoff- from a chicken farm and from a snow storage site; six for sections of stream channel manipulation, six for dams and impoundments, one because of the presence of invasive plants, and one for the presence of an outlet. Each of these sites is being examined in relation to the place-based BMP locations identified in the WBP to determine if the areas overlap. While the areas of concern represent a potential physical, chemical, or biological problem, they may not necessarily be related, directly or indirectly, to the bacterial or nutrient issues associated with the Coginchaug River. Regardless, additional investigation of the areas of concern should be undertaken to ascertain the degree of the problem and what measures, if any, should be implemented.

Conclusions

The streamwalk data represents a snapshot in time of the stream corridor conditions in the watershed. It should be understood that the ideal timeframe for data collection is between June and mid-September. This is when worst case stream conditions are most easily observed. A combination of factors, from volunteer involvement to timing of storm events, delayed data collection for the Coginchaug River streamwalk. As a result, the data may not entirely reflect conditions in the watershed as they were during the summer months, the period of worst case scenario. With cooler temperatures in fall/winter months the presence of either algae or vascular aquatic plants is greatly reduced or non-existent. Seasonal precipitation and local weather patterns for that time period may have affected average water width and depth. With cooler temperatures evaporation also tends to decrease, and with seasonal increases in precipitation, stream levels rise. The fall and winter of 2006 was milder than normal.

As a quality control measure, field spot checks were conducted by NRCS staff during 2006. Stream segments were visited and the data collected for those segments were checked. Additionally, during field work in spring 2007, algae were observed along some stream sites that were not identified in the 2006 streamwalk data. An informal follow-up field survey was conducted to determine whether or not algae were present at other locations as well. Approximately 8 sites that did not have algae noted on the stream segment survey sheets were revisited and a short section of stream observed to assess the condition. In approximately 5 of those areas algae was noted, at least in spots.

While the data collected through the streamwalk process is valuable to understanding watershed conditions and engaging local stakeholders, as a volunteer based effort there is variability and inconsistencies in the data collection process. As described above, the number of in-stream channel impoundments recorded on the stream segment survey sheets was 36. Only six of those 36 impoundments were identified as Areas of Concern. According to The Fisheries Resource Assessment of the of the Coginchaug River mainstem, conducted as part of this project, there are five major impoundments downstream of Wadsworth Falls, alone. This discrepancy in the data reinforces that fact that the streamwalk can only be considered a "first cut" assessment and further field work should be conducted to verify the extent and scope of the resource concerns and make subsequent land management decisions.

In 2005 the Connecticut River Coastal Conservation District conducted a streamwalk of the Coginchaug River mainstem. The data from these two streamwalk efforts supports the notion that a variety of potential water quality concerns exist on a range of scales. Examining this information in context and relationship to the other analyses will help to better understand the potential sources of pollution and present some potential opportunities for implementation of solutions. Despite the discrepancies, the streamwalk data provides physical locations to initiate further field investigation, in an effort to address the water quality related resource concerns within a particular drainage basin.

Table 33: Summary of Streamwalk Segment Impairments

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
Stream Name: Allyn Brook					**Basin Code: 4605-00-2-R1**				
Segment Code C		**Survey Segment 4605-00-2-R1C**							
>100'	>100'	0	2		10	No	Yes	No	No
Segment Code D		**Survey Segment 4605-00-2-R1D**							
>100'	>100'	0	0		25	No	No	No	Yes
Stream Name: Asmun Brook					**Basin Code: 4606-02-1**				
Segment Code A		**Survey Segment 4606-02-1A**							
>100'	>100'	0	0			No	Yes	No	No
Segment Code B		**Survey Segment 4606-02-1B**							
>100'	>100'	0	2		5	Yes	No	No	No
Segment Code C		**Survey Segment 4606-02-1C**							
>100'	>100'	0	4			Yes	No	No	No
Stream Name: Ball Brook					**Basin Code: 4605-04-1**				
Segment Code A		**Survey Segment 4605-04-1A**							
>100'	25-100'	0	1		15	No	No	No	No
Segment Code B		**Survey Segment 4605-04-1B**							
>100'	>100'	0	0		70	No	No	No	No

Segment Code C **Survey Segment 4605-04-1C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	1	0		35	No	Yes	No	No

Segment Code D **Survey Segment 4605-04-1D**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		35	No	Yes	No	No

Stream Name Chalker Brook — Basin Code 4607-03-1

Segment Code A **Survey Segment 4607-03-1A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	1	0			No	No	No	No

Segment Code B **Survey Segment 4607-03-1B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0			No	No	No	No

Segment Code C **Survey Segment 4607-03-1C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0			No	No	No	No

Segment Code D **Survey Segment 4607-03-1D**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
<25'	25-100'	2	1		20	No	Yes	No	Yes

Segment Code E **Survey Segment 4607-03-1E**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	>100'	0	0	20	80	No	No	No	No

Stream Name Coginchaug River — Basin Code 4607-00-3-R1, R2; 4607-00-2-R5

Segment Code A **Survey Segment 4607-00-3-R1, R2; 4607-00-2-R5A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0	30	30	No	Yes	No	Yes

Segment Code A Survey Segment 4607-00-2-R3A

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		98	No	No	No	No

Segment Code A Survey Segment 4607-00-3-R5A

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0	100		No	No	No	No

Segment Code A Survey Segment 4607-00-3-R8A

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	1				No	No	No	Yes

Segment Code A Survey Segment 4607-00-3-L2A

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	25-100'	1	1	5	10	No	Yes	No	No

Segment Code A Survey Segment 4607-00-3-R9A

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0	45	21	No	No	No	Yes

Segment Code A Survey Segment 4607-00-R2A

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	0	20	20	No	No	No	No

Segment Code A Survey Segment 4607-06-1-aA

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0	40	5	No	No	No	No

Segment Code A-1 Survey Segment 4607-00-2-R1A-1

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0	5	20	No	No	No	No

Segment Code A-2 **Survey Segment 4607-00-2-R1A-2**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		80	No	No	No	No

Segment Code B **Survey Segment 4607-00-R2B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
<25'	25-100'	0	2	20	20	No	No	No	No

Segment Code B **Survey Segment 4607-00-3-R5B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	25-100'	0	0	80	10	No	No	No	Yes

Segment Code B **Survey Segment 4607-00-3-L2B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	1		50	25	No	No	No	Yes

Segment Code B **Survey Segment 4607-00-3-R7B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
<25'	>100'	1	0	25		No	No	No	No

Segment Code B **Survey Segment 4607-00-3-R9B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	4	15	25	No	Yes	No	Yes

Segment Code B-1 **Survey Segment 4607-00-1B-1**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	1	0	10	45	No	No	No	No

Segment Code B-2 **Survey Segment 4607-00-1B-2**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	<25'	1		10	85	No	No	No	No

Segment Code B-3 **Survey Segment 4607-00-1B-3**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	1	2	80	No	Yes	No	No

Segment Code C **Survey Segment 4607-00-3-R7C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	2	0	5		No	No	No	Yes

Segment Code C **Survey Segment 4607-00-3-R9C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	<25'	1	3		12	No	Yes	No	No

Segment Code C **Survey Segment 4607-00-3-R5C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	0	55	20	No	No	No	Yes

Stream Name Cream Pot Brook — Basin Code 4607-06-1-b

Segment Code A **Survey Segment 4607-06-1-bA**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	25-100'	3	4			No	No	No	No

Segment Code B **Survey Segment 4607-06-1-bB**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
						No	No	No	No

Stream Name Ellen Doyle Brook — Basin Code 4607-10-1

Segment Code A **Survey Segment 4607-10-1A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	0	5	25	No	No	No	No

Segment Code B **Survey Segment 4607-10-1B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	2		5	No	Yes	No	No

Segment Code C **Survey Segment 4607-10-1C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	<25'	4	10	10		No	Yes	No	No

Segment Code D **Survey Segment 4607-10-1D**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	2	0	0		Yes	No	No	No

Segment Code E **Survey Segment 4607-10-1E**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	25-100'	0	0			No	No	No	No

Stream Name Folley Brook — Basin Code 4605-05-1-d1; 4605-05-1

Segment Code A **Survey Segment 4605-05-1-d1; 4605-05-1A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0	45		No	Yes	No	No

Segment Code B **Survey Segment 4605-05-1; 4605-00-2-L1B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	1			15	No	No	No	No

Stream Name Hemlock Brook — Basin Code 4607-01-1

Segment Code 1A **Survey Segment 4607-01-11A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	1	0	5	30	No	No	No	Yes

Segment Code 1B **Survey Segment 4607-01-11B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		50	No	No	No	No

Segment Code 3A **Survey Segment 4607-01-13A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		30	No	No	No	No

Segment Code 5A **Survey Segment** **4607-01-15A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	25-100'	0	0		15	No	Yes	No	No

Stream Name Hersig Brook — Basin Code 4605-01-2-R3

Segment Code A **Survey Segment** **4605-01-2-R3A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	<25'				15	No	Yes	No	No

Segment Code B **Survey Segment** **4605-01-2-R3B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'		1		5	No	Yes	No	No

Segment Code C **Survey Segment** **4605-1-2-R#; 4605-01-2-R1C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
<25'	>100'	1	1		15	No	Yes	No	No

Segment Code D **Survey Segment** **4605-01-2-R2D**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'		2		7	No	Yes	No	No

Segment Code E **Survey Segment** **4605-01-2-R2; 4605-01-2-R1E**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'		2	2	10	No	Yes	No	No

Segment Code F **Survey Segment** **4605-01-2-R1; 4605-01-1F**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	<25'	1	2		15	No	Yes	No	No

Stream Name Parmalee Brook — Basin Code 4607-05-1-b

Segment Code A **Survey Segment** **4607-05-1-bA**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	2	0		10	No	Yes	No	No

Segment Code A — Survey Segment 4607-05-1-dA

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	>100'	0	0		10	No	Yes	No	No

Segment Code B — Survey Segment 4607-05-1-b, 4607-05-1-cB

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	0		5	No	No	No	No

Segment Code B — Survey Segment 4607-05-1-dB

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
		0	0		10	No	No	No	No

Segment Code C — Survey Segment 4607-05-1-cC

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0	25	15	No	No	No	No

Segment Code D — Survey Segment 4607-05-1-CD

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	2	5	5	No	Yes	No	No

Stream Name Sawmill Brook — Basin Code 4606-00-1

Segment Code — Survey Segment 4606-00-1

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	1		25	No	No	No	No

Segment Code A — Survey Segment 4606-00-2-R1A

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		34	No	No	No	No

Segment Code D — Survey Segment 4606-00-1D

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		30	No	No	No	Yes

Segment Code E **Survey Segment 4606-00-1E**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	1		5	No	No	No	No

Stream Name Unnamed Tributary Basin Code 4607-07-1

Segment Code A **Survey Segment 4607-07-1A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	<25'	1	0		20	No	No	No	No

Segment Code A **Survey Segment 4605-02-01A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	1	0			No	No	No	No

Segment Code A **Survey Segment 4607-11-1A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	>100'	1	0		5	No	No	No	No

Segment Code A **Survey Segment 4605-03-01A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		10	No	No	No	No

Segment Code A **Survey Segment 4607-14-1A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0	20		No	Yes	No	No

Segment Code A **Survey Segment 4607-00-3-R7A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
<25'	<25'	0	0		40	No	No	No	No

Segment Code A **Survey Segment 4607-04-1; 4607-002-R4A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	0		20	No	No	No	No

Segment Code A **Survey Segment 4607-09-01A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	>100'	1	0	100		No	No	No	Yes

Segment Code A **Survey Segment 4607-05-1-aA**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		5	No	No	No	No

Segment Code B **Survey Segment 4607-09-01B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	>100'	0	0		10	No	No	No	No

Segment Code B **Survey Segment 4607-14-1B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	>100'	0	1		5	No	No	No	No

Segment Code B **Survey Segment 4607-05-1-aB**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'					No	No	No	No

Segment Code B **Survey Segment 4607-11-1B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	1			No	Yes	No	Yes

Segment Code B **Survey Segment 4607-04-1; 4607-002-R4B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	25-100'	0	0		10	No	No	No	No

Segment Code B **Survey Segment 4605-03-01B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	1	5		10	No	No	No	No

Segment Code C **Survey Segment 4607-00-3-L2C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
<25'	<25'	1	2		20	No	No	No	No

Segment Code C **Survey Segment 4607-04-1; 4607-00-2-R4C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
						No	No	No	No

Segment Code C **Survey Segment 4607-14-1C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	1	2		10	No	No	No	No

Segment Code C **Survey Segment 4607-00-R2C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	0	1			No	No	No	No

Segment Code D **Survey Segment 4606-02-1D**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
25-100'	25-100'	1	1		2	No	Yes	No	Yes

Stream Name Unnamed Tributary to Cream Pot Brook — Basin Code 4607-06-1-b

Segment Code **Survey Segment 4607-06-1-b**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		20	No	No	No	No

Segment Code C **Survey Segment 4607-06-1-bC**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0			No	No	No	No

Stream Name Unnamed Tributary to Hemlock Brook — Basin Code 4607-01-1

Segment Code 2A **Survey Segment 4607-01-12A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0			No	No	No	No

Segment Code 4A **Survey Segment** **4607-01-14A**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		4	No	No	No	No

Stream Name Unnamed Tributary to Sawmill Brook — Basin Code 4606-01-1

Segment Code B **Survey Segment** **4606-01-1B**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		29	No	No	No	No

Segment Code C **Survey Segment** **4606-01-1C**

Width of Left Buffer	Width of Right Buffer	Number of Impoundments	Number of Discharge Pipes	% Silt or Clay	% Sand	Algae Everywhere	Algae In Spots	Plants Everywhere	Plants In Spots
>100'	>100'	0	0		20	No	No	No	No

Table 34: Summary of Areas of Concern

Stream Name	Basin Code	Seg. Code	Identified Concern #1	Description of Concern1	Identified Concern #2	Description of Concern 2	Identified Concern #3	Description of Concern 3	Identified Concern #4	Description of Concern 4	Identified Concern #5	Description of Concern 5	Identified Concern #6	Description of Concern 6
Allyn Brook	4605-00-2-R1	C	stream-bank erosion	15'-20' section of bank, about 3-4' high. Undergoing erosion. Material is sloughing off in area that is mowed regularly and comprised primarily of grasses. Severe erosion began 10/04. Area used by people, dogs, etc…										
Allyn Brook Count:			**1**											
Asmun Brook	4606-02-1	B	sediment; temperature (?)	steep banks cleared, lots of rock bank flow-through bypassing ??????(check with lisa/phil); some channelizing, dam	sediment; outlet	Storm drain, 3/4 full of sandy sediment	Sediment - storm drain	Storm drain discharge from detention pond.						
		C	Didn't see any	white underdrain pipe? 2 six inch pipes	Didn't see any	white underdrain pipe? 2 six inch pipes	Didn't see any	12-15" culvert; road drainage?						
Asmun Brook Count:			**6**											
Ball Brook	4605-04-1	A	Bank erosion	No buffer - eroding bank - pipe (from swamp?)	outlet?	industrial site - treatment pond? No change in water.								
		B	Animals	Pasture encloses stream but stream has brush buffer.										
		C	nutrient?	impoundment - impedes fish passage; some algae										
Ball Brook Count:			**4**											
Chalker Brook	4607-03-1	D	Sand from pipe	pipe from PWD yard.										
Chalker Brook Count:			**1**											
Coginchaug River	4607-00-1	B-3	Erosion / Sedimentation	large open area with stockpiled earth materials.										
	4607-00-3-L2	A	Dam/ Impoundment	Industrial building - dam just upstream of road. Approx. 15' high/60'wide - stone/concrete; fish passage barrier - alters stream hydrology.										
		B	Dam	12' high; 60' wide; stone/concrete; deterioration on spillway and millworks on left side; Barrier to fish; hydrologic impact.										

Stream Name	Basin Code	Seg. Code	Identified Concern #1	Description of Concern1	Identified Concern #2	Description of Concern 2	Identified Concern #3	Description of Concern 3	Identified Concern #4	Description of Concern 4	Identified Concern #5	Description of Concern 5	Identified Concern #6	Description of Concern 6
Coginchaug River	4607-00-3-R1, R2; 4607-00-2-R5	A	Manure solids in and along stream	Slow moving section of river in forested wetland. Manure solids observed along floodplain , streambank, and streambed. Methane odor noticed.										
	4607-00-3-R7	B	Impound-ment 15' dam	Large dam but there is a fish way										
		C	Large Dam	15' high dam = barrier to fish passage	small dam	8' high dam = barrier to fish passage	Wadsworth Falls	15' Falls - no fishway. Natural barrier (Seth's comment)						
	4607-00-3-R8	A	Dam with 600 feet channelized below	Dam height 10 feet, large factory.										
	4607-00-3-R9	B	Lack of Riparian Vegetation	Riparian area has little to no vegetation other than managed grass. Discharge from pipes draining water from park and Palmer field directly into the River.										
		C	Snow storage runoff	plowed snow stored at top of the hill in parking lot - storage area is next to catch basin and road - water drains from pipe at bottom of road (road runoff) toward stream. Discharges into floodplain.	Lack of riparian vegetation; artificial streambank materials	Complete lack of riparian vegetation; parking are up to edge of stream; fill material (questionable material), riprap.								
	4607-00-R2	B	Lack of Riparian Vegetation	Stream has been channelized 9historically) and lack of riparian vegetation exists -- several residences/some off-stream impoundments for ponds/mowing to stream edge.										
Coginchaug River Count: 13														
Cream Pot Brook	4607-06-1-b	A	Dam	Old stone dam. Partially breached; 4.5' high, barrier to fish run of river, no impoundment???	Dam	old stone dam; 3' high; barrier to fish passage run of river; no impoundment	Dam	Old stone dame; approx. 12' high; no impoundment						
Cream Pot Brook Count: 3														

Stream Name	Basin Code	Seg. Code	Identified Concern #1	Description of Concern1	Identified Concern #2	Description of Concern 2	Identified Concern #3	Description of Concern 3	Identified Concern #4	Description of Concern 4	Identified Concern #5	Description of Concern 5	Identified Concern #6	Description of Concern 6
Ellen Doyle Brook	4607-10-1	B	24" discharge pipe	Drain from Route 147 leads directly to stream through pipe	3' discharge pipe	Drain from small dry stream combined with drain from Route 147	60' section eroded and dead fish	Bank height 10 feet and not vegetation, actively eroding; 4 dead fish	300 foot channel-ized section	Channeled, lined with large riprap, mown lawn to R, Route 147 to L lots of algae.				
		C	Stream no longer there.		10' dam	no fishway	15' dam and small mill pond	No fishway; pond full of matted algae.	Channeled		15' dam leading to culvert under road	no fishway; impoundment full of algae.	Multiple storm drains	in area where 147 parallels brook.
		D	6' dam	no fishway										
Ellen Doyle Brook Count: 11														
Folley Brook	4605-05-1; 4605-00-2-L1	B	Impoundment	Old stone impoundment. Perhaps remnant of millpond area. Stones still present 1-2' drop in some spots. Has been breaached.	Exposed stream-banks	Exposed banks range from 10' - 12' high to 3' - 5' high. They are on both right and left banks.								
	4605-05-1-d1; 4605-05-1	A	Excessive fines.	Streambed comprised of excessive fines. Some may be road sand. Impression is that most is natural streambed material from associated wetlands.										
Folley Brook Count: 3														
Hemlock Brook	4607-01-1	1A	Earthen Dam -	Low dam on south end of Pond. Some evident erosion on downstream bank.										
		3A	erosion	Very steep bank (30' L) with visible erosion - may be exposed bedrock at erosion scar.										
Hemlock Brook Count: 2														
Hersig Brook	4605-01-2-R1; 4605-01-1	F	stormwater discharge pipe	Slimy algae mat assoc. with discharge from this pipe.	small mechanical discharge pump	pumping clear water into brook - assoc. with residence - active when we were there.	Cement dam with a water control device that was open.	Brook may be dammed up at times - personal use? No vegetation here.	Back hoe parked next to Brook - had been working at edge of brook	Trees cut here and soil is bare and has been pushed around. Tracks from backhoe right next to Brook.				
	4605-01-2-R2	D	Runoff from chicken farm	Most algae growth observed in Hersig Brook - possible nutrient enrichment.										

Stream Name	Basin Code	Seg. Code	Identified Concern #1	Description of Concern1	Identified Concern #2	Description of Concern 2	Identified Concern #3	Description of Concern 3	Identified Concern #4	Description of Concern 4	Identified Concern #5	Description of Concern 5	Identified Concern #6	Description of Concern 6
Hersig Brook	4605-01-2-R3	A	Erosion - slumping of bank	Land is meadow and probably mowed (1 - 2 times/year) Bank slumping along border.										
	4605-1-2-R#; 4605-01-2-R1	C	Impoundment	Concrete dam under a bridge - water passing through and spilling over 3' drop back to stream	multi access points to stream. Heavy usage caused serious erosion/exposed soil and roots	Grassy lawn up to water - few scattered trees - no real riparian border - heavy usage as a Park; foot traffic in and out of stream by kids.								
Hersig Brook Count: 8														
Parmalee Brook	4607-05-1-b	A	Dam	2' high stone and concrete dam - barrier under some flow conditions to minnow species. Lawn at edge, chairs.	Lack of riparian vegetation	Left side about 150' and riparian veg., mowed grass to edge.								
	4607-05-1-b	D	Discharge/outlet pipe	Solid 12" diam.. Pipe - protruding from left bank - discharging groundwater at top of hill is concrete collection well - all down gradient from houses in subdiv. Seems to be outfall from road runoff in cul-de-sac.										
Parmalee Brook Count: 3														
Sawmill Brook	4606-00-1		Lack of Riparian Vegetation	Lawn extended to the edge of stream, lawn appeared to be well maintained.										
Sawmill Brook Count: 1														
Un-named Tributaries	4605-02-01	A	Dam; Dewatered Pond	20' high dam. Bottom valve open; pond is dewatered; no riparian vegetation in dewatered flood pool.	Channel manipulation	Approx. 100' of 4"-6" rip rap on bank, outside meander.								
	4605-03-01	B	lack of riparian vegetation; streambank manipulation	Residential site - landowner abuts right up to streambank, some debris and fill on streambank.	Lack of riparian vegetation. Channel manipulation	Lack of riparian vegetation, rip rap to channel.	Pipe culvert	2 foot long drain outlets; 16" and 14" pipe w/excessive iron ????? Bacteria?? (check with Todd)	Small dam	1.5' high stone dam. No impoundments (? Check with Todd)	Stream bank erosion; lack of riparian vegetation	100' + section - eroding streambank. Bank height = 3'; lack of riparian veg. = lawns, abut stream.	Channel-iz-tion; Fish passage barrier	Approx. box culvert/ on steep slope; barrier to fish passage.
	4606-02-1	D	Dam interrupting flow	Impoundment of unknown depth. Invasive plant buffer around pond.	Parking lot drain	Parking lot catch basin and pipe outlet to pond.								

Stream Name	Basin Code	Seg. Code	Identified Concern #1	Description of Concern1	Identified Concern #2	Description of Concern 2	Identified Concern #3	Description of Concern 3	Identified Concern #4	Description of Concern 4	Identified Concern #5	Description of Concern 5	Identified Concern #6	Description of Concern 6
Un-named Tributaries	4607-00-3-L2	C	Lack of Riparian Vegeta-tion	Suburban houses line the stream; stream channel manipulation and lack of riparian vegetation.	Dam	Stream is impounded and water discharges through corrugated metal pipe. Impoundment is 8' high, earth/stone material.								
	4607-00-3-R7	A	Piped section	1000' section completely piped.										
	4607-00-R2	C	Stream is piped	Cement pipe roughly 500' - 600' long. Outlets just on west side of Route 77. No riparian from pipe outlet to confluence with Coginchaug.	Lack of riparian vegeta-tion	No riparian vegetation. Small rivulet transporting water to Coginchaug river.								
	4607-05-1-a	A	Channeled stream; lack of riparian vegeta-tion	Residential properties channeled stream and lack of riparian veg.. Mowed lawns abut stream.										
	4607-07-1	A	Small pond with small impound ment	Stream runs through property - small impoundment in stream creates small pond in stream channel.										
	4607-09-01	A	New Impound-ment	Driveway across stream with 18" culvert (above flow), and impoundment on upstream side.										
	4607-11-1	A	Dam - fish passage	Small stone dam 10' wide/3' high. Potential fish passage barrier. 75' upstream from dam - Road/driveway crossing with stone box culvert at base - 2 openings.	Concrete culvert - fish passage	2 concrete culverts - 1 = 48" diam.; 1 = 36" diam. Fish passage barrier at low flow.								
		B	discharge pipe	8" diameter pipe. Discharges at top of hill Runoff has created small rill erosion leading down to stream.										

Stream Name	Basin Code	Seg. Code	Identified Concern #1	Description of Concern1	Identified Concern #2	Description of Concern 2	Identified Concern #3	Description of Concern 3	Identified Concern #4	Description of Concern 4	Identified Concern #5	Description of Concern 5	Identified Concern #6	Description of Concern 6
Un-named Tributaries	4607-14-1	B	Lac of Riparian Buffer	Riparian vegetation has been cleared (under scour??) and	Stream channel manipula-tion	Same site. Stream has been rock lined and three grade control structures installed (at least one is a fish barrier)								
		C	Impound-ment/ Barrier	~2 ft. high broken concrete & rock dam/barrier to fish passage.	Lack of riparian vegeta-tion	Lack of riparian vegetation. Animals (cows) access to stream evidence of fill in floodplain and stream.	Barriers to fish passage	1' rise to concrete/rock A barrier under low flow conditions and certain age classes.						
Unnamed Tributaries Count: 27														
Un-named Tributary to Hemlock Brook	4607-01-1	2A	invasive barberry	barberry present.										
		4A	erosion	Steep bank with exposed soil (10' +)	Invasive Barberry									
Unnamed Tributary to Hemlock Brook Count: 3														
Total # Identified Concerns: 86														

Appendix G: Level I Geomorphic Stream Assessment

Objective

The objective of the NRCS Level I Geomorphic Assessment is to provide a base level classification of the fluvial network within the basin, including both stream type (Rosgen Methodology) and stream order. The base level classification then allows for the prediction of a river's behavior, based on morphological attributes, and enables the comparison and/or extrapolation of site-specific data or stream tendencies from a particular stream reach to other stream reaches with similar morphological characteristics. It should be noted that a Level 1 geomorphic assessment is derived from an investigation and analysis only of channel slope, shape and patterns. As such, the presented information is useful for broad-scale planning purposes and not site specific design. A Level II and Level III analysis would be needed to develop site specific designs and remediation measures.

Imagery / Data / Mapping

The Coginchaug River is a 4th order tributary to the Mattabesset River, the confluence of which is approximately 1.35 miles upstream of the confluence of the Mattabesset River and the Connecticut River. The 39 square mile watershed, exhibits a dendritic drainage pattern, with approximately 98 linear miles of stream comprising the fluvial network. Subsequently, the drainage basin density or stream density is 2.4 mi/sq. mi.

The Coginchaug River becomes a 4th order stream after the confluence of Allyn Brook, a 3rd order tributary. Sawmill Brook is the only other 3rd order tributary in the watershed, with all other tributary streams entering the Coginchaug River being either 1st or 2nd order streams.

The Coginchaug River primarily transitions between a C and E stream type from it's headwaters to the confluence with the Mattabesset. There is evidence of significant stream channel modifications in many reaches, including channelization, floodplain filling and dams. As a result, those sections of channel are often classified as an F stream type, such as the reach through Veterans Memorial Park. In some cases the modified stream reaches are unclassified, such as the ¾ mile section downstream of Wadsworth falls, because the frequency of dams and associated backwater do not allow for adequate channel development.

The sections of stream identified as C stream type can be described as moderate to low gradient, slightly entrenched streams with well developed floodplains and a meandering, riffle/pool channel morphology of moderate sinuosity. Typical channel gradients for a C stream type range between 0.1% and 2%. The E stream types can be described as a low gradient stream with a well developed floodplain. Although, the E stream type is still a riffle/pool dominated channel, it tends to be more sinuous and has a lower width/depth ratio than the C stream type. Typical channel gradients for an E stream type are less than 2%. Conversely, the F stream types are both incised and entrenched with limited if any access to a floodplain. The F stream types have a homogeneous channel with a high width/depth ratio, and very low sinuosity. Typical channel gradients for an F stream type are also less than 2%.

While the above referenced stream types were observed in the tributaries, many sections of the tributaries were also classified as either an A or B stream type. An A stream type can be described a steep, entrenched stream, with a very low sinuosity, dominated by a cascade or step/pool morphology. These are high energy streams with virtually no floodplain. Typical channel gradients for an A stream type range between 4% and 10%. The B stream type has a moderate gradient, mostly dominated by riffle, with some irregularly spaced pools. The “B” streams are moderately entrenched with access to a limited floodplain, with a typical channel gradient between 2% and 4%.

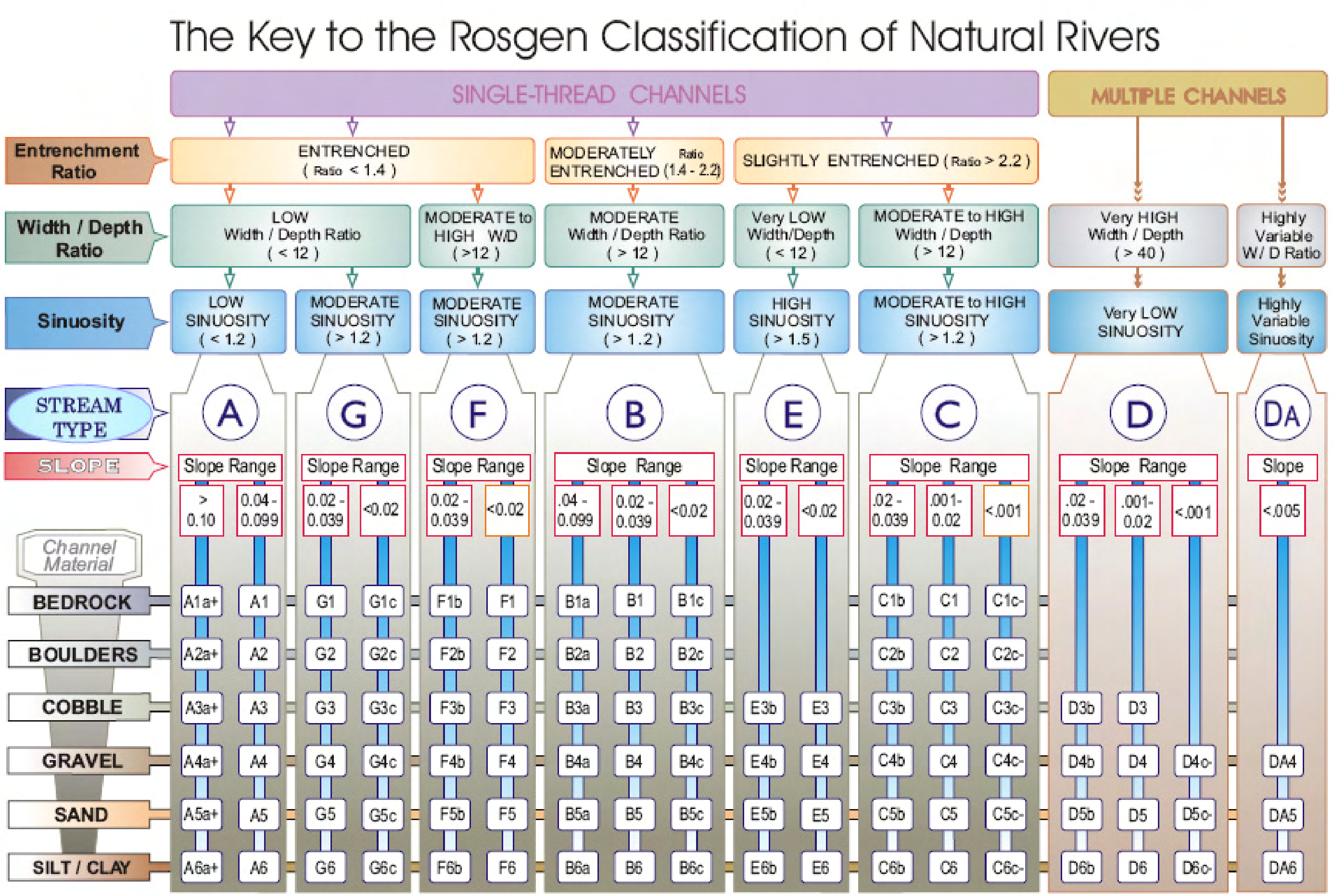
Quality Control

The accuracy of determining stream types and stream order is based on the accuracy of the topographic maps, aerial photographs and hydrography layers that were used for analysis. Some significant discrepancies between channel location and pattern were noted between the available data layers. Field verifications of various stream reaches throughout the watershed were made to ensure accuracy of stream types.

General Approach

Stream order is a hierarchical ordering of streams based on the degree of branching. A first order stream is a headwater stream without any branching. Two first order streams converge to form a second order stream, and two second order streams converge to form a third order stream. Although stream size may increase in a down-valley progression, stream order only increases when two streams of equal order converge. If a lesser order stream converges with a higher order stream the stream order does not change, the resulting stream retains it's preexisting higher order.

Level I stream classification is a geomorphic characterization of a stream (Rosgen methodology) based on channel slope, channel shape and channel patterns. Stream classification is ascertained through review of topographic maps and aerial photography. The Rosgen stream classification system for Level I and Level II classification is outlined in the figure below.



KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

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Specific Approach

Stream order was determined by analysis of the hydrosub24k_l_ct007 data layer using ArcGIS 8.3. No distinction was made between intermittent and perennial streams; both were included within the ordering sequence. Stream segments less than 1000 linear feet were not included in the ordering sequence.

Stream type was determined by analysis of both the topography and orthophotography data layers in ArcGIS 9.2. No distinction was made between intermittent and perennial streams; both were included in the geomorphic characterization of stream type. Verification of stream type was made through field checks, and stream measurements.

Appendix H: Fisheries Resources Assessment

Objective

The objective of the NRCS Fisheries Resources Assessment was to compile and summarize existing data on the distribution of resident fish as well as the existence of, or potential for diadromous fish species in the Coginchaug River. In addition, a rapid assessment of existing fish migration barriers within the historic range of anadromous fish was conducted. Map 29 shows the locations of Dams throughout the Coginchaug River Watershed

Geography

The NRCS Fisheries Resources Assessment for the Coginchaug River Watershed includes only the main stem of Allyn Brook (4605), Sawmill Brook (4606) and the Coginchaug River (4607) - which themselves are sub-regional basins of the Mattabesset River Basin (46).

Diadromous Fish Data:

Diadromous fish migrate between fresh water and salt water, and include the anadromous and catadromous fish of Connecticut. Anadromous fish spend the majority of their life cycle in salt water, and then migrate from salt water to fresh water to spawn. Conversely, catadromous fish spend the majority of their life cycle in fresh water and then migrate to salt water to spawn.

Resident Fish:

In addition to the eight (8) diadromous fish species identified, the Coginchaug is home to several resident fish species. The Connecticut DEP Inland Fisheries Division has conducted fish sampling surveys to determine species abundance and composition.

Based on the 1990 report "A Survey of Connecticut Streams and Rivers – Connecticut River Tributaries, Scantic River, Mattabesset River, Salmon River, Coginchaug River and Eightmile River Drainages", two surveys were conducted on the mainstem of the Coginchaug River, one on Allyn Brook, and two on Sawmill Brook.

Map 29: Locations of Dams in the Coginchaug River Watershed

The first site on the mainstem of the Coginchaug River, site number 1093, is located just off of Fisher Road in the town of Middletown. The survey (150 meter sample length) documented the presence of; American eel (*Anguilla rostrata*), American shad (*Alosa sapidissima*), bluegill (*Lepomis macrochirus*), brown trout (*Salmo trutta*), fallfish (*Semotius corporalis*), largemouth bass (*Micopterus salmoides*), pumpkinseed (*Lepomis gibbosus*), rock bass (*Ambloplites rupestris*), redbreast sunfish (*Lepomis auritus*), sea lamprey (*Petromyzon marinus*), tessellated darter (*Etheostoma olmstedi*), white sucker (*Catastomus commersoni*), and yellow perch (*Perca flavescens*). The American eel, redbreast sunfish, bluegill and rock bass were the most numerous with population estimates of; 144, 68, 56 and 38 individuals per hectare, respectively.

The second site on the Coginchaug River, site number 1044, is located at the lower Wadsworth Fall State Park, in the town of Middletown. The survey (150 meter sample length) documented the presence of; American eel (*Anguilla rostrata*), bluegill (*Lepomis macrochirus*), brook trout (*Salvelinus fontinalis*), blacknose dace (*Rhinichthys atratulus*), brown trout (*Salmo trutta*), fallfish (*Semotius corporalis*), largemouth bass (*Micopterus salmoides*), longnose dace (*Rhinichthys cataractae*) pumpkinseed (*Lepomis gibbosus*), redbreast sunfish (*Lepomis auritus*), rainbow trout (*Oncorhynchus mykiss*), tessellated darter (*Etheostoma olmstedi*), and white sucker (*Catastomus commersoni*). The American eel and longnose dace were by far the most abundant with estimated population sizes of 423 and 361 individuals per hectare, respectively. While the tessellated darter, fallfish, pumpkinseed, redbreast sunfish, and blacknose dace were the next most abundant grouping of fish, with population estimates between 24 and 43 individual per hectare.

On Allyn Brook, just downstream of Route 17 in the town of Durham is site number 1046 in the CT DEP survey. The survey (100 meter sample length) documented the presence of; American eel (*Anguilla rostrata*), bluegill (*Lepomis macrochirus*), brook trout (*Salvelinus fontinalis*), blacknose dace (*Rhinichthys atratulus*), brown trout (*Salmo trutta*), fallfish (*Semotius corporalis*), pumpkinseed (*Lepomis gibbosus*), redfin pickerel (*Esox americanus*), common shiner (*Notropis cornutus*), tessellated darter (*Etheostoma olmstedi*), and white sucker (*Catastomus commersoni*). The tessellated darter and common shiner are the most prevalent, with population estimates of 341 and 143 individuals per hectare, respectively. While the fallfish, white sucker and blacknose dase were the next most abundant grouping of fish, with population estimates between 92 and 69 individuals per hectare.

Two surveys were conducted on Sawmill Brook, one in Durham and the other in Middletown. The survey are in Durham (site number 1045), located just below Trimountain Brook Road, had a sample length of 50 meters and documented the presence of; brown bullhead (Ameiurus nebulosus), bluegill (*Lepomis macrochirus*), common shiner (*Notropis cornutus*), fallfish (*Semotius corporalis*), largemouth bass (*Micopterus salmoides*), pumpkinseed (*Lepomis gibbosus*), and white sucker (*Catastomus commersoni*). The White sucker was the most abundant, with an estimated population size of 41 individuals per hectare. While the bluegill and fallfish were the next most abundant species of fish with estimated population sizes of 13 and 15 individuals per hectare, respectively.

The survey area in Middletown, on Sawmill Brook (site number 1043) is located along Bell Street. The survey (100 meter sample length) documented the presence of; American eel (*Anguilla rostrata*), bluegill (*Lepomis macrochirus*), blacknose dace (*Rhinichthys atratulus*), common shiner (*Notropis cornutus*), fallfish (*Semotius corporalis*), longnose dace (*Rhinichthys cataractae*), largemouth bass (*Micropterus salmoides*), tessellated darter (*Etheostoma olmstedi*), and white sucker (*Catastomus commersoni*). The common shiner and fallfish were the most abundant, with population estimates of 91 and 73 individuals per hectare, respectively. While the blacknose dace and white sucker made up the next most abundant grouping, with population estimates of 33 and 34 individuals per hectare.

Quality Control

The accuracy of the fisheries data is based on the accuracy of the stream sampling conducted by the CT Department of Environmental Protection –Inland Fisheries Division. No additional sampling was conducted to verify the published results.

Measurements of dam heights and weir crest length were made in the field by the author. Weir crest heights were determined using a standard survey rod, held at the face of the dam, and measured from the tail water elevation to the weir crest. Measurements were taken to the nearest

0.1 foot. Measurement of the weir length were taken using a laser rangefinder, and taken to the nearest 0.5 meter. The accuracy of the laser range finder is +/- 0.5 meters.

General Approach

A fisheries assessment, would typically involve a review of the current published data complemented with a comprehensive sampling protocol to determine the current distribution and abundance of fish throughout the entire watershed. Although NRCS has the capability of conducting a watershed-wide sampling effort, such an effort was outside of the scope of this project.

Subsequently, the data used to determine the distribution and abundance and/or the presence of fish was taken from existing data and communications with DEP staff. It should be noted the most recent data for the resident stream fish sited in the report was gathered in 1889. The various land-use changes within the watershed that have occurred over the past 17 years could have had significant implications in the distribution and abundance of the resident stream fish.

Specific Approach

Fisheries data was gathered from communication with CT DEP staff and review of the published DEP stream survey results for the Coginchaug River Watershed.

The rapid assessment of migratory barriers to anadromous fish was conducted by field reconnaissance and assessment of each individual barrier. A general photograph of the barrier was taken, as were barrier height measurements and weir length measurements. Based on observed site conditions, a recommendation for fish passage was made.

Benthic Monitoring Information

The Chernoff Lab at Wesleyan University conducted its benthic macroinvertebrate sampling at two sites on the Coginchaug River. CR is the upstream site close to the headwaters of the River; it is surrounded by agricultural fields, and has a riparian corridor of mainly herbaceous vegetation. LCR is the downstream site, close to its confluence with the Mattabesset River; its watershed includes a much larger proportion of developed land cover. The LCR sampling site is at a location of extremely high silt and sand build up, presumably from road run-off throughout the developed portion of the watershed.

Upstream sampling was done from the spring of 2004 to the fall of 2007; downstream from spring 2005 through summer 2007. The purpose of this sampling was to monitor temporal changes within and between river sites, and as such generally goes from May/June through October/November. However, most sampling done by the State and Riverwatch programs for the purpose of monitoring water quality are done only in the fall. All data are included in the table (see Table 2); fall months are highlighted.

Most of the results are from Surber samples, in which the rocks within a square foot area of substrate are scrubbed into a filter. Some samples were from rock bags, in which netted rock bags are placed in the stream, and retrieved and scrubbed one month later. Each sample in the table represents the sum of 25% of each of three replicates (samples within the same riffle); 25% of each sample is identified to family, regardless of the number of organisms.

Table 4 shows the application of various biometrics. Abundance (organism density), EPT richness, Percent Model Affinity (% MA) and % Dominant Family (% D) are described earlier, in the *Water Quality Summary and Monitoring Data*. Percent EPT is the percent of total organisms that are in the EPT taxa, in comparison to the total from all taxa. MW richness is the number of "most wanted" taxon. We have modified the CT DEP's rapid bio-assessment protocol to consider only those families with a narrow range of low tolerances (within species of the family). This might be considered the best indicator of water quality since it is only of organisms with low tolerance (for conditions found in degraded streams). The DEP considers those samples with 5 or more to be indicative of high water quality. Richness is the total number of taxon identified – it is offered to provide some comparison for EPT and MW taxon richness.

While a lower than "minimum" density may signify impacts to water quality, a very high number can also be indicative of human impacts, such as from nutrient inputs. To some extent, this can also be reflected in % dominant family.

Percent model affinity compares the percentage of organisms in particular families with an "ideal" benthic macroinvertebrte community (for CT, Hoffman 2005). Adjusted % Model Affinity is a proposed change to this metric that alters the formula so that neither an excess of stoneflies (all stonefly species having low tolerance values) nor an under abundance of chironomids (tolerant midge species) reduces the final rating and need not widen the gap between the sample and the ideal (Unpublished, Olins 2005).

Conclusions:

- Biometrics for these sites are different from one another and from the Veteran's Park **sample**.
- Temporal variability: Biometrics vary widely between and within sites over time, with impacts for some changing from none to severe. These variations do not appear to be seasonal.
- Impact: There is a dearth of "most wanted" taxa at either site, indicating that neither could be considered high quality. Both are lower (averages of 2 for CR and .5 for LCR) than at other sites that we sampled, located in the Eight Mile River watershed (average 4.3). Percent dominant family indicates impacts at both sites. There is no statistical difference between the number or percent of EPT taxa at either; both fall below the standard of 10 for a healthy site. Percent Model Affinity has similar variability at each site; CR overall fits this model better.
- Average abundance. This is significantly higher at CR than LCR, perhaps due to increased nutrients from local run-off. However – or additionally - the lower abundances at LCR may also be due to the high degree of substrate embeddedness there (the degree to which rocks on the river bottom are surrounded or covered in silt and/or sand).
- Water Chemistry: Average pH and average conductivity are very similar between sites when both years are summed. However, when we look at the years individually, we see that conductivity at CR rose from 1.8 in 2006 to 2.7 in 2007. Conductivity is a measurement of the ions in the water, which can increase with salts and other particles commonly in high quantity in street run-off.

Appendix I: General BMP Costs

To assist local stakeholders and as one of the 319 watershed based plan requirements, a cost estimate has been developed for each of the place-based BMPs. Additionally NRCS developed cost estimates for two possible scenarios that are not specific to any sites. These estimates can be used as a general guideline for planning structural BMPs.

The first scenario is a small scale project, one acre in size, with 95% impervious area. For a parcel this size the Connecticut Stormwater Quality Manual (2004) has calculated the Water Quality Volume (WQV) to be 0.0754 ac-ft. (3285 cubic feet). The WQV is the volume of runoff generated by one inch of rainfall. The second scenario is a 40 acre suburban/residential area with 35% impervious cover. The WQV for this scenario is 1 ac-ft.

Table 35: General BMP Costs – Scenario 1

Scenario One: 1 acre watershed at 95% imperviousness CT Water Quality Volume (WQV)= 0.0754 ac-ft									
		Design & Contingency				Annual Cost Over Lifespan ($/yr)	Operation & Maintenance (O&M)		Total Cost /yr over Lifespan
	Construction ($)	% Const.	Cost	Total	Lifespan (years)		% Const.	$ / yr	
Stormwater Ponds	$8,800	25%	$2,200	$11,000	30	$886	4.5%	$396	$1,282
Stormwater Wetlands	$12,000	25%	$3,000	$15,000	30	$1,209	4.5%	$540	$1,749
Gravel Wetland	$21,600	25%	$5,400	$27,000	20	$2,549	5%	$1,080	$3,629
Infiltration									
Basin	$6,400	25%	$1,600	$8,000	10	$1,139.04	7.5%	$480	$1,619
Trench	$22,400	25%	$5,600	$28,000	12	$3,525.20	7.5%	$1,680	$5,205
Filtration									
Surface Sand Filter	$20,800	25%	$5,200	$26,000	15	$2,855	12%	$2,496	$5,351
Underground Sand Filter	$21,600	25%	$5,400	$27,000	15	$2,964	12%	$2,592	$5,556
Bioretention(Rain Gardens)	$24,000	25%	$6,000	$30,000	15	$3,294	6%	$1,440	$4,734
Manufactured Tech Devices									
Biofilters (e.g. StormTreat)	$24,000	15%	$3,600	$27,600	15	$3,030	5%	$1,200	$4,230

Included in the cost estimates for the two scenarios are BMPs which are in the range of somewhat effective to effective for bacteria, and that are generally considered suitable for the size of the scenario. Stormwater ponds, stormwater wetlands, and infiltration basins are not typically suitable for urban areas due to the large area requirements. They were included as part of the small scale project scenario because they may be suitable for a smaller site within a residential or rural area.

Catch basin inserts with media filters that target bacteria were not included since they are on a per unit basis and do not depend solely on watershed size or WQV. Nor were rain gardens (bioretention) included in the suburban/residential scenario. Although rain gardens are suitable for a parcel in a residential area, a single rain garden would have a limited effect in an area with a WQV of 1 ac-ft.

Table 36: General BMP Costs – Scenario 2

Scenario Two: 40 acres at 35% impervious CT Water Quality Volume (WQV)= 1 ac-ft									
		Design & Contingency				Annual Cost Over Lifespan ($/yr)	Operation & Maintenance (O&M)		Total Cost /yr over Lifespan
	Construction ($)	% Const.	Cost	Total	Lifespan (years)		% Const.	$ / yr	
Stormwater Pond	$56,000	25%	$14,000	$70,000	30	$5,641	4.5%	$2,520	$8,161
Stormwater Wetland	$76,000	25%	$19,000	$95,000	30	$7,656	4.5%	$3,420	$11,076
Gravel Wetland	$132,000	25%	$33,000	$165,000	20	$15,574	5%	$6,600	$22,174
Infiltration									
Basin	$52,000	25%	$13,000	$65,000	10	$9,254.70	7.5%	$3,900	$13,155
Filtration									
Surface Sand Filter	$80,000	25%	$20,000	$100,000	15	$10,979	12%	$9,600	$20,579

Table 37: Summary of BMP's – with References

	Initial cost ($)	Lifespan (yrs)	Capitalized cost over Lifespan^ ($/yr)	Capitalized cost over Lifespan^ units	Operation & Maintenance ($/yr)	Operation & Maintenance units	Total ($/yr)	Total units
Street Sweeping-regen. air/vac sweeper serving 8160 curb miles/yr*	$185,000	8	$3.80	curb mi.	$18.50	curb mi.	$22.30	curb mi.
Catch basin insert for bacteria (e.g. AbTech Ultra Urban Filter with Smart Sponge)#	$1,100	1 to 3	$420 to $1,100	ea.	$180.00	ea.	$600 to $1,100	ea.

*Ref. from EPA 1999 EPA determination Sweeper can service 8160 curb miles per year
#lifespan depends on maintenance & loading
^Capitalized cost over the Lifespan takes the total cost of the initial cost and capitalizes it over the its lifespan at an interest rate of 7%.

BEST MGT PRACTISES (BMPs) - continued				
	Amount	Units	Comments	Reference
Pet Waste Station sign with bags & receptacle on post	$500.00	ea.		On-line products Paw Pal &J J B Solutions Inc. plus installation
Pet waste flyer mailing				
Pet waste ad-TV				
-newspaper				
Riparian Buffer-Herbaceous	$450.00	ac.		In-house Draft Cost Sheet for EQIP & WHIP
-Shrub/Tree	$2,400.00	ac.		In-house Draft Cost Sheet for EQIP & WHIP
-Warm Season grasses for goose manage	$850.00	ac.		In-house Draft Cost Sheet for EQIP & WHIP
Fencing-Woven Wire	$10.00	lf		In-house Draft Cost Sheet for EQIP & WHIP
-4/5 strand barbed wire	$5.70	lf		In-house Draft Cost Sheet for EQIP & WHIP
-4/5 strand electric	$9.00	lf		In-house Draft Cost Sheet for EQIP & WHIP
solar charger for elec.	$300.00	ea.		In-house Draft Cost Sheet for EQIP & WHIP
Wetland Restoration-broadcast seed	$2,600.00	ac.		In-house Draft Cost Sheet for EQIP & WHIP
Livestock Watering Facility	$525.00	ea.		In-house Draft Cost Sheet for EQIP & WHIP
Well for watering facility	$6,300.00	ea. (average)	can vary widely	In-house Draft Cost Sheet for EQIP & WHIP
Pumping Plant for water facility	$2,500.00	ea.		In-house Draft Cost Sheet for EQIP & WHIP
2 " underground supply pipe	$7.00	lf		In-house Draft Cost Sheet for EQIP & WHIP