Long Meadow Pond Brook Watershed

Naugatuck, Connecticut

King's Mark Environmental Review Team Report

King's Mark Resource Conservation & Development Area, Inc.

Long Meadow Pond Brook Watershed
Naugatuck, Connecticut

Environmental Review Team Report

Prepared by the
King's Mark Environmental Review Team

Of the
King's Mark Resource Conservation & Development Area Project

For the
Inland Wetland Commission
Naugatuck, Connecticut

November 2013

#358

Acknowledgments

This report is an outgrowth of a request from the Naugatuck Inland Wetlands Commission to the Southwest Conservation District (SWCD) and the Connecticut ERT Subcommittee for their consideration and approval. The request was approved and the measure reviewed by the King's Mark Connecticut Environmental Review Team (ERT).

The Connecticut Environmental Review Team Coordinator, Elaine Sych, would like to thank and gratefully acknowledge the following Team members whose professionalism and expertise were invaluable to the completion of this report.

The field review took place on Wednesday, April 18, 2012.

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I would also like to thank Keith Rosenfeld, Town Planner/Wetlands Enforcement Officer, Wayne Zirolli, Borough Engineer, Jim Stewart, Director of Public Works, Mary Davis, Chair, Inland Wetlands Commission, Alexander Olbrys, Member, Inland Wetlands Commission, Amanda Fargo-Johnson, ERT Project Assistant, and Susan Peterson, CTDEEP-Watershed Management and Don Mysling, CTDEEP-Fisheries Division for their cooperation and assistance during this environmental review.

Prior to the review day, each Team member received a summary of the proposed project with location and soils maps. During the field review Team members were given other reports and maps. Some Team members made separate or follow-up visits to the site. Following the review, reports from each Team member were submitted to the ERT coordinator for compilation and editing into this final report.

This report represents the Team's findings. It is not meant to compete with private consultants by providing site plans or detailed solutions to resource problems. The Team does not recommend what final action should be taken on a proposed project - all final decisions rest with the town and landowners. This report identifies the existing resource base and evaluates its significance to the proposed use, and also suggests considerations that should be of concern to the town. The results of this Team action are oriented toward the development of better environmental quality and the long term economics of land use.

The King's Mark RC&D Project hopes you will find this report of value and assistance in reviewing flooding concerns and stormwater and watershed management for the Long Meadow Pond Brook watershed.

If you require additional information please contact:

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Introduction

INTRODUCTION

The Naugatuck Inland Wetlands Commission requested Environmental Review Team (ERT) assistance in reviewing the Long Meadow Pond Brook watershed, specifically the area from Field Street to the Naugatuck River along Rubber Avenue. In recent years, residents and businesses along the Long Meadow Pond Brook channel have experienced repeated flooding of yards and structures. Many residents have expressed the concern that the problem is becoming more severe as the frequency of events increases.

OBJECTIVES OF THE ERT STUDY

An overall visual inspection of Long Meadow Pond Brook watershed and information on geology, topography, soils, wildlife, vegetation, and planning issues will assist the in identifying potential problem areas so the Borough can develop plans to address these issues. Specifically a study of the watershed and stream channel will 1) evaluate the existing and proposed storm water management strategies; 2) target areas to improve existing erosion and sedimentation controls and 3) provide guidance on management of natural resources. General information on Best Management Practices and Low Impact Development techniques are also given. The Team did not identify present and potential pollution/contamination sources or abatement techniques. The Appendix also provides information from The Northeast Regional Climate Center's (NRCC) work on *Extreme Precipitation in a Changing Climate for New York and the New England States*. Their new extreme precipitation study will provide an updated standard upon which regulations, engineering design, and policy can be based. There is also information from the town's hazard mitigation plan, climate change, and riparian buffers.

THE ERT PROCESS

Through the efforts of the Naugatuck Inland Wetlands Commission this environmental review and report was prepared for the Borough of Naugatuck.

This report provides an information base and a series of recommendations and guidelines which cover some of the issues of concern to the town. Team members were able to review maps, plans and supporting documentation provided by the town and the applicant.

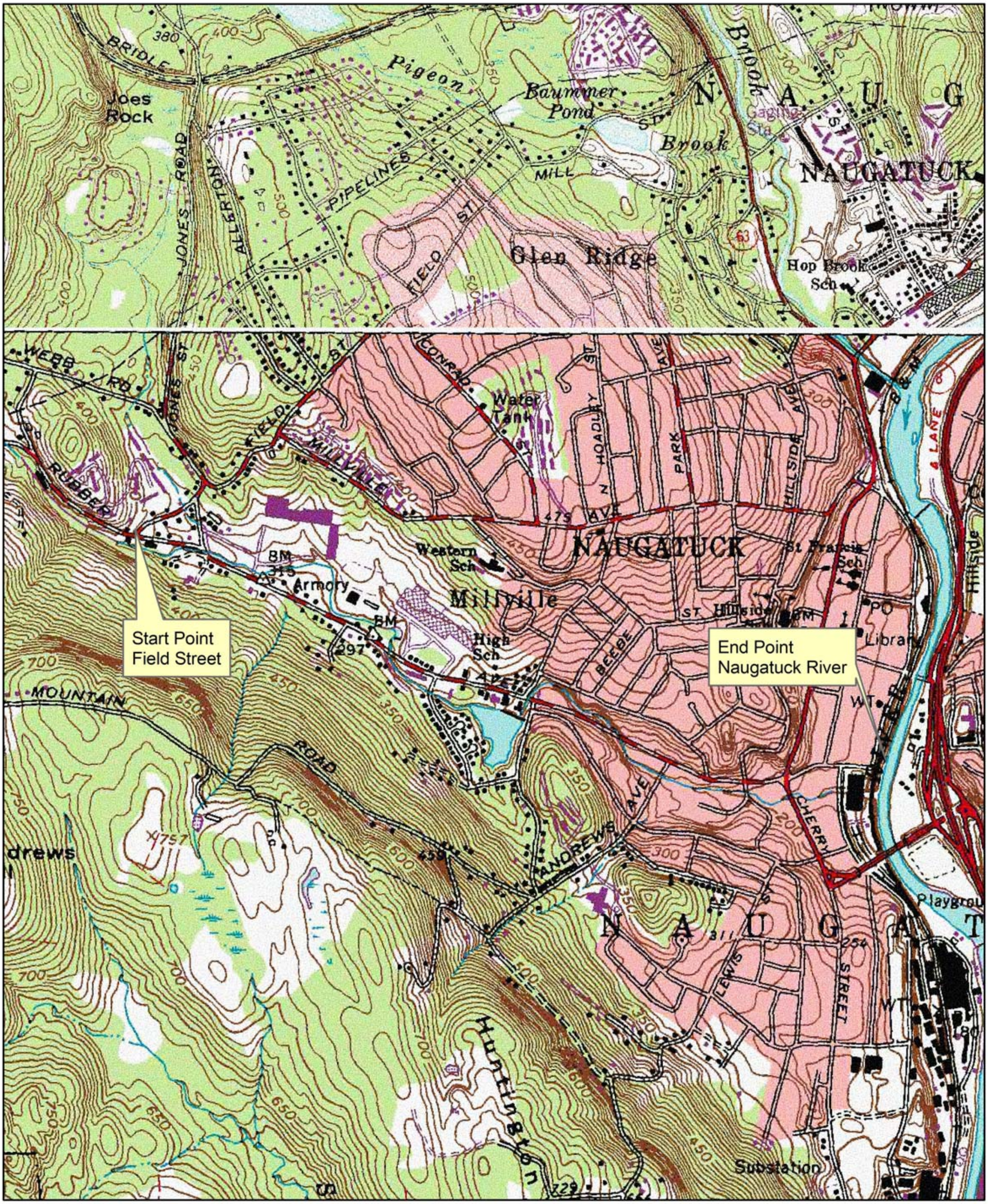
The review process consisted of four phases:

1. Inventory of the site's natural resources;
2. Assessment of these resources;
3. Identification of resource areas and review of plans; and
4. Presentation of education, management and land use guidelines.

The data collection phase involved both literature and field research. The field review was conducted on Wednesday, April 18, 2012. Some CTDEEP staff participated on the field review but did not submit a written report. The emphasis of the field review was on the exchange of ideas, concerns and recommendations. Being on site allowed Team members to verify information and to identify other resources.

Once Team members had assimilated an adequate data base, they were able to analyze and interpret their findings. Individual Team members then prepared and submitted their reports to the ERT coordinator for compilation into this final ERT report.

Long Meadow Pond Brook Watershed Study Topo Map



The Connecticut Environmental Review Team

This map was prepared by Amanda Fargo-Johnson for
the Connecticut Environmental Review Team.
This map is for educational use only.
It contains no authoritative data.
March 2012.

N

0 0.1 0.2 0.4 0.6 Miles

Naugatuck, CT

Long Meadow Pond Brook Watershed Study Aerial Map

The Connecticut Environmental Review Team

This map was prepared by Amanda Fargo-Johnson for the Connecticut Environmental Review Team.
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It contains no authoritative data.
March 2012.

Naugatuck, CT

Long Meadow Pond Brook Watershed Study Color Aerial Map

The Connecticut Environmental Review Team

This map was prepared by Amanda Fargo-Johnson for the Connecticut Environmental Review Team.
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It contains no authoritative data.
March 2012.

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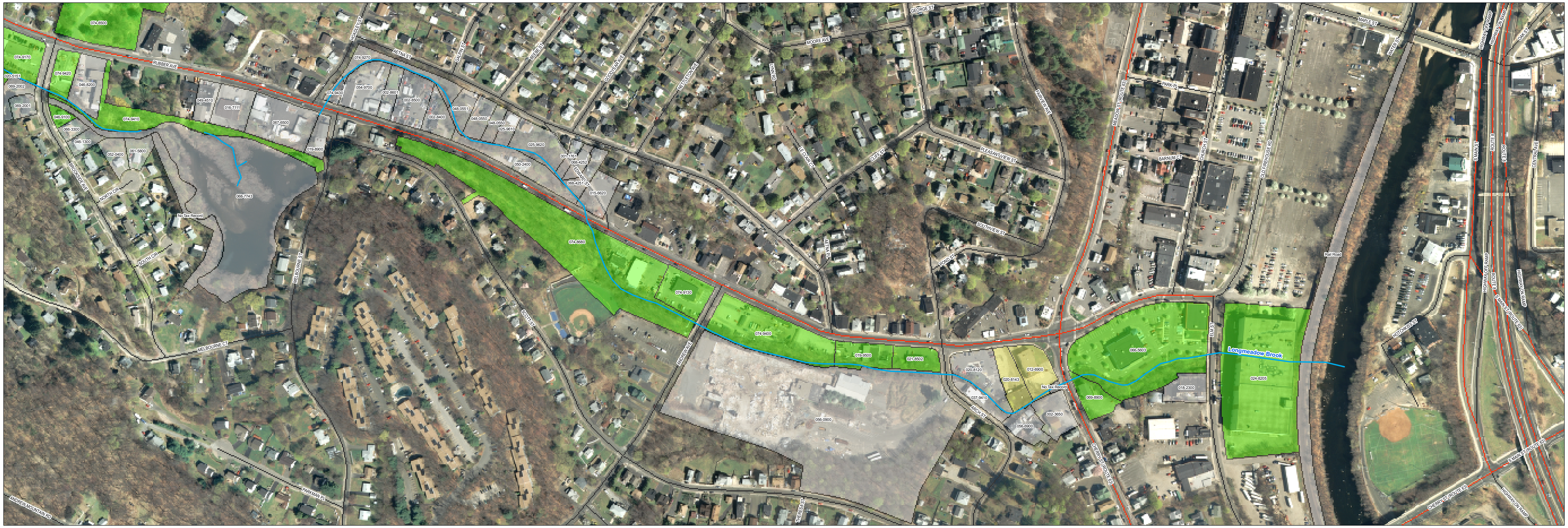
Naugatuck, CT



N

0 90 180 360 Feet

1 inch = 130 feet

Access Granted

Access Desired

No Response

The spatial information on this map is not a survey
and is subject to any changes an actual land survey discloses.

Borough of Naugatuck - Long Meadow Brook Abutters
Neuman Street to the Naugatuck River

Topography and Geology.

Long Meadow Brook is about 6 miles in length. Its drainage basin (watershed) about 5 miles long and 1-2 miles in width. Its headwaters are just south east of Lake Quassapaug in Middlebury where the basin divide lies at approximately 770 feet above sea level. The brook empties into the Naugatuck River at an elevation of approximately 180 feet above sea level. Hill tops surrounding the drainage basin (watershed) of Long Meadow Brook are generally just over 800 feet above sea level with Great Peak in Middlebury reaching a height of 970 feet above sea level. Slopes of the valley wall are steep in the lower reaches of the brook, but upper reaches of the watershed have less steep valley walls.

The courses of the river is interesting geologically (Figure 1). It originates on Ordovician aged rocks (~450 million years). It flows downstream and crosses onto Cambrian Aged rocks (~500+ m.y.) in the Lake Elise – Long Meadow Pond region. The brook then flows down a valley that follows the pattern of Ordovician aged rocks which form a large s-shaped fold. The Ordovician rocks are metasedi-mentary and metavolcanic. The river swings northward around the upper hinge of the "S" and then

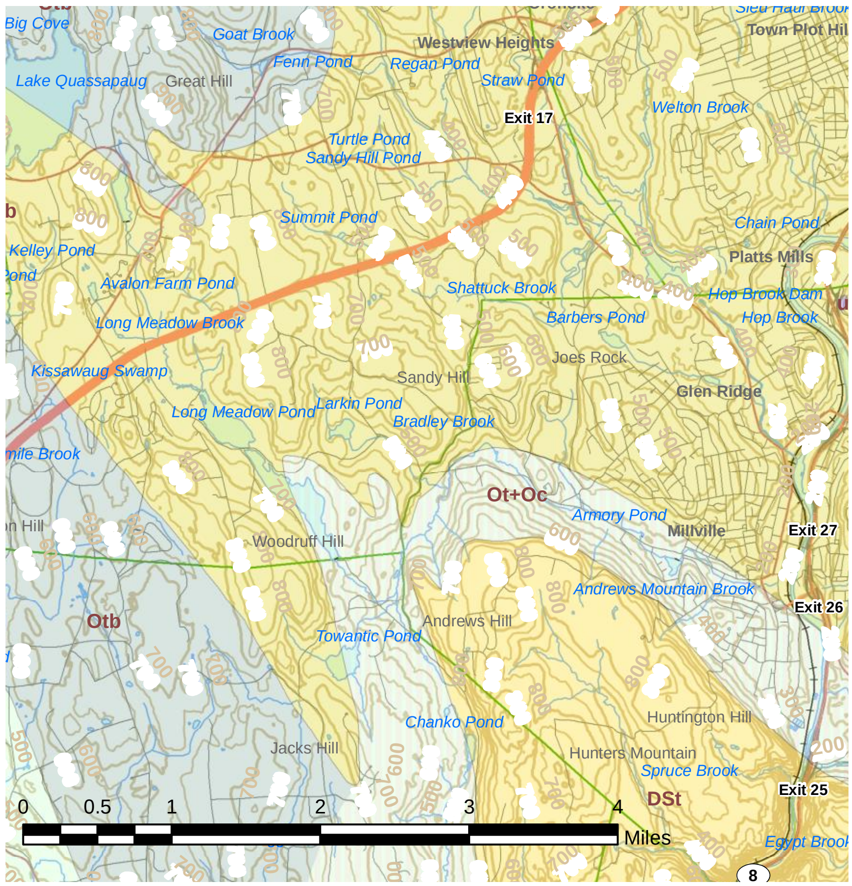


Figure 1. Geologic Map of the Long Meadow Brook watershed: Otb, Ot + Oc (Pale green and bluish-green areas) are areas underlain by Ordovician metasedimentary and metavolcanic rocks. Pale yellow area in north-central and northeast is Cambrian Waterbury Gneiss. Yellow area to southeast is Straits Schist (DSt). Heavy red line is I-84.

eastward again around the lower hinge. The underlying rocks (to the north and east) are the Cambrian Waterbury Gneiss, the same formation over which the brook flows in its upper reaches. To the southeast, the overlying rocks are the Devonian Straits Schist . The flooding problems of Long Meadow Brook seem more related to urbanization than to the underlying geology.

The longitudinal profile of the river has a couple of steeper areas where the stream gradient is in excess of 200 feet/mile: one where the brook enters Lake Elise (Figure 2a) and the other where the stream exits Long Meadow Pond (Figure 2b). Interestingly, both areas are underlain by Ordovician aged rocks. Generally Long Meadow Brook has only a moderate gradient (70-80 feet/mile). The upper reaches of the watershed are partly rural with some subdivision development. The lower reaches of the watershed, however, are urbanized with resulting severe impact to the brook.

In simplistic terms, urbanization affects streams because it causes environmental changes that upset the natural balance the stream system tries to achieve. A stream has many components that adjust to each other. Streams are networks designed to carry water and eroded sediment through a system in channels of just the right depth, just the right width, just the right gradient, and just the right

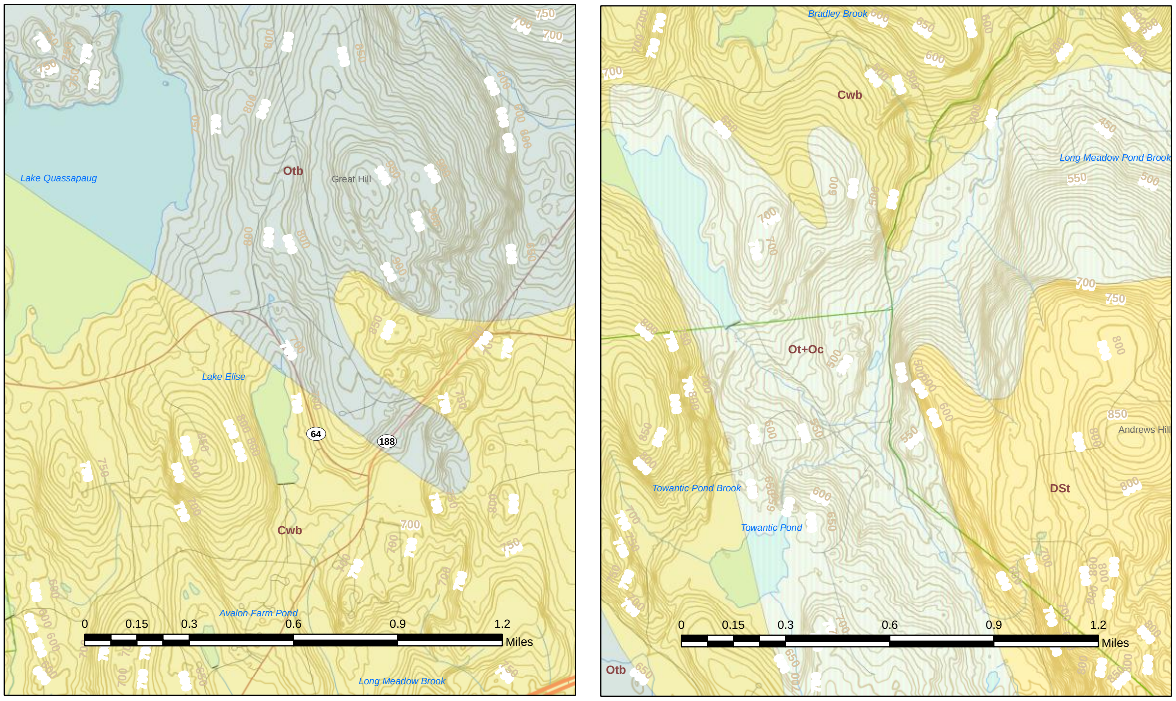


Figure 2a (left). Lake Elise, upper reaches of watershed. Note steep stream gradient in area underlain by Ordovician rocks (Pale blue-green) north of lake. 2b (right). Lower Long Meadow Pond area. Note steep gradient of Brook downstream of pond where brook is underlain by Ordovician rocks (pale green).

velocity on flood plains of just the right area to drain the land most efficiently. Through a series of feed-back mechanisms the all the stream parameters change in reaction to changes in any one parameter. Through the feed-back mechanism, streams attempt to achieve equilibrium.

The first affect of urbanization is the covering of porous soil that normally soaks up rain water and snow melt with impervious surfaces (Figure 3) that are sloped so that the water rapidly drains off of them. What this does is to deliver more water into the streams as quickly as possible, increasing the height of the stream. For this reason alone, it is not surprising that the urbanized areas of the Long Meadow Brook basin are the areas where

Figure 3. Aerial photograph of mall on Rubber Avenue near Neumann Street. Gray and black areas are impervious asphalt, which in this area cover perhaps 70% of the watershed surface, up to the very edge of the brook channel. Rain falling on this area quickly drains into storm sewers and then into the brook.

increased flooding has been reported. The brook may have been able to withstand increased flow except that the development was allowed by the town's regulating bodies to fill in the flood plain (Figure 4). The flood plain is a natural flood retention area. Excess water spreads out across the flood plain during an event, thus temporarily reducing the volume of water downstream. Floodplain encroachment results in floodwaters having no place to go other than to spill out of the banks and in effect create a new flood plain to replace that which was developed (filled in).

Figure 4. Floodplain encroachment. In all three pictures, fill has been placed to the very edge of the stream channel, eliminating the natural flood retention area. a. Looking upstream at Cherry Street crossing. The brook has effectively been channelized here. Regulating agencies even allowed building foundation to be installed on the stream bank. b. Crossing at west entrance to mall on Rubber Avenue, looking upstream; bank on right. Channelization has occurred here also, but the fill is not as high as at Cherry Street. The brook flooded here, in part because the channel is not as deep, but more importantly, the conduits below this crossing were sized too small. Here there is no floodplain, so in effect, when a heavy rain even occurs, the stream creates its own flood plain, spilling across the street and into adjacent buildings that are built where the flood plain was. c. Looking downstream at west entrance to mall. Regulatory agencies allowed filling of the floodplain up to the very edge of the river channel to create a parking area. Then the filled area was covered with an impervious surface.

River channel crossings also exacerbate the problem by constricting downstream flow from the full cross-sectional area of the river and its flood plain to conduits with a relatively small cross-sectional area (Figure 5) or bridges with abutments having a cross-sectional area that is smaller than the natural cross-section. This is actually a technique used in some flood retention basins to slow downstream flow of water during the height of an event and to let it slowly drain downstream as the flood subsides.

Figure 5. West entrance to mall on Rubber Avenue, looking downstream; bank on left. The conduit shown was replaced when a smaller conduit washed out during floods that accompanied precipitation of the remains of tropical storm Irene in August, 2011.

Conservation District Review

CORRIDOR RESOURCES AND ATTRIBUTES

This report applies to the latter portion Long Meadow Pond Brook (6917-00) riverine corridor and the physical attributes that have affected the quality and volume of water resources plus the translation of flows to its terminus into the Naugatuck River. Long Meadow Brook enters the Borough from Middlebury to the west and trends in a westerly direction as it receives additional discharges from Webb Brook sub basin with its mouth located at the intersection of Jones Road and Rubber Ave. continuing to its confluence with the Naugatuck River. Historically, Long Meadow Pond Brook has experienced frequent flooding problems in the area of the National Guard access crossing due to the inadequate capacity of its crossings, the confluence of Webb Brook and more recently at the crossings around Webster Bank.

The ERT request for review selected the brook segment from Field Street to the Naugatuck River. However, the District report found additional opportunities may exist in the hydrologic reaches further upstream on Long Meadow Pond Brook (6917-00 and within the sub basin of Webb Brook (6917-03). The soil characteristics and topographic attributes are based on the historical soils series descriptions and the new digital mapping unit descriptions as presented in the Soil Survey of Connecticut, remote survey interpretations plus field observations. In an effort to inventory and assess the natural resources within this corridor, this report looks at four (4) areas and issues related to the soils, their physical attributes and their ability to affect water quality.

TOPOGRAPHY

The topography of the Borough of Naugatuck is generally moderate to steeply sloping toward the Naugatuck River. There is an elevational change of some 740 feet from its highest point in Andrews Hill to the Naugatuck River, which contributes to the hydraulic dynamics of the tributaries within the community. Long Meadow Pond Brook's 8.41 square mile contributory drainage area, plus its continuous natural down-cutting ability coupled with the loss of flood plains due to development has exacerbated the threat of flooding throughout the tributary.

SOILS RESOURCES

Wetland Soils

The drainage classes of these soil types throughout the watersheds selected corridor range from somewhat poorly to poorly drained soils.

Glacial Till – These glacial deposits have a lithology comprised of schist, granite and gneiss. Typically, these soils formed in dense basal till along drainageways adjacent to the stream channel and in depressions within the stream floodplain. They are very deep, fine sandy loam, loam, silt loam textures to a depth of 60 inches or more.

Soil type names found within the corridor and possessing these attributes are **Whitman** (immediately adjacent to streams) and **Ridgebury** soils that are found to occupy higher positions.

Glaciofluvial – These stratified sand and gravel deposits are comprised of acidic crystalline rocks that have formed into loamy over sandy and gravelly glacial outwash deposits. These soils have a watertable within 1.5 feet of the surface much of the year. Typically, they have a silt loam, very fine sandy loam, or fine sandy loam surface layer and subsoil over a stratified sand and gravel substratum that extends to a depth of 60 inches or more. One such soil name found in abundance in these hydraulic reaches is the soil named **Raypol**.

Note: These portions of the watershed may be of considerable interest in the potential flood control opportunities that allow for temporary storage capacity and increasing retention time to slow inputs to long Meadow Brook and ease the translation of concentrated flows during storm events.

Alluvial **–** These alluvial deposits are stratified sand and silt comprised of gneiss, schist and granite formed in lower flood plains of major streams and their tributaries. Typically, these soils have a fine sandy loam texture overlying stratified sand and gravel to a depth of 60 inches or more. The predominant soil type found with this catena is Rippowam within the corridor.

Non-wetland Soils

The non-wetland soil characteristic in the uplands of the watershed can be characterized as well and moderately well drained, glacial tills and glaciofluvial deposits with a lithology of acidic crystalline rock whose parent material was of schist, granite or gneiss in origin.

Glacial Till – These **g**lacial tills are steep to moderately steep, well drained soils on hills, ridges and steep valleys where the relief is affected by underlying bedrock. Runoff is rapid. Severe erosion hazard.

Soil type names found within these uplands surrounding the stream corridor and possessing these attributes are **Charlton, Hollis and Paxton,** which have slopes ranging from C to E slope designations. The latter **Paxton** soil type combined with steep topographic relief and slow permeability to the substratum is the dominant upland soil type that presents the second greatest threat to surface water runoff besides the impervious cover from commercial, industrial and roadway surfaces.

Glaciofluvial – These stratified sand and gravel deposits are excessively well drained formed in glacial outwash. Runoff is rapid. Permeability is paid in the surface layer, subsoil and very rapid in the substratum. Combined with the steepness of slopes, the hazard of erosion is severe when soil is disturbed. Soils having these characteristics would be the Hinckley and Ninigret soil types.

CONCERNS

The flood plains and floodways of Long Meadow Pond Brook have largely been adversely affected by encroachment and the installation of inadequate stream crossings throughout the corridor. The natural surface water runoff coupled with the community's dense development has also increased the volume and velocity of stormwater discharges into its watercourses. The resulting in acceleration in erosion and deposition from runoff has given rise to the obstructions of event flows and increases the frequency of the waters coming out of bank along the Brook.

RECOMMENDATIONS

The highly developed stream segment of Long Meadow Pond Brook from the confluence of Webb Brook to the Naugatuck River could benefit from the installation of strategically located stormwater detention and retention facilities and retrofits that will supplement storage capacity and slow flows during storm events. However, there may be additional opportunities in the upper regions of the watershed that utilize the natural landscapes capabilities for flood storage and provide enhanced controls on flow velocities and volumes. The following locations present potential opportunities for flood control, reduction of stormwater runoff discharges, erosion and sedimentation control plus water quality along this portion of the watershed.

Flood Control – See Exhibit #1
Retention and detention locations of runoff volumes in upper hydraulic reaches of 6917-00 watershed are:

FC-1 – Andrew Mountain Road – Control outlet of wetland complex PSS1E / PEME. Preliminary calculation of 1 foot elevation of control outlet feature could provide 12.8 acre feet of storage and slow flows into main stem.

FC-2 –Rubber Ave – Southside. Between Amanda and Coventry Lanes. Control outlet on wetland PEME. Preliminary calculation of 1 foot elevation of control outlet feature could provide 5.2 acre feet of storage and slow flows along main stem.

FC-3 –Rubber Ave – Northside. Above Crofut Lane. Control outlet on watercourse/wetland R3OWH Preliminary calculation of 1 foot elevation of control outlet feature could provide 13.5 acre feet of storage and slow flows along main stem. Includes drainage from 6917-02.

FC-4 – Breached Dam, Rubber Ave. – Rear of Restaurant. See Photo #1. The dam is in disrepair and diverted flows are eroding the southern streambank. These sediments continue to be entrained and are adding to the bed-load of Longmeadow Pond Brook, where deposition downstream a-grades the brook bottom. This causes the loss of flood storage capacity, constrains the translation of flows and makes it easier for the brook to come out of bank and flood adjacent properties. This dam served as a control point to sequester sediments and flood control.

Consideration should be given to repair or replace the dam. An alternative to this structure would be an in-stream gabion structure that would reduce erosion, enable the deposition and periodic removal of sediments to limit bed loads downstream plus restore some flood storage capacity.

FC-5 –Jones Road – North of Webb Rd. Control outlet on wetland PSS1E. Preliminary calculation of 1 foot elevation of control outlet feature could provide 10+ acre feet of storage and slow flows along Webb Brook and confluence of Long Meadow Pond Brook.

FC-6 –Naugatuck High School – Northeast sector south of Millville Rd. Delineated wetland PFO1E. Preliminary calculation of 1 foot elevation of control outlet feature could provide 1.7 acre feet of storage and slow flows and polish surface water runoff from roadways and high density residential land use area. Currently, this direct discharge to the Brook remains uncontrolled and untreated.

Note: Prior drainage study done for Naugatuck High School renovation for discharge point and Watershed DA-6 of the Stormwater Management Report from Langan Engineering dated April 25, 2012.

FC-7 – Elm Street Building – Watercourse R3OWH. Coursing underneath this building and its site footprint, the confluence of Long Meadow Brook with the Naugatuck River could be utilized as a waterfront park that would service the community aesthetically and provide a control point prior to discharge into the Naugatuck River for the sequestration of sediments and pretreatment of associated pollutants from the watersheds wide array of upstream land uses.

FC-8 –New Dam Pond – POWHh – This impoundments outlet structures are in need of repair and it has lost a majority of its storage capacity due to the deposition of sediments. The pond is in need of dredging and all points of inflow to the pond should be redesigned with adequate forebays to intercept and perform periodic removal of these deposits prior to getting into the main body of the pond. Draw down capabilities for storm events and scheduled sediment removal will be a significant enhancement to the flood management plan for the Borough.

FC-9 –Rubber Road, Northside, Rear of Human Resources Bldg – R3OWH – Stream channel revisions and the loss of some flood plain to parking needs has accelerated deposition and restricted flows under Rubber Ave. This section has benefited by periodic dredging to ease the translation of flows through this section of the brook on two occasions and is in need of this maintenance once again.

FC-10 –National Guard Armory – R3OWH – Historically, the entrance crossing has been a factor in some of the flooding issues. The armory and much of the parking area were once part of a larger floodplain that was capable of diffusing event flow volumes and velocities. That encroachment and loss of floodway constrained flows and reduced the flood storage capacity of this segment dramatically. There may be an opportunity to reclaim and restore part of the flood storage capacity of the Brook with the potential closure of the facility. It would be prudent to explore this scenario for future consideration in developing the flood management plan of the Borough.

Intent: Increase Upslope Flood Storage Capacity - Utilize and nominally modify the natural attributes of the landscape, wetlands, watercourses and flood plains to increase watershed storage capacity through the control of volume and velocity runoff introduced to main stem of long Meadow pond Brook. Engineer and install low maintenance control devices across outlet points of sizeable wetlands to increase acre-feet of temporary storage during storm events with pervious gabion dams and control weirs.

Stormwater Management – 2004 CT Stormwater Quality Manual (CT SWQM)

SWC-1 – Naugatuck High School – Eastern / Upslope section. Rear of School. Two (2) Delineated wetlands PFO1E. Expand and enhance size of mid-slope wetlands to increase storage capacity, time of retention and travel to renovate and slow the release of stormwater discharge volumes to Long Meadow Pond Brook. Consider configuring an adequately sized a multi-celled stormwater runoff basin that performs additional nutrient uptake and treats associated contaminants from roadways and high density residential areas to the north and east of the high school.
Note: Prior drainage study done for Naugatuck High School renovation for discharge point and Watershed DA-5 & DA-3 of the Stormwater Management Report from Langan Engineering dated April 25, 2012.

SWC-2 – Naugatuck High School – South Entrance – Redirect, store and pretreat stormwater runoff generated from the southern portion High Schools impervious surfaces and eastern, upslope environments into a series of multi-celled, water quality basins situated on the sides of the south entrance and discharging to the Borough's stormwater infrastructure on Rubber Ave.

Diverted discharges would be introduced to the south of the bridge and avoid adding flow volumes under the crossing, ease the translation of flows and reduce the potential for flooding upstream.

SWC-3 - Commercial and Industrial Developments Threat to Water Quality – Impervious surfaces. Sources of non-point source pollutants entrained in stormwater runoff discharges from commercial and industrial development need to be identified, ranked and prioritized regarding their affect on water quality. Direct discharge points to the Naugatuck River relative to the City's Stormwater Infrastructure mapping are potential retrofit opportunities that can renovate stormwater discharges that reduce the adverse effect of water quality and reduce the risk of flooding.

The direct discharge of concentrated and contaminated stormwater runoff from impervious surfaces along the stream corridor is a huge contributor to the flooding issues on Long Meadow Pond Brook.

<u>RECOMMENDATIONS</u> **– See Cross-section of Infiltrator Diagram**

Separate clean water from stormwater discharges to reduce volume discharges. Utilize infiltration techniques within CT SWQM. IE; rain gardens, parking lot bleed offs to vegetated swales, etc.

Disrupt contiguous impervious surfaces with stormwater runoff facilities that perform needed temporary storage capacity, infiltration and pretreatment of stormwater prior to discharge along the interior and perimeter of parking areas.

Erosion Control / Streambank Stabilization / Surface Water Runoff Control – Increased, direct runoff discharges to tributaries and the river from development has increased velocities and volume, which entrain and transport solids and organic materials. This is evidenced in the eroding banks, which have introduced sediments downstream, which have advanced the aggrading of the streams, loss of carrying capacity increasing the flooding threat, results in the loss of aquatic environment.

Permanent Diversions – PD - Strategically placed permanent diversions at the base of highly erodible slopes that intercept and convey concentrated surface water runoff away from buildings and undersized stormwater infrastructure systems can reduce inflows to segments of the stream corridor. This applies to the largely commercial area along the south side of Rubber Ave, where they are located at the base of steep slopes with Paxton soils that present severe erosion and runoff is rapid.

Buffering of Watercourses and Wetlands – Most of the upland soils in close proximity to these watercourses and wetlands have **moderate to severe erosion hazards** that relate to their composition and their topographic relief. Establishing well defined limits of disturbance and preserving the majority of the natural landscape reduces the risk of erosion and siltation, degradation of water quality and surface water runoff.

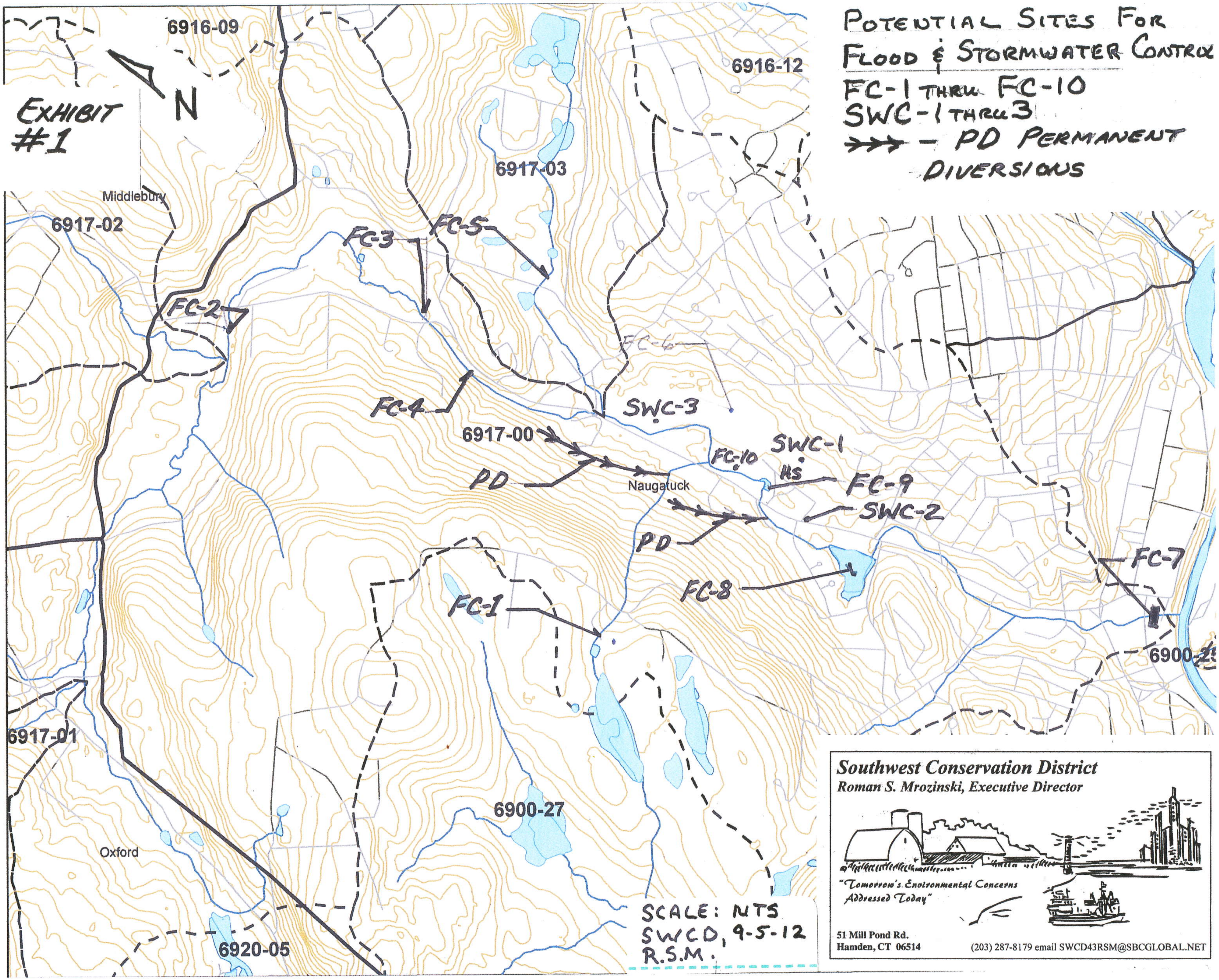
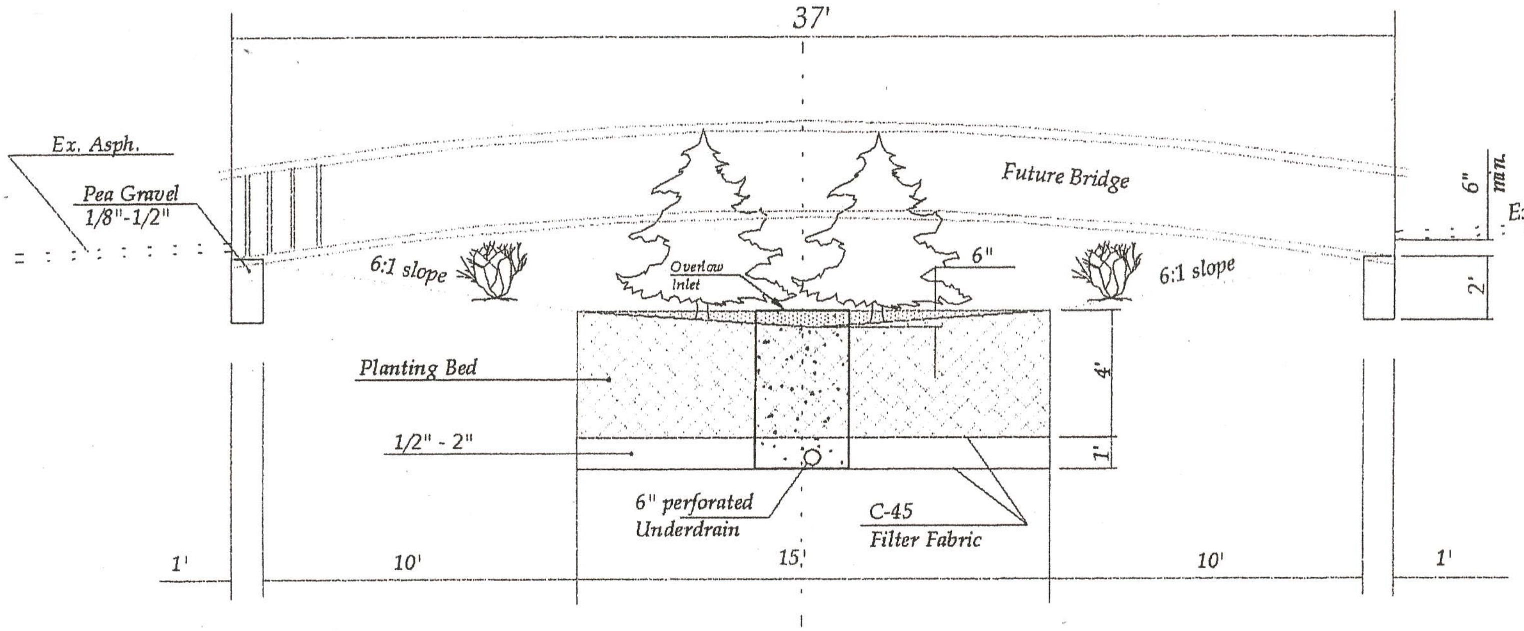

Potential Sites for Flood & Stormwater Control
FC-1 thru FC-10
SWC-1 thru 3
→→→ - PD Permanent Diversions
Exhibit #1
N
6916-09
6916-12
6917-03
Middlebury
6917-02
FC-3
FC-5
FC-2
FC-6
FC-4
SWC-3
6917-00
SWC-1
FC-10
HS
FC-9
PD
Naugatuck
SWC-2
PD
FC-7
FC-8
FC-1
6900-25
6917-01
6900-27
Oxford
6920-05
Scale: NTS
SWCD, 9-5-12
R.S.M.
Southwest Conservation District
Roman S. Mrozinski, Executive Director
"Tomorrow's Environmental Concerns Addressed Today"
51 Mill Pond Rd.
Hamden, CT 06514
(203) 287-8179 email SWCD43RSM@SBCGLOBAL.NET


Photo 1



Typical Section

INFILTRATOR X-SECTION

Southwest Conservation District
Roman S. Mrozinski, Executive Director

"Tomorrow's Environmental Concerns Addressed Today"

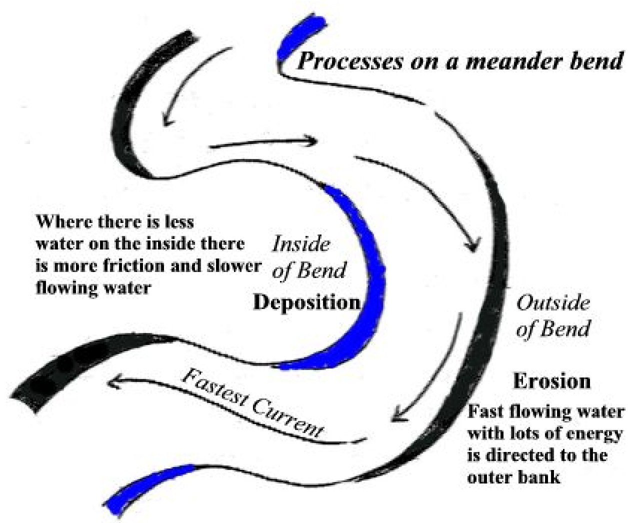
51 Mill Pond Rd.
Hamden, CT 06514
(203) 287-8179 email SWCD43RSM@SBCGLOBAL.NET

LANDSCAPE ECOLOGIST REVIEW

The Borough of Naugatuck is to be commended for seeking to deal with water issues relating to stormwater management, erosion and sediment controls, and stream pollution in Long Meadow Pond Brook. As they have rightly recognized, existing development and increased development in the watershed lands that send water down to the stream play a big role. Land use changes that remove forest cover and/or increase impervious surfaces (pavement, roofs, dense manicured grass, etc.) are likely to cause excess stormwater to be routed into storm sewers or to reach streams via overland flow (rather than being absorbed into the earth as it would be in undisturbed settings). Precipitation cannot be controlled, but it is possible to design and modify developed areas so that stormwater stays on the property where it fell rather than gets routed into streams.

Long Meadow Pond Brook has multiple problems; and, no one size solution will fit all. The area from the Naugatuck Ice Company Pond Dam (located near 410 Rubber Avenue behind Thurston Energy, Inc.) downstream to the confluence with the Naugatuck River is shown in the May 31, 2011 Connecticut list of impaired waterbodies as (1) impaired for fish, other aquatic life, and wildlife by unknown causes and sources and (2) impaired for recreational use by E. coli whose potential source is unspecified urban storm water.

In the area from Field Road downstream to the Naugatuck Ice Company Pond Dam, Long Meadow Pond Brook is unconstrained and it flows through a wide floodplain. In a natural setting, the stream would flood this area during some storms; and, its channel would meander over time. The location of a meandering stream is changed gradually by flowing water cutting on the outside bank of a curve and depositing sediments on the inside curve. Occasionally the cut curves meet and the course of the stream changes abruptly, leaving a portion (an oxbow) of the old stream channel without flowing water.



Whether the meandering energy of a stream is a problem depends on whether development has taken place in the natural floodplain. The obvious solution is to not build in floodplains. Equally obvious is that downstream of Field Avenue, Long Meadow Pond Brook is heavily developed and subject to flooding. Control of flooding can be offset by things done to control water inputs from the upstream portions of the watershed (including sidestreams and uplands that could contribute stormwater runoff) and by measures taken at the vulnerable streamside sites.

The presence of streambank vegetation can slow stormwater, making it more likely that floods occur in a given spot. However, the absence of streambank vegetation contributes to erosion and siltation. Further, the absence of streambank vegetation that is large enough the shade the stream causes the water to be warmer (lessening its habitat value for desirable fish such as trout).

Many species of invasive plants were observed on the streambank in the stretch from Field Avenue to Naugatuck High School. With the possible exceptions of species such as Phragmites (Phragmites australis var. australis; also called Common Reed and noted in a small patch near Naugatuck High School) and the large, bamboo-like Knotweed (Polygonum (also known as Fallopia) sp. noted at various sites), the invasive plants are probably doing more good holding the banks than they are harm. The large Knotweed observed in places along Long Meadow Pond Brook was not identified as to species. It probably was Polygonum cuspidatum [Fallopia japonica] – Japanese Knotweed; but Polygonum sachalinense [Fallopia sachalinensis] – Giant Knotweed, or hybrids of the two are possible (and equally undesirable).

Streamside vegetation provides habitat for birds and other wildlife and it shades the water. Vegetated buffers adjacent to the stream that include many fine stems near the ground can slow overland water flow and allow the water to drop down into the soil rather than flow overland into the stream. Water that enters the stream after going through the soil has the opportunity to lose some of its pollutants.

The stormwater and pollution issues associated with Long Meadow Pond Brook are unlikely to be all addressed in a short time. Some ideas for engaging the public in finding more out about the stream include:

- A streamwalk (trained volunteers walk down the stream and record observations about the nature of the stream bottom, the aquatic vegetation, streamside vegetation, streamside erosion, manipulation of the natural stream bank or stream channel, adjacent land uses, and presence of discharge pipes, barriers to fish movement, etc.) Contact Seth Lerman, USDA-Natural Resources Conservation Service for more information. (203) 287-8038, ext. 104 or seth.lerman@ct.usda.gov

- Organize training for rapid bioassessment of water quality based on the presence of indicator invertebrate species in the water. CT DEEP has offered training.

Contact Meghan Ruta, Volunteer Monitoring Coordinator at (860) 424-3061 or
Meghan.ruta@ct.gov
http://www.ct.gov/deep/rbv

- Also, the Borough or a public group could do a best management practice (BMP) demonstration of a particular way of doing things to manage storm water on publicly visible/accessible property.

UCONN's Nonpoint education for Municipal Officials (NEMO) website provides tools, resources, publications and more: www.nemo.uconn.edu

CTDEEP website has information on water resources, water quality and watershed management at www.ct.gov/deep. *The Torrent* newsletter is also available on their website. It is a newsletter written for Connecticut's floodplain managers.

The NorthCentral Conservation District has been involved with many watershed projects in the Hockanum River Watershed and the Scantic River Watershed.
www.conservect.org/northcentral/servicesandprojects.

POTENTIAL FUNDING SOURCES

A. Project Funding

There are a variety of small grants available relating to water quality and water quantity. (Contact Susan Peterson at DEEP (860-424-3854) would be a good source of information.)

Below are a few sources:

Watershed Assistance Small Grants Program (through Rivers Alliance)
http://www.riversalliance.org/2012WASGPRFP.htm

EPA Urban Waters Small Grants Program
http://www.epa.gov/urbanwaters/funding/rfp20120123qanda.html
CT is in EPA region 1 and is served out of the Boston office

Connecticut DEEP Section 319 Nonpoint Source Grant requirements for FY2013
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325586

Where to get information on impaired streams in Connecticut
http://www.ct.gov/dep/lib/dep/water/water_quality_management/305b/ctiwqr10final.pdf
In the May 31, 2011 final draft of the State of Connecticut Integrated Water Quality Report, Table 3-2 Connecticut Impaired Waters List begins p. 207 with an explanation beginning p. 201. The table is ordered by Waterbody Segment Number, and 6917 -00 _01 (p.285) lists the stretch of Long Meadow Pond Brook from the Naugatuck Ice Company Pond Dam to the confluence with the Naugatuck River

B. EWP (Emergency Watershed Program) Funding

If a storm or a back-to-back set of storms causes a significant change to a stream that creates an imminent hazard to human life or property, the USDA Natural Resources Conservation Service (NRCS) may be able to offer EWP (Emergency Watershed Program) cost-share funding to put things back the way they were before the storm. (EWP funding cannot be used to make improvements.) EWP funding is available to Towns and private citizens (with benefits to more than one person). It is not available to fix Town roads. EWP funding is cost-share funding. It does not cover the entire cost of the project. More information on EWP is available at: ftp://ftp-fc.sc.egov.usda.gov/CT/water%20resources/EWP%20FACTSHEET.pdf

Eligibility for EWP funding:

1. Your site must be in an area declared a disaster area by the State or Federal government.
2. You need a non-federal sponsor that is a governmental entity, i.e., Town, State, Special District or Tribal government. (Towns needing a sponsor for their share of the costs would apply to the State of Connecticut Department of Energy and Environmental Protection's Inland Water Resources Division.)
3. Assuming your area is declared a disaster area, then you have 60 days after the event to request assistance.
4. Requesting assistance does not guarantee funding.

Contacts for requesting EWP funding:

1. Ultimately, your sponsor will make your request to the USDA-Natural Resources Conservation Service. (NRCS is the federal agency responsible for administering EWP.)
2. To get more information to get started:
   - You may go to the NRCS District Office that serves the county you are in -- the person in charge of the office (District Conservationist) is trained to lead you through the process.
   - New Haven County - Diane Blais, District Conservationist, (203) 287-8038 http://offices.sc.egov.usda.gov/locator/app?service=page/CountyMap&state=CT&stateName=Connecticut&stateCode=09
   - You also may want to go first to the entity that you think would serve as your sponsor.

Wildlife Resources

BACKGROUND

The Naugatuck Inland Wetlands Commission requested an environmental review of the Long Meadow Pond Brook watershed, specifically, the area from Field Street to the Naugatuck River along Rubber Avenue because of the increase in flooding of yards and residential structures in recent years.

The Borough is seeking information in order to evaluate storm water management strategies, improve erosion and sediment control and address pollution source identification and abatement; including information on wildlife habitat. The following information is provided based on a review of topographic maps and aerial photography.

RIPARIAN ZONE

The riparian zone is defined as the area where terrestrial and aquatic ecosystems converge; it is the area between a stream channel and the surrounding uplands that are influenced by that stream channel. While riparian zone boundaries may not necessarily be well-defined, they can be determined by the change in vegetative structure from plants that are tolerant of periodic flooding to those that are not.

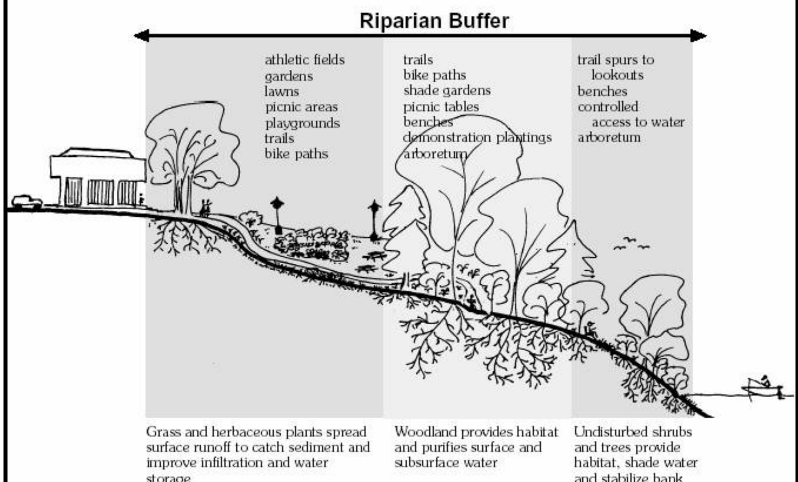
Riparian zones serve to function both as wildlife habitat and, if properly managed, can help slow floodwaters and reduce problems caused by runoff.

Riparian zones are important to a whole host of species, in that they provide both upland and wetland habitat, and function as travel corridors. Beaver and muskrat are two examples of species that are dependent upon dual habitats, and there are many more, including white-tailed deer, mink, otter and many songbirds that utilize both the upland and wetland portions of riparian zones. Predators such as coyotes and fox may utilize these areas as travel corridors to move from one location to another. Some small mammals, such as water shrews, may spend their entire existence in a riparian zone.

Three Zone Buffer System

The most effective urban buffers have three zones.

- **streamside**: to top of bank for erosion control, shade, visual screen, noise control
- **middle zone**: inland from top of bank; to capture pollutants and recharge groundwater; width should ideally reflect size of stream, extent of 100 year flood plain, and adjacent steep slopes; the goal is a mature woodland, with some clearing for recreational uses
- **outer zone**: between the rest of the buffer and the nearest permanent structure; to capture sediment and absorb runoff; open, unpaved space (turf or lawn); playing fields, gardens, playgrounds, and other common community activities are suitable



Source of diagram: Connecticut River Watershed, 2000. No. 6 *Urban Buffers.* Charlestown , NH . Pg. 5

IMPACTS TO THE RIPARIAN ZONE

There are many factors that can influence the riparian zone and the water channel within it. The vegetative structure determines how much shading occurs on the stream, and vegetative inputs, such as twigs, branches, logs can change stream flow and create microhabitats within the larger stream. Construction or land management activities around the riparian zone can increase soil erosion, and lack of a vegetated riparian zone can result in sedimentation, as there may be insufficient vegetation to slow runoff from the adjacent upland. Sedimentation and the potential resultant turbidity (cloudiness) in the water can be detrimental to many species, as sediments on the bottom of the stream channel may fill or cover microhabitats and turbid waters keep light from penetrating deeply, affecting plant photosynthesis.

EXISTING CONDITIONS AND RECOMMENDATIONS

An examination of aerial orthophotographs shows that, in this highly developed section of Naugatuck, the buffer between the stream and existing structures or roadways averages about 25-50', with some variability. Given the level of development (buildings, roadways, parking lots), it is improbable that significant wildlife habitat improvement activities can be implemented; however, there is likely some wildlife use through the area for travel, as the narrow buffer is a better alternative than utilizing roadways or moving through human habitations. Existing buffers should be retained, and if opportunities for improvement do arise, it would benefit wildlife to create forested buffer areas in the riparian zone and adjacent uplands. These areas should include trees, such as alder, cottonwood and tulip tree, planted along the streamside; this would improve aquatic habitat, improve existing travel corridors and potentially create new areas for travel, provide food, shelter and cover for wildlife. Berry-producing shrubs would be a beneficial food source for songbirds; this includes red-osier dogwood, spicebush, and chokeberry. Expanding existing buffer and creating larger buffers, at least 50' wide are preferable, but, any opportunity to improve travel corridors and provide food for migrating wildlife should be utilized. (Please also see the Appendix for a copy of "Buffers for Habitat" Fact Sheet No.4 in the Series Riparian Buffers for the Connecticut River Watershed.)

REFERENCES

Managing Grasslands, Shrublands, and Young Forest Habitats for Wildlife: A Guide for the Northeast.
The Northeast Upland Habitat Technical Committee and the Massachusetts Division of Fisheries & Wildlife. 2006.

Regional Planning Review

ISSUE

In recent years Naugatuck has experienced significant flooding along Long Meadow Pond Brook. The floods have caused major damage in the built-up portions of the brook along Rubber Avenue in Naugatuck. Most of the buildings affected by the flooding brook are decades old and are just now experiencing flooding for the first time.

Intense storms that drop large amounts of rain in a short period of time and cause flooding are becoming more common. These storms may be due to the effects of climate change. Some climate models predict more violent and erratic weather with increasing mean global temperature. As global temperatures rise, flooding along Long Meadow Pond Brook may worsen. Very little on the local level can be done to prevent climate change and the more intense storms that it may bring.

LONG MEADOW POND BROOK DRAINAGE BASIN

Long Meadow Pond Brook's drainage basin covers 5,420 acres in parts of three municipalities: Naugatuck, Oxford, and Middlebury (Map 1 Aerial). The largest portion of the basin is in Middlebury, followed by Naugatuck, and then Oxford. The eastern third of the basin is urbanized, and the western two-thirds are mostly green, with limited development (Map 2 Land Cover). The majority of the land in the drainage basin is in residential use, with a small amount of industrial and commercial uses (Map 3 Existing Land Use). There are approximately 2,351 acres of undeveloped, buildable land in the drainage basin.

The vast majority of the basin's undeveloped land is zoned for low-density residential use. Most residential zones require a minimum parcel size of 40, 65, or 80 thousand square feet (Map 4 Zoning). The R-CGD district in Oxford and R-40/PRD in Middlebury allow for smaller parcel sizes. There are only a handful of industrial and commercially zoned parcels in the basin.

The future land use map of the Regional Plan of Conservation and Development (2008) classifies most of the undeveloped areas of the Long Meadow Pond Brook drainage basin as Rural Areas (Map 5 Regional Plan). The Regional Plan recommends that any development in Rural Areas respect natural resources and environmental constraints. Major public investment in infrastructure is discouraged in Rural Areas. The parts of the basin that are identified as Growth, Major Economic, and Regional Core areas in the Regional Plan are for the most part already developed. The most significant exception is the portion of the R-CGD district in Oxford which is located in a Growth Area. The portion of the R-CGD district in the basin has the potential of 255 new housing units.

The State Plan of Conservation and Development: 2013-2018 map identifies almost the entire Long Meadow Pond Brook drainage basin as a Priority Growth Area (Map 6 Draft State Plan).

Small portions of the basin are identified as Balanced Growth or Priority Conservation Areas. Under the draft State Plan, most of the basin would be eligible for state investments, including new state facilities and grants to municipalities for new infrastructure. Municipal grants for land preservation or recreational uses in Priority Growth Areas in the State Plan may require an exception. Exceptions to the State Plan need to be backed up by recommendations of a municipal plan of conservation and development that is less than ten years old.

STORMWATER RUNOFF

Water from falling rain or melting snow in Long Meadow Pond Brook's drainage basin flows into the brook via streams and rivulets or soaks into the soil, recharging groundwater. Water flowing on the surface is naturally slowed by vegetation and natural obstacles, before entering the brook. The slowing effect extends the amount of time that stormwater takes to drain into the brook. This delays and lowers the brook's cresting.

Conventional buildings and pavement are impervious to stormwater, preventing it from soaking into the ground. Conventional drainage structures facilitate the efficient and fast flow of stormwater by man-made impervious surfaces into waterways. Even green, man-made surfaces such as lawn and compacted soil are less pervious than more natural surfaces and shed stormwater more readily. The result of typical development types and stormwater handling techniques is faster and higher cresting of watercourses, and the potential of more frequent and worse flooding downstream.

Stormwater runoff can have other significant environmental impacts as well. Stormwater flowing over parking lots, lawns, and roofs can flush litter, automotive and lawn chemicals, and heat into neighboring waterbodies. These pollutants destroy habitat and kill fish and species that require clean, cool water.

GIS ANALYSIS OF LAND USES IN THE LONG MEADOW POND BROOK DRAINAGE BASIN

COGCNV analyzed development patterns in the basin to investigate how much development has occurred and how much more can potentially occur. Between 1985 and 2006 the amount of developed land in the basin increased 23.3% (Map 7 Land Cover Change). Development has predominately used conventional stormwater handling and impervious surface. The amount of stormwater runoff into Long Meadow Pond Brook has, in all likelihood, increased due to this development. More development has taken place since 2006.

COGCNV staff conducted a buildout analysis of Long Meadow Pond Brook's drainage basin.A buildout is a projection of the maximum development potential of an area under current zoning regulations. Natural constraints and assumptions of the efficiency of land use were taken into account in the buildout. The buildout only looks at currently undeveloped parcels or large parcels that have significant, undeveloped areas. Expanded or more intense use of already developed parcel is not taken into account in the buildout.

According to satellite data from 2006, 9.6% of Long Meadow Pond Brook's drainage basin was covered by impervious surfaces (Map 8 2006 Imperviousness). If the basin's undeveloped land was built out, 4.3% more of the basin area could become impervious (Map 9 Buildout Imperviousness). A total of 13.9% of the basin's 5,420 acre could be impervious, increasing potential stormwater runoff and impairing the health of the brook.

Using Community VIZ software, COGCNV staff estimated that approximately 1,763 new housing units and 488,405 sq. feet of new industrial / commercial space could be built in the Long Meadow Pond Brook drainage basin based on current zoning (Map 10 Community Viz Buildout). Middlebury has the largest portion of the basin and the most growth potential with room for 856 new housing units. Naugatuck has room for 586 new housing units and Middlebury has room for 321. Also according to the Community VIZ buildout, 7 industrial buildings could be built in Naugatuck, 3 in Oxford, and 1 in Middlebury.

There is significant development potential in the Long Meadow Pond Brook drainage basin. The draft State Plan 2013-18 would support additional development. New development will risk increasing stormwater flow into the brook, worsening flooding along Rubber Avenue in Naugatuck.

FLOOD MITIGATION AND PREVENTION

There are three ways that flooding along Long Meadow Pond Brook can be prevented or mitigated: increase the brook's capacity for stormwater, build flood control structures, and/or reduce the amount and flow of stormwater into the brook. The first option is to increase the capacity of the brook by replacing undersized culverts, removing debris in the stream channel, and re-establishing the floodplain. The second is to construct flood control structures such as dikes to prevent the brook from overflowing banks or dams that slow stormwater flow. The third option is to reduce the volume and slow the speed of stormwater that flows into the brook.

The capacity of the brook to carry stormwater is impaired by garbage and vegetation in the stream channel. During storms these materials clog culverts and dam the flow of the brook. Removing garbage and clearing trees and shrubs from the channelized portion of the brook will help reduce flooding and can be done relatively easily. Recommendations for larger culverts and the feasibility of flood control structures would require an engineering study of the brook. Implementation of low impact development and modern storm water handling techniques, can reduce and slow the flow of stormwater into the Long Meadow Pond Brook.

Since the Long Meadow Pond Brook drainage basin covers three municipalities, Naugatuck will have to work cooperatively with Oxford and Middlebury to ensure that development in these towns doesn't worsen the flooding being experienced along Rubber Avenue in Naugatuck. All three municipalities should require that new development avoid creating additional stormwater runoff into Long Meadow Pond Brook. This can be accomplished by requiring, when possible, the use of low impact development techniques in zoning and subdivision regulations.

A number of techniques and materials have been developed to reduce the impact of impervious surfaces and stormwater runoff. These techniques and materials can be used in new construction and to mitigate the impacts of existing generators of storm water runoff, such as large parking lots. The Connecticut Department of Energy and Environmental Protection published a manual on stormwater handling techniques and best practices. The 2004 manual is available at

http://www.ct.gov/deep/cwp/view.asp?a=2721&q=325704

These and other low impact development (LID) techniques can also be utilized to limit the impact of development on stormwater runoff. The state DEEP is developing a LID manual that will list best management practices (BMPs) to control stormwater. Municipalities should reference these manuals in their subdivision and zoning regulations and require the use of these techniques whenever practicable. DEEP has information on LID on their website:

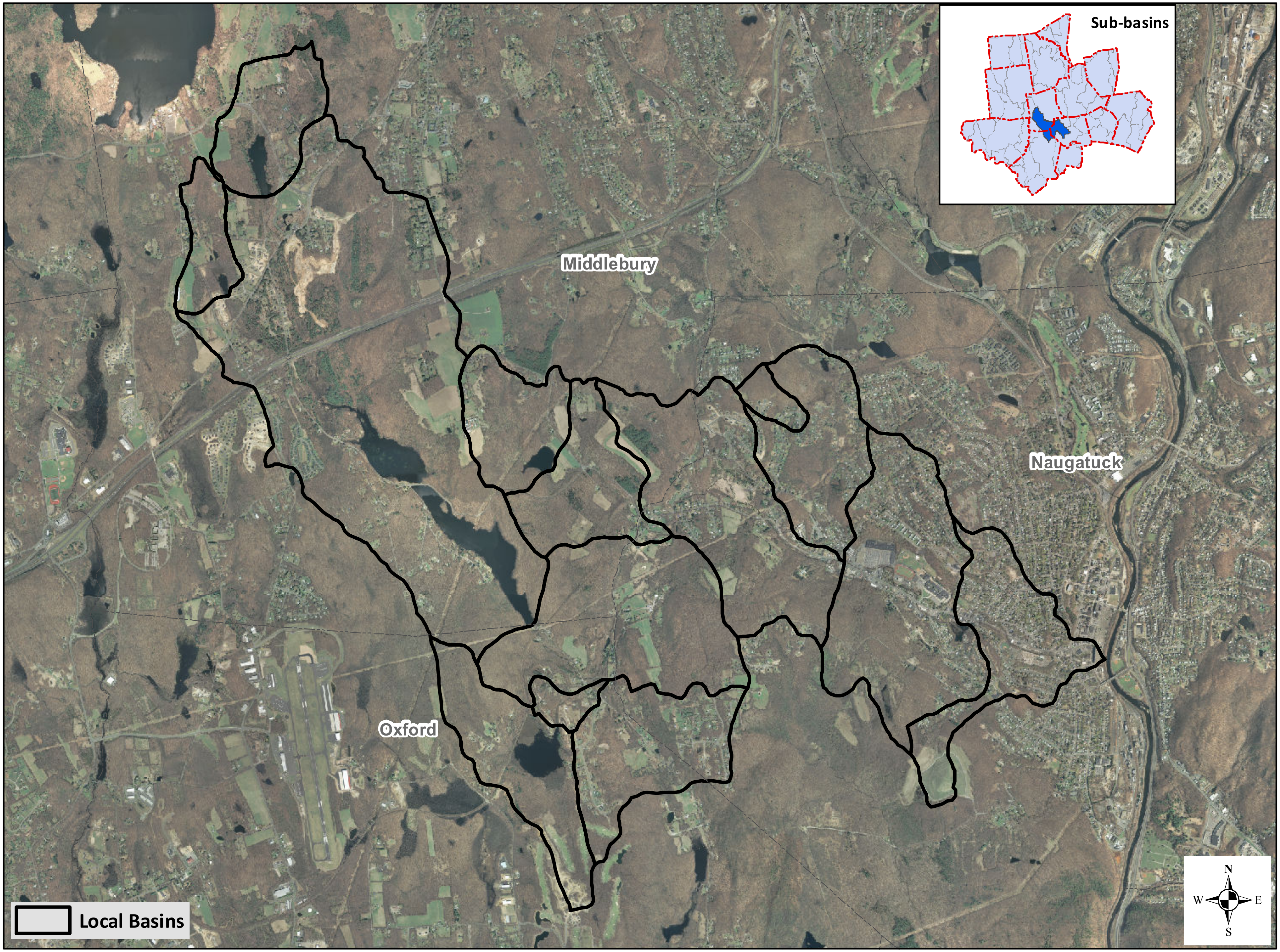
http://www.ct.gov/deep/cwp/view.asp?A=2719&Q=464958

http://www.ct.gov/deep/lib/deep/water/watershed_management/wm_plans/lid/lid_resources.pdf

The University of Connecticut's Center Landuse Education and Research (CLEAR) conducts research on storm water management and low impact development. CLEAR also provides assistance to municipalities. CLEAR educator Mike Dietz can assist Naugatuck and its neighbors with stormwater mitigation efforts in the Long Meadow Pond Brook basin. The CLEAR website (http://clear.uconn.edu/) also has additional information and mapping resources.

Map 1

Long Meadow Pond Brook Basin and Sub-Basins - 2006 Aerial Photography



Map printed May 2012
Delineations may not be exact.
For planning purposes only.

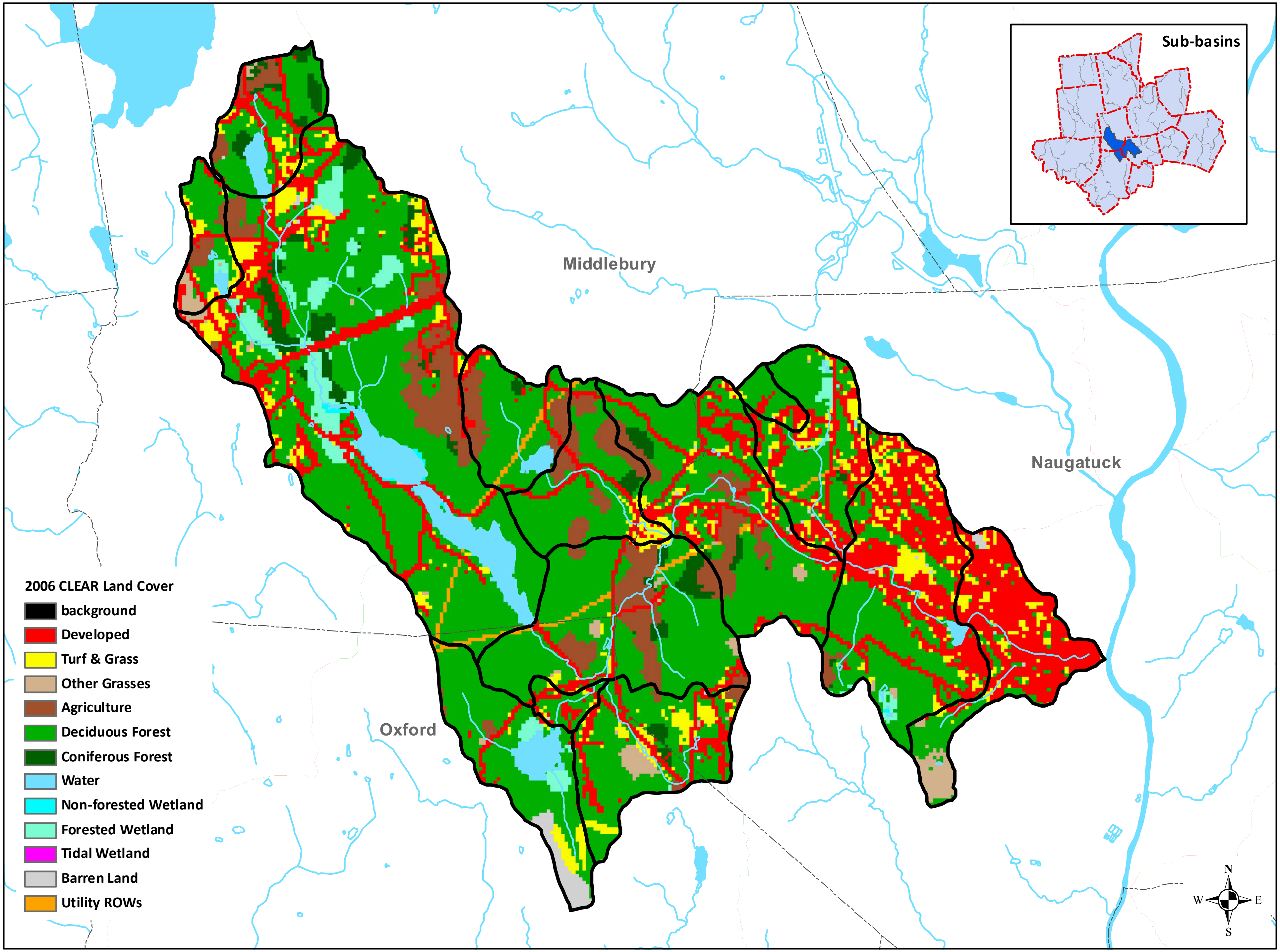
Source Data: 2006 AT&T Aerial Imagery
Connecticut DEEP Boundary Data

0 0.25 0.5 1 Miles

Council of Governments
Central Naugatuck Valley

Map 2

Long Meadow Pond Brook Basin - 2006 Land Cover



Map printed May 2012
Delineations may not be exact.
For planning purposes only.

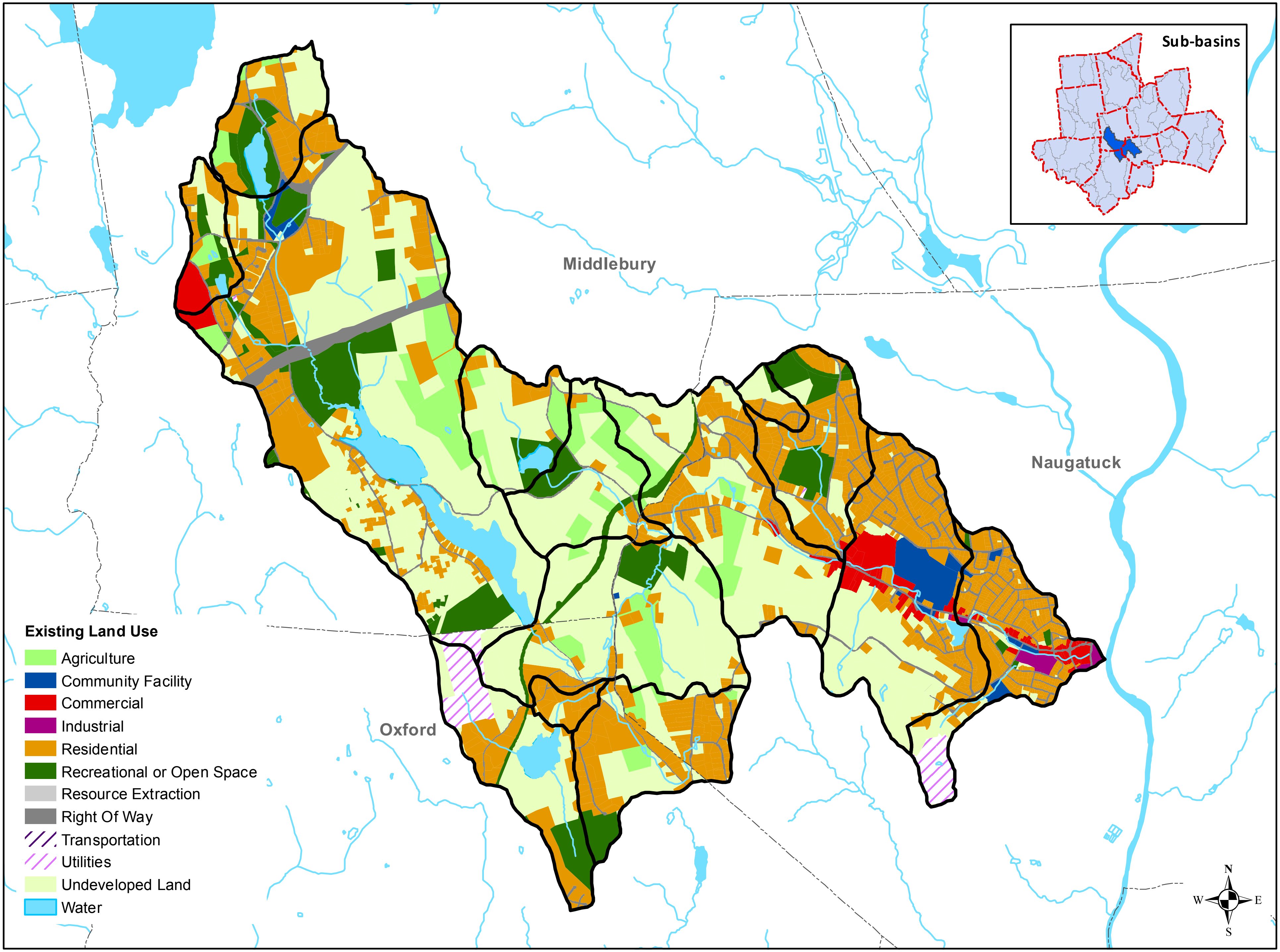
Source Data: CLEAR Land Cover - Landsat 30m Imagery
Connecticut DEEP Hydrology and Boundary Data

0 0.25 0.5 1 Miles

Council of Governments
Central Naugatuck Valley

Map 3

Long Meadow Pond Brook Basin - Existing Land Use



Map printed May 2012
Delineations may not be exact.
For planning purposes only.

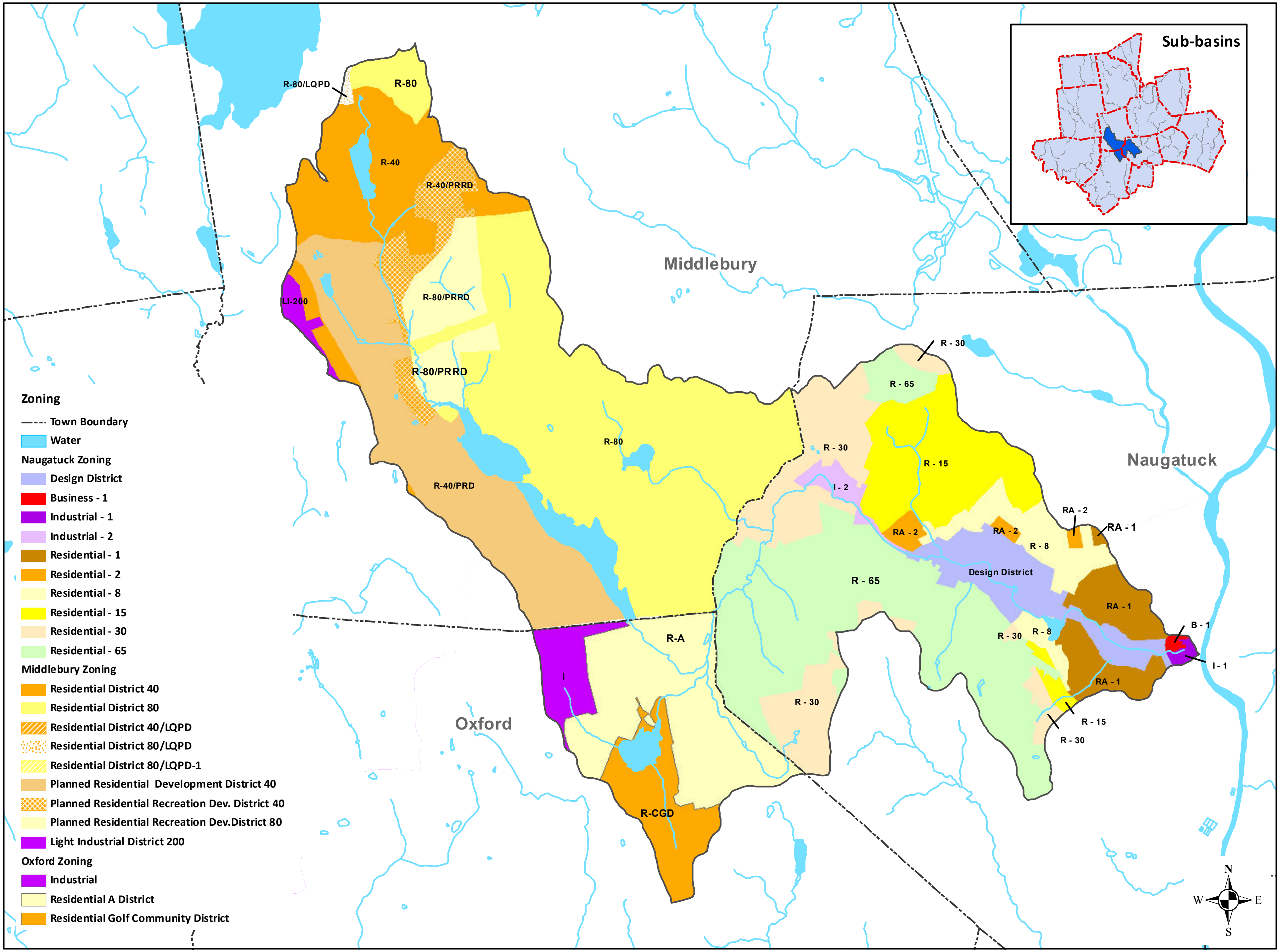
Source Data: 2010 COGCNV Existing Land Use
CLEAR & Connecticut DEEP
hydrology and boundary data

0 0.25 0.5 1 Miles

Council of Governments
Central Naugatuck Valley

Map 4

Long Meadow Pond Brook Basin - Zoning



Map printed May 2012
Delineations may not be exact.
For planning purposes only.

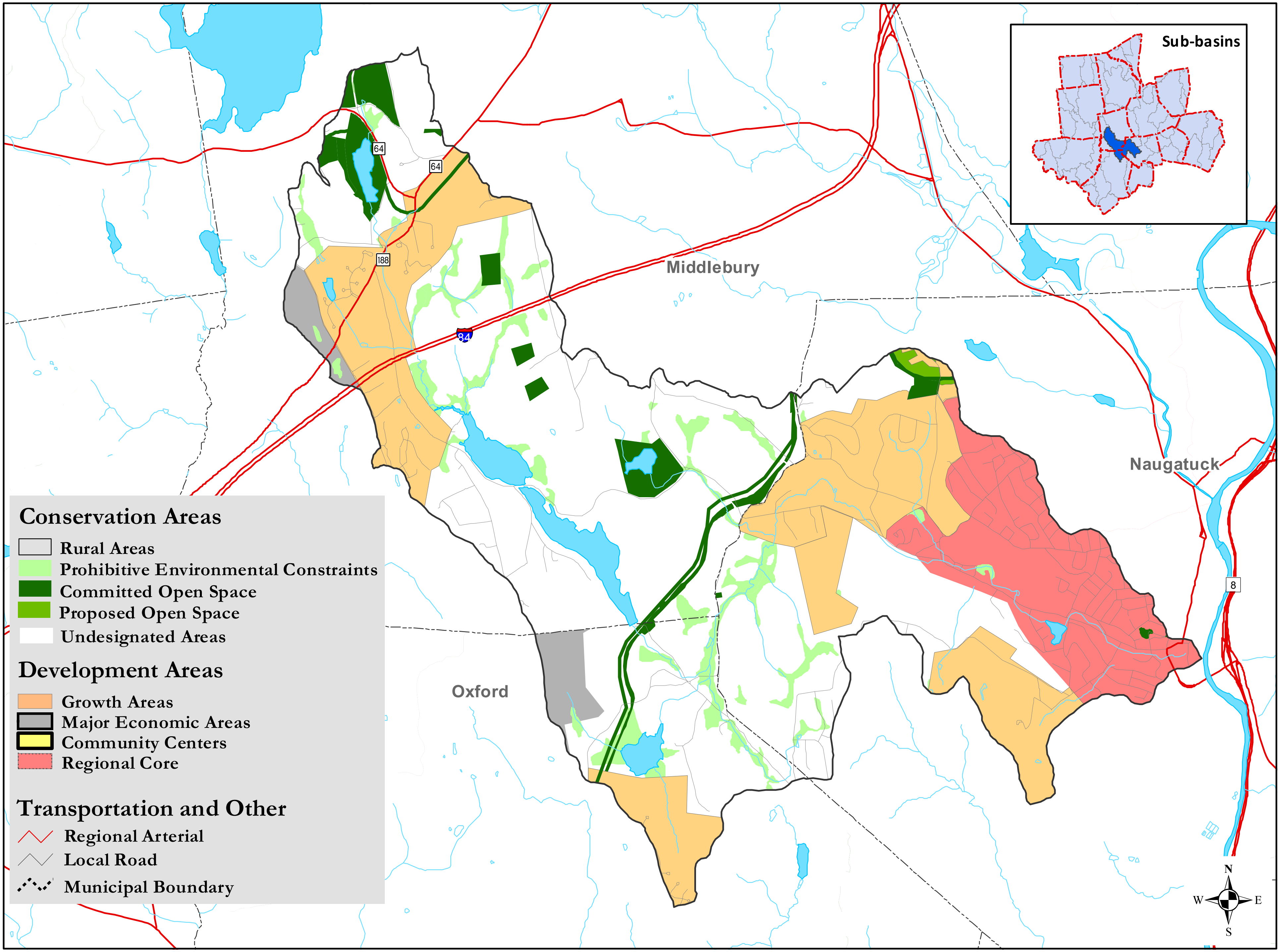
Source Data: Middlebury Town Zoning, Naugatuck Town Zoning
Oxford Town Zoning & Connecticut DEEP
hydrology and boundary data

0 0.25 0.5 1 Miles

Council of Governments
Central Naugatuck Valley

Map 5

Long Meadow Pond Brook Basin-COGCNV Future Regional Land Use Plan 2008



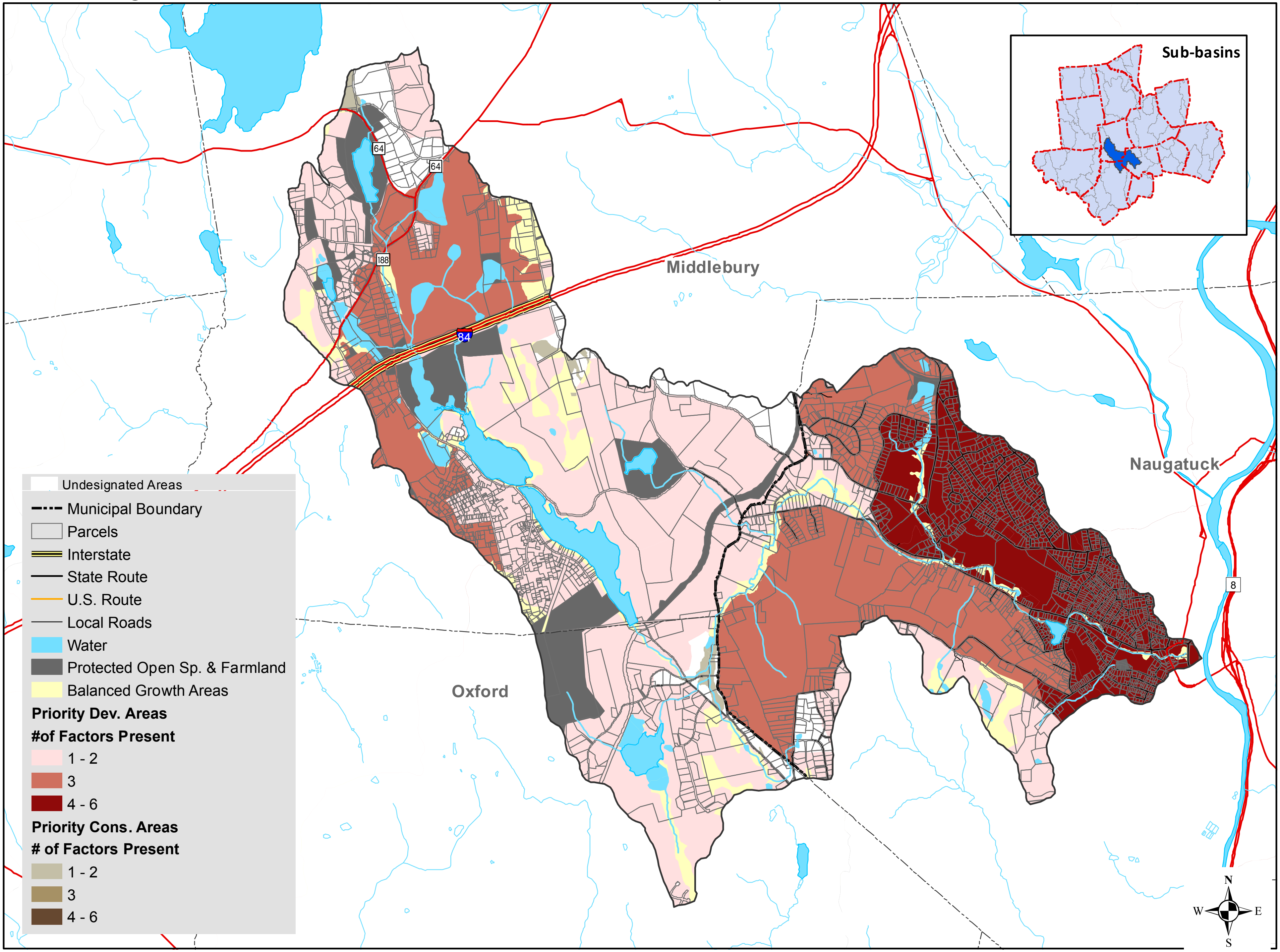
Map printed May 2012
Delineations may not be exact.
For planning purposes only.

Source: "Roads", State of Connecticut & TeleAtlas 2009
"Town Boundary", "Hydrography", DEP
"Conservation & Development", State of Connecticut, Draft, 2012

0 0.25 0.5 1 Miles

Council of Governments
Central Naugatuck Valley

Map 6 Long Meadow Pond Brook Basin -Draft Conservation & Development Policies Plan for Connecticut 2013-2018



Map printed May 2012
Delineations may not be exact.
For planning purposes only.

Source: "Roads", State of Connecticut & TeleAtlas 2009
"Town Boundary", "Hydrography", DEP
"Conservation & Development", State of Connecticut, Draft, 2012

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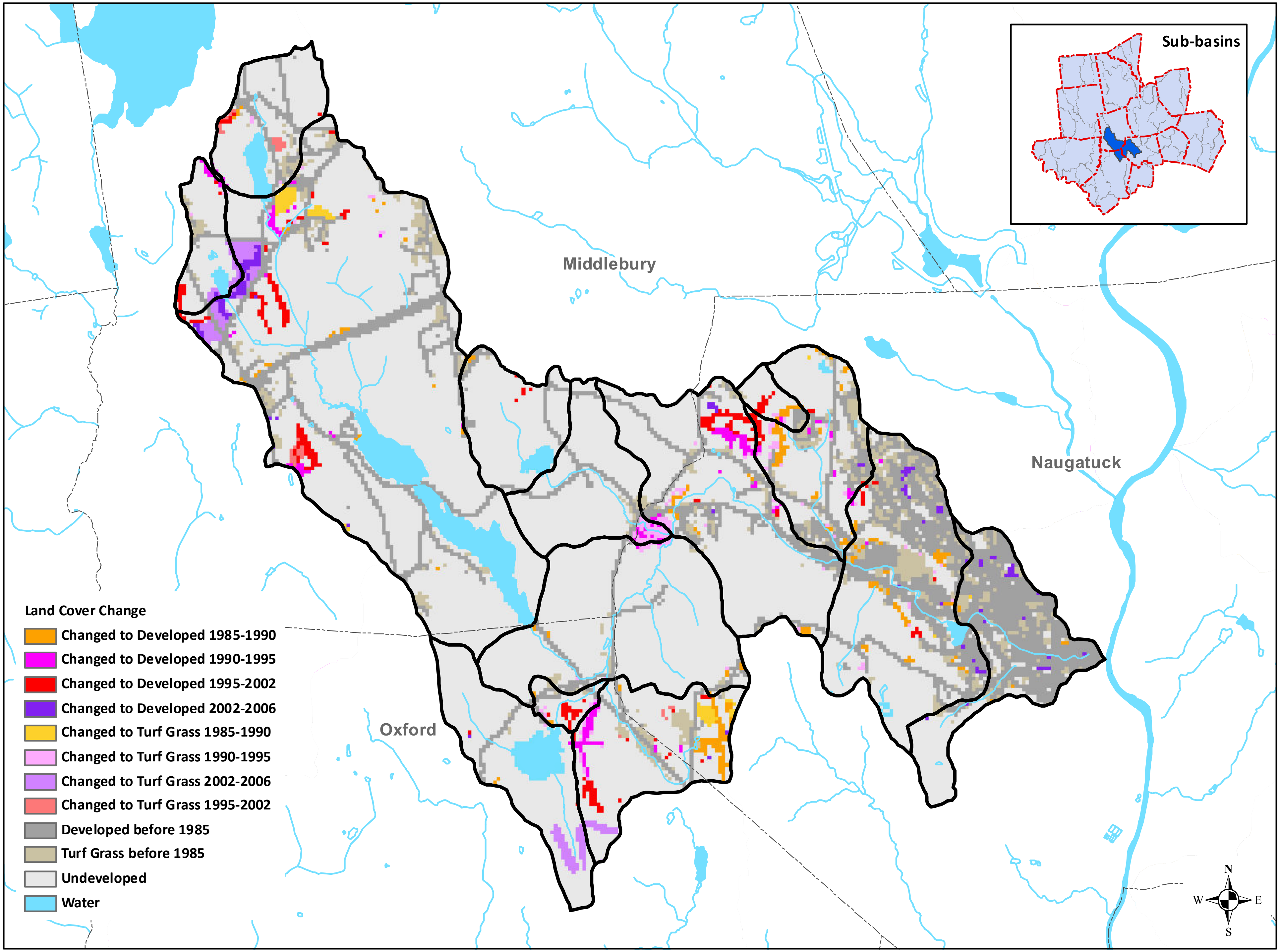
Central Naugatuck Valley

Map 7

Long Meadow Pond Brook Basin - Land Cover Change



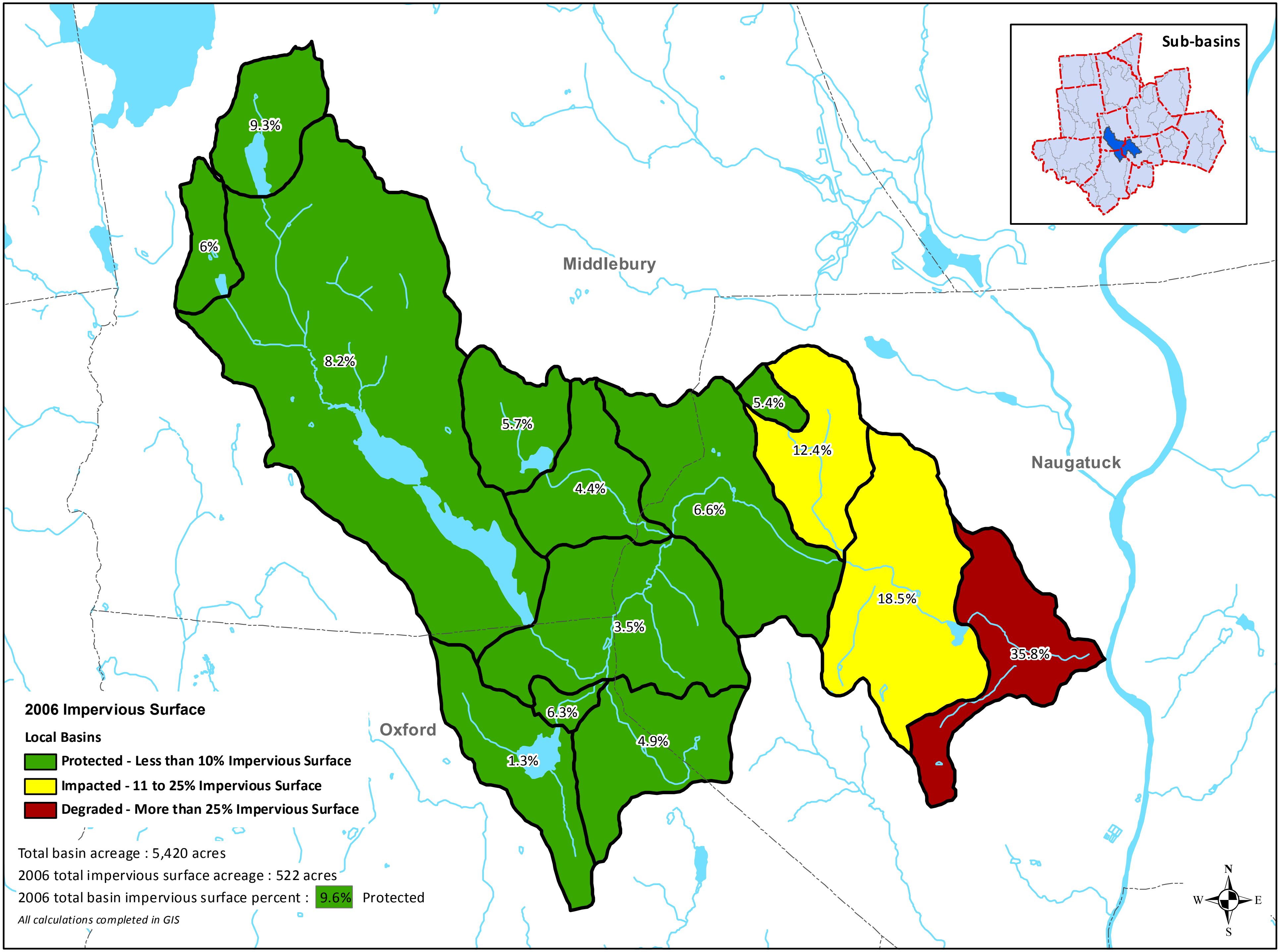
Map printed May 2012
Delineations may not be exact.
For planning purposes only.

Source Data: CLEAR Land Cover - Landsat 30m Imagery
Connecticut DEEP Hydrology and Boundary Data

Council of Governments
Central Naugatuck Valley

Map 8

Long Meadow Pond Brook Basin - 2006 Impervious Surface Coverage



Map printed May 2012
Delineations may not be exact.
For planning purposes only.

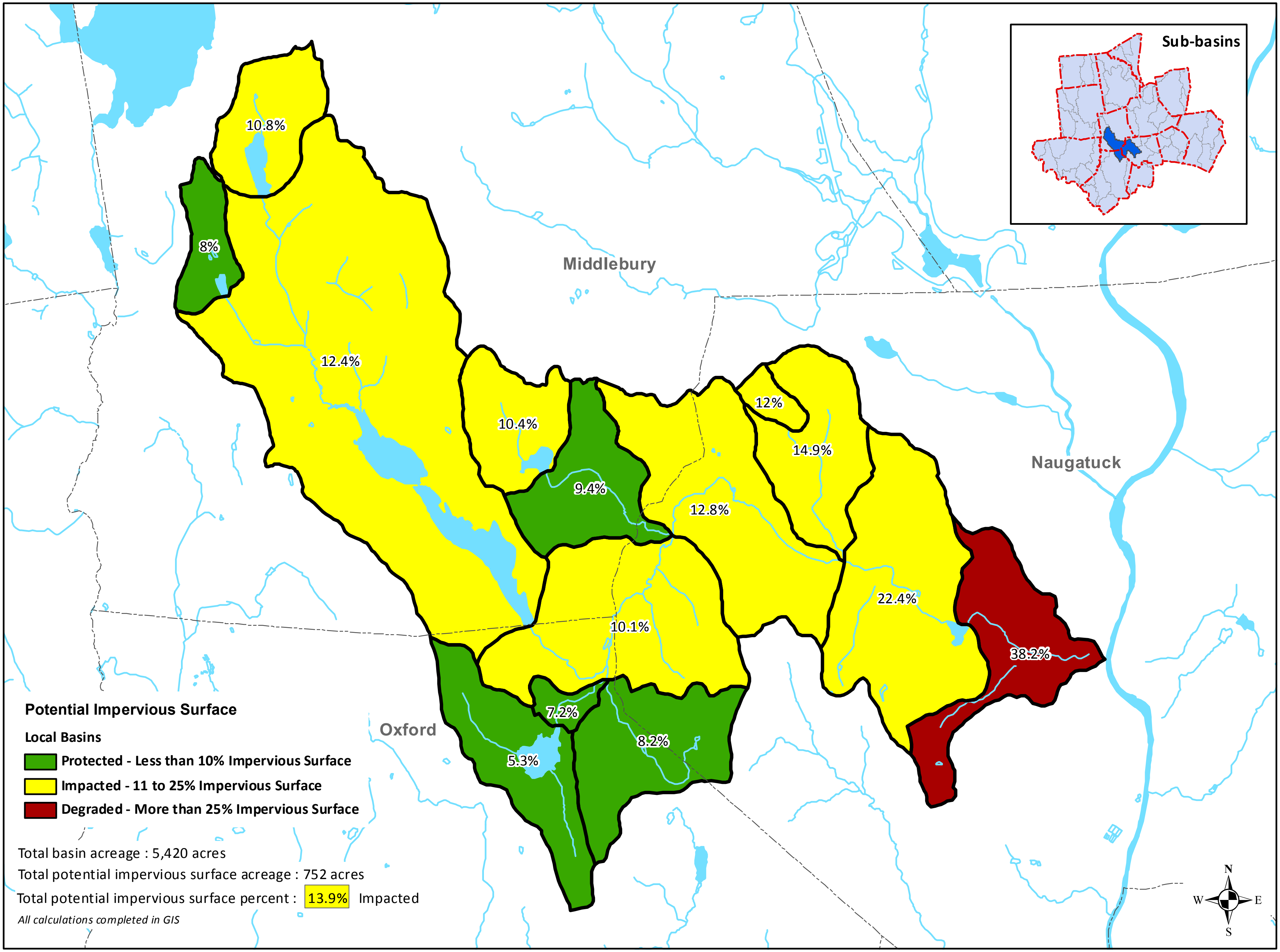
Source Data: CLEAR Impervious Surface - Landsat 30m Imagery
Connecticut DEEP Hydrology and Boundary Data

0 0.25 0.5 1 Miles

Council of Governments
Central Naugatuck Valley

Map 9

Long Meadow Pond Brook Basin - Potential Buildout Impervious Surface Coverage

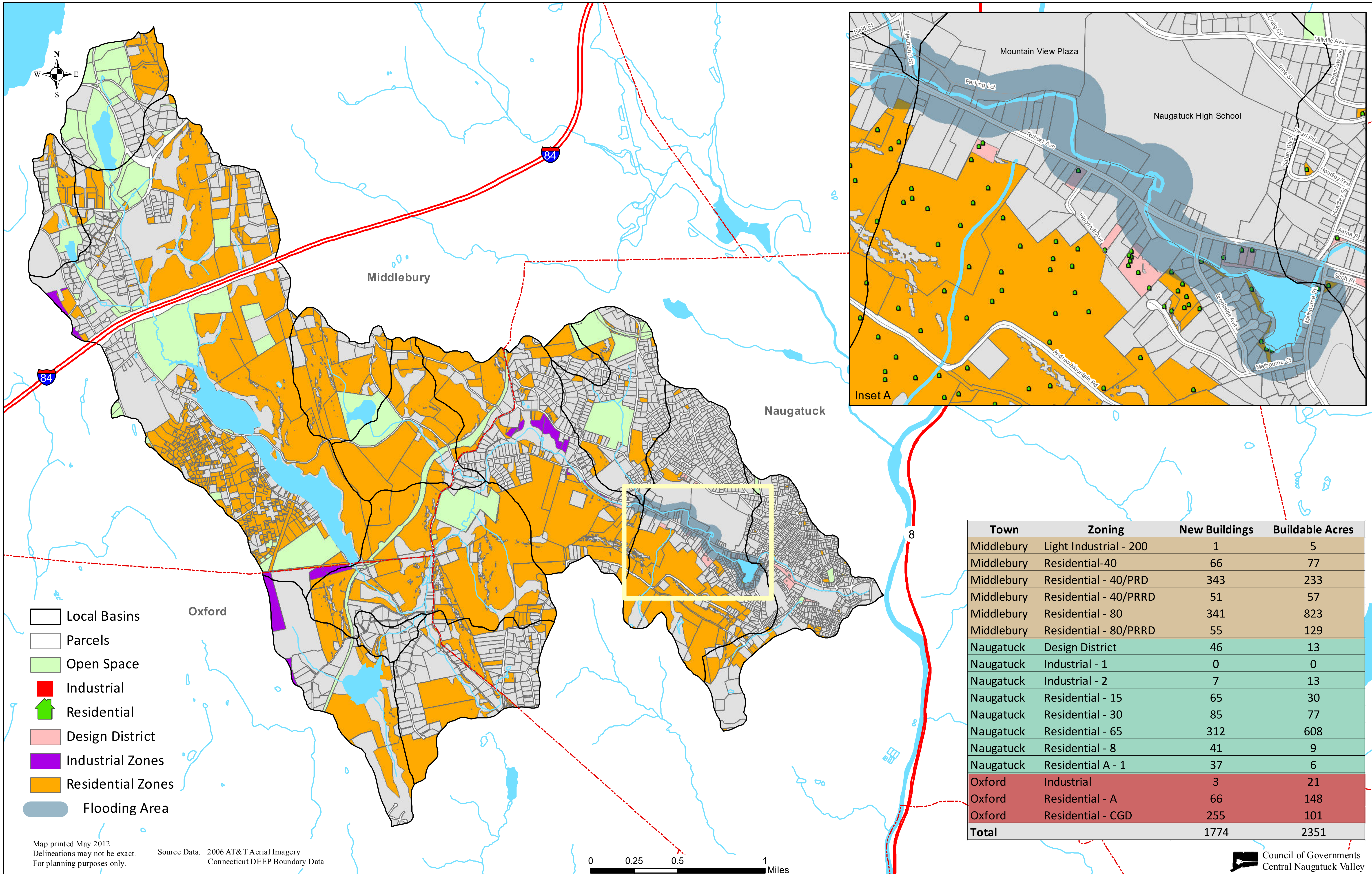


Map printed May 2012
Delineations may not be exact.
For planning purposes only.

Source Data: CLEAR Impervious Surface - Landsat 30m Imagery
Connecticut DEEP Hydrology and Boundary Data

Council of Governments
Central Naugatuck Valley

Long Meadow Pond Brook Basin CommunityVIZ Build-Out Results



Town	Zoning	New Buildings	Buildable Acres
Middlebury	Light Industrial - 200	1	5
Middlebury	Residential-40	66	77
Middlebury	Residential - 40/PRD	343	233
Middlebury	Residential - 40/PRRD	51	57
Middlebury	Residential - 80	341	823
Middlebury	Residential - 80/PRRD	55	129
Naugatuck	Design District	46	13
Naugatuck	Industrial - 1	0	0
Naugatuck	Industrial - 2	7	13
Naugatuck	Residential - 15	65	30
Naugatuck	Residential - 30	85	77
Naugatuck	Residential - 65	312	608
Naugatuck	Residential - 8	41	9
Naugatuck	Residential A - 1	37	6
Oxford	Industrial	3	21
Oxford	Residential - A	66	148
Oxford	Residential - CGD	255	101
Total		1774	2351

Map printed May 2012
Delineations may not be exact.
For planning purposes only.

Source Data: 2006 AT&T Aerial Imagery
Connecticut DEEP Boundary Data

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Central Naugatuck Valley

Appendix

Natural Hazard Pre-Disaster Mitigation Plan, Naugatuck, Connecticut 2009
Pages 10-3, 10-4, 10-5 and Figure 3-5 (concerning Long Meadow Pond Brook)
The Plan is currently undergoing an update by Milone & MacBroom, contact David Murphy, P.E., CFM for additional information at 203-271-1773, Ext. 295.

Connecticut's Natural Hazard Mitigation Plan Update 2013
Pages 3-12, 3-13, 3-17, 3-79, 3-80
http://www.ct.gov/deep/lib/deep/water_inland/hazard_mitigation/plan/nathazmitigationplandraftupdate2013july.pdf

Northeast Regional Climate Center (NRCC)
Extreme Precipitation in a Changing Climate for New York and the New England States
http://www.precip.net/

The Heat is on: a Look into New England's Future Climate by David J. Nicosia

CTDEEP Inland Fisheries Division Position Statement – Utilization of 100 Foot Buffer Zones to Protect Riparian Areas in Connecticut

The Architecture of Urban Stream Buffers – Article 39
Feature article from Watershed Protection Techniques. 1(4): 155-163

http://www.crjc.org/riparianbuffers.htm
River Banks and Buffers
No. 1 – Introduction to Riparian Buffers for the Connecticut River Watershed
No. 2 – Backyard Buffers for the Connecticut River Watershed
No. 4 – Buffers for Habitat for the Connecticut River Watershed
No. 6 – Urban Buffers for the Connecticut River Watershed
No. 7 – Guidance for Communities in the Connecticut River Watershed

2010 Waterbody Report for Long Meadow Pond Brook

- As required by law, continue to annually review and update the Borough Emergency Operations Plan.
- Continue reviewing subdivision applications to ensure new neighborhoods and driveways are properly sized to allow access of emergency vehicles.
- Upgrade at least one secondary shelter that is unlikely to be impacted by natural hazards into a primary shelter facility. Attempt to acquire the resources necessary to be able to shelter 10% of the population of Naugatuck.
- Continue to encourage two modes of egress into every neighborhood by the creation of through streets.

Flooding

Prevention

- Streamline the permitting process and work toward the highest possible education of a developer or applicant. Develop a checklist that cross-references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to the proposed project. This list could be provided to an applicant at any Borough department. A sample checklist for the Borough of Naugatuck is included as Appended Table 3.
- Consider joining FEMA's Community Rating System.
- Continue to require applications for approval of a development in a floodplain for activities within SFHAs.
- Consider requiring buildings constructed in floodprone areas to be protected to the highest recorded flood level, regardless of being within a defined SFHA.
- Ensure new buildings be designed and graded to shunt drainage away from the building.
- After Map Mod has been completed, consider restudying local flood prone areas and produce new local-level regulatory floodplain maps using more exacting study

techniques, including using more accurate contour information to map flood elevations provided with the FIRM.

Property & Natural Resource Protection

- Pursue the acquisition of additional municipal open space properties inside SFHAs and set it aside as greenways, parks, or other non-residential, non-commercial, or non-industrial use.
- Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents.
- Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains.
- Work with property owners along Long Meadow Pond Brook, Hop Brook, Beacon Hill Brook, Cold Spring Brook, Fulling Mill Brook, and their tributaries to pursue wet floodproofing, dry floodproofing, or elevation of structures. If FEMA funds are to be pursued, a cost-benefit analysis for each home will help determine whether wet floodproofing, dry floodproofing, or elevation of any given structure is most appropriate.

Structural Projects

- Consider performing a Borough-wide analysis to help identify undersized and failing portions of the stormwater and drainage systems. Prioritize repairs as needed. Incorporate anecdotal information where appropriate, such as observations described in this plan regarding the nuisance flooding at May Street.
- Upgrade the drainage systems in downtown Naugatuck where necessary to enhance drainage.
- Increase maintenance of the storm drainage system near the building on Arch Street near Long Meadow Pond Brook to prevent flooding of this area.
- If necessary, increase the conveyance capacity of Crown Spring Bridge over Hop Brook at Bridge Street.

- Assess dredging options for the sediment laden Union Ice Company Pond to potentially increase its potential for flood mitigation.
- Increase the conveyance capacity of the culvert for the tributary to Fulling Mill Brook under East Waterbury Road downstream of the Union Ice Company Pond.
- Upgrade the drainage system on Highland Avenue near Galpin Street to mitigate future nuisance flooding.
- Evaluate flood mitigation options, such as dredging of the silted pond adjacent to Nichols Garage/Irving Gas Station, where Pigeon Brook flows underground before entering Hop Brook.
- Pursue flood mitigation along the unnamed stream associated with the Spencer Street corridor, including increased conveyance capacity of the culverted portions of the stream, channel restoration or maintenance of the un-culverted section of the stream, and/or siting of detention systems.

Wind Damage Related to Hurricanes, Summer Storms, and Winter Storms

- Continue Borough-wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- Focus tree limb maintenance and inspections along Route 63, Route 68, Spring Street, Union City Road, and other evacuation routes. Increase inspections of trees on private property near power lines and Borough right-of-ways.
- Continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas.
- Review potential evacuation plans to ensure timely migration of people seeking shelter in all areas of Naugatuck, and post evacuation and shelter information on the Borough website and in municipal buildings.
- Provide for the Building Department to have literature available regarding appropriate design standards for wind.

Engineering, Landscape Architecture and Environmental Science MILONE & MACBROOM® 99 Realty Drive Cheshire, Connecticut 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com	**Long Meadow Pond Brook Study Area**	LOCATION: **Naugatuck, CT**
	MMI#: 2937-02 MXD: H:\Figure3-3Long.mxd SOURCE: 2004 CLEAR, CT DEP N **Naugatuck Natural Hazard Pre-Disaster Mitigation Plan**	Map By: SJB Date: Jan. 2009 Scale: 1" = 600' SHEET: **Figure 3-5**

Floodplain Management and Mitigation Act

During the 2004 session, the State legislature passed the Floodplain Management and Hazard Mitigation Act. This legislation covers many aspects of floodplain management. It requires municipalities to revise their current floodplain zoning regulations or ordinances to include new standards for compensatory storage and equal conveyance of floodwater. Municipalities were not required to make such revisions until they revise their regulations for another purpose. The DEEP has developed model regulation language which incorporates these new State requirements and has issued this model floodplain ordinance to communities for their use since 2007.

Other enabling State Legislation related to flood plain management includes:

- Sections 22a-36 through 22a-45, inclusive – Inland Wetlands and Watercourses Act;
- Section 22a-401 through 22a-410, inclusive – Dam Safety;
- Section 13a-94 – Construction Over and Adjacent to Streams;
- Section 25-84 through 25-98 – Flood & Erosion Control Board Statutes;
- Section 22a-318, 22a-321 – NRCS Statutes;
- Section 25-74 through 25-76 – Authorization to perform flood and erosion projects under Federal authority;
- Section 22a-342 through 22a-350 – Stream Channel Encroachment Line Program Statutes; and
- Section 22a-365 through 22a-378 – The Connecticut Water Diversion Policy Act.

Table 3-3 shows each state funded program related to floodplain management and whether it is associated with pre-disaster mitigation or post-disaster mitigation efforts.

Table 3-3 – State Funded Programs Related to Floodplain Management

State Funded or Staffed Program in Hazard Prone Area.	Pre or Post Disaster
Flood Management Section 25-68	Pre and Post Disaster
Dam Safety Section 22a-401 – 22a-410	Pre and Post Disaster
Flood and Erosion Control Boards Section 25-84	Pre and Post Disaster
National Flood Insurance Program	Pre-Disaster
Stream Channel Encroachment Line Program Section 22a-342 through 22a-350	Pre-Disaster
Section 22a-318, 22a-321 – NRCS Statutes	Pre and Post Disaster
Section 25-74 through 25-76 – Authorization to perform flood and erosion projects under Federal authority.	Pre and Post Disaster
Floodplain Management and Mitigation Act	Pre-Disaster
PDM Planning	Pre-Disaster

NRCS Water Resources Programs

The Watershed Protection and Flood Prevention Act, P.A. 83-566, CGS 22a-318 through 22a-323, authorizes the Secretary of Agriculture to "cooperate with states and local agencies in the planning and carrying out of works of improvement for soil conservation and other purposes." It provides for technical and financial assistance by the department through the NRCS to local organizations representing persons living in small watersheds (less than 250,000 acres). The Act provides for a project-type approach to solving land, water, and related resource problems. Flood prevention is an eligible purpose for which NRCS can pay 100% of the costs for planning studies, design and construction of structural solutions. The local sponsoring organization is solely responsible for land rights, operation and maintenance. Often these costs are equal to 1/2 the total costs of the project. For on-site measures such as flood proofing, the costs for implementation are divided 75% federal and 25% non-federal.

Federal Level Recommendation 3 of "A Unified National Program for Floodplain Management" and Section 6 of PL 83-566 provide the authorization to NRCS for Floodplain Management and Cooperative USDA River Basin studies.

Floodplain Management Studies (FPMS) authorized in Section 6 of PL-566 are a means of NRCS assisting state agencies and communities in the development, revision, and implementation of their floodplain management programs.

A FPMS can identify site-specific flood problem areas (or potential problem areas), inventories natural values, incorporates public participation, studies the community's management alternatives, and provides for study follow-up assistance. A FPMS may serve as the source of technical data for the community to implement local floodplain management programs.

Emergency Watershed Protection (EWP)

The Emergency Watershed Protection Program (EWP) is administered by the NRCS under Section 216, PL 81-516 and Section 403 of Title IV of the Agricultural Credit Act of 1978, PL 95-334. The EWP program provides the State and local units of government with technical and financial assistance to plan, design and implement measures that repair watershed impairments resulting from natural disasters. This program's objective is to assist in relieving imminent hazards to life and property from floods and the products of erosion created by natural disasters. Any corrective measure must prevent flooding or soil erosion, and reduce threats to life or property.

Authorized EWP technical and financial assistance may be made available when an emergency exists. Federal funds may bear a percentage of the construction costs of emergency measures in an exigency situation as well as in a non-exigency situation.

Sponsors are responsible for obtaining any needed land rights and federal, state, and local permits. The numbers of EWP projects initiated after the most recent natural hazard events in Connecticut include:

- 37 EWP projects after the June 1982 floods;
- 1 EWP project after a thunderstorm in June 1989 in Franklin, Connecticut;
- 1 EWP project after the July 1989 tornadoes in western Connecticut;
- 5 EWP projects after Tropical Storm Floyd;
- 1 EWP project after the April 2005 storm in Danbury;
- 7 EWP projects after the October 2005 storm;
- 4 EWP projects after the April 2007 storm and floods;
- 10 EPW projects after Tropical Storm Irene in 2011; and
- 4 EWP projects after Storm Sandy in 2012.

3.1.4 United States Army Corps of Engineers (USACE)

The USACE has undertaken several large flood control projects all across New England to reduce flood levels by retaining storm water runoff in upstream impoundments. These projects located in the Connecticut, Housatonic, Naugatuck, and Thames river basins. These structural measures have saved the State millions of dollars in flood damages.

The USACE has provided significant flood assistance to Connecticut and continues to do so. In its role as an assisting federal agency, the USACE has undertaken several flood and erosion control projects within the State since the 1950s.

The USACE has worked in Connecticut to develop several floodplain management studies. These studies include ice jam protection on the Salmon River in Haddam and East Haddam, and a feasibility study of flood protection on the West River in West Haven, Connecticut and New Haven, Connecticut.

Connecticut is able to undertake projects with the USACE as authorized under CGS Section 25-76 entitled "Small Flood Control, Tidal and Hurricane Protection and Navigation Projects; and State Cooperation with Federal and Municipal Governments," and through CGS Section 25-95 entitled "Agreements Concerning Navigation and Flood and Erosion Control."

The USACE, in cooperation with the DEEP and the city of Milford, elevated 36 residential structures under the authority of Section 205 of PL-858 in 2002 and 2003. The total cost of the project was estimated at $3.4 million. The city and State contributed 35% of the cost and the USACE covered the remaining 65% of the construction costs. The project was completed in 2003.

In many communities, the local planning department includes the administrator of the local flood regulations under the NFIP, if it is not the Building Official as discussed above. This person also has access to map information showing the location and extent of SFHAs in the community. This mapping is important in raising the public's awareness of natural hazards in the community.

Because the Planning Department typically directly assists the applicable commissions with administration of the Zoning Regulations, Subdivision Regulations, and Inland Wetland Regulations, the department is responsible for elements of almost all six facets of mitigation ("prevention," "property protection," "natural resource protection," "structural projects," "emergency services," and "public education"). For example, wetlands preservation is one of the purest forms of hazard mitigation due to the natural functions and values of wetlands including stream bank and shoreline stabilization and flood water storage.

In coastal communities, the Planning and Zoning / Land Use Department typically assists the local Harbor Management Commission in administering any Waterway Protection Line Ordinances, as well as reviewing coastal site plan applications for certain development types within the coastal management area defined by the State.

Tree Wardens

Most Connecticut communities have designated an individual as Tree Warden and administer a tree-trimming program. The tree warden is typically the public works director or a staff member from the planning or engineering departments. Tree-trimming on municipally-owned property is typically conducted on an as-needed basis or following complaints by residents. Most tree-trimming is conducted with clean-up activities following storms. In general, local governments maintain small trees and downed branches and contract with tree companies to deal with larger trees.

Flood and Erosion Control Boards

CGS Sections 25-85 through 25-98, inclusive, enable municipalities to form a municipal Flood and Erosion Control Board (FECB) with the power to plan, layout, acquire, construct, reconstruct, repair, maintain, supervise and manage flood and erosion control systems, flood control projects, and dam repair projects. These boards may also enter upon, take and hold by purchase, condemnation or otherwise, property which it determines necessary for use in connection with flood or erosion control systems; defray the cost of such systems by issuing bonds or other evidence debt, or from general taxation, special assessment or any combination thereof; and assess those properties benefiting from such project according to such rules as the FECB may adopt. The FECB is further empowered to negotiate, cooperate, and enter into agreement with: 1) The United States, 2) the United States and the State of Connecticut or 3) the State of Connecticut in order to satisfy the conditions imposed by the United States or the State of Connecticut in authorizing any system for the improvement of navigation of any harbor or river and for protection of property against damage by floods or by erosion, provided such system shall have been approved by DEEP Commissioner.

These statutes listed above enable a municipality, which has recognized a particular flood or erosion hazards potential and is dedicated to reducing or eliminating the hazards, to work with, and receive assistance from, federal and state agencies. The municipality must make a financial commitment based on federal cost-sharing requirements for a federal project. For a state/local project, the cost-sharing ratio is based on the ownership of the benefited property. The State will provide two-thirds of the project cost if the property protected is municipally owned. When the project benefits private properties, the State will provide one-third and the municipality will provide two-thirds of the project costs.

Although most of the municipalities in Connecticut posses the appropriate municipal code to enable the formation of FECBs, few FECBs are actively operating in Connecticut. In some communities, the existing Inland Wetland and Watercourse Commission or Agency or Board of Selectmen may act as the FECB.

Parks and Recreation Department

The Parks and Recreation Department typically oversees community open space and parks. This responsibility includes the properties acquired by the community for hazard mitigation purposes and converted to open space.

Attorney

A community's Attorney's office plays a critical role in hazard mitigation. The office typically reviews and helps to administer grant applications and projects under the HMA programs such as HMGP and PDM.

Commissions Related to Hazard Mitigation

Many commissions are involved with hazard mitigation. These may include:

- Conservation Commissions – Charged with the development, conservation, supervision, and regulation of natural resources and water resources (hazard mitigation through the category of "natural resource protection")
- Inland Wetlands and Watercourses Commissions – Charged with implementing and enforcing all provisions of the Connecticut General Statutes as regards the Inland Wetlands and Watercourses Act (hazard mitigation through "prevention," "natural resource protection," and "structural projects")
- Planning and Zoning Commissions – Charged with establishing, implementing, and overseeing planning and zoning regulations as provided by the Connecticut General

About this Project | **Data & Products** | **Daily Monitoring** | **Documentation**

The climatology of very large precipitation events is a critical component of engineering design and regulations for structures and facilities that must withstand or protect against such events. These events can produce localized urban and widespread flooding with damage to property, degradation of water quality, and potential loss of life. On a national level, a comprehensive climatology of rainfall events has not been updated since the early 1960s

Past Extreme Rainfall Analyses

In New York and New England this is a concern as the current climatology excludes almost 50 additional years of data. The National Weather Service is using a regional approach to update the 1960s analysis with two climatologies completed for the southwestern and middle Atlantic regions of the U.S. The Mid-Atlantic analysis extends as far north as Pennsylvania and thus excludes New York and New England. In these states, several regional and state-specific extreme rainfall analyses were conducted in the 1990 and early 2000s, but even these analyses are over a decade old and differences in the data records used do not provide a consistent regional analysis of rainfall extremes.

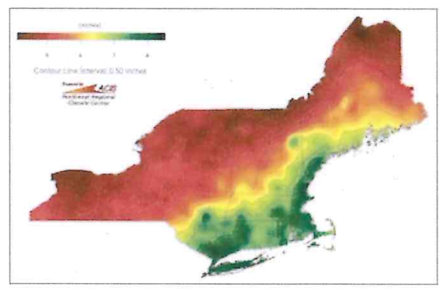
Extreme Rainfall Since the 1960s

The previous climatologies have been based on the premise that the extreme rainfall series do not change through time. Therefore it is assumed that older analyses reflect current conditions. Recent analyses show that this is not the case, particularly in New York and New England where the frequency of 2 inch rainfall events has increased since the 1950s and storms once considered a 1 in 100 year event have become more frequent. Such storms are now likely to occur almost twice as often.

Project Mailing List
Click here to Subscribe

Web Site Features

A number of features are included in this website to make it compatible with the NWS analysis for the Middle Atlantic region and to enhance its usability. The design of the site and its products have been reviewed by stakeholders with the U.S. Natural Resource Conservation Service (NRCS), various state agencies, and private engineering consulting firms. The site includes estimates of extreme rainfall for various durations (from 5 minutes to 10 days) and recurrence intervals (1 year to 500 years). These data are interpolated to a 30-second grid. Confidence intervals for these values are also included as are the partial duration rainfall series used in their computation. Regional extreme rainfall maps and graphic products are also available. Precipitation distribution curves can be generated for each grid either directly or from the USDA NRCS Win TR-20 software, eliminating the need to use a static Type II or Type III curve.



This project is a joint collaboration between:
Northeast Regional Climate Center (NRCC) **Natural Resources Conservation Service (NRCS)**

Cornell University USDA NRCS

Contact: precip@cornell.edu

Extreme Precipitation in a Changing Climate for New York and the New England States

William Merkel & Quan D. Quan, Natural Resources Conservation Service, USDA, Beltsville, MD
Art DeGaetano & Dan Zarrow, Northeast Regional Climate Center, Cornell University, Ithaca, NY

Background

Why is extreme precipitation analysis important?
Extreme precipitation events can produce localized and widespread flooding with damage to property, degradation of water quality, and potential loss of life. The climatology of very large precipitation events is therefore a critical component of engineering design and regulations for structures and facilities that must withstand or protect against such events.

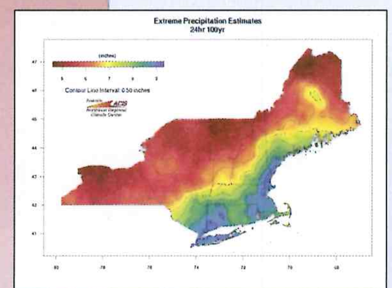
Why is this particular study important?
The last comprehensive climatology of extreme rainfall events on a national level was detailed in Technical Paper 40, published by the United States Weather Bureau (now the National Weather Service) in 1961. While subsequent studies have been performed for other regions of the country, many agencies and companies in the Northeast are still using this half-century old data. This new extreme precipitation study will including rainfall events through the end of 2008 in its analysis, providing an updated standard upon which regulations, engineering design, and policy can be based.

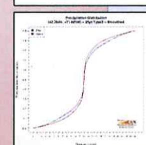
How is this analysis being performed?
Climatological precipitation data is collected and quality controlled at daily, hourly, and subhourly durations for stations across the Northeast. A partial duration series, representing the highest rainfall values, is generated for each station and fit to a Beta-P distribution. From the distribution, extreme precipitation returns are calculated at the 1yr, 2yr, 5yr, 10yr, 25yr, 50yr, 100yr, 200yr, and 500yr recurrence periods. This output then undergoes a series of gridding and smoothing steps to interpolate and extrapolate the data to an approximately half-mile by half-mile grid.

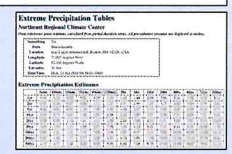
Which states does this study cover?
The Northeast Regional Climate Center has partnered with the Natural Resources Conservation Service state offices in New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine to produce extreme rainfall statistics for those seven states.

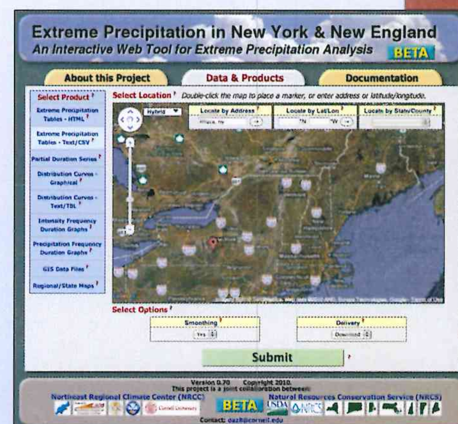
Web Tools

A public, user-friendly web interface will offer fast and easy access to the data in a variety of formats. Users will be able to set their location by address, latitude/longitude coordinates, or through an intuitive clickable, zoomable map. The data will output in a variety of map, chart, text, and GIS formats. This web site is currently available at **http://www.precip.net/**









In addition, a set of tools to monitor rainfall events in realtime is under development. Using the Northeast Regional Climate Center's Applied Climate Information System (ACIS) infrastructure to retrieve daily precipitation data, maps and lists will be generated to indicate stations that have exceeded their extreme precipitation return periods for a given date.

The **Northeast Regional Climate Center (NRCC),** one of six regional climate centers in the US, facilitates and enhances the collection, dissemination and use of climate data and information for the northeast United States
http://www.nrcc.cornell.edu

http://www.precip.net/

The **Natural Resources Conservation Service (NRCS)**, part of the United States Department of Agriculture (USDA), assists land owners and managers conserve soil, water, and other natural resources.
http://www.nrcs.usda.gov

The Heat is On:
A Look into New England's Future Climate

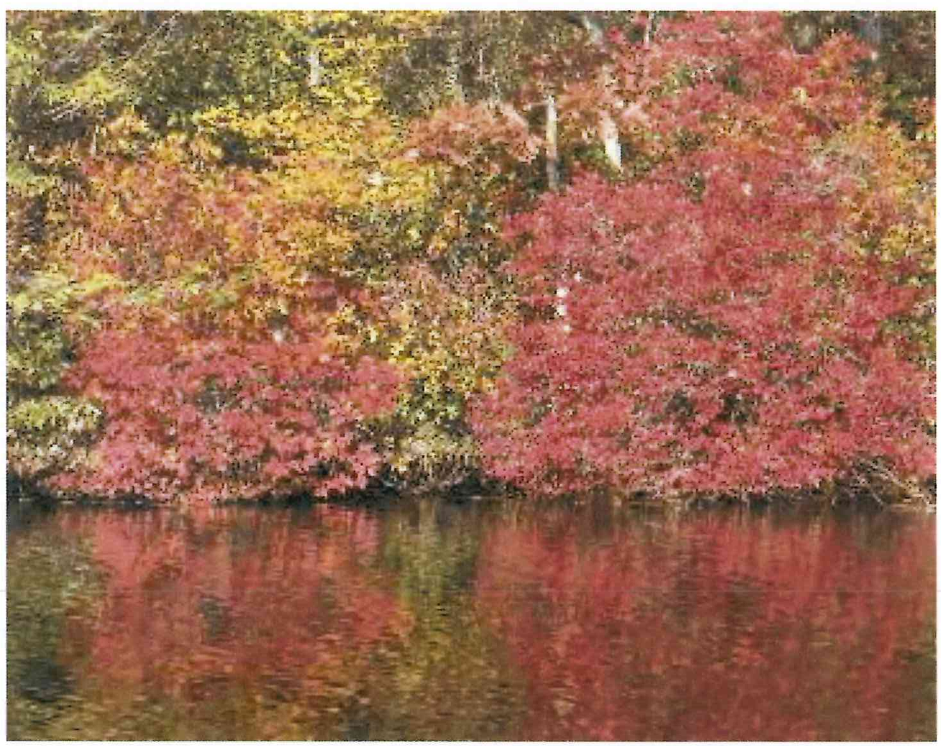
David J. Nicosia

Every Autumn, tourists flock to admire the spectacular fiery foliage of New England. Tourists and residents alike take photos and many show children how to preserve colorful leaves by pressing them between sheets of waxed paper. We tend to take this annual show for granted. However, if fossil fuel burning goes unchecked, the climate of southern New England will be very different than it is today. In the worst case, New England's vivid fall foliage display could become a memory of the past.

Consider these scenarios for future New England winters and summers:

It is early December, the weather forecast for tonight is calling for clear skies with a widespread killing frost. It is expected to be the first freeze of the fall season. It has been a long and very mild fall season with temperatures consistently in the 60s and 70s with high temperatures occasionally in the 80s. This first freeze is a sign of things to come, as colder weather will become more common as late fall transitions into winter. Winter typically brings daytime temperatures in the 50s and 60s with morning lows in the 30s. Frost with occasional freezing temperatures will become more common. The chances for snow are slim to none in a given winter season. Measureable snow falls about once every 4 years. When it does fall, entire communities are paralyzed because they just don't have the equipment, salt and sand to cope with snow and ice, and residents don't know how to drive on snow and icy roads. Anytime the weather forecast calls for snow or ice, people rush to the stores, schools shut down, and businesses close. If several inches fall, a state of emergency is declared. Fortunately, a snowstorm of several inches is very rare and occurs once every 10-20 years. The vast majority of the time, precipitation falls as rain. The rains are often heavy and lead to floods.

Spring arrives early with temperatures frequently rising into the 70s by March. By the middle of March, the chances of sub-freezing temperatures are extremely small. By May, daytime highs frequent the 80s and toward the end of May, temperatures often climb past 90 degrees. The humidity also kicks in strongly during May. Summers are long, hot, and humid with about 50 days exceeding 90 degrees. On a few days of the summer, temperatures exceed 100 degrees. Even though the heaviest rainfall comes in the summer season, the searing heat of the summer leads to intense evaporation of moisture from the soils. So despite an increased frequency of intense flooding rains, short term drought conditions occur almost every summer. Although rare, longer droughts of up to 6 months occur once every 10-20 years. Thus, the cycle of flooding rains and summer drying with occasional drought leads to challenges for both agriculture, and water supply. The heat and humidity of the summer lasts well into September with cooler weather not typically arriving until October.

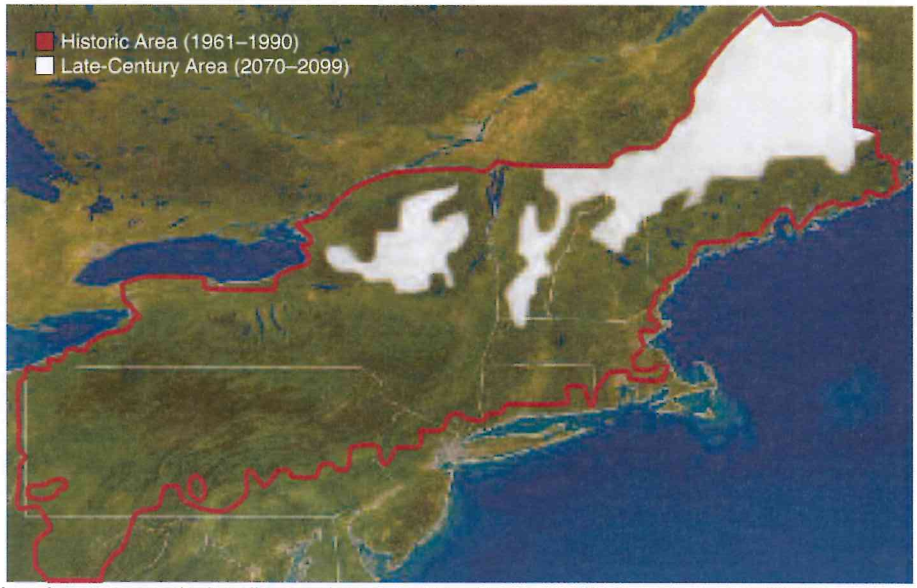


C. Arnold

Could New England's legendary fall foliage color become a thing of the past? Many scientists say yes, if we continue to emit the amount of greenhouses gases we currently do.

Even so, temperatures in October often exceed 80 degrees. One would have to travel very far to the north to see fall color. The predominant forest type is pine and oak which lack the brilliant fall hues typical of a maple dominated forest. The above describes the current climate of South Carolina. But, it could someday describe our climate in southern New England.

If fossil fuel burning goes unchecked and we follow the Intergovernmental Panel on Climate Change's (IPCC's) high greenhouse gas emission scenario, by the end of this century, the climate of southern New England will be similar to the climate of South Carolina today.



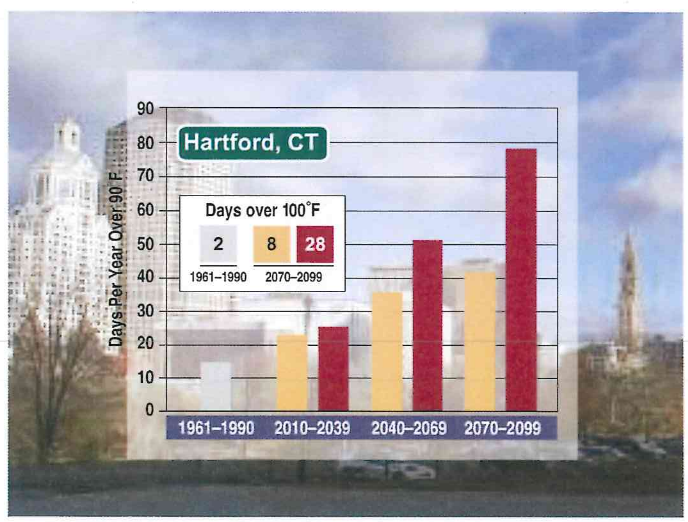
In a future scenario for climate change in New England, this is the area in which snow covers the ground for at least half of the days in December, January and February.

Source: Union of Concerned Scientists (http://www.climatechoices.org/) which is adapted from ***Climate Change in the U.S. Northeast*** (PDF): A report of the Northeast Climate Impacts Assessment (NECIA), October 2006.

The forests of maple, beech, birch, hemlock, spruce and fir will respond, as climatic zones shift to the north, vacating central and southern New England. Indeed, there was a time 6 to 8 thousand years ago, as indicated from pollen samples taken from lake cores, when these tree species did retreat far to the north of central and southern New England. The forests were predominantly oak, pine and chestnut. It is postulated that summers were 4 to 8 degrees F warmer than today during this time. Thus, it is entirely plausible that our forest composition will change with maples becoming much less common. With the retreat of the maples to the north, comes the loss of the brilliant fall colors so common in much of New England today. In addition, the maple sugaring business will suffer. Snow will become much rarer, especially along the coast. Snow cover will become non-existent across most of New England except over the far north and in the higher mountains of Vermont, New Hampshire and Maine. In these areas, snow cover would still remain for about 1/2 of the winter. The ski industry would be decimated with only a few resorts hanging on across the highest mountains.

In addition to the loss of fall color, and snow, summers would become brutally hot and humid in southern New England. An average summer would be much worse than even the recent hot and humid summer. For comparison, the summer of 2010 saw 34 days exceed 90 degrees in Hartford, Connecticut; tied for third most days in a year above 90 degrees. The record number of days above 90 degrees is 38 days set in 1983. If such high emission climate projections hold true, the average number of days topping 90 degrees would be a staggering 78, with the number of days exceeding 100 degrees averaging almost 30! This would make the summer of 2010 seem cool in comparison! Coastal locations would see fewer 90 degree days than inland stations but would likely top 50 per year similar to the South Carolina coast.

With the marked increase in air temperatures will come a sharp increase in our ocean temperatures. Under a high emission scenario, sea surface temperatures in coastal New England and the Long Island Sound will increase as much as 9 degrees F relative to today. This means that summer ocean temperatures which normally average close to 70 degrees could approach 80 degrees. This change in ocean temperature will have a profound impact on marine life with changing composition of fish species. Cold adapted species, including lobster, would migrate well to the north of Long Island Sound. This would end the lobster industry for southern New England. Brown kelp could vanish from the Sound as well, causing changes in the benthic estuarine ecosystem.

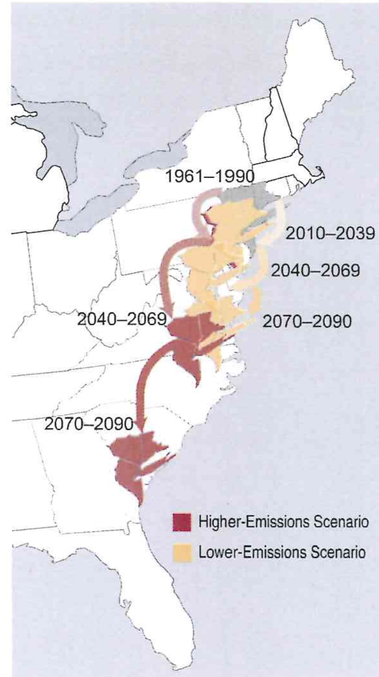


In summer 2010, 34 days exceeded 90 degrees in Hartford, Connecticut; tied for third most days in a year above 90 degrees.

Low-lying coastal cities such as Bridgeport, Connecticut and transportation corridors such as Interstate 95 will have to adapt to rising sea level.

Source: Union of Concerned Scientists (http://www.climate-choices.org/) which is adapted from ***Climate Change in the U.S. Northeast*** (PDF): A report of the Northeast Climate Impacts Assessment (NECIA), October 2006.

NYC Tri-State Region



Will New England be the "new South Carolina" by 2090?
If we continue our energy-consuming patterns, very possibly.

Accompanying the rising sea surface temperatures would be a rise in sea level due to thermal expansion of the ocean waters. Sea levels are projected to rise almost 20 inches under a high emission scenario. This is from thermal expansion only. If one factors in potential increase from glacial melt, which is much more uncertain, the rise could reach almost 3 feet. This would certainly flood many of our coastal communities. To make matters worse, rainfall intensity and storminess are projected to increase. Most climate models are indicating that the number of days with 2 inches of rain may double by the end of this century. This increased storminess not only would increase flooding but also lead to more coastal flood events as there would be more frequent coastal storms.

Agriculture will also be significantly impacted by such rapid changes as well. Even with an increase in rainfall over the entire year, the higher summer temperatures will allow evaporation to outpace the increase in rainfall. This will lead to more summer-time drying, increasing the incidence of drought. The occurrence of droughts lasting 3-6 months is projected to increase by almost threefold.

In contrast, agriculture could benefit by an extended growing season. Under a higher emission scenario, the growing season could be extended by as much as 6 weeks with first frosts not occurring until well into November, or even December, along the coast. The last freeze would be in March instead of April or May.

It is hard to believe that a child born today, in his or her lifetime, could see such profound changes in our climate. In a human lifetime, our familiar climate with 4 distinct seasons of winter snows, spring thaws and maple sugaring, warm, pleasant summers and crisp, cool colorful falls could radically change. Gone will be the colorful falls, and winter snows to be replaced by very hot and humid summers. Fall and winter will be mild and rainy with a much warmer and earlier spring. Rainfall patterns would be more erratic, leading to increasing instances of flooding and droughts. Such changes would be the most the human species has had to encounter since the end of the last ice age around 10,000 years ago! If you believe the climate models, this will occur under a high emission scenario. Even lower emission scenarios still have pronounced warming of around 5 degrees F which would make southern New England's climate more like North Carolina and Virginia instead of South Carolina.

Will there be some benefits to climate change? Longer growing seasons could benefit agriculture. Imagine growing two crops of tomatoes in a summer season! Recreation could shift away from winter sports to summer recreation. Maybe the beaches of Southern New England will become more sought after vacation destinations with warmer water temperatures and hotter summers. Of course, this is only true if the sea levels don't rise too much. Warmer and mild winters could make southern New England a popular winter destination for the snow-birds of central Canada. Can you imagine that?!

David J. Nicosia is a Warning Coordination Meteorologist for NOAA's National Weather Service in Binghamton NY.

POSITION STATEMENT

UTILIZATION OF 100 FOOT BUFFER ZONES TO PROTECT RIPARIAN AREAS IN CONNECTICUT

BY

BRIAN D. MURPHY

TECHNICAL ASSISTANCE BIOLOGIST

INLAND FISHERIES DIVISION

I. INTRODUCTION

One tenet of the Inland Fisheries Division Policy on Riparian Corridor Protection is the utilization of a 100 foot buffer zone as a minimum setback along perennial streams. The adoption of such a policy is sure to be controversial. Laymen, developers and natural resource professionals alike will ask questions such as: Why was a standard setting method adopted? What's magical about 100 feet? Will 100 feet be sufficiently protective, or will it be overly protective? In response, this paper outlines the ramifications of adopting a riparian corridor policy including the use of a 100 foot buffer zone.

II. STANDARD SETTING VERSUS SITE SPECIFIC BUFFER ZONES

There are two approaches for determining buffer zone width; standard setting and site specific. Standard setting methods define an area extending from the streambank edge or highwater mark to some landward fixed point boundary. Site specific methods utilize formulas that incorporate and consider special site specific land characteristics, hence, the calculation of a variable width buffer zone. In both case, buffers are employed to define an area in which development is prohibited or limited.

A major advantage of standard setting methods is that they are easy to delineate and administer, thereby improving the consistency and quality of environmental assessments. Furthermore, valuable staff time would not be required to determine site specific buffer zones along each and every watercourse of concern.

The exact width of a buffer zone required for riparian corridor protection is widely disputed (Bottom et al. *1985* and Brinson et al. 1981). Buffer width recommendations found in the literature vary from as little as 25 feet to as great as 300 feet (Palfrey et al. 1982). The 100 foot buffer is widely accepted in Connecticut having been adopted by numerous inland wetland and conservation commissions as an appropriate minimum setback regulation for streambelts. In addition, Division staff have been recommending the utilization of the 100 foot buffer zone to protect streambelts since the early 1980's. Scientific research has not been generated to dispute the adequacy of utilizing 100 foot buffer zones to protect Connecticut's riparian corridors. In fact, to ensure that riparian functions are not significantly altered, recent scientific information points towards maintaining buffer zones that would be at a minimum, 100 feet in width (see section III).

Site specific methods define buffer widths according to the character and sensitivity of adjacent streamside lands. These buffer widths, also referred to as "floating buffers," consider

physical site characteristics such as slope, soil type, and vegetative cover. The advantage of site specific methods is that buffer widths are designed using site characteristics and not an arbitrary predetermined width. Unfortunately, there is no "one" universally accepted formula or model and none have been developed for use in Connecticut. Most formulas are based on the degree to which sediment can be removed or filtered by natural vegetation, thus, the primary useage is sediment control. Other weaknesses of site specific techniques are (1) all areas must be evaluated on a case—by case basis and, (2) the subjectivity of different techniques (i.e. if the evaluation technique is inadequate, the buffer width will also be inadequate).
Additionally, these formulas only concentrate on one specific riparian function at a time and do not take into account multiple riparian functions, especially those of inland fisheries values as discussed in Section III. Consequently, site specific formulas approach riparian function on a single dimension rather than taking a more realistic, holistic approach.

In the absence of a scientific model to determine buffer widths suitable to protect Connecticut's riparian corridors, the utilization of a standard setting method is environmentally and politically prudent.

III. RIPARIAN FUNCTION

To assess the efficacy of a 100 foot buffer zone, the literature was searched to identify studies which have applied a quantitative approach to buffer width determination. Literature was searched for studies which both support and dispute the 100 foot zone. The following is a summary "by riparian function" of quantitative studies which assess buffer widths.

Sediment Control

Width, slope and vegetation have been cited as important factors in determining effectiveness of buffer zones as sediment filters (Karr and Schlosser 1977). Wong and McCuen (1981), who developed and applied a mathematical model to a 47 acre watershed, found that a 150 foot zone along a 3% slope reduced sediment transport to streams by 90%. Mannering and Johnson (1974) passed sediment laden water through a 49.2 foot strip of bluegrass and found that *54%* of sediment was removed from the water. Trimble and Sartz (1957) developed recommendations as to width of buffer areas between logging roads and streams to reduce sediment load. They determined a minimum strip of 50 feet was required on level land with the width increasing 4 feet for each 1% slope increase. Buffer widths as determined by Trimble and Sartz (1957) have been characterized as evaluated guesses rather than empirically defined widths (Karr and Schlosser 1977). Rodgers et al. (1976) state that slopes greater than 10% are too steep to allow any significant detention of runoff and sediment regardless of buffer width. After a critical review of the literature, Karr and Schlosser (1977) determined that the size and type of vegetative buffer strip needed to remove a given fraction of the overland sediment load cannot be universally quantified. Existing literature does suggest that 100 foot riparian buffers will assist with sediment entrapment, although efficacy will vary according to site conditions.

Temperature Control

Brown and Brazier (1973) evaluated the efficacy of buffer widths required to ameliorate stream water temperature change. They concluded that angular canopy density (ACD), a measure of the ability of vegetation to provide shading, is the only buffer area parameter correlated with temperature control. Results show that maximum angular canopy density or maximum shading ability is reached within a width of 80 feet. Study sites were 9 small mountain streams in Oregon that contained a conifer riparian vegetative complex. Whether or not maximum angular canopy density is reached within 80 feet in a typical Connecticut deciduous forest riparian zone is doubtful. Tree height in Connecticut riparian zones is smaller than in Oregon (Scarpino, personal communication), therefore buffers greater than 80 feet in width would be required for temperature maintenance in Connecticut.

Nutrient Removal

Nutrient enrichment is caused by phosphorous and nitrogen transport from, among other things, fertilized lands and underground septic systems. Most research on nutrient enrichment has focused on overland surface flow. Karr and Schlosser (1977) report that 88% of all nitrogen and 96% of all phosphorous reaching watercourses in "agricultural watersheds" were found to be attached to sediment particles; thus, successful nutrient removal can be accomplished through successful sediment removal. There are conflicting reports on the ability of buffer widths to remove nutrients with most research being tested on grass plots. Butler et al. (1974) as cited by Karr and Schlosser (1977) found that a *150* foot buffer width of reed canary grass with a 6% slope caused reductions in phosphate and nitrate concentrations of between 0—20%. Wilson and Lehman (1966) as cited by Karr and Schlosser (1977) in a study of effluent applied to 300 m grass plots found that nitrogen and phosphorous concentrations were reduced 4 and 6%, respectively. Studies on subsurface runoff as cited in Clark (1977) found high concentrations of nitrates at 100 feet from septic systems with unacceptable levels at 150 feet. Clark (1977) recommended that a 300 foot setback be used whenever possible, with a 150 setback considered adequate to avoid nitrate pollution. Environmental Perspective Newsletter (1991) states that experts who commonly work with the 100 foot buffer zone set by the Massachusetts Wetlands Protection Act are increasingly finding that it is insufficient since many pollutants routinely travel distances far greater than 100 feet with nitrate—nitrogen derived from septic systems moving distances of greater than 1000 feet. Research indicates that the adoption of 100 foot buffer widths for Connecticut riparian zones will assist with the nutrient assimilation; albeit, complete removal of all nutrients may not be achieved.

Large Woody Debris

The input of large woody debris (LWD) to streams from riparian zones, defined as fallen trees greater than 3 m in length and 10 cm in diameter has been recently heralded as extremely critical to stream habitat diversity as well as stream channel maintenance. Research on large woody debris input has mainly been accomplished in the Pacific Northwest in relation to timber harvests. Murphy and Koski (1989) in a study of seven Alaskan watersheds determined that almost all (99%) identified sources of LWD were within 100 feet of the streambank. Bottom et al. 1983 as cited by Budd et al. (1987) confirm that in Oregon most woody structure in streams is derived from within 100 feet of the bank. Based on research done within old—growth forests, the Alaska region of the National Marine Fisheries Service, recognizing the importance of LWD to salmonid habitat, issued a policy statement in 1988 advocating the protection of riparian habitat through the retention of buffer strips not less than 100 feet in width (Murphy and Koski 1989). All research findings support the use of a 100 foot buffer zone in Connecticut for large woody debris input.

Food Supply

Erman et al. (1977) conducted an evaluation of logging impacts and subsequent sediment input to 62 streams in California. Benthic invertebrate populations (the primary food source of stream fishes) in streams with no riparian buffer strips were compared to populations in streams with buffer widths of up to 100 feet. Results showed that buffer strips less than 100 feet in width were ineffective as protective measures for invertebrate populations since sediment input reduced overall diversity of benthic invertebrates. Buffer strips greater than 100 feet in width afforded protection equivalent to conditions observed in unlogged streams. The ultimate significance of these findings is that fish growth and survival may be directly impacted along streams with inadequate sized riparian buffer zones. All research supports the feasibility of implementing a 100 foot buffer zone in Connecticut to maintain aquatic food supplies.

Streamflow Maintenance

The importance of riparian ecosystems in terms of streamflow maintenance has been widely recognized (Bottom et al. 1985). In Connecticut, riparian zones comprised of wetlands are of major importance in the hydrologic regime. Riparian wetlands store surplus flood waters thus dampening stream discharge fluctuations. Peak flood flows are then gradually released reducing the severity of downstream flooding. Some riparian wetlands also act as important groundwater discharge or recharge areas. Groundwater discharge to streams during drier seasonal conditions is termed low flow augmentation. The survival of fish communities, especially coldwater salmonid populations is highly dependent upon low flow augmentation (Bottom et al. 1985). Research, although documenting the importance of riparian zones as areas critical to streamflow maintenance, has not investigated specific riparian buffer widths required to provide the most effective storage and release of stream flows.

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Article 39

Feature article from Watershed Protection Techniques. 1(4): 155-163

The Architecture of Urban Stream Buffers

Headwater streams comprise as much as 75% of the total stream and river mileage in the contiguous United States (Leopold *et al.*, 1964). These critical headwater streams are often severely degraded by the urbanization process (Schueler, 1995). As a consequence, many communities have adopted stream buffer requirements as one element of an overall urban watershed protection strategy. Up to now, buffer requirements have been relatively simplistic—the "design" of a stream buffer often consists of no more than drawing a line of uniform width on a site plan. As Heraty (1993) notes, buffers designed in this manner often become invisible to contractors, property owners, and even local governments. As a result, many stream buffers fail to perform their intended function, and are subject to disturbance and encroachment.

A buffer network acts as the "right-of-way" for a stream and functions as an integral part of the stream ecosystem. Stream buffers add to the quality of the stream and the community in many diverse ways, as summarized in Table 1. In many regions, these benefits are multiplied when the streamside zone is in a forested condition. While the benefits of urban stream buffers are impressive, their capability to remove pollutants borne in urban stormwater should not be overstated. Although communities frequently cite pollutant removal as the key benefit when justifying the establishment of stream buffers in urbanizing areas (Heraty, 1993), their capability to remove pollutants in urban stormwater is fairly limited. This is a surprising conclusion given the moderate to excellent sediment and nutrients removal reported for forested buffers in rural areas (Desbonnet *et al.*, 1994) Much of the pollutant removal observed in rural and agricultural buffers appears to be due to relatively slow transport of pollutants across the buffer in sheetflow or under it in shallow groundwater. In both cases, this relatively slow movement promotes greater removal by soils, roots, and microbes.

Ideal buffer conditions are rarely encountered in urban watersheds. In urban watersheds rainfall is rapidly converted into concentrated flow. Once flow concentrates, it forms a channel that effectively short-circuits a buffer. Unfortunately, stormwater flows quickly concentrate within a short distance in urban areas. It is doubtful, for example, whether sheetflow condition can be maintained over a distance of 150 feet for pervious areas and 75 feet for impervious areas (Figure 1). Consequently, as much as 90% of the surface runoff generated in an urban watershed concentrates before it reaches the buffer, and ultimately crosses it in an open channel or an enclosed stormdrain pipe. As a result, some kind of structural stormwater practice is often needed to remove pollutants from runoff before they enter the stream.

Figure 1: Watershed Geometry and the Concentration of Flow: The Overland Flow Path to the Stream and the Distance Before Flow Concentrates

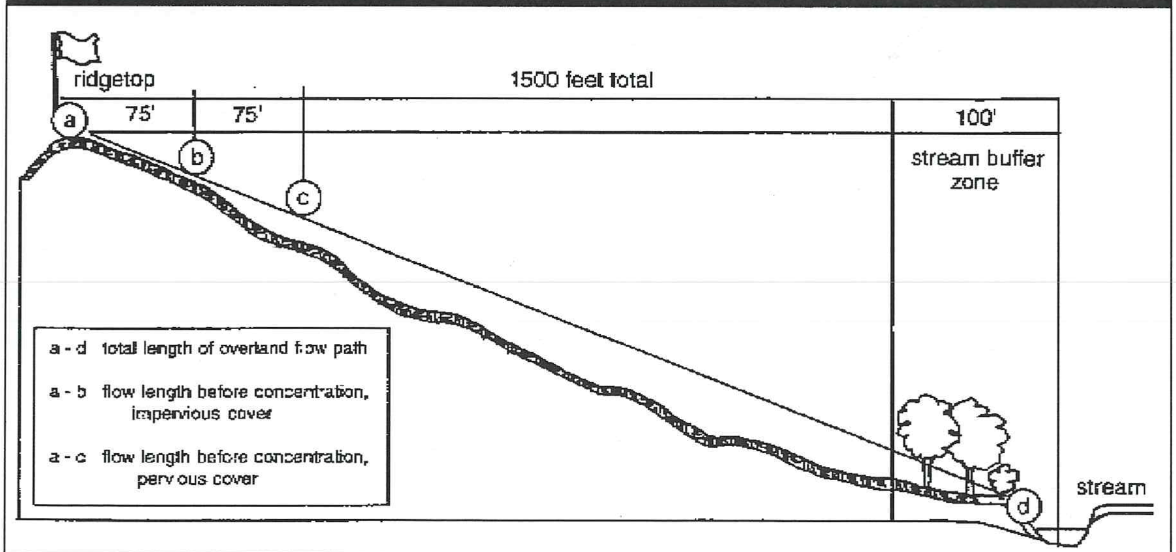


Table 1: Twenty Benefits of Urban Stream Buffers
(*f*) = Benefit Amplified by or Requires Forest Cover

1. **Reduces watershed imperviousness by 5%.** An average buffer width of 100 feet protects up to 5% of watershed area from future development.
2. **Distances areas of impervious cover from the stream.** More room is made available for placement of stormwater practices, and septic system performance is improved. (*f*)
3. **Reduces small drainage problems and complaints.** When properties are located too close to a stream, residents are likely to experience and complain about backyard flooding, standing water, and bank erosion. A buffer greatly reduces complaints.
4. **Stream "right of way" allows for lateral movement.** Most stream channels shift or widen over time; a buffer protects both the stream and nearby properties.
5. **Effective flood control.** Other, expensive flood controls not necessary if buffer includes the 100-yr floodplain.
6. **Protection from streambank erosion.** Tree roots consolidate the soils of floodplain and stream banks, reducing the potential for severe bank erosion. (*f*)
7. **Increases property values.** Homebuyers perceive buffers as attractive amenities to the community. 90% of buffer administrators feel buffers have a neutral or positive impact on property values. (*f*)
8. **Increased pollutant removal.** Buffers can provide effective pollutant removal for development located within 150 feet of the buffer boundary, when designed properly.
9. **Foundation for present or future greenways.** Linear nature of the buffer provides for connected open space, allowing pedestrians and bikes to move more efficiently through a community. (*f*)
10. **Provides food and habitat for wildlife.** Leaf litter is the base food source for many stream ecosystems; forests also provides woody debris that creates cover and habitat structure for aquatic insects and fish. (*f*)
11. **Mitigates stream warming.** Shading by the forest canopy prevents further stream warming in urban watersheds. (*f*)
12. **Protection of associated wetlands.** A wide stream buffer can include riverine and palustrine wetlands that are frequently found along the stream corridor.
13. **Prevent disturbance to steep slopes.** Removing construction activity from these sensitive areas is the best way to prevent severe rates of soil erosion. (*f*)
14. **Preserves important terrestrial habitat.** Riparian corridors are important transition zones, rich in species. A mile of stream buffer can provide 25-40 acres of habitat area. (*f*)
15. **Corridors for conservation.** Unbroken stream buffers provide "highways" for migration of plant and animal populations. (*f*)
16. **Essential habitat for amphibians.** Amphibians require both aquatic and terrestrial habitats and are dependent on riparian environments to complete their life cycle. (*f*)
17. **Fewer barriers to fish migration.** Chances for migrating fish are improved when stream crossings are prevented or carefully planned.
18. **Discourages excessive storm drain enclosures/channel hardening.** Can protect headwater streams from extensive modification.
19. **Provides space for stormwater ponds.** When properly placed, structural stormwater practices within the buffer can be an ideal location for stormwater practices that remove pollutants and control flows from urban areas.
20. **Allowance for future restoration.** Even a modest buffer provides space and access for future stream restoration, bank stabilization, or reforestation.

The ability of a particular buffer to actually realize its many benefits depends on how well the buffer is planned or designed. In this article, we present a more detailed scheme for stream buffer design, drawn from field research and local experience across the country. The suggested urban stream buffer criteria are based on 10 practical performance criteria that govern how a buffer will be sized, delineated, managed, and crossed (Table 2). In addition, the buffer design contains several provisions to respect the property rights of adjacent landowners.

Table 2: Nuts and Bolts of an Urban Stream Buffer

- Minimum total width of 100 feet, including floodplain
- Zone-specific goals and restrictions for the outer, middle, and streamside zones
- Adopt a vegetative target based on predevelopment plant community
- Expand the width of the middle zone to pick up wetlands,slopes and larger streams
- Use clear and measurable criteria to delineate the origin and boundaries of the buffer
- The number and conditions for stream and buffer crossings should be limited
- The use of buffer for stormwater runoff treatment should be carefully prescribed
- Buffer boundaries should be visible before, during, and after construction
- Buffer education and enforcement are needed to protect buffer integrity
- Buffer administration should be flexible and fair to landowners

Criteria 1: Minimum Total Buffer Width

Most local buffer criteria are composed of a single requirement that the buffer be a fixed and uniform width from the stream channel. Urban stream buffers range from 20 to 200 feet in width on each side of the stream according to a national survey of 36 local buffer programs, with a median of 100 feet (Heraty, 1993). Most jurisdictions arrived at their buffer width requirement by borrowing other state and local criteria, local experience, and, finally, through political compromise during the buffer adoption process. Most communities require that the buffer fully incorporate all lands within the 100-year floodplain, and others may extend the buffer to pick up adjacent wetlands, steep slopes or critical habitat areas.

In general, a minimum base width of at least 100 feet is recommended to provide adequate stream protection. In most regions of the country, this requirement translates to a buffer that is perhaps three to five mature trees wide on each side of the channel.

Criteria 2: Three-Zone Buffer System

Effective urban stream buffers are divided into three lateral zones: streamside, middle core, and outer zone. Each zone performs a different function, and has a different width, vegetative target and management scheme, as follows:

- The *streamside zone* protects the physical and ecological integrity of the stream ecosystem. The vegetative target is mature riparian forest that can provide shade, leaf litter, woody debris and erosion protection to the stream. The minimum width is 25 feet from each stream bank—about the distance of one or two mature trees from the streambank. Land use is highly restricted and is limited to stormwater channels, footpaths, and a few utility or roadway crossings.

- The *middle zone* extends from the outward boundary of the streamside zone, and varies in width, depending on stream order, the extent of the 100-year floodplain, adjacent steep slopes and protected wetland areas. Its functions are to protect key components of the stream and provide further distance between upland development and the stream. The vegetative target for this zone is also mature forest, but some clearing may be allowed for stormwater management, access, and recreational uses. A wider range of activities and uses are allowed within this zone, e.g., recreation, bike paths, and stormwater practices. The minimum width of the middle core is about 50 feet, but it is often expanded based on stream order, slope or the presence of critical habitats.

- The *outer zone* is the buffer's buffer, an additional 25-foot setback from the outward edge of the middle zone to the nearest permanent structure. In most instances, it is a residential backyard. The vegetative target for the outer zone is usually turf or lawn, although the property owner is encouraged to plant trees and shrubs, and thus increase the total width of the buffer. Very few uses are restricted in this zone. Indeed, gardening, compost piles, yard wastes, and other common residential activities are promoted within the zone. The only major restrictions are no septic systems and no new permanent structures.

Criteria 3: Predevelopment Vegetative Target

The ultimate vegetative target for the streamside and middle zone of most urban stream buffers should be specified as the predevelopment riparian plant community—usually mature forest. Notable exceptions include prairie streams of the Midwest, or arroyos of the arid West, that may have a grass or shrub cover in the riparian zone. In general, the target should be based on the natural vegetative community present in the floodplain, as determined from reference riparian zones.

A vegetative target has several management implications. First, if the streamside zone does not currently meet its vegetative target, it should be managed to ultimately achieve it. For example, a grassy area should be allowed to grow into a forest over time. In some cases, active reforestation may be necessary to speed up the successional process. Second, a vegetative target implies that the buffer will contain mostly native species adapted to the floodplain. Thus, non-native or invasive tree, shrub and vine species should be avoided when revegetating the buffer. Removal of exotic shrubs and vines (e.g. multiflora rose or honeysuckle) that are often prevalent along the buffer edge should be encouraged.

Criteria 4. Buffer Expansion and Contraction

Many communities require that the minimum width of the buffer be expanded under certain conditions. Thus, while the streamside and outer zones of the buffer are fixed, the width of the middle zone may vary. Specifically, the average width of the middle zone can be expanded to include:

- The full extent of the 100-year floodplain
- All undevelopable steep slopes (> 25%)
- Steep slopes (five to 25% slope, at four additional feet of slope per 1% increment of slope above 5%)
- Adjacent delineated wetlands or critical habitats

The middle zone also expands to protect streams of higher order or quality in a downstream direction. For example, the width of the middle zone may increase from 75 feet (for first- and second-order streams) to 100 feet (for third- and fourth-order streams) and as much as 125 feet for fifth- or higher order streams/rivers. The width of the buffer can also be contracted in some circumstances to accommodate unusual or historical development patterns, shallow lots, stream crossings, or stormwater ponds (see Criteria 10).

Criteria 5: Buffer Delineation

Three key decisions must be made when delineating the boundaries of a buffer. At what mapping scale will streams be defined? Where does the stream begin and the buffer end? And from what point should the inner edge of the buffer be measured?

The *mapping unit*. The traditional mapping scale used to define the stream network are the bluelines present on USGS 7.5 minute quadrangle maps (1 inch = 2,000 feet). It should be kept in mind that bluelines are only a first approximation for delineating streams, as this scale does not always reveal all first order perennial streams or intermittent channels in the landscape or precisely mark the transition between the two. Consequently, the actual location of the stream channel can only be confirmed in the field

The *origin of a first order stream* is always a matter of contention. As a practical rule, the origin of the stream can be defined as the point where intermittent stream forms a distinct channel, as indicated by the presence of an unvegetated streambed and high water marks. Other regions define the origin of a stream as the upper limit of running water during the wettest season of the year. Problems are frequently encountered when the stream network has been extensively modified by prior agricultural drainage practices.

The *inner edge* of the buffer can be defined from the centerline of small first- or second-order streams. The accuracy of this method is questionable in higher order streams with wider channels. Thus, the inner edge of the buffer is measured from the top of each streambank for third and higher order streams.

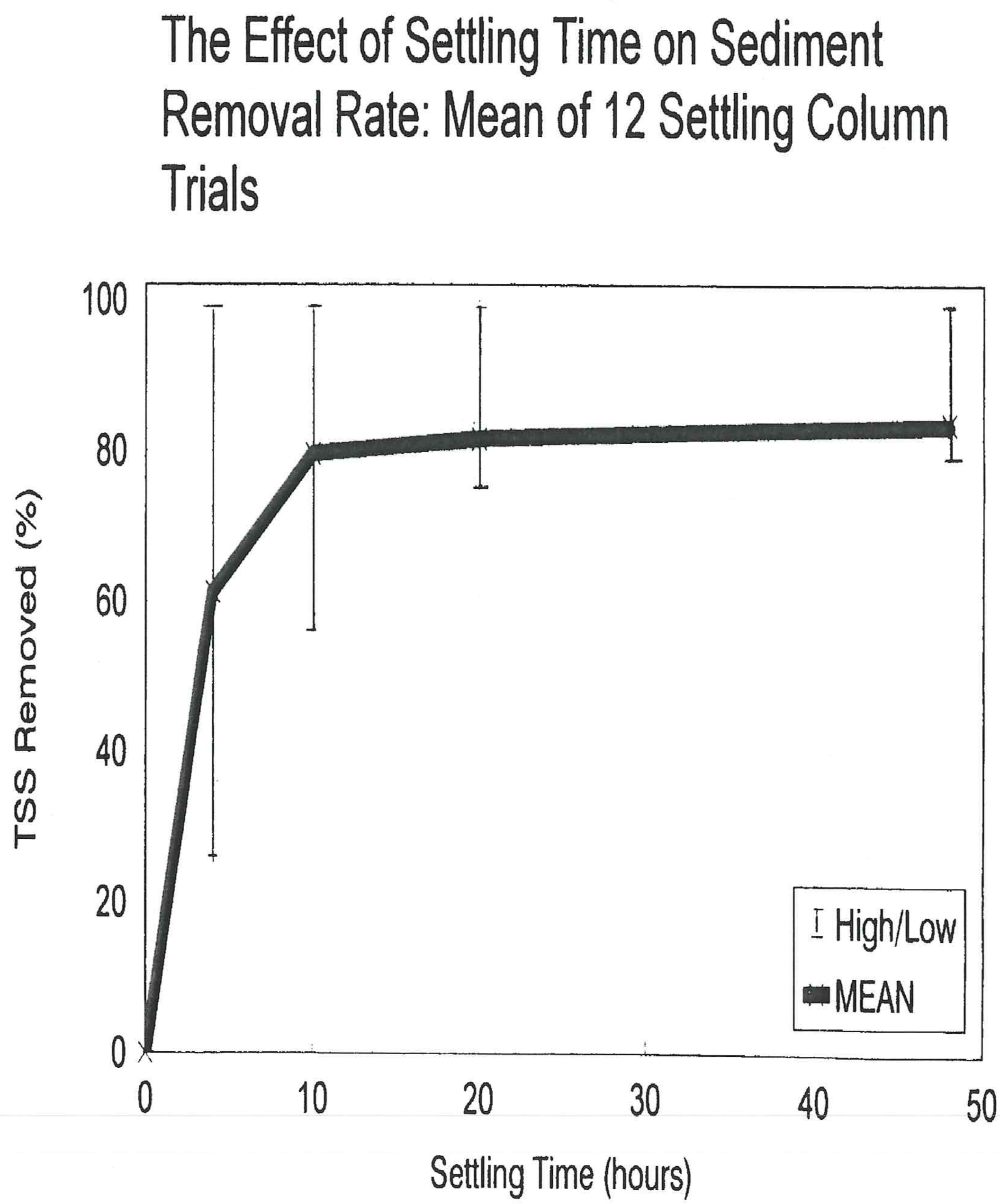
Criteria 6. Buffer Crossings

Two major goals of a stream buffer network are to maintain an unbroken corridor of riparian forest and maintain the upstream and downstream passage of fish in the stream channel. From a practical standpoint, it is not always possible to meet both goals everywhere along the stream buffer network. Some provision must be made for linear forms of development that must cross the stream or the buffer (Figure 2), such as roads, bridges, fairways, underground utilities, enclosed storm drains or outfall channels.

It is still possible to minimize the impact to the continuity of the buffer network and fish passage. Performance criteria should specifically describe the conditions under which the stream or its buffers can be crossed. Some performance criteria could include:

- *Crossing width.* Minimum width to allow for maintenance access.
- *Crossing angle.* Direct right angles are preferred over oblique crossing angles, since they require less clearing in the buffer.
- *Crossing frequency.* Only one road crossing is allowed within each subdivision, and no more than one fairway crossing is allowed for every 1,000 feet of buffer.
- *Crossing elevation.* All direct outfall channels should discharge at the invert elevation of the stream. Underground utility and pipe crossings should be located at least three feet below the stream invert, so that future channel erosion does not expose them, creating unintentional fish barriers. All roadway crossings and culverts should be capable of passing the ultimate 100-year flood

Figure 2: Crossing the Stream Buffer: Guidance on Minimizing Disruption to the Stream Network



event. Bridges should be used in lieu of culverts when crossings require a 72 inch or greater diameter pipe. The use of corrugated metal pipe for small stream crossings should be avoided, as they tend to create fish barriers. The use of slab, arch or box culverts are much better alternatives. Where possible, the culvert should be "bottomless" to ensure passage of water during dry weather periods (i.e., the natural channel bottom should not be hardened or otherwise encased).

Criteria 7: Stormwater Runoff

Buffers can be an important component of the stormwater treatment system at a development site. They cannot, however, treat all the stormwater runoff generated within a watershed (generally, a buffer system can only treat runoff from less than 10% of the contributing watershed to the stream). Therefore, some kind of structural stormwater practice must be installed to treat the quantity and quality and stormwater runoff from the remaining 90% of the watershed. More often than not, the most desirable location for the practices is within or adjacent to the stream buffer. The following guidance is recommended for integrating stormwater practices into the buffer.

A. The Use of Buffers for Stormwater Treatment

The outer and middle zone of the stream buffer may be used as a combination grass/forest filter strip under very limited circumstances (Figure 3). For example, if the buffer cannot treat more than 75 feet of overland flow from impervious areas and 150 feet of pervious areas (backyards or rooftop runoff discharged to the backyard), the designer should compute the maximum runoff velocity for both the six-month and two-year storm designs from each contributing overland flow path, based on the slope, soil, and vegetative cover present. If the computation indicates that velocities will be erosive under either condition (greater than 3 fps for six-month storm, 5 fps for two-year storm), the allowable length of contributing flow should be reduced.

When the buffer receives flow directly from an impervious area, the designer should include curb cuts or spacers so that runoff can be spread evenly over the filter strip. The filter strip should be located three to six inches below the pavement surface to prevent sediment deposits from blocking inflow to the filter strip. A narrow stone layer at the pavements edge often works well.

The stream buffer can only be accepted as a stormwater filtering system if basic maintenance can be assured, such as routine mowing of the grass filter and annual removal of accumulated sediments at the edge of the impervious areas and the grass filter. An enforceable maintenance agreement that allows for public maintenance inspection is also helpful.

B. Location of Stormwater Ponds and Wetlands Within the Buffer

A particularly difficult management issue involves the location of stormwater ponds and wetlands in relation to the buffer. Should they be located inside or outside of the buffer? If they are allowed within the buffer, where exactly should they be put? Some of the possible options are outlined in Figure 3.

A number of good arguments can be made for locating ponds and wetlands within the buffer or on the stream itself. Constructing ponds on or near the stream, for example, affords treatment of the greatest possible drainage area, making construction easier and cheaper. Second, ponds and wetlands require the dry weather flow of a stream to maintain water levels and prevent nuisance conditions. Lastly, ponds and wetlands add a greater diversity of habitat types and structure, and can add to the total buffer width in some cases. On the other hand, placing a pond or wetland in the buffer can create environmental problems, including the localized clearing of trees, the sacrifice of stream channels above the stormwater practice, the creation of a barrier to fish migration, modification of existing wetlands, and stream warming.

Locating ponds and wetlands in buffers will always be a balancing act. Given the effectiveness of stormwater ponds and wetlands in removing pollutants, it is generally not advisable to completely prohibit their use within the buffer. It does make sense, however, to choose pond and wetland sites carefully. In this respect, it is useful to consider possible performance criteria that restrict the use of ponds or wetlands:

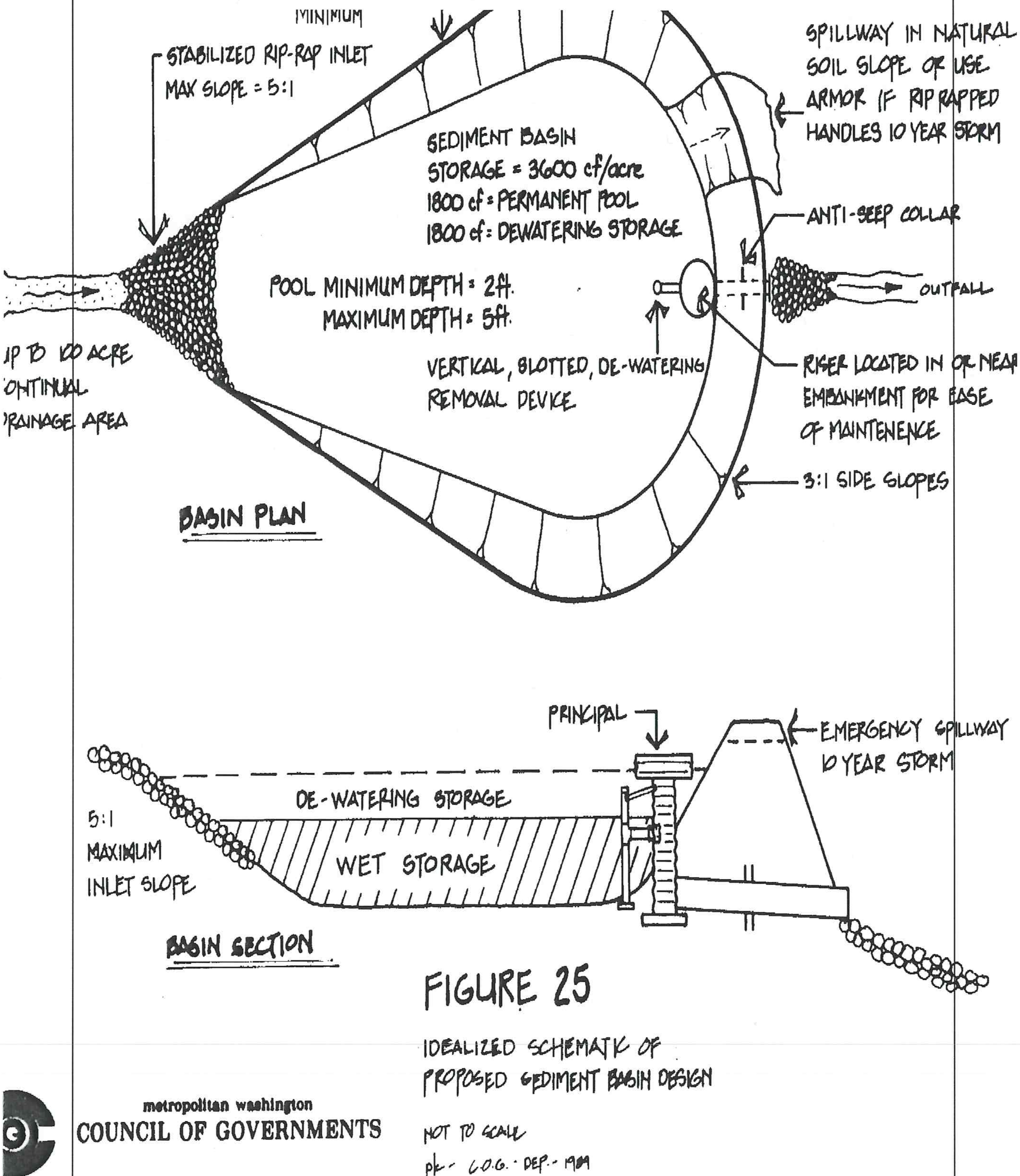
- A maximum contributing area (e.g. 100 acres)
- The first 500 feet of stream channel
- Clearing of the streamside buffer zone only for the outflow channel (if the pond is discharging from the middle zone into the stream)
- Off-line locations within the middle or outer zone of the buffer
- Use ponds only to manage stormwater quantity within the buffer

Criteria 8: Buffers During Plan Review and Construction

The limits and uses of the stream buffer system should be well defined during each stage of the development process—from initial plan review through construction. The following steps are helpful during the planning stage:

- Require that the buffer be delineated on preliminary and final concept plans
- Verify the stream delineation in the field

Figure 3: Options for Locating Stormwater Ponds Within the Stream Buffer Network



- Check that buffer expansions are computed and mapped properly
- Check suitability of use of buffer for stormwater treatment
- Ensure that the other stormwater practices are properly integrated in the buffer
- Examine any buffer crossings for problems

Stream buffers are vulnerable to disturbance during construction. Steps to prevent encroachment during this stage include:

- Mark buffer limits on all plans used during construction (i.e., clearing and grading plans, and erosion and sediment control plans)
- Conduct a preconstruction stakeout of buffers to define limit of disturbance
- Mark the limit of disturbance with silt or snow fence barriers, and signs to prevent the entry of construction equipment and stockpiling
- Familiarize contractors with the limit of disturbance during a preconstruction walk-through

Criteria 9: Buffer Education and Enforcement

Future integrity of the buffer system requires a strong education and enforcement program. Two primary goals are to make the buffer "visible" to the community, and to encourage greater buffer awareness and stewardship among adjacent residents. There are several simple steps that can accomplish these goals:

- Mark the buffer boundaries with permanent signs that describe allowable uses
- Educate buffer owners about the benefits and uses of the buffer with pamphlets, streamwalks and meetings with homeowners associations
- Ensure that new owners are fully informed about buffer limits/uses when property is sold or transferred
- Engage residents in a buffer stewardship program that includes reforestation and backyard "bufferscaping" programs
- Conduct annual bufferwalks to check on encroachment

The underlying theme of education is that most encroachment problems reflect ignorance rather than contempt for the buffer system. The awareness and education measures are intended to increase the recognition of the buffer within the community. Not all residents, however, will respond to this effort, and some kind of limited enforcement program may be necessary (Schueler, 1994). This usually involves a series of correction notices and site visits, with civil fines used as a last resort if compliance is not forthcoming. Some buffer ordinances have a further enforcement option, whereby the full cost of buffer restoration is charged as a property lien (Schueler, 1994). A fair and full appeals process should accompany any such enforcement action.

Criteria 10: Buffer Flexibility

In most regions of the country, a 100-foot buffer will take about 5% of the total land area in any given watershed out of production (Schueler, 1995). While this constitutes a relatively modest land reserve at the watershed scale, it can be a significant hardship for a landowner whose property is adjacent to a stream. Many communities are legitimately concerned that stream buffer requirements could represent an uncompensated taking of private property. These concerns can be eliminated if a community incorporates several simple measures to ensure fairness and flexibility when administering its buffer program. As a general rule, the intent of the buffer program is to modify the location of development in relation to the stream but not its overall intensity. Some flexible measures in the buffer ordinance include the following.

Maintaining Buffers in Private Ownership

Buffer ordinances that retain property in private ownership generally are considered by the courts to avoid the takings issue, as buffers provide compelling public safety, welfare and the environmental benefits to the community (Table 1) that justify partial restrictions on land use. Most buffer programs meet the "rough proportionality" test recently advanced by the Supreme Court for local land use regulation (Hornbach, 1993). Indeed stream buffers are generally perceived to have a neutral or positive impact on adjacent property value. The key point is that the reservation of the buffer cannot take away all economically beneficial use for the property. Four techniques—buffer averaging, density compensation, conservation easements, and variances—can ensure that the interests of the property owners are protected.

Buffer Averaging

In this scheme, a community provides some flexibility in the width of the buffer. The basic concept is to permit the buffer to become narrower at some points along the stream (e.g., to allow for an existing structure or to recover a lost lot), as long as the average width of the buffer meets the minimum requirement. In general, buffer narrowing is limited, such that the streamside zone is not disturbed, and no new structures are allowed within the 100-year floodplain (if this is a greater distance).

Density Compensation

This scheme grants a developer a credit for additional density elsewhere on the site, in compensation for developable land that has been lost due to the buffer requirement. Developable land is defined as the portion of buffer area remaining after the 100-year floodplain, wetland, and steep slope areas have been subtracted. Credits are granted when more than 5% of developable land is consumed, using the scale shown in Table 2. The density credit is accommodated at the development site by allowing greater flexibility in setbacks, frontage distances or minimum lot sizes to squeeze in "lost lots." Cluster development also allows the developer to recover lots that are taken out of production due to buffers and other requirements. The intent of stream buffers is to modify the location but not the intensity of development. Buffer averaging, density compensation, and variances can all minimize the impact on property owners.

Conservation Easements

Landowners should be afforded the option of protecting lands within the buffer by means of a perpetual conservation easement. The easement conditions the use of the buffer, and can be donated to a land trust as a charitable contribution that can reduce an owner's income tax burden. Alternatively, the conservation easement can be donated to a local government, in exchange for a reduction or elimination of property tax on the parcel.

Variances

The buffer ordinance should have provisions that enable a existing property owner to be granted a variance or waiver, if the owner can demonstrate severe economic hardship or unique circumstances make it impossible to meet some or all of the buffer requirements. The owner should also have access to a defined appeals process should the request for a variance be denied.

Table 2: Example of the Use of Density Credits to Compensate Developers for Excessive Land Consumption by Buffers (Burns, 1992)

Percent of site lost to buffers	Density * credit
1 to 10 %	1.0
11 to 20%	1.1
21 to 30%	1.2
31 to 40%	1.3
41 to 50%	1.4
51 to 60% **	1.5
61 to 70% **	1.6
71 to 80% **	1.7
81 to 90% **	1.8
91 to 99% **	1.9

* Additional dwelling units allowed over base density (1.0)

** Credit may be transferred to a different parcel

Summary

Urban stream buffers are an integral element of any local stream protection program. By adopting some of these rather simple performance criteria, communities can make their stream buffers more than just a line on a map. Better design and planning also ensure that communities realize the full environmental and social benefits of stream buffers.

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RIVER BANKS & BUFFERS

No. 1

Introduction to Riparian Buffers

for the Connecticut River Watershed

Riparian buffers are the single most effective protection for our water resources in Vermont and New Hampshire. These strips of grass, shrubs, and/or trees along the banks of rivers and streams filter polluted runoff and provide a transition zone between water and human land use. Buffers are also complex ecosystems that provide habitat and improve the stream communities they shelter.

Natural riparian buffers have been lost in many places over the years. Restoring them will be an important step forward for water quality, riverbank stability, wildlife, and aesthetics in the Connecticut River Valley. Landowners, town road agents, local governments, farmers, and conservation organizations can all help restore and protect the riparian buffers which in turn restore and protect the quality of our streams.

HOW BUFFERS GO TO WORK

For water quality

Sediment Filter

Riparian buffers help catch and filter out sediment and debris from surface runoff. Depending upon the width and complexity of the buffer, 50–100% of the sediments and the nutrients attached to them can settle out and be absorbed as buffer plants slow sediment-laden runoff waters. Wider, forested buffers are even more effective than narrow, grassy buffers.

Pollution Filter, Transformer, and Sink

The riparian buffer traps pollutants that could otherwise wash into surface and groundwater. Phosphorus and nitrogen from fertilizer and animal waste can become pollutants if more is applied to the land than plants can use. Because excess phosphorus bonds to soil particles, 80–85% can be captured when sediment is filtered out of surface water runoff by passing through the buffer. Chemical and biological activity in the soil, particularly of streamside forests, can capture and transform nitrogen and other pollutants into less harmful forms. These buffers also act as a sink when nutrients and excess water are taken up by root systems and stored in the biomass of trees.

Stream Flow Regulator

By slowing the velocity of runoff, the riparian buffer allows water to infiltrate the soil and recharge the groundwater supply. Groundwater will reach a stream or river at a much slower rate, and over a longer period of time, than if it had entered the river as surface runoff. This helps control flooding and maintain stream flow during the driest time of the year.

For bank stability

Bank Stabilizer

Riparian buffer vegetation helps to stabilize streambanks and reduce erosion. Roots hold bank soil together, and stems protect banks by deflecting the cutting action of waves, ice, boat wakes, and storm runoff.

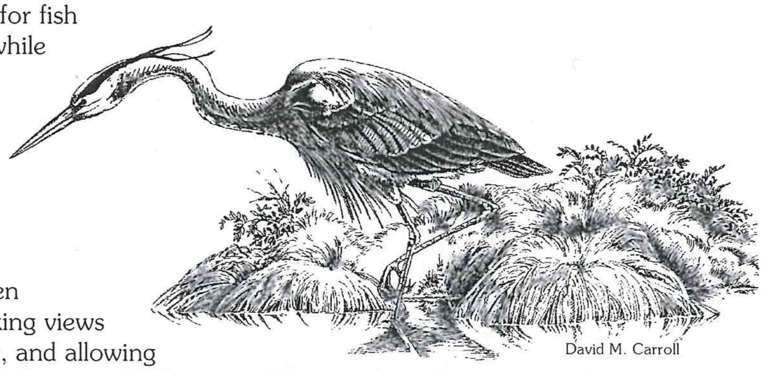
Bed Stabilizer

Riparian buffers can also reduce the amount of streambed scour by absorbing surface water runoff and slowing water velocity. When plant cover is removed, more surface water reaches the stream, causing the water to crest higher during storms or snowmelt. Stronger flow can scour streambeds, and can disturb aquatic life.

Wildlife Habitat
The distinctive habitat offered by riparian buffers is home to a multitude of plant and animal species, including those rarely found outside this narrow band of land influenced by the river. Continuous stretches of riparian buffer also serve as wildlife travel corridors.

For fish and wildlife

Aquatic Habitat
Forested riparian buffers benefit aquatic habitat by improving the quality of nearby waters through shading, filtering, and moderating stream flow. Shade in summer maintains cooler, more even temperatures, especially on small streams. Cooler water holds more oxygen and reduces stress on fish and other aquatic creatures. A few degrees difference in temperature can have a major effect on their survival. Woody debris feeds the aquatic food web. It also can create stepped pools, providing cover for fish and their food supply while reducing erosion by slowing flow.


David M. Carroll

Recreation and Aesthetics
Forested buffers are especially valuable in providing a green screen along waterways, blocking views of nearby development, and allowing privacy for riverfront landowners. Buffers can also provide such recreational opportunities as hiking trails and camping.

THE BETTER BUFFER

For every buffer there is a reason. Whether it is pollution filtration, erosion control, wildlife habitat, or visual screening, the size and vegetation of the buffer should match the land use and topography of the site.

Topography
A buffer is more important for water quality in areas that collect runoff and deliver it to streams, and less critical on land that tips away from the water. Steeper slopes call for a wider riparian buffer below them to allow more opportunity for the buffer to capture pollutants from faster moving runoff. This is also true at both ends of a flood chute, or the path a river takes across a meander at high water.

Hydrology and Soil
The ability of the soil to remove pollutants and nutrients from surface and ground water also depends upon the type of soil, its depth, and relation to the water table. On a wetter soil, a wider buffer is needed to get the same effect.

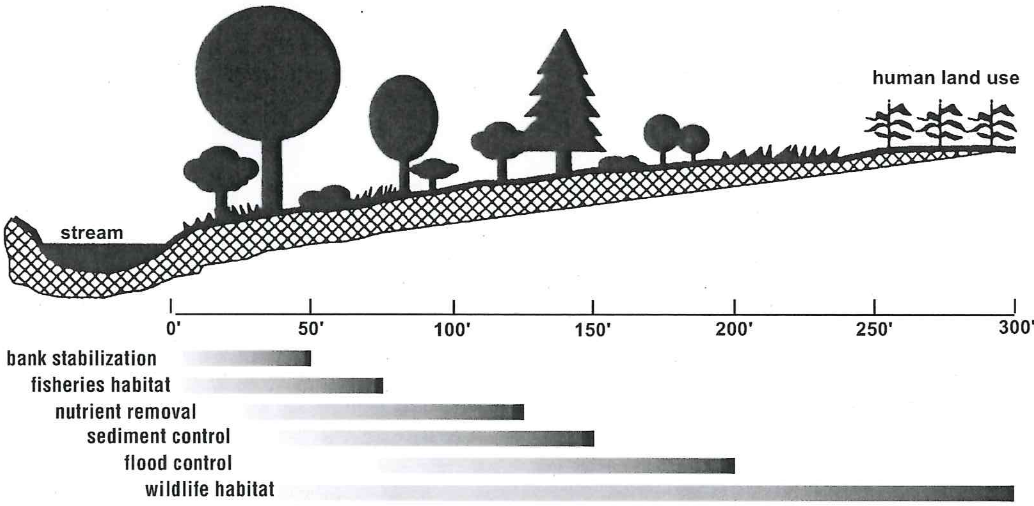
Vegetation
The purpose(s) of the buffer will influence the kind of vegetation to plant or encourage. In urban and residential areas, trees and shrubs do a better job at capturing pollutants from parking lots and lawn runoff and providing visual screening and wildlife habitat.

Between cropland and waterways, a buffer of shrubs and grasses can provide many of the benefits of a forested buffer without shading crops, and trees can be used on the north side of fields.

Trees have several advantages over other plants in improving water quality and offering habitat. Trees are not easily smothered by sediment and have greater root mass to resist erosion. Above ground, they provide better cover for birds and other wildlife using waterways as migratory routes. Trees can especially benefit aquatic habitat on smaller streams. Native vegetation is preferable to non-native plants.

BUFFER WIDTH

How big should a buffer be? One size doesn't fit all. It depends on what you want the buffer to do. There isn't one generic buffer which will keep the water clean, stabilize the bank, protect fish and wildlife, and satisfy human demands on the land. The minimum acceptable width is one that provides acceptable levels of all needed benefits at an acceptable cost. **The basic bare-bones buffer is 50' from the top of the bank. You get more with every foot.**



To Stabilize Eroding Banks

On smaller streams, good erosion control may require only covering the bank with shrubs and trees, and a 35' managed grass buffer. If there is active bank erosion, or on larger streams, going beyond the bank at least 50' is necessary. Severe bank erosion on larger streams requires engineering to stabilize and protect the bank - but this engineering can be done with plants. For better stabilization, put more of the buffer in shrubs and trees.

To Filter Sediment and Attached Contaminants from Runoff

For slopes gentler than 15%, most sediment settling occurs within a 35' wide buffer of grass. Greater width is needed on steeper slopes, for shrubs and trees, or where sediment loads are particularly high.

To Filter Dissolved Nutrients and Pesticides from Runoff

A width up to 100' or more may be necessary on steeper slopes and less permeable soils to allow runoff to soak in sufficiently, and for vegetation and microbes to work on nutrients and pesticides. Most pollutants are removed within 100', although in clay soils, this may not happen within 500'.

To Protect Fisheries

Buffer width depends on the fish community. For cold water fisheries, the stream channel should be shaded completely. Unless there are problems with algae blooms, warm water fisheries do not require as wide a buffer or as much shade, but they still benefit from water cleaned by a buffer's filtering action. Studies show that at least up to 100', the wider the buffer, the healthier the aquatic food web.

To Protect Wildlife Habitat

Buffer width depends upon desired species: 300' is a generally accepted minimum. Much larger streamside forest buffer widths are needed for wildlife habitat purposes than for water quality purposes. The larger the buffer zone, the more valuable it is. Larger animals and interior forest species generally require more room. Some use so much habitat that it would be nearly impossible to protect the size buffers they require. A narrow width may be acceptable for a travel corridor to connect larger areas of habitat. Continuity is important — even small patches of trees are better than none at all when it comes to migrating birds.

To Protect Against Flood Damage

Smaller streams may require only a narrow width of trees or shrubs; a larger stream or river may require a buffer that covers a substantial portion of its flood plain. This is why it is not a good idea to build a permanent structure where a river can get at it.

To Grow Valuable Products

Buffer width depends upon the desired crop and its management. Don't forget to consider tax incentives and cost-share programs when looking at the economic return from a riparian buffer.

DECIDING ON THE RIGHT WIDTH FOR YOUR PROPERTY

From the top of the streambank, turn back and take 15 long paces. This should carry you 50' from the bank. This area should be covered with native vegetation. Another 15 paces brings you about 100' from the bank. The ability of a buffer to remove pollutants is uncertain if it is narrower than this. A 100' buffer will generally remove 60% or more of pollutants, depending on local conditions. It will also provide food, cover and breeding habitat for many kinds of wildlife but only fulfill a few needs for others, such as travel cover.

Remember, a bigger buffer is needed to do the job if:

- the riverside land is sloped and runoff is directed here
- the land above is sloped (the steeper the slope, the wider a buffer should be)
- land use is intensive (crops, construction, development)
- soils are erodible
- the land is floodplain
- the stream naturally meanders
- the land drains a large area (ratio of drainage area to buffer area is more than 60:1; based on the soil loss factor in the Connecticut River Valley)
- more privacy is desired

Fact sheets in the series *Riparian Buffers for the Connecticut River Watershed*

No. 1 Introduction to Riparian Buffers
No. 2 Backyard Buffers
No. 3 Forestland Buffers
No. 4 Buffers for Habitat
No. 5 Buffers for Agricultural Land
No. 6 Urban Buffers
No. 7 Guidance for Communities
No. 8 Planting Riparian Buffers (& plant list)
No. 9 Field Assessment
No. 10 Sources of Assistance

See also the companion series for land owners:
The Challenge of Erosion in the Connecticut River Valley, Connecticut River Joint Commissions, 1998.

Part of the ***Living with the River*** series. May be reprinted without permission.
Riparian Buffers for the Connecticut River Watershed was prepared by the Connecticut River Joint Commissions of NH & VT with support from the Silvio O. Conte National Fish & Wildlife Refuge Challenge Cost Share Program, PG&E National Energy Group, NH Dept. of Environmental Services, and EPA. Technical assistance was provided by UNH Cooperative Extension Service, USDA Natural Resources Conservation Service, VT Dept. of Environmental Conservation, Connecticut River Conservation District Coalition, Upper Valley Land Trust, Environmental Protection Agency, Appalachian Mountain Club, NH Dept. of Environmental Services, US Fish & Wildlife Service, PG&E National Energy Group, CRJC river commissioners and local river subcommittee members. September 2000

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RIVER BANKS & BUFFERS

No. 2

Backyard Buffers

for the Connecticut River Watershed

That river or stream in your back yard is telling you something. It's reminding you that humans aren't the only ones who prefer riverfront property. You might be sharing it with kingfishers, trout, salamanders, or otters. You're also responsible for whether the water is better or worse off when it leaves your land.

THE REASON FOR CONCERN

Riparian buffers (streamside plants) link the land and the water together. Whether your waterfront slice of the 11,720 square mile Connecticut River watershed is a large river or a small, intermittent creek, the water is affected by what happens on your home turf. In fact, we are all riverfront landowners because we live in a watershed — even that storm drain at the bottom of your driveway or street eventually leads to a waterway.

The backyard buffer: boundary between the natural and man-made worlds.

The bad news is that a residential neighborhood can be a major source of pollution. Water flowing over roads, lawns, and yards picks up sediments, lawn fertilizers, pesticides, herbicides, heavy metals, and other pollutants that people don't want in their waterways. Americans have long loved the park with its neatly trimmed grass. But disturbing the riverfront to expand a lawn, create a view, or build a boat landing invites these troubles:

- **erosion**: cutting riverbank vegetation destabilizes the shoreline and can lead to loss of land. The area between the water's edge and the top of the bank must stand up to scouring currents, fluctuating water levels, moving ice, flooding, surface runoff from higher ground, and, on a large river, boat wakes and wind-driven waves.
- **flooding**: land development increases runoff from impervious surfaces such as roofs, roads, sidewalks, and parking lots. Rainwater can run off lawns twice as fast as from forests. More water reaches the stream faster than it would naturally, causing it to flood during heavy rains and run low or even dry out during dry spells.
- **water damage**: building structures within the riparian area places them in harm's way.
- **unsightly algae blooms**: just as fertilizers make your lawn green, they make your river green by feeding algae and aquatic weeds.
- **damage to fisheries**: clearing trees exposes waters to more sunlight, raising water temperatures and stressing fish and their food supplies.
- **loss of habitat**: the river's edge is prime real estate for birds and other wildlife. Backyard bird feeders are no substitute for good plant cover and natural food.
- **loss of privacy**: thirty years of pollution control have given us clean rivers to enjoy once again. The Connecticut River and its tributaries have been discovered by boaters, anglers, water skiers, jetskiers, and swimmers. Shoreline vegetation screens homes from public view and helps reduce noise from boats on the water.

Understand the risks involved in building or living near a river.

BUFFER BENEFITS

The good news is that plants protect your property by slowing runoff and allowing it to soak into the ground, recharging wells and reducing flooding. Roots help hold the soil and control erosion. Trees cast their shade over the water to keep it cool for fish and frogs, and provide perching places for birds. Buffer plants can provide seasonal blooms and autumn color to beautify your yard while attracting butterflies and birds.

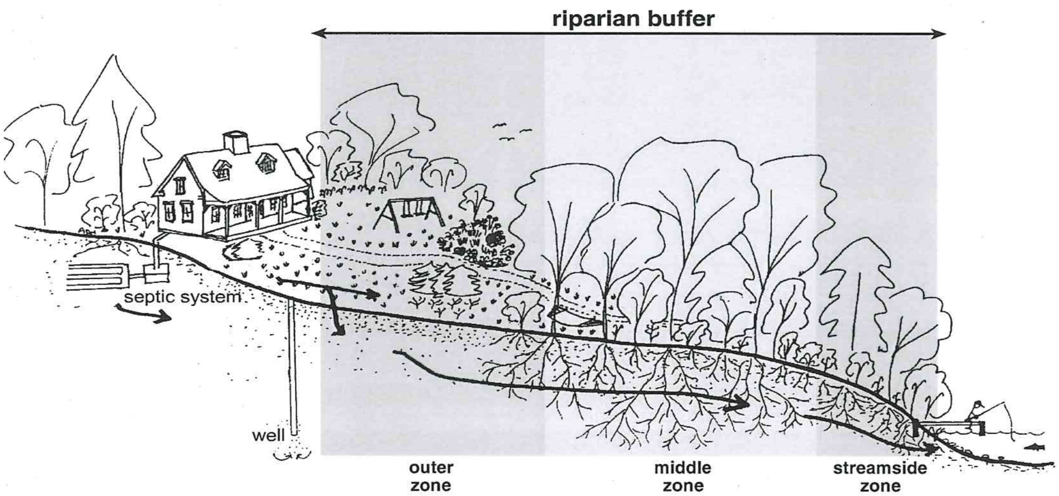
Permanent vegetation along your streambank provides a "living filter" for both surface and subsurface water running off the land, while providing your home landscape with privacy and the pleasure of watchable wildlife.

The flood and erosion "insurance" provided by a riparian buffer is all the more important now that weather patterns are taking a turn. Whether global climate warming is natural or human-induced, New England is seeing a definite shift toward heavy storms that deliver several inches of rain in a single day. Sturdy plantings on your streambank are the best protection you can provide for your own property and your neighbors.

No stream is too small to benefit from a buffer. In fact, the smaller the stream, the more your buffer will help. It is those many little streams that make up the mighty Connecticut.

ANATOMY OF A RIPARIAN BUFFER

Use the description below as a general guide which can be altered to fit the available space between the river and your home. Every bit of buffer counts. Even a 50' buffer is better than no buffer at all. (See *Introduction to Riparian Buffers*, No. 1 in this series, for more on buffer width.)



A THREE ZONE BUFFER SYSTEM — the most effective backyard buffer has three zones:

- **streamside**: from the water to the top of the bank. Protects the bank and offers habitat. The best buffer has mature forest but large shrubs may be a better choice where trees have collapsed a bank. Let it grow and let it go for the best protection.
- **middle zone**: from the top of the bank inland. Protects stream water quality and offers habitat. Varies in width depending on size of stream and the slope and use of nearby land. The best buffer has trees, shrubs, and perennial ground plants. It can allow some clearing for recreational use.
- **outer zone**: the yard, garden, or woods between your home and the rest of the buffer. Traps sediment; play areas, gardens, compost piles, and other common residential activities are suitable here.

A buffer is a right-of-way for a stream.

BEGINNING YOUR BUFFER

First Steps

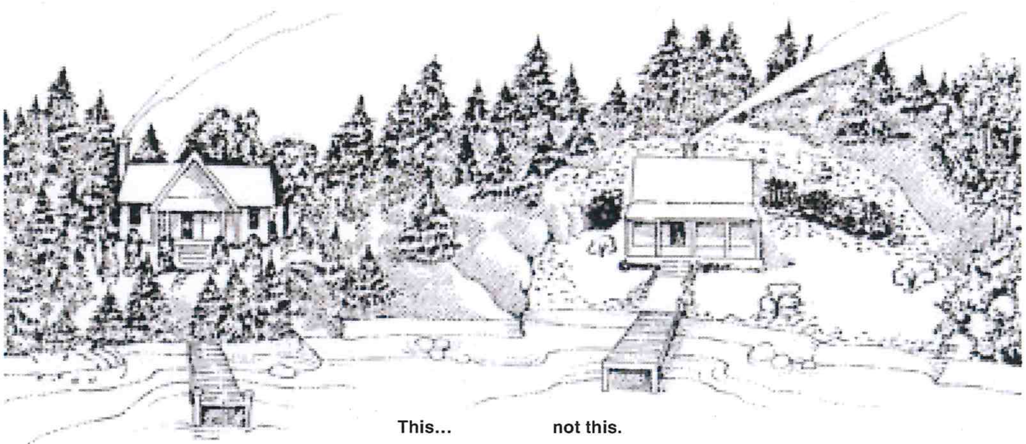
Spend some time outside during a heavy rainstorm, watching your property to see where the water goes. Your buffer does the best job of filtering runoff when the water spreads out and does not flow straight to the stream in a channel. Regrade, or use stones or landscape timbers to divert runoff into flatter areas where it can soak in. If your land receives stormwater runoff from a road, an engineer's advice is useful.

If you have an unstable bank, deal with this first. Consult *The Challenge of Erosion in the Connecticut River Watershed*, published by the Connecticut River Joint Commissions. Remember that a buffer will provide good insurance for your riverbank. Your county Conservation District office has an inventory of erosion sites on the Connecticut River mainstem.

Choose building sites wisely: protect your property and the river by not building in the river's flood plain. Streamside land is a high risk area for development even above flood elevation, since a river channel may not stay where you wish it would. Don't be fooled into thinking that you can dramatically change a natural shoreland to fit your desires. *Be certain to get a permit before starting any work on a riverbank or in a wetland.*

Protect a natural buffer from clearing.

The first goal is to avoid planting a lawn to the water's edge. This is the worst and most common mistake homeowners make in setting up housekeeping next to water. Lawns have no habitat value (except for mice and moles). They put your property at risk for erosion, and deliver lawn chemicals directly to the stream, to say nothing of ruining the fishing. You don't have to return your entire yard to a natural forest to protect a stream, however. A lawn nearer your house can work as part of your riparian buffer, by soaking up runoff and catching sediment from driveways and bare ground.



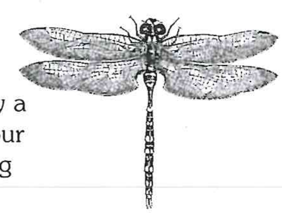
This... not this.

If You Have a Lawn to the Water's Edge

You can begin a buffer by starting a wildflower meadow on the water side of your lawn. Create islands of unmown areas around the edges of the lawn. Seed these with wildflowers, and mow around them if you want a tidier look. Eventually allow these wildflower islands to expand until they create a continuous garden by the water. Keeping grass at a height of 2½-3" encourages deeper rooting to withstand heat and drought. You can create an appealing riverfront garden landscape while eliminating time-consuming lawn care and watering. Even in water-rich New England, as much as 70% of summer water use is for lawns.

The no-mow option is the least expensive and the easiest; the lawn will gradually become a meadow, shrubs will move in, and then trees. If you want to keep part of your yard as a wildflower meadow, mow once every two to three years, except along the immediate streambank.

You can also encourage your meadow to fill in with trees and shrubs, by letting the birds plant them for you. Don't mow, and plant one or two berry-bearing shrubs or trees. This attracts the birds to perch in your yard and distribute seeds through their droppings. Of course, you can speed the process up by planting more nursery-grown plants.

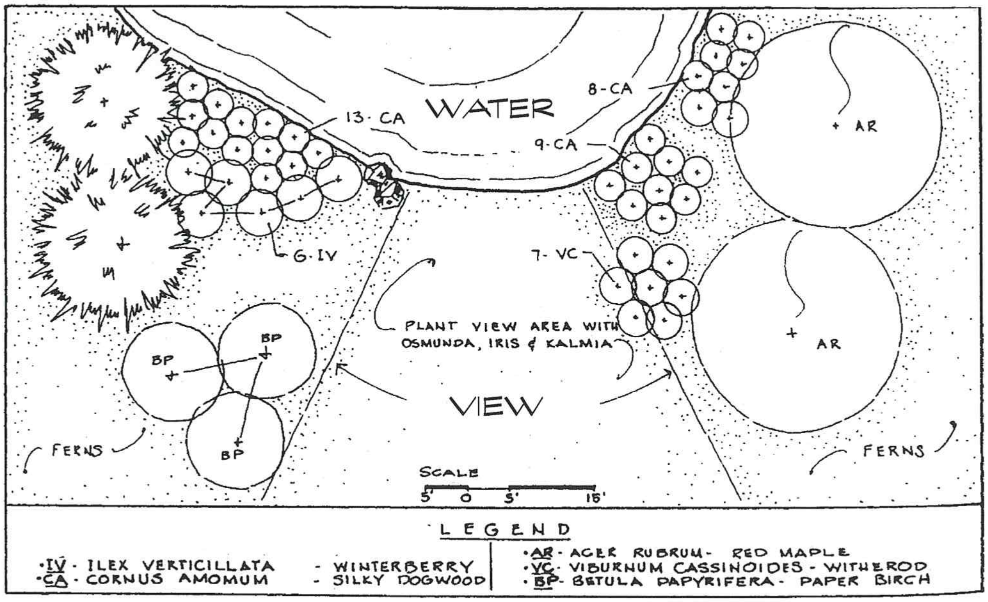


If Natural Vegetation Remains

Consider retaining the natural beauty of a wooded shoreline. You might like the way a natural buffer looks — a carefree collection of native plants. If that's what you have, your best option is to let nature alone. If large trees block your view, consider careful pruning rather than removal. You can always cut a tree later, but it takes decades to replace a mature tree, and its root system is better at removing pollutants. Keep heavy equipment at least 25' from trees you wish to save, and avoid changing the grade around their roots.

Access to the Water

Frame your view of the river or stream with plants that add to your property value, or by careful pruning. If foot access to the stream is important, lay out a curved path and plant around it. Grade the path if necessary to keep it from becoming a tiny stream channel during rainstorms. Slopes over 15% require constructing steps or stairs. Try to keep children and pets on this path to discourage them from trampling the rest of the riverbank. Choose fence locations with equal care - fences built on flood plains near the water have a bad habit of catching ice floes and debris. If you have a dock, sturdy shoreline vegetation will help protect your riverbank from the wake of your boat.



Select Native Plants

Native plants are far better for buffers than exotic ones. Many trees, shrubs, and herbaceous perennials used in conventional landscape plantings are non-native species from Europe or Asia. A number have escaped from cultivation to become pests. Their novelty can also attract nuisance wildlife. Aggressive exotics such as purple loosestrife and glossy buckthorn can overwhelm native plants and turn your yard into a virtual desert where wildlife is concerned. You don't have to settle for a dull buffer, however. Many native plants are particularly attractive, with showy flowers, berries, branching habits, and autumn color. The buffer is also a good place to grow the family's Christmas trees.

Native plants need less help from you so you can spend more time in the hammock.

Visit some nearby natural areas to see what grows there. You're better off copying Mother Nature: these plants have proven their ability to survive there with no care. They're resistant to most diseases and insects, are adapted to the local climate, and they're what wildlife expect to find. Sheet No. 8 in this series identifies native plants with ornamental value and those that attract birds, butterflies, or other desirable wildlife.

Since the backyard buffer forms the boundary between the natural and man-made worlds, the most successful streamside planting design aims for a less manicured look than one might expect on the street side of the home landscape. Group plants in odd-numbered clusters and repeat plants across the waterfront for a naturalistic effect.

Do not try to transplant wildflowers from the wild — it often fails and is illegal without the landowner's permission. Purchase nursery-grown wildflowers from a responsible supplier.

THE BETTER BUFFER

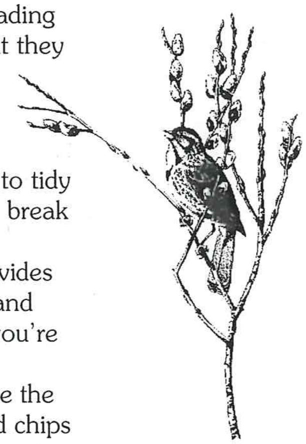
The best safeguard for water quality, both in the river and in your well, is a woodland. A variety of trees and shrubs will do the best job of filtering runoff and providing habitat diversity for wildlife.

Copy Mother Nature.

The bigger the buffer, the better. Trout streams, those used for water sports, and sources of drinking water need the most protection. You need a wider buffer if you have a lawn, landscaped area or garden where fertilizers and pesticides are used, or if there are parking lots, roads, or hillsides sending runoff through your yard into the stream.

Add buffers between your house and the street to filter runoff before it enters a storm drain or ditch on its way to a river. Another good place for buffers is along a parking area or driveway, where they can be disguised as perennial flower beds, shrub borders, or fern gardens.

Trees planted on the south or west side of your stream will do the best job of shading and cooling its waters for fish. Trees cannot entirely shade rivers wider than 75', but they can still help hold the soil, filter runoff, and provide habitat.



CARING FOR YOUR BUFFER

The best care is the least care when it comes to a stream buffer. Resist the urge to tidy up. A natural forest floor, with its "litter" of fallen leaves and twigs, helps the buffer break down pollutants and soak up water. Raking or removing them defeats its purpose.

Fish appreciate natural woody debris which falls into their stream because it provides hiding places and creates resting pools. Remove only debris that could form dams and cause inundation. If a large tree threatens to fall from a steep bank, cut the tree if you're concerned that it will pull the riverbank with it, but leave the root system in place.

Mulch with pine needles or bark chips on high visibility areas if you wish, and leave the rest alone or shield the forest floor with ferns or other herbaceous plants. Fresh wood chips should compost six to twelve months before use. Cedar and redwood bark mulch are not recommended for stream buffers because their chemistry interferes with neutralizing nutrients and other pollutants. If you must fertilize near the water, use only lime or wood ash.

Mowing and removing clippings from a lawn on the land edge of the buffer helps recycle nutrients it has captured and promote vigorous sod growth. Watch your buffer for signs of erosion or channeled runoff. Keep pet droppings from washing into the stream.

Remember that Nature will probably rearrange your efforts to some degree, and that as the buffer grows, natural succession will replace shorter-lived plants with more shade tolerant, long-lived plants.

WHAT ABOUT COST?

It's hard to put a dollar figure on your time behind a lawnmower or the value of watching wildlife. Here are some of the costs and benefits involved in adding a buffer to your backyard.

Costs

- wildflower seed
- plant material: use cuttings or bare root plants from a native source; nursery grown plants are more expensive but more reliable
- mulch; pine needles can be gathered and highway crews can supply chips for free
- labor in planting
- labor in mowing: once/year for meadows

Benefits

- less time spent mowing lawn and maintaining yard
- less money spent on fertilizer, pesticides, herbicides, fuel, equipment maintenance
- reduced air conditioning costs if house is shaded by buffer plants
- reduced heating costs if buffer plants provide winter windbreak
- more stable shoreline: avoid costs of engineering design, permits, bank stabilization
- more interesting birds, butterflies, and wildlife to watch
- better fishing
- cleaner, safer, more attractive water for recreation
- source of decorations — Christmas trees, miniature alder cones, grape vines for wreaths, flowers, fall foliage
- safer, more reliable drinking water from on-site well
- better flood protection
- possible tax benefits from conservation easement on buffer
- increased general property value

Blue-flag iris, *Iris versicolor.*

KNOW STATE AND LOCAL REGULATIONS

Since buffers are amongthe very best means for protecting rivers and streams, state and local authorities protect buffers in several ways. In both Vermont and New Hampshire, septic systems must be set back 75' from rivers and streams. Many towns also have their own local zoning ordinances for buffers and setbacks from surface waters. Some require buffers of a standard width, and others prescribe a range and assign a width appropriate to the site.

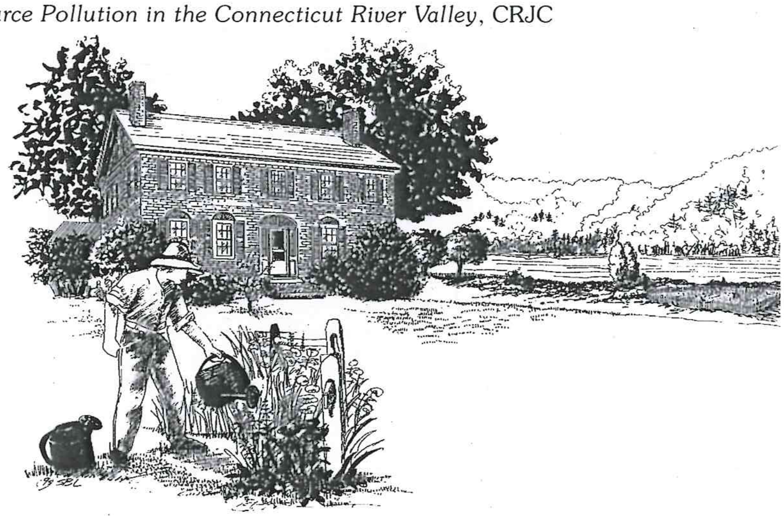
In New Hampshire, the Comprehensive Shoreland Protection Act (RSA 483-B) protects existing natural woodland buffers within 150' of the public boundary line on all 4th order streams, including lower portions of the Ashuelot, Ammonoosuc, Cold, Gale, Israel, Mascoma, Mohawk, Sugar, Little Sugar, and Upper Ammonoosuc Rivers, and Mink, Partridge, and Stocker Brooks. On these waterways, not more than 50% of the basal area of trees and a maximum of 50% of the total number of saplings can be removed in a 20 year period. A healthy, well-distributed stand of trees, saplings, shrubs, and ground covers and their living, undamaged root systems must be left in place. While the Connecticut River mainstem was exempt from the Comprehensive Shoreland Protection Act at the time of printing, some riverfront towns have adopted its provisions, and the law may apply to the rest in the future. If you are unsure what laws apply to your riverfront property, contact your town office.

MORE ON MANAGING THE HOME LANDSCAPE

The Homeowner's Guide to Nonpoint Source Pollution in the Connecticut River Valley, CRJC 1994. Available from the Connecticut River Joint Commissions or on the web at [www.crjc.org/pdffiles/homeguide.pdf]

A Guide to Developing and Re-Developing Shoreland Property in New Hampshire, North Country Resource Conservation & Development Area. 1999.

Native Vegetation for Lakeshores, Streamsides, and Wetland Buffers, Vermont Department of Environmental Conservation. 1994.



Wildlife and plant illustrations courtesy of David M. Carroll, NH author and naturalist.
Final drawing by Susan Berry Langsten, NH artist.

Fact sheets in the series *Riparian Buffers for the Connecticut River Watershed*

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RIVER BANKS & BUFFERS

Buffers for Habitat

No. 4

for the Connecticut River Watershed

Down by the river exist habitats unlike any other in the Valley. Blanketed against killing cold by shrouds of fog, this riparian region is the last to freeze in the fall and the first to green up in spring. Soils fertilized by spring freshets drink in the moisture that hovers over even the smallest brook. Life is simply richer along rivers and streams.

Stream corridors are prime real estate for birds and other wildlife.

More species of wildlife use the delicate edge between and land and water than any other habitat in Vermont and New Hampshire. Because the riparian zone is a transition between upland and water, it supports plants and animals from both.

This is an area in high demand, however: trout, herons, and turtles face stiff competition from bulldozers, Holsteins, and chainsaws. Landowners who encourage riparian buffers are good hosts to native wildlife.

CONTE NATIONAL FISH & WILDLIFE REFUGE

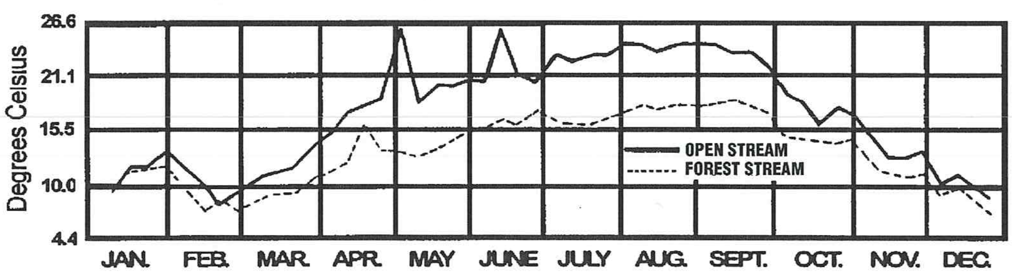
The Connecticut River Watershed's remarkable natural wealth prompted Congress to designate the entire 7.2 million acre basin as the selection area for the Silvio O. Conte National Fish and Wildlife Refuge in 1991. No ordinary refuge, its work depends substantially upon the participation of private property owners in protecting and improving the fish and wildlife habitat under their care. Restoring riparian buffers may be the single most effective means of achieving this goal.

HOW LAND USE AFFECTS AQUATIC HABITAT

Trout and other aquatic life don't always take well to changes on the land around their home. Trading naturally vegetated riparian buffers for open, managed landscapes such as lawns, golf courses, and cropland can harm water quality when chemical pesticides and fertilizers wash into the stream. Some stream life is more tolerant of this pollution than others, but caddis and mayflies, the favorite food of trout, are usually the first to go.

The shade which keeps the water cool also helps it store oxygen. Aquatic weed growth from excess nutrients also reduces oxygen, causing a shift to carp, catfish, suckers, and other rough fish more tolerant of poor oxygen supplies. Sediment eroding off construction sites abrades fish gills and covers spawning areas. The human instinct to tidy up a yard steals the woody debris that provided food and hiding places for fish and their prey.

Weekly Maximum Temperature for Open and Forested Streams



Forested buffers keep streams cool.

BUFFER BENEFITS

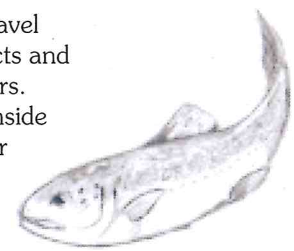
To Life in the Stream

Keeping a forested buffer along a stream is the single most important thing landowners can do to improve or maintain fish habitat both at home and in the river beyond. Even tiny brooks not big enough to hold trout can benefit, because shade keeps the water cool and rich in oxygen for trout habitat downstream. Small brooks are actually more vulnerable since they have less water to flush pollutants, and since they are shallower, they can dry out, heat up, or freeze more easily.

A brook trout is as dependent upon trees as a squirrel.

A good trout stream first needs to be a good insect stream. Insects, the favorite food of trout, are abundant in waters kept cool by streamside forests. Streams flowing through older, more complex forests receive the biggest buffet. Leaves, twigs, and other organic matter from streamside vegetation are both lunch and breeding ground for instream invertebrates which then in turn feed many others in the food chain. This means that a brook trout is as dependent upon trees as a squirrel. Studies show that the wider the buffer, the more kinds of aquatic insects appear on the menu, at least in streams with buffers up to 100' wide.

Woody debris stabilizes the stream, and helps create plunge pools, riffles, and gravel beds. Fallen logs deflect current, exposing more of the rocky substrate used by insects and many fish to lay their eggs, and provide cover for fish to rest and hide from predators. Debris dams keep natural organic litter and food from washing downstream. Streamside forests capture rainfall better than any other kind of land use, and keep groundwater recharged so that their streams don't dry out in summer.



On the Land and in the Air

The Connecticut River and its tributaries conveyed European settlers on their migration into the valley. So it has been every spring with migrating songbirds and waterfowl, who depend upon the early-greening riparian habitat along the larger rivers for food and cover until upland areas are ready to receive them.

Streamside buffers provide wildlife foods, such as seeds, buds, fruits, berries, and nuts, in addition to cover and nesting places. Birds, mammals, and amphibians use streams as travel corridors and breed or hunt along them. Continuous travel corridors for wildlife are key to genetically healthy populations.

Riparian land tends to have an abundance of cavity trees and woody debris that is useful to many kinds of wildlife. Osprey, kingfishers, flycatchers, and other birds use snags along the water as feeding perches. Bats roost under the loose bark of dying trees when they're not out catching insects. The microclimate and moist soils near streams also offer the right conditions for delicate ferns and wildflowers such as water lilies, orchids, and gentians, as well as others less celebrated.

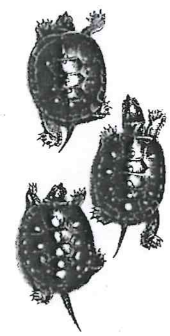
ROUNDUP OF RIPARIAN LIFE

Mammals dependent upon water habitat include mink, muskrat, otter, water shrew, beaver, and moose. Those using mixed upland and lowlands include raccoon and deer. Bats forage on insects above water. All use river corridors as travel routes.

Birds that use rivers for breeding and migrating include shorebirds, ducks, teal, mergansers, grebes and geese, belted kingfishers, osprey (not nesting in the Upper Connecticut River Valley yet but often seen), eagles (nesting as of 2000), herons, bittern, water thrushes, cormorants, and gulls. Woodcock prefer wet meadows as their primary feeding and nesting habitat.

The Connecticut River is a major migration route for many species of songbirds, such as vireos, flycatchers, thrushes, tanagers, and wood warblers, and also larger birds such as northern harrier and peregrine falcons. A recent study of spring bird migration on the Connecticut, Ashuelot, and White rivers by the Silvio O. Conte National Fish & Wildlife Refuge, in partnership with Smith College and the Audubon Society of New Hampshire, found that this is especially true for insect-eating birds early in the season, and on the first leg of their return to NH and VT.

Amphibians and reptiles: salamanders, frogs, turtles, and their kin require water or damp habitats to reproduce and disperse, although many then leave for upland habitats. Much less mobile than birds and mammals, they require unbroken riparian corridors of natural habitat because they may be unable to cross even small areas of unsuitable habitat, such as parking lots. Stormwater catch drains are insidious amphibian traps, and to a salamander whose life history revolves around its river, a granite curb might as well be the Great Wall of China.



Insects: cobblestone tiger beetles, damselflies, butterflies, dragonflies...the parade of insect life in and near rivers and streams is the number one attraction for birds, amphibians, and other creatures of the wild and wet.

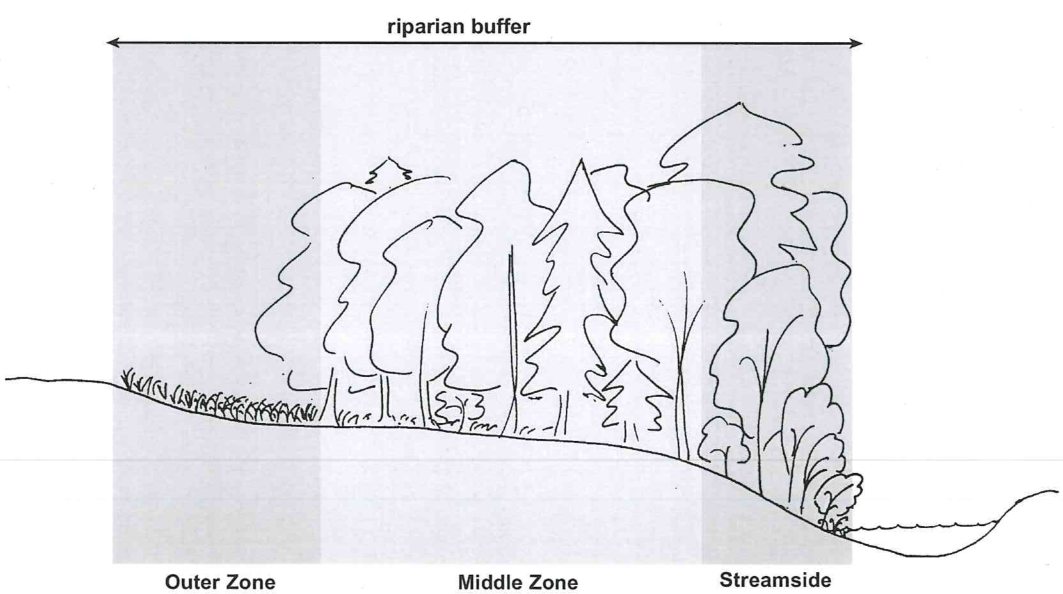
Rare and endangered species: The riparian zone of the Connecticut River Valley is home to a significant concentration of rare, threatened, and endangered plant and animal species. The mainstem from the mouth of the White River to Weathersfield Bow is especially rich, and has caught the attention of biologists who refer to it as the "Connecticut River Rapids Macrosite."

ANATOMY OF A RIPARIAN BUFFER

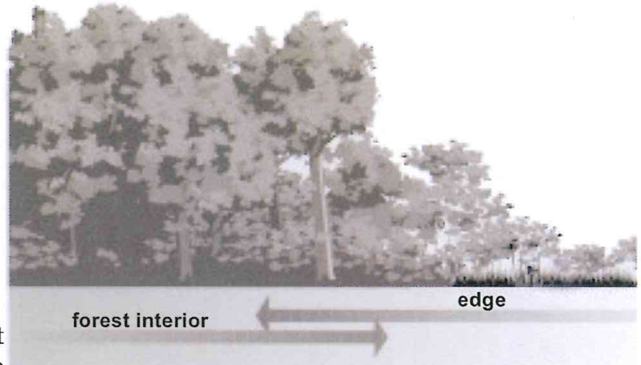
The Three-Zone Buffer System

The most effective buffers for fish and wildlife have three zones:

1. **Streamside**: protects the stream bank from erosion and offers habitat. The best buffer has mature forest for shade and erosion protection. Large shrubs may be a better choice where large trees have collapsed a bank.
2. **Middle Zone**: protects water quality and offers habitat. Slows flow, catches sediment. Width depends on size of stream and the slope and use of nearby land. The best buffer has trees, shrubs, and ground plants, and may allow some clearing for recreational use, depending on the species it is intended to accommodate.
3. **Outer Zone**: yard or woods between the nearest permanent structure and the rest of the buffer; play areas, gardens, compost piles, and other common residential activities are suitable here.



A Word on Width



A buffer that will truly benefit wildlife often means a much larger streamside forested buffer than for water quality purposes alone. A generally accepted minimum width is 300', but it depends upon how much land is available, and what species the landowner hopes to accommodate (see chart below). Narrow buffers are often edge type habitat which can attract disproportionate numbers of predators such as blue jays, crows, raccoons, skunks, foxes, and domestic cats and dogs, as well as parasites like the brown-headed cowbird. However, because small or isolated patches of habitat can be so important to migrating birds, even patches are better than no buffer at all.

Recommended Minimum Buffer Widths for Wildlife

A buffer must not only provide enough room for an animal to take shelter, find food, successfully raise young, and hide from predators, but must also provide the right conditions, such as water that is clean and cool enough, suitable vegetation, and freedom from disturbance the animal cannot tolerate. For instance, while we often observe wildlife such as mink moving along a riverbank, there is more to a mink's life that requires other habitat space. Here are some other examples:

SPECIES	DESIRED WIDTH (in feet)
Wildlife dependent on wetlands or watercourses	**30-600'**
Bald eagle, nesting heron, cavity nesting ducks	600
Pileated woodpecker	450
Beaver, dabbling ducks, mink	300
Bobcat, red fox, fisher, otter, muskrat	330
Amphibians and reptiles	100-330
Belted kingfisher	100-200
Songbirds	**40-660**
Scarlet tanager, American redstart, rufous-sided towhee	660
Brown thrasher, hairy woodpecker, red-eyed vireo	130
Blue jay, black capped chickadee, downy woodpecker	50
Cardinal	40
Cold water fisheries	**100-300**

A GOOD BEGINNING

On small streams, the streamside zone 1 may be all that is needed if the sole purpose is to safeguard aquatic habitat. On larger streams, locate new buffers to connect existing natural patches of vegetation to create corridors. Surround spring seeps, wetlands, brooks, and wet or highly erodible soils with a minimum of 100' of native vegetation. Cross streams with the narrowest possible bridge, rather than a culvert, to present less of a barrier to fish movement. For streams less than 60' wide, measure the width and add or encourage trees on at least the south and west sides which will grow tall enough to shade the stream. On larger rivers, a shaded bank won't have much influence on water temperature, but it can provide cooler cover. Select native plants for the buffer based on requirements of desired wildlife or insects (see No. 8 in this series).

THE BETTER BUFFER

Maintain or restore as much space as possible in an undisturbed, naturally vegetated state. Identify and safeguard natural features valuable to wildlife, such as:

- large dead standing trees (hawks, osprey, and eagles use for nesting and roosting)
- large cavity trees (nesting by owls, wood ducks, hooded mergansers & others)
- large dying trees (bats roost under loose bark)
- seasonal and vernal pools (used by amphibians for breeding)
- understory tangles (cover for many wildlife species)
- large woody debris in streams (basking areas for turtles; cover for fish)
- streambank burrows (homes of weasels, otters, muskrats)
- sandy soils with good sun exposure (used by turtles as nesting areas)
- stone walls and rock piles (snakes and small mammals)
- large trees overhanging the water (flycatchers, kingfishers, osprey, and other birds use for feeding perches)
- large stands of conifer trees (used by deer as wintering areas)
- hollow trees and logs (suitable as dens for some mammals)
- fallen shaded logs (preferred habitat for some salamanders)

BUFFER MANAGEMENT

Plant diversity means animal diversity

To aim for maximum wildlife diversity, manage for maximum vegetation diversity. Timber harvesting in zones 2 and 3 is compatible with buffers for habitat, although trees within 25' of the stream should be left undisturbed. Remove large trees on the riverbank only if they threaten to fall and open the bank to erosion; leave the root system intact. Allow natural woody debris to remain in a stream unless it causes flooding. Elsewhere, use small scale harvesting, cutting single trees or small groups. Use long rotations, allowing older, uneven-aged stands to develop. Operate timber harvests in late summer or during frozen ground to minimize disturbance to forest floor and understory vegetation. This also avoids conflicts with wildlife breeding periods (April–June). Locate log landings or haul roads outside the riparian area, or at least 200' from the stream. Exclude vehicles and livestock from the buffer during the nesting season of desired species. For grassland birds, wait to mow until their nesting cycle is complete in July. Encourage runoff to spread rather than enter the buffer as concentrated flow, and remove sediment if it accumulates in zone 3.

Buffer Plants to Please Everyone

Grouse, engineers, and gardeners agree: grey dogwood—*Cornus racemosa*—is a great choice for the riparian buffer. This native deciduous shrub provides excellent riverbank protection, forming a handsome hedge or barrier, and grows in both wet and dry soils and in sun or part shade. The plant's striking red stems are especially attractive in winter against the snow. Pale flower clusters are followed by distinctive white fruits beloved by grouse, turkey, thrushes, bluebirds, grosbeaks, woodpeckers, vireos, catbirds, and more.

Another native equally valuable around the home and in the buffer is American cranberry bush—*Viburnum trilobum*—an outstanding plant with year-round interest. Showy white flowers in a halo arrangement are followed by scarlet fruits which persist into winter to offer food much appreciated by wildlife when the cupboard is otherwise bare. Its handsome foliage turns deep red and purple in fall. This very hardy deciduous shrub tolerates dry soil or wet feet and grows in sun or part shade. Grouse, pheasant, and small birds use the plant for cover, and bluebirds, finches, thrushes, cedar waxwings, cardinals, flickers, and robins eat the fruit.

For more information on native plants for wildlife, see No. 8 in this series.

FURTHER READING

Buffers for Wetlands and Surface Waters: A Guidebook for NH Municipalities, Chase, Deming, & Latawiec. ASNH, NH Office of State Planning, NRCS, UNH Cooperative Extension, 1997

Stream Buffers in Urban Landscapes, USDA, EPA, Norwalk River Watershed Initiative, Fairfield County Conservation District, CT DEP, Oct 1998

Information provided by the Connecticut River Conservation District Coalition for the Wildlife Habitat Incentives Program (WHIP).

Turtle illustration courtesy of NH author and naturalist David M. Carroll; fish and eagle illustrations courtesy of VT artist Angela Faeth; final drawing by Susan Berry Langsten, NH artist.

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Part of the ***Living with the River*** series. May be reprinted without permission.
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RIVER BANKS & BUFFERS

Urban Buffers

No. 6

for the Connecticut River Watershed

Cities and towns all over America are recapturing their river fronts. Local officials are looking at ways to make responsible, river-friendly use of public lands, to develop public recreation and enjoyment of the waterfront. They may wish to encourage owners of commercial and industrial sites to improve their riverfront property. Such a natural amenity is a key to economic growth and quality of life.

Once America's "best land-scaped sewer," the Connecticut River is now not only a recreation magnet, but the heart of a national fish and wildlife refuge.

The Connecticut River and its tributaries, large and small, once provided both the original avenue for settlement of the Valley and power for the towns which grew around them. Somewhere along the way, however, the byproducts of our communities turned these waters into open sewers, and our forebears responded by turning their backs on the river. Although its 11,720 square mile, four-state watershed remains largely rural, sprawling development still threatens the Connecticut River and its tributaries. Now that public and private investment in pollution control has given people rivers to enjoy once again, riverfront lands are needed to do more than ever before: protect the waterway from land-based pollution, and provide a place to recreate.

THE CHALLENGE

Water flowing over parking lots, industrial sites, roads, and lawns picks up heavy metals, toxics, trash, pathogens, sediment, hydrocarbons, fertilizers, pesticides, and other pollutants. Removal of streamside vegetation for land development and rip-rap has reduced the natural ability of streams to cleanse themselves.

Development, particularly in narrow side valleys, has brought traffic close to water, with longer lasting effects on riparian areas than any other type of disturbance. Roadside snowbanks can be stockpiles of such pollutants as petroleum byproducts, salt, metals, and anti-skid grits, which can get into streams.

Development also typically increases the amount of impervious or compacted surfaces such as roofs, roads, sidewalks, and parking lots. The result is cumulative changes in the dynamics of nearby streams. Since rainwater cannot penetrate such surfaces, it runs off, reaching the stream faster than it would naturally, increasing flood hazard and making streambanks unstable.

Runoff from impervious surfaces can turn that tame little backyard stream into a land-eating monster.

That tame little backyard stream suddenly turns into a raging torrent on a regular basis, nearly drying up in between. Too often, this prompts city officials to look at structural attempts at flood control, such as confining waterways into narrow constructed channels, which actually worsens future flooding downstream, relocates flooding from one place to another, and risks greater destruction when the river breaks through such defenses.

A BUFFER IS THE ANSWER

A riparian buffer can offset the effects of development, serve public health, and bring beauty—and pleasure—back to the riverfront.

Protects Public Water Supplies

Many communities take their drinking water directly out of rivers, as Woodsville, NH, does from the Ammonoosuc River. Others depend upon public and private wells drawing from stratified drift aquifers near rivers. These wells can actually be contaminated by pollutants from parking lots, lawns, or agricultural chemicals in rivers 1000 feet away. Nature has provided a very efficient, low-cost and low-maintenance water treatment system in the form of natural riparian vegetation. Keeping streamside land naturally vegetated is a far more effective and less expensive way to safeguard drinking water over the long term than building elaborate facilities to treat polluted water. Forests are especially good at both cleansing runoff and stowing this water in aquifers. Clearing a forest for development reduces by 33-67% the water infiltrating the soil to become groundwater than if the forest, with its root network and more porous soils, had been left in place.

Protects Property

Streamside land is a high risk area for development even above flood elevation. Public and private investments in property risk damage or loss if stream dynamics are ignored. Using vegetated buffers to set back human developments and land uses from shorelines is cost effective protection against the hazards caused by flooding, shoreline erosion and moving streams. Sheet No. 7 in this series offers guidance for town officials and developers on various ways to promote buffers.

Provides Community Value

Disguised as riverfront parks, riparian buffers can host a range of activities with economic and educational value to the community. Welcome the public to hike or bike, walk or run on trails, or try their luck in fishing tournaments. Excursion boats, water parades, canoeing or kayaking races, and rowing regattas can launch on larger rivers. Riverside festivals and concerts have a special appeal. Forested buffers are good locations for ropes adventure courses, orienteering competitions, or marathons. Public gardens offer pleasant passive recreation. People will notice that a forested buffer/park is especially enjoyable because it reduces noise from nearby roads, development and industry, and offers a cool, shaded place for a picnic with a view. In winter, the riparian buffer offers space for snowshoeing, cross-country skiing, and ice skating.

Disguise riparian buffers as riverside parks.

Riparian forests in heavily developed areas may be the refuge of last resort for a variety of birds and other animals, and offer the best birdwatching in town. A buffer is a good place for river-related school studies and adult workshops in natural history.

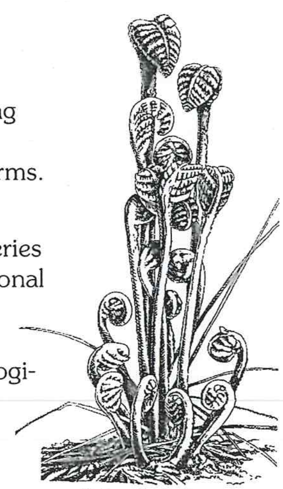
By making riparian buffers people-friendly places, smart communities gather allies for river protection and encourage citizen participation. Citizen groups can develop a feeling of ownership that translates into monitoring, volunteer labor, and a welcome source of stewardship for town property. Corporate citizens owning riverfront property can contribute to the quality of life for their employees and the community at large.

Supports Stream Life

The quality of life in a stream goes distinctly downhill when its watershed reaches 10-15% of impervious cover. Above 25% impervious cover, it can no longer support aquatic life. Heavy metals, common in runoff from urbanized areas, accumulate in fish tissues, threatening fish health as well as those who eat them. However, streams flowing through urbanized areas with intact streamside forests have healthier aquatic life than those that do not. Microbes in forest soil can convert some pollutants into less toxic forms.

Protects Historic and Archeological Resources

To the Valley's native people, rivers provided food and served as transportation arteries and geographic markers. The remains of villages, hunting and fishing camps, and seasonal activity sites are commonly discovered near the water's edge. The Connecticut River's tributaries later provided access into the interiors of Vermont and New Hampshire for 18th century Euro-Americans. Vegetated, stable streambanks help to preserve archeological and historic sites from erosion and other disturbance.



Nature illustrations: David M. Carroll

GETTING STARTED

Urban situations confront planners, property owners, and city officials with more space and zoning constraints than in more rural areas. Check local zoning and master plan provisions for shoreline setbacks. Perform a visual analysis of existing buffers to see where to focus municipal effort, and perhaps financial incentives, to restore missing buffers.

Limit encroachments through site planning by setting back permanent structures, roads, and paved paths as far as possible, where streamside vegetation exists or could be restored. Avoid creating new bridge, sewer, or utility crossings except where there is no reasonable alternative. Check culverts to ensure that they can handle a 100-year storm and offer fish passage. Arch, or other "bottomless" culverts allow the best fish movement.

A buffer is a river's right-of-way.

For an Unstable Riverbank

Deal with an eroding riverbank first before restoring its buffer. Urban riverbanks often show evidence of past abuse and will benefit from the advice of a trained specialist. Consult *The Challenge of Erosion in the Connecticut River Watershed*, published by the Connecticut River Joint Commissions. Structural solutions, such as rip-rap and retaining walls, are as hard on the river and buffer as they are on the eye. Use them only on the lower portion of the vertical profile to the extent necessary, and only when bio-engineering techniques may not be adequate to prevent significant losses of land and property.

Rip-rap usually results in buffer destruction and can trigger new erosion.

Where Natural Vegetation Exists

Discourage the cutting of existing trees and other vegetation on stream banks. Plans to cut selected trees near the bank or shoreline for views and recreational access should ensure that a canopy is maintained. Maintain the duff layer to the greatest extent possible, and leave stumps with their roots intact to help hold the bank in place. Convert runoff to sheet flow by regrading or using landscape timbers, stone, or other structural devices.

Where Natural Vegetation Has Been Removed

Revegetate streamsides as well as rock rip-rapped areas with native shrubs, trees and grasses on as much of the vertical profile as possible. To avoid raising water temperature live stakes can be driven into joints of rip-rap where they will sprout, shrouding and shading the stone. Vines can also help here. Where native streamside vegetation is gone but soil remains, change mowing and cutting practices to allow gradual natural succession of native plants. Better yet, plant groups of attractive native shrubs and trees to hasten buffer restoration. Since the urban buffer forms the boundary between the natural and man-made worlds, the most successful planting design aims for an unmanicured look. Check the plant list in this series for native plants with ornamental value or those that attract birds, butterflies, or other desirable wildlife. Set them in irregular groups of odd numbers of plants for a naturalistic effect. Where riparian land has been paved, communities such as Hartford, CT, are reversing this all too common riverbank treatment by relocating roads, removing pavement, and restoring vegetation.

Showcase native Connecticut River Valley plants.

DEALING WITH URBAN STORMWATER

Riparian buffers can do only part of the job when there's a man-made stormwater transport system in the picture. An urban buffer's ability to treat stormwater depends on how much the flow has become channelized before it enters, and how long it is detained in the buffer. If a buffer receives stormwater directly from impervious areas, use flow-spreading devices such as multiple curb cuts or spacers to distribute flow. Buffers are useful wherever runoff heads toward a river, such as around storm drains, detention ponds, and drainage ditches.

Where a river front has already been developed and vegetated buffers cannot be restored, turn to structural technology, such as detention ponds, infiltration systems, and commercially available stormwater treatment systems. These may be required if the watershed has a high percentage of impervious surface, since its stream may produce more sediment-laden runoff than a buffer can effectively handle. Note that some urban pollutants pass through a buffer unchanged: salt, heavy metals such as cobalt, lead, and mercury are not removed by natural buffer processes.

The choice to place a stormwater detention pond within a buffer depends upon the relative impacts and performance potential. Ponds can contribute to stream warming, but can also lend habitat diversity to the buffer. Limit such ponds to the outer or middle zones, and avoid placing them where they could threaten bank stability or where groundwater lies close to the surface—the pond could recharge the aquifer with dissolved pollutants.

PLAN FOR RECREATIONAL USE

Guide river access by establishing well defined trails and paths to help keep the streambank stable. Use marker posts, boulders, signs, and fences to direct traffic by people and equipment. Design trails to run across rather than down slope, to avoid creating runoff problems and erosion. A common mistake is to run a bike path right next to a river, which can result in an open swath rather than a closed tree canopy. Instead, locate bike paths at a slight distance, with spurs to the river. Designate sensitive areas, especially steep slopes, for low impact use rather than high impact activities such as off road vehicles, biking, or horseback riding. Restrict access where vegetation is not fully established or is of a rare type. If problems arise, discuss trail closures, tree cutting, or other decisions with interested citizen groups in advance. In high use areas, select structurally reinforced turf systems rather than an impervious surface. Encourage pet owners to avoid walking their dogs in areas where pet droppings could wash off into the stream, and remind them to pick up after their pets. To protect public safety, plant low, deciduous shrubs or ground covers and prune tree branches to 8' above the ground along walkways. Provide carefully selected illumination to avoid over-lighting the landscape.

MANAGING A RIPARIAN BUFFER

Inspect the buffer regularly and remove accumulated sediments in the outer grass zone. Exclude dumping, filling, and construction machinery from the buffer to protect damage to soils and vegetation. Caution road crews to avoid mowing riparian buffers where roadways abut waterways. Mowing of the outer grass buffer, however, is important for vigorous sod growth and helps remove the nutrients and pollutants it has captured. Raking leaves, clearing brush, and removing fallen logs can significantly reduce the time that runoff is detained and cleaned by the buffer. If the public demands it, restrict such tidying up to highly visible areas, and screen the view of the rest with ferns and low growing shrubs.

Reduce water and maintenance needs by mulching with shredded bark, leaf mulch or bark chips. Cedar and redwood bark are not recommended because their chemistry interferes with buffer function. While fresh wood chips are often available from highway crews, they should be composted for six months to avoid introducing disease and other troubles. Use only lime or wood ash to fertilize near a stream, and avoid pesticides.

Cut only trees that threaten to pull the riverbank with them if they fall, but leave their root systems in place to hold the bank. Remove a tree snag from a stream channel only when it clearly presents a flood hazard. Identify and control invasive exotic plants—they can quickly spread and overrun less aggressive native plants. Educate the public about the value and function of the buffer through signage, meetings with homeowner associations, and field demonstrations, to help prevent encroachment.

KNOW STATE AND LOCAL REGULATIONS

Prevent encroachment through public education.

Since riparian buffers are among the best ways to protect the quality of rivers and streams, state and many local authorities have taken steps to protect them. In both Vermont and New Hampshire, septic systems must be set back 75' from rivers and streams, and most municipalities have setbacks for structures. Some require buffers of a standard width, and others prescribe a range and assign a width appropriate to the site.

In New Hampshire, the Comprehensive Shoreland Protection Act (RSA 483-B) protects existing natural woodland buffers within 150' of the public boundary line on all 4th order streams, including lower portions of the Ashuelot, Ammonoosuc, Cold, Gale, Israel, Mascoma, Mohawk, Sugar, Little Sugar, and Upper Ammonoosuc rivers, and Mink, Partridge, and Stocker brooks. On these waterways not more than 50% of the basal area of trees and a maximum of 50% of the total number of saplings can be removed in a 20-year period. A healthy, well-distributed stand of trees, saplings, shrubs, and ground covers and their living, undamaged root systems shall be left in place. While the Connecticut River mainstem was exempt from this law at the time of printing, the law may apply in the future.

In Vermont, the Agency of Natural Resources has adopted a Buffer Procedure pursuant to 3 V.S.A. § 835 which is not a rule or regulation, but may be used as guidance in conditioning permits.

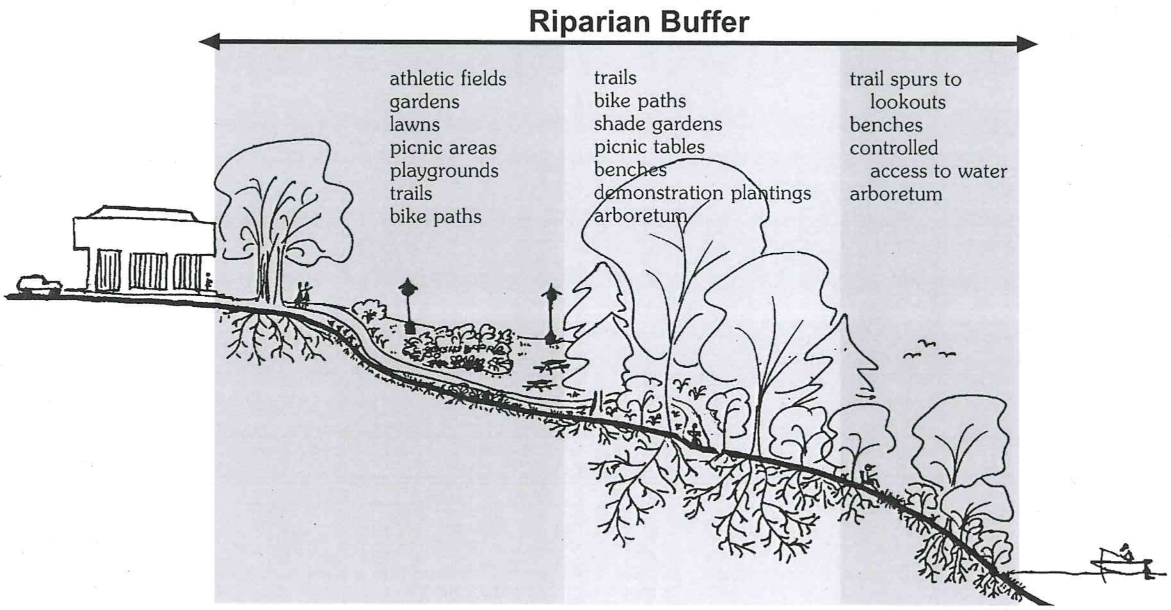
ANATOMY OF A BUFFER

Use the description below as a general guide which can be altered to fit the available space between the river and the built environment. While it is never in the best long-term interest of either the public or the landowner to sacrifice an existing riparian buffer for development next to a river or stream, even a 50' buffer is better than no buffer at all. For more on buffer width, see *Introduction to Riparian Buffers*, No. 1 in this series.

Three Zone Buffer System

The most effective urban buffers have three zones.

- **streamside**: to top of bank for erosion control, shade, visual screen, noise control
- **middle zone**: inland from top of bank; to capture pollutants and recharge groundwater; width should ideally reflect size of stream, extent of 100 year flood plain, and adjacent steep slopes; the goal is a mature woodland, with some clearing for recreational uses
- **outer zone**: between the rest of the buffer and the nearest permanent structure; to capture sediment and absorb runoff; open, unpaved space (turf or lawn); playing fields, gardens, playgrounds, and other common community activities are suitable



Grass and herbaceous plants spread surface runoff to catch sediment and improve infiltration and water storage

Woodland provides habitat and purifies surface and subsurface water

Undisturbed shrubs and trees provide habitat, shade water and stabilize bank

THE BETTER BUFFER

Naturally vegetated streamside forests are the best possible use of land when it comes to water quality, land and water recreation, and wildlife habitat. While available open space near waterways is often limited in heavily developed areas, encourage the widest possible forested buffer wherever space permits. The longer runoff is detained in the buffer before entering the stream, the better.

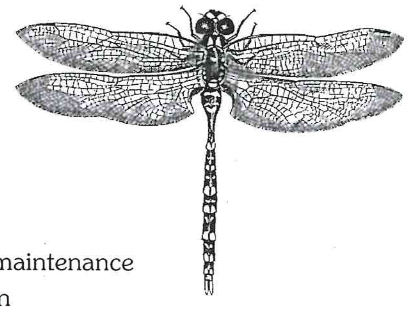
Plant labeled demonstration gardens of native tree, shrub, and herbaceous species for public education and enjoyment, such as a garden of plants valuable to wildlife. Add buffers (disguised perhaps as shrub borders, or flower beds surrounded by filtering grass) between paved areas and storm drains or ditches.

WHAT ABOUT COSTS?

It's hard to put a dollar figure on the value of watching migrating songbirds or the quality of life provided by a public waterfront park. The following list describes some of the costs and benefits involved in adding a buffer in an urban setting.

Costs

- grass or wildflower seed
- correction of compacted soil or other soil problems
- plant material: use cuttings or bare root plants from a native source; nursery grown plants are more expensive but more reliable
- mulch, if not provided by highway crews and composted in advance
- labor in planting, pruning, mowing, sediment removal
- signage and fencing to guide public use if appropriate
- monitoring for signs of erosion and plant damage
- cost of administering buffer program
- land acquisition (if applicable)



Benefits

- reduced costs for mowing and maintaining open fields
- reduced costs for fertilizer, pesticides, herbicides, fuel, equipment maintenance
- avoided costs of engineering design, permits, and bank stabilization
- public land: recreation area and activities within buffer and along waterfront
- cleaner, safer, more attractive water for recreation
- safer, more reliable drinking water from public water supplies
- averted costs of building drinking water treatment system
- flood protection
- improved ambient air temperature and quality in summer
- visual screen and noise buffer between land and water
- preserve important habitat
- better fishing
- increased property values

Further Reading

A Guide to Developing and Re-Developing Shoreland Property in New Hampshire, North Country Resource Conservation & Development Area. 1999

Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in NH. 1992

BMPs for Erosion Control During Trail Maintenance and Construction, NH Department of Resources & Economic Development. 1994

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RIVER BANKS & BUFFERS

No. 7

Guidance for Communities

in the Connecticut River Watershed

Our most fertile soils, our most valuable fish and wildlife habitat, and some of our most expensive real estate are found along rivers and streams. Add to that the power of flooding waterways to destroy private property, and here is a situation which begs for sensible town policy.

THE CHALLENGE

The high quality of life offered in the beautiful valley of the Upper Connecticut River, with waters clean and attractive once again, brings with it both the promise of growth and the threat of losing a landscape our children will recognize in the years ahead.

Our region has a long tradition of respect for the rights of individual property owners. This understanding must include concern for the rights of neighbors and, along rivers, for those downstream who can be directly affected by the actions of a single landowner. In the tug of war between unlimited freedom in the use of private property, and the need to protect both private property and the public good from harm, many town decision-makers are recognizing that it is in their own economic and environmental self-interest to guide development near moving water. Allowing development too close to a waterway has too often led to damage or loss of roads and buildings, and pollution of the river, not to mention a growing threat to the rural character which is the signature of the Connecticut River Valley.

Riparian buffers are a river's right-of-way.

The flood and erosion "insurance" provided by a riparian buffer is all the more important now that weather patterns are taking a turn. Whether global climate warming is natural or human-induced, New England is seeing a definite shift toward heavy storms that deliver several inches of rain in a single day. Sturdy buffers are the best protection for private property. Smaller tributaries are just as important as the larger streams they supply. If land adjacent to small streams is altered to reduce its flood control function, the cumulative impact will result in worse flooding in the mainstem, even if mainstem flood plains are safeguarded against further development.

Development pressure inevitably means pressure on aquifers. Nature's own water treatment facilities, riparian buffers help cleanse and recharge wells and groundwater supplies. They are a real bargain compared to a multi-million dollar piece of infrastructure.

Small streams need buffers, too.

Land conversion also brings traffic closer to waterways. In the upper Connecticut River Valley, roads and railroads often closely follow rivers and streams, pinching the riparian zone. These may have longer lasting impacts on riparian land than any other type of human land use.

Local officials can help by utilizing town wetland and zoning regulations to protect stream buffers in areas that have not yet been developed, and by encouraging buffer restoration in developed areas. Developers and property owners can help by maintaining or restoring adequate stream buffers before, during, and after construction.

Rewards of Riparian Buffers

Economic services

- protect citizens against property loss through flood damage and erosion
- recharge aquifers
- protect quality of public drinking water supplies
- support the recreation and tourism industry
- support sustainable yields of timber

Social services

- protect clean surface water for public recreation
- protect prime agricultural soils from permanent loss through development
- provide natural fences, visual screens, and noise control
- provide outdoor laboratories for teaching and research
- offer places for camping, nature study, hunting and fishing
- improve air quality
- recycle nutrients
- trap heavy metals and toxins
- store excess sediments
- trap excess carbon dioxide

Biological services

- support predators of rodent and insect pests
- protect fish and wildlife habitat
- provide corridor for movement of wildlife

FIRST STEPS

Build public support and awareness by assembling citizens interested in their town's future who can offer experience in engineering, home building, and conservation issues. Look at existing local policy with both small streams and large rivers in mind: master plan, zoning ordinance, subdivision regulations, and site plan review. Consult your regional planning commission for expert advice, model ordinances, or an evaluation of how well streams and riparian buffers fare under your town's current zoning provisions.

Your regional planning commission can perform a build-out analysis to show the density and pattern of development that could occur under current zoning. This jump into the future can identify where adjustments should be made today to avoid an unwelcome tomorrow.

Develop guidelines that remain flexible to site-specific needs. There is no one-size-fits-all buffer width adequate to protect water quality, habitat, and human interests. These policies should establish a clear link between water quality protection and riparian buffers.

THE TOWN PLANNER'S TOOL BOX

MASTER OR TOWN PLAN

The entire community and its waterways will benefit from a natural resources inventory that includes streams, their flood ways, and flood plains, as well as the town's stated resource protection goals and objectives. Refer to the *Connecticut River Corridor Management Plan* for information. In Connecticut river front towns, this plan can be adopted as an adjunct to the master plan following a public hearing, in New Hampshire by vote of the planning board, and in Vermont by vote of the selectmen. This provides the footing for a zoning ordinance that will help the town protect its waterways, and can also help the town foster connections among conservation lands.

Stating the town's support of riparian buffers in the master plan, however, is only window dressing if the zoning ordinance does not back it up. Towns can also employ a number of non-regulatory tools for promoting buffers.

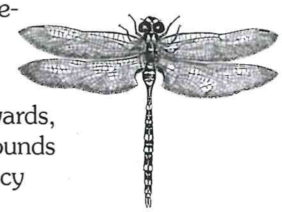
ZONING ORDINANCE

Shoreland conservation zoning is not a "taking"—because it doesn't reduce density.

Don't prohibit development—guide its location. Apply shoreland and buffer guidelines on small streams as well as on larger rivers. Small streams are most vulnerable because they respond most dramatically to changes in adjacent land uses, tend to be located on the steepest sloping and erosion-prone lands, and often have the highest quality remaining habitat. The zoning ordinance can apply a shoreland protection overlay district to all year-round streams within its borders, with the guidelines that follow. To encourage use of the various shoreland conservation techniques presented below, allow them by right, rather than by special exception.

Suggested allowable uses

Encourage agriculture and forestry, provided they use best management practices established by NH and acceptable management practices established by VT; parks, recreation areas with minimal structural development; non-motorized trails; utility transmission lines. Encourage passive use of land for recreation and nature appreciation. Maintain wetlands, flood plains, seeps, and bogs in their natural condition. Allow harvest of timber for firewood or commercial use, consistent with state forestry harvesting guidelines.



Suggested prohibited uses

All uses that present a higher potential for pollution: filling stations, car washes, junkyards, bulk fuel storage, truck terminals, any facilities handling hazardous material. Campgrounds other than dispersed forested tenting sites should be excluded because of their tendency toward deforestation and soil compaction. Towns may wish to guide use of ATVs and mountain biking to less sensitive locations since these higher impact uses can contribute to vegetation loss and erosion. Buildings that do not depend on proximity to water should be sited outside a riparian buffer.

Lot coverage

Discourage impervious surfaces. The quality of life in a stream goes distinctly downhill when its watershed reaches 10-15% of impervious cover. A stream whose watershed is more than 25% impervious can no longer support aquatic life. Encourage developers to use alternatives that allow rain and snowmelt to soak in rather than run off, including retention of open space. Reducing the overall area of impervious surfaces and suburban lawns by encouraging conservation zoning, which minimizes site disturbance, will result in a lower total volume of stormwater runoff. Manicured lawns might as well be green asphalt, since they shed most of the water that falls on them. Encourage developers to retain natural vegetation already at work protecting the town's waterways.

Lot size and density

Some communities have actually done away with minimum lot sizes in order to guide development away from a stream buffer or other sensitive land. Allow flexibility so that developers can establish the same number of lots on the parcel outside the riparian buffer as they would in a conventional cookie-cutter layout, considering the total amount of land that is high, dry, and flood-free. A community can even give density bonuses for land-conserving design, and density *dis*incentives to actively discourage land-consuming layouts. Experience shows that the added value of open space for views and for passive and active recreation can balance and even outweigh the conventionally perceived lower value of smaller lots.

Minimum frontage and road setbacks

The larger these are, the more they tend to intrude on the riparian buffer. A flexible design should be allowed, even on small properties, when there is a possibility of increasing a riparian buffer. It is better to site a building closer to a road than to a stream.

Open space/cluster development

Cluster development concentrates construction on land with less conservation value, and allows owners of house lots in the development to share undivided ownership and enjoyment of the portion of the property remaining in a scenic and natural condition. This usually decreases the developer's costs for road and utility construction, and increases both the initial and the resale value of each lot, resulting in economic incentives for the developer and attraction to the buyer. The land can be managed by a homeowner's association, land trust, or the town.

Building on the 100-year flood plain is inherently unsafe.

Stream setback

The town can establish a riparian buffer similar to a utility right-of-way, whose width is determined before construction begins. Buffer averaging allows flexibility to account for the 100-year flood plain, steepness of slopes, adjacent wetlands, limited lot size, stormwater ponds, and pre-existing structures. The town can adopt the provisions of the NH Comprehensive Shoreland Protection Act for those waters not covered under the Act. On the mainstem of the Connecticut and its larger tributaries, towns should consider enacting stronger local protection that better reflects the flood and erosion potential of these larger rivers. It is best to deter building on the 100-year flood plain; construction here is inherently unsafe.

Buffer Width Options

See *Introduction to Riparian Buffers*, No. 1 in this series, for more on buffer widths for various functions.

Fixed width — select a distance to protect most desired functions: for example, a 75' buffer for 1st and 2nd order (small) streams, 100' for 3rd and 4th order (medium-sized) streams, and 150' for large rivers, 5th order and higher. This is simplest to administer but will be more than adequate in some situations and inadequate in others.

Variable width — based on site-specific conditions such as slope and intensity of land use. Since every stream, parcel, and land use is different, buffers are better tailored to the land rather than to a cookie-cutter approach. While more science-based, this requires more site evaluation and is more difficult to administer.

Combination of the above — determine a standard width, and specify criteria for expanding or contracting, such as to include the 100-year flood plain, undevelopable steep slopes, and/or adjacent wetlands or critical habitats. For example, Weathersfield VT requires a 50' minimum buffer for land with 0-10% slope next to streams wider than 10', and adds 20' in buffer width for each 10% increase in slope.

Protected slope areas

Address slope gradient, soil erodability, and proximity to stream channels, since increasing slope results in a need for an increase in buffer width.

SUBDIVISION REGULATIONS

Map of existing resources & site analysis

The single most important document is a map prepared at the outset, showing

- streams, wetlands, and their buffers
- 100-year flood plains
- soil types and contours with areas of slopes over 15% indicated
- other valued natural resources such as farmland, aquifers and public water supply protection areas, woodlands, & significant wildlife habitat
- cultural resources such as historic/archeological features, and also views into and out of the site.

Information for this map is readily available, requires little or no cost or engineering except for the slopes and soils, and will form the basis for all the major design decisions. Much information can be gained from aerial photographs available from the county Natural Resources Conservation Service office.

Urge developers to retain natural riparian vegetation.

Encourage a pre-application meeting and schedule a site visit early in the review process in order to discuss the conservation potential of the property and to help the developer save time and expense designing around it. This is a good opportunity to discuss the value of a riparian buffer and the reasons to keep existing vegetation.

Applicants should be asked to submit a lightly engineered sketch showing the maximum number of lots they could reasonably expect to gain under a conventional layout after discounting unbuildable land. This better reflects the development capacity of the property, and gives the developer and the town time to work together before investing in an engineered "preliminary plan."

Then use the approach used by successful designers of golf course developments: locate house sites around the most valuable natural features just as one might around a fairway or putting green, keeping structures as far away from the stream as possible. Finally, align streets and trails, and draw in lot lines.

Wastewater management specifications

Include erosion and sedimentation control, stormwater management, landscaping, and provisions for special investigative studies. It is appropriate to incorporate the NH Comprehensive Shoreland Protection Act criteria here.

Road design specifications

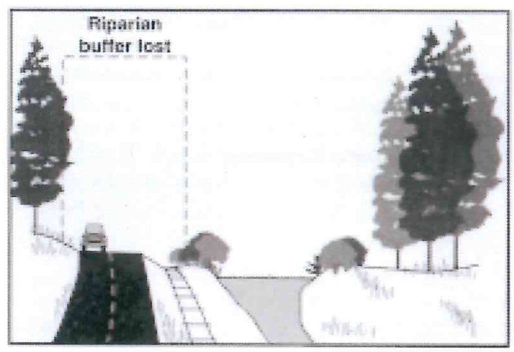
Flexible road width dimensions will help make room for greater setbacks from streams.

Drainage design specifications
Providing buffers should reduce the cost and size of stormwater detention basins needed on the site, freeing land and funds for other uses. Promote forested buffers as part of stormwater management planning and allow the pollution removal effectiveness of buffers to be credited in stormwater plans and calculations, but ensure that the size of the proposed buffer is adequate to handle the job. Criteria of state regulations such as NH RSA 483-B can be added as written after reviewing them for consistency with locally adopted language. Include sections on erosion and sedimentation control.

Innovative land use controls
The town can allow transfer of development rights from riverfront lands to other parts of town designated for more intensive development. This protects the property value of the riverfront land while keeping it on the job protecting the river.

A WORD ABOUT ARCHEOLOGICAL RESOURCES
Since stream corridors have been powerful magnets for human settlement throughout history, it is not uncommon for historic and prehistoric resources to be buried by sediment or obscured by vegetation along stream corridors. Contact the State Historic Preservation Office to identify any potential cultural resources before beginning work. If a site is uncovered unexpectedly, all activity that might adversely affect it must cease. The SHPO will determine the significance of the site and advise on how to proceed to avoid delay.

NON-REGULATORY OPTIONS FOR PROTECTING RIPARIAN BUFFERS



Encourage road agents to avoid mowing vegetation in riparian buffers where roads are close to streams. The often-too-small strip of grass, ferns, and other volunteer plants has a big job to do to keep trash, road pollutants, and sand out of the water.

Encourage the local conservation commission to educate townspeople about the value of buffers and the ways in which personal choices can have lasting effects, both good and bad, on the region's water resources. Let them know how unintentional encroachment such as dumping, understory removal, or altering drainage can reduce buffer function. Contact your county conservation district office to visit a riparian buffer demonstration site. Recognize landowners who do maintain buffers: designate "watershed friendly farms," make an annual award from the conservation district or conservation commission, and provide publicity.

Work with a local land trust to acquire development rights through purchased or donated conservation easements. The landowner continues to use and enjoy the land within the limits of the easement. An easement should include both the streambank and a buffer around it. Guidance on timber harvesting, land conversion, construction, or road building within the buffer can be written into the easement. This will run with the land forever, providing for continuity of management as owners change. A conservation easement need not require the landowner to provide public access, and it can offer significant tax advantages.

The town can also consider providing property tax incentives for landowners who set aside buffers, and can acquire especially sensitive waterfront lands for public space, perhaps using funds from the Land Use Change Tax.

EXISTING STATE & LOCAL REGULATIONS

Since riparian buffers are among the very best ways to protect both private property and the quality of rivers and streams, state and many local authorities have taken steps to protect them. In both Vermont and New Hampshire, septic systems must be set back 75' from rivers and streams, and many municipalities also have setbacks for structures. Some require vegetated buffers of a standard width, while others prescribe a range and assign a width appropriate to the site, often based on slope.

New Hampshire: The Comprehensive Shoreland Protection Act (RSA 483-B) protects existing natural woodland buffers within 150' of the public boundary line on 4th order streams, including lower portions of the Ashuelot, Ammonoosuc, Cold, Gale, Israel, Mascoma, Mohawk, Sugar, Little Sugar, and Upper Ammonoosuc Rivers, and the lower parts of Mink, Partridge, and Stocker Brooks. On these waterways, not more than 50% of the basal area of trees and a maximum of 50% of the total number of saplings can be removed in a 20-year period. A healthy, well-distributed stand of trees, saplings, shrubs, and ground covers and their living, undamaged root systems must be left in place. RSA 483-B does not protect smaller streams. While the Connecticut River mainstem was also exempt from this law at the time of printing, its provisions may apply in the future.

While forestry is exempt from RSA 483-B, the Basal Area Law (RSA 227-J:9) requires that within 150' of 4th order streams and great ponds, 50% of the pre-harvest basal area must be maintained, and that 50% of the preharvest basal area must be maintained within 50' of all perennial streams, rivers, and brooks.

Vermont: *There is no shoreland protection law in Vermont as of this writing.* The Agency of Natural Resources has adopted a Buffer Procedure pursuant to 3 V.S.A. § 835 which is not a rule or regulation, but may be used as guidance in conditioning permits. *The Manual of Acceptable Management Practices* for forestry specifies that except for stream crossings, a protective strip shall be left along streams in which only light thinning or selection harvesting can occur, so that breaks made in the canopy are minimal and a continuous cover is maintained. Log transport machinery must remain outside a 25' margin along the stream. Including this 25' margin, the width of the protective strip shall be 50' for land sloping 1-10%, adding another 20' for each additional 10% increase in grade.

FURTHER READING

The Connecticut River Corridor Management Plan, Connecticut River Joint Commissions, 1997. Copies of this plan were provided to each member of the board of selectmen, planning board/commission, and conservation commission of the 53 NH & VT riverfront towns, and to each town's library, school, and historical society. It is also available on the Web (www.crjc.org).

Buffers for Wetlands and Surface Waters: A Guidebook for NH Municipalities, Chase, Deming, & Latawiec. Audubon Society of NH, NH Office of State Planning, NRCS, UNH Cooperative Extension, 1997

A Guide to Developing and Re-Developing Shoreland Property in New Hampshire, North Country Resource Conservation & Development Area, 1999.

Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in NH. NH Department of Environmental Services, 1992.

Growing Greener — Putting Conservation into Local Plans and Ordinances, Randall Arendt. Island Press, Washington DC, 1999.

Dealing with Change in the Connecticut River Valley: A Design Manual for Conservation and Development, Center for Rural Massachusetts. Lincoln Institute of Land Policy & the Environmental Law Foundation, 1988.

Natural Resources: An Inventory Guide for New Hampshire Communities, Upper Valley Land Trust & UNH Cooperative Extension Service, 1992.

Watershed Guide to Cleaner Rivers, Lakes & Streams, Brian Kent. Connecticut River Joint Commissions, 1995

Wildlife illustrations by New Hampshire naturalist David M. Carroll

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Watershed Assessment, Tracking & Environmental Results

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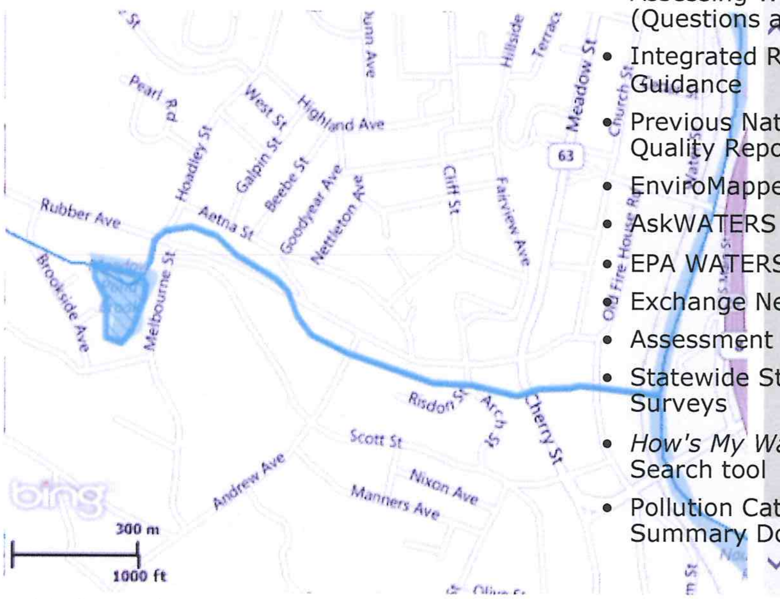
2010 Waterbody Report for Long Meadow Pond Brook-01



Click on the waterbody for an interactive map

Features

- About This Database (Integrated Report)
- Assessing Water Quality (Questions and Answers)
- Integrated Reporting Guidance
- Previous National Water Quality Reports
- EnviroMapper for Water
- AskWATERS
- EPA WATERS Homepage
- Exchange Network
- Assessment Database
- Statewide Statistical Surveys
- *How's My Waterway* Local Search tool
- Pollution Categories Summary Document

State: Connecticut
Waterbody ID: CT6917-00_01
Location: From mouth at confluence with Naugatuck River (DS of Elm Street crossing and RailRoad crossing), US to outlet of Naugatuck Ice Company Pond Dam (just US of Rubber Avenue crossing), Naugatuck.
State Waterbody Type: River
EPA Waterbody Type: Rivers and Streams
Water Size: .94
Units: miles
Watershed Name: Housatonic

Waterbody History Report

Data are also available for these years: 2008 2006

Water Quality Assessment Status for Reporting Year 2010

The overall status of this waterbody is Impaired.

Description of this table

Designated Use	Designated Use Group	Status
Fish Consumption	Aquatic Life Harvesting	Good
Habitat For Fish, Other Aquatic Life And Wildlife	Fish, Shellfish, And Wildlife Protection And Propagation	Impaired
Recreation	Recreation	Impaired

Causes of Impairment for Reporting Year 2010

Description of this table

Cause of Impairment	Cause of Impairment Group	Designated Use(s)	State TMDL Development Status
Cause Unknown	Cause Unknown	Habitat For Fish, Other Aquatic Life And Wildlife	TMDL needed
Escherichia Coli (E. Coli)	Pathogens	Recreation	TMDL completed

Probable Sources Contributing to Impairment for Reporting Year 2010

Description of this table

Probable Source	Probable Source Group	Cause(s) of Impairment
Source Unknown	Unknown	Cause Unknown; Escherichia Coli (E. Coli)
Unspecified Urban Stormwater	Urban-Related Runoff/Stormwater	Escherichia Coli (E. Coli)

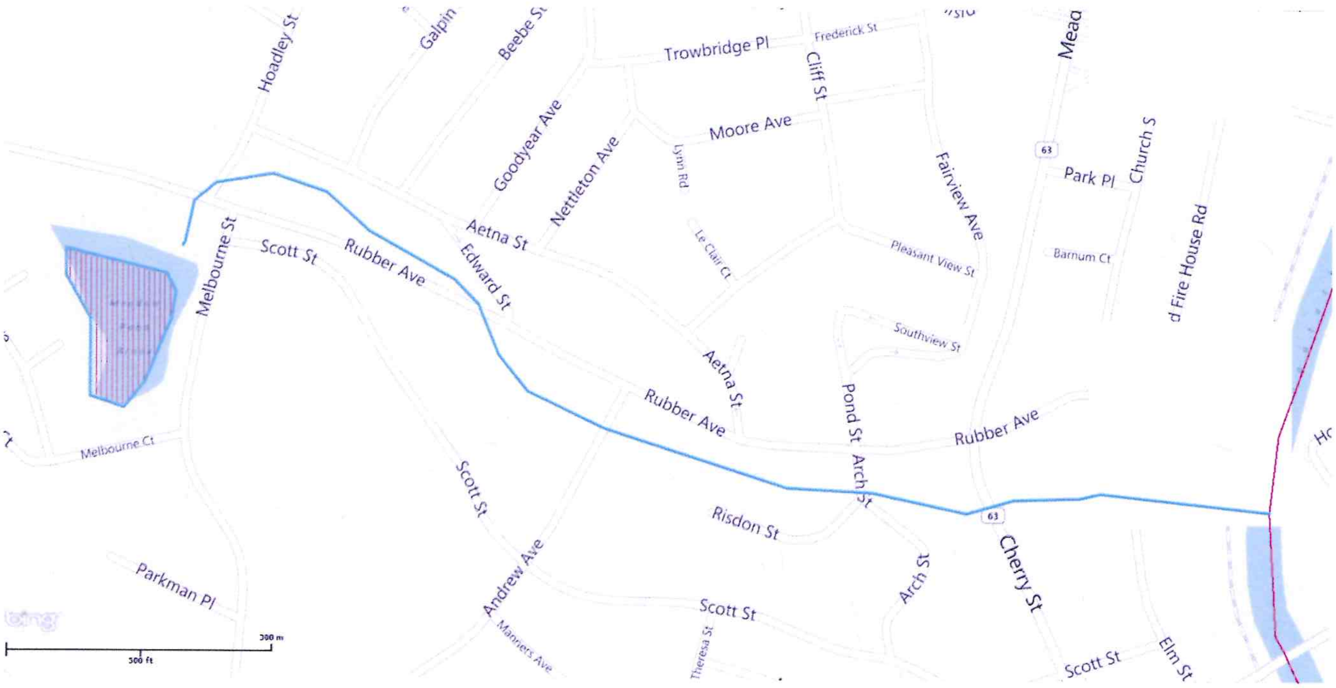
TMDLs That Apply to this waterbody

Description of this table

Long Meado W Pond	Jun-04-2008	Escherichia Coli (E. Coli)	Point/Nonpoint Source	Escherichia Coli (E. Coli)

Previous Causes of Impairments Now Attaining All Uses

No causes of impairment are recorded as attaining all uses for this waterbody.


Hoadley St
Galpin
Beebe St
Trowbridge Pl
Frederick St
Cliff St
Mead
Goodyear Ave
Moore Ave
Nettleton Ave
Lynn Rd
Fairview Ave
63
Park Pl
Church S
Aetna St
Edward St
Melbourne St
Scott St
Rubber Ave
Le Clair Ct
Pleasant View St
Barnum Ct
d Fire House Rd
Southview St
Aetna St
Rubber Ave
Pond St
Rubber Ave
Melbourne Ct
Arch St
Scott St
Risdon St
63
Cherry St
Parkman Pl
Andrew Ave
Arch St
Scott St
Scott St
Elm St
Theresa St
300 m
500 ft

About the Team

The King's Mark Environmental Review Team (ERT) is a group of environmental professionals drawn together from a variety of federal, state and regional agencies. Specialists on the Team include geologists, biologists, soil scientists, foresters, climatologists and landscape architects, recreational specialists, engineers and planners. The ERT operates with state funding under the aegis of the King's Mark Resource Conservation and Development (RC&D) Area - an 83 town area serving western Connecticut. (www.kingsmark.org)

As a public service activity, the Team is available to serve towns within the King's Mark RC&D Area - *free of charge.*

PURPOSE OF THE ENVIRONMENTAL REVIEW TEAM

The Environmental Review Team is available to assist towns in the review of sites proposed for major land use activities or natural resource inventories for critical areas. For example, the ERT has been involved in the review of a wide range of significant land use activities including subdivisions, sanitary landfills, commercial and industrial developments and recreation/open space projects.

Reviews are conducted in the interest of providing information and analysis that will assist towns and developers in environmentally sound decision making. This is done through identifying the natural resource base of the site and highlighting opportunities and limitations for the proposed land use.

REQUESTING AN ENVIRONMENTAL REVIEW

Environmental reviews may be requested by the chief elected official of a municipality or the chairman of an administrative agency such as planning and zoning, conservation or inland wetlands. Environmental Review Request Forms are available at your local Conservation District and through the CTERT Coordinator. This request form must include a summary of the proposed project, a location map of the project site, written permission from the landowner / developer allowing the Team to enter the property for the purposes of a review and a statement identifying the specific areas of concern the Team members should investigate. When this request is reviewed by the local Conservation District and approved by the CTERT Subcommittee, the Team will undertake the review. At present, the ERT can undertake approximately two reviews per month depending on scheduling and Team member availability.

For additional information regarding the Environmental Review Team, please contact the CT ERT Coordinator, Connecticut Environmental Review Team, P.O. Box 70, Haddam, CT 06438. The telephone number is 860-345-3977, connecticutert@aol.com, www.cterg.org.