August 25, 2003

Colchester Strategic Water Quality Plan

SEI # 02 1278-W

Prepared For:	*Prepared By:*
Department of Public Works	**Stone Environmental, Inc.**
Town of Colchester	**535 Stone Cutters Way**
P.O. Box 55	**Montpelier, Vermont 05602 USA**
Colchester, Vermont 05446	**Phone / 802.229.4541**
Phone / 802.654.0717	**Fax / 802.229.5417**
Fax / 802.654.0757	**E-Mail / sei@stone-env.com**

TABLE OF CONTENTS

LIST OF APPENDICES

1. EXECUTIVE SUMMARY

1.1. Background

Colchester's citizens value the environmental, recreational, aesthetic, human and aquatic health, and economic importance of clean water in Malletts Bay and all of Colchester's waters. This Strategic Water Quality Plan (SWQP) was drafted to maintain and improve the health of Colchester's waters and, ultimately, the quality of life for residents and visitors.

The Colchester Select Board appointed the Water Quality Committee members in 2000. The Water Quality Committee, in consultation with the Select Board, chose to draft the SWQP to help the Town comprehensively manage its water resources. It was approved by the Select Board on September 9, 2003 and is to be used by the Select Board in conjunction with the Town's Master Plan, capital plans, and all other comprehensive planning documents to guide planning and regulatory decisions. The Water Quality Committee hopes that this Plan will help put water quality impacts on the agenda for considering in connection with any major Town activity.

A survey of available literature on water quality in Colchester identified the major water resources in Colchester as well as the extent and causes of degradation. The Town of Colchester has about thirty miles of shoreline on Lake Champlain, while the arms of Malletts Bay nearly surround almost ten square miles of the lake. The Town's southern border has about nine miles of frontage on the Winooski River, and the northwestern border has about three miles of frontage on the Lamoille River. Inland from Lake Champlain, 186-acre Colchester Pond is the major open water body.

Thirty-five subwatersheds have been identified in Colchester, discharging into one of five destinations: Lake Champlain (broad lake), Winooski River, Lamoille River, outer Malletts Bay, and inner Malletts Bay. Eight of the watersheds extend outside of town; the major ones are: Allen Brook, Malletts Creek, Pond Brook, Indian Brook, and Sunderland Brook. Most of the water in the Lamoille and Winooski Rivers also originates upstream of Colchester.

With 165 mapped wetlands, comprising a total of 3066 acres, and many unmapped wetlands, Colchester has one of the most diversified and valuable collections of habitats in the state.

Ground water is also an important water resource for Colchester, with much of the Town's drinking water coming from private wells.

1.2. Challenges

Types and causes of degradation found in Colchester's water resources include:

Phosphorus. When phosphorus levels in Lake Champlain increase, the Lake becomes over-fertilized, leading to over-production of algae and other aquatic plants. As the Lake Champlain Basin Program puts it, "these blooms alter fish and wildlife habitat, impair scenic views, reduce recreational appeal, impair water supplies, and lower property values." Human activities have boosted phosphorus loads to Lake Champlain to four times what they were before development, with nonpoint sources (e.g., lawn and agricultural fertilizers, manure and agricultural wastes, runoff from urban areas) accounting for 70% of the load.

Malletts Bay is near but not over the goal set for it by the Lake Champlain Basin Program: the average total phosphorus concentration is 9.8 parts per billion (ppb), while the goal is 10 ppb or less. However, the input to Malletts Bay is still greater than target levels set for maintaining under 10 ppb phosphorus. Phosphorus loads to Malletts Bay dropped from 32.9 metric tons per year (mt/year) in 1991 to 29.7 mt/year in 1995, the latest year for which data are available. This is still 1.1 mt/year over the target. Furthermore, developed land in the Lake Champlain basin contributes more phosphorus runoff per acre than agricultural or forest land, so that Colchester's continued growth leads to a high potential for further growth in phosphorus output. However, 90% of the phosphorus flowing to Malletts Bay comes via the Lamoille River, which Colchester has relatively little impact on.

Toxins. In Lake Champlain in general, mercury appears in such high amounts that the Vermont Department of Health has issued an advisory suggesting strict limits on consumption of fish from the lake. Because pollution from PCBs in Lake Champlain adds to the toxicity from mercury, the Department of Health advisory for lake trout from Champlain is stricter than for other waters. A primary source for mercury is depositions from coal-fired power plants west of Vermont; PCBs have been depostited in sediments by industrial pollution, like the wood products industry near Plattsburgh, New York.

Invasive species. Invasive species in Lake Champlain that affect Malletts Bay include sea lamprey (Petromyzon marinus), zebra mussel (Dreissena polymorpha), and Eurasian milfoil (Myriophyllum spicatum). Lampreys have been identified as threats to the lake's native lake trout and salmon fisheries and its introduced rainbow (steelhead) trout fishery. Zebra mussels, small mollusks whose dense growth encrusts solid objects and allows them to outcompete native mussels, have had an impact on native mussel populations in outer Malletts Bay. Eurasian milfoil is a highly invasive and aggressive aquatic plant that outcompetes native plants and clogs waterways with its dense growth. Colchester's Master Plan reports that Eurasian milfoil is "present but not pervasive" (Town of Colchester Vermont 2001).

Pathogens. Judging from tests for indicator bacteria, the waters of inner Malletts Bay are affected by pathogen contamination near the shore, which may cause swimmers to become ill. The Town of Colchester has been taking water quality samples, mostly at outlets to tributaries and at recreational areas, during the summer for over ten years. Five "hot spots" were identified after eight years of sampling, where 21-69% of the samples exceeded Vermont's standards for contact recreation. Leaking onsite wastewater treatment systems, stormwater, and wildlife have all been identified as possible causes of the elevated bacteria levels found.

Stream degradation. Crooked Creek and Smith Hollow Brook have been placed on a list which the US EPA and the State use to track which water bodies do not meet water quality standards, the 303(d) list (Part A). Indian Brook is on the Part A list from the Colchester-Essex town line, upstream to Butlers Corner, because of its poor biological condition and habitat degradation. Insufficient data exist to classify the Colchester portion of Indian Brook as impaired. The entire length of Sunderland Brooks is on the Part A list, with sediment as the principal pollutant of concern. In addition, the DEC has found a number of possible impairments in Indian Brook, Malletts Creek, Crooked Creek, and Smith Hollow Brook; all of these are on the 303(d) Part C list, a list of waters where more investigation is recommended to see whether they are impaired. Sedimentation and bank erosion have been observed in many streams in Colchester.

1.3. Goals

With a good understanding of the challenges facing the waters of the town and a decision on the relative priority of the water resources, specific goals have been identified. Some of these goals may only be achievable in the long term.

Very high priority goals, high priority goals, and medium priority goals for water quality were identified. The very high priority goals are:

- Reduce bacterial contamination to and in Malletts Bay in order to eliminate closures of public beaches and ensure that water at major recreation areas meets contact recreation standards throughout the recreation season
- Reduce phosphorus loads to Malletts Bay to levels recommended by the Vermont Agency of Natural Resources
- Improve the water quality in Sunderland Brook to achieve good or better on all of Department of Environmental Conservation's biological assessments
- Ensure no increase in invasive species in Malletts Bay and no entry of invasive species to Colchester Pond
- Improve water quality so that fish caught in Colchester's water are edible, with no restrictions
- Reduce sediment loads to Colchester streams, rivers, and the lake

The high priority goals are:

- Improve the water quality in non-impaired creeks and Colchester Pond to achieve good or better on all of Department of Environmental Conservation's biological assessments
- Ensure no net loss of Class I, II, or III wetlands
- Where surface water and ground water quality now meets standards, ensure that no degradation occurs

The medium priority goal is:

- Improve water quality by eliminating contamination by oil and fuel from boat fueling

1.4. Recommendations

In order to achieve these stated goals,alternatives were developed and screened through extensive discussions and ranking with theWater Quality Committee members and Town staff. The top priority recommendations that emerged out of those discussions are:

- Prioritize Lakeshore Drive for special wastewater management attention, using current needs and future plans as a basis for a decision on how to address wastewater needs.
- Design and implement increased bacterial monitoring and microbial source tracking at Bayside Beach to determine the main sources of bacteria found there.
- Perform a townwide wastewater needs assessment
- Develop and adopt a townwide onsite wastewater management program
- Require stormwater structural best management practices (BMPs) for priority watersheds
- Upgrade high and medium priority stormwater outfalls and inspect and maintain all outfalls
- Revise zoning, site plan, and subdivision standards for new development throughout the town to reduce or reverse the impact of development on water quality
- Develop a pilot project coordinating actions against aquatic nuisance species

The second rank priority recommendations are:

- Correct any stormwater outfalls that were identified as receiving illicit discharges.
- Inventory the existing public stormwater systems and develop a program for periodic inspection of storm sewer structures.
- Use the prevention measures and approaches identified in the Stormwater Outfall Assessment in the Town review process for new development projects.

- Add to permit requirements the most effective methods to control sediment runoff from all construction sites.
- Clean catch basin structures located in public areas, prioritizing impaired watersheds and those draining to Malletts Bay
- Identify lands with high impact on water quality and determine regulatory, financial and management techniques to protect those lands.

Other recommendations include:

- Complete a comprehensive inventory of the existing public and private stormwater systems
- Perform additional sweeping of public roadways located in the impaired watersheds and inner Malletts Bay area.
- Seek actions by upstream communities to minimize adverse impacts on Colchester's water quality, first by joining the Lamoille River basin planning process.

Public involvement is an important part of achieving many of these recommendations, and specific suggestions for increased public involvement have been included in the plan. In addition, it is recommended that the Water Quality Committee continue its existence as a citizen committee charged with advising the Town on water quality issues and promoting public involvement in actions directed at maintaining and improving water quality.

An implementation schedule for these and other recommendations is included. The SWQP is designed to be a living document, so it is to be revisited and updated every five years, to assess progress towards the goals.

1.5. Acknowledgement

The Town of Colchester and the Water Quality Committee wish to thank the US Environmental Protection Agency for the funding which made this plan possible, and to thank Senator James Jeffords and his staff for their help in procuring the funding.

2. INTRODUCTION TO THE STRATEGIC WATER QUALITY PLAN (SWQP)

Colchester's citizens value the environmental, recreational, aesthetic, human and aquatic health, and economic importance of clean water in Malletts Bay and all of Colchester's waters. This Strategic Water Quality Plan (SWQP) was drafted to maintain and improve the health of Colchester's waters and, ultimately, the quality of life for residents and visitors.

Over the past ten years, the Town has developed a heightened concern for water resources. Several water quality components have been completed, and additional efforts are underway, with the overall goal of protecting and improving water resources throughout the community. Prior to the completion of this plan, the components have been developed as discrete units. Consequently, critical links between such components as stormwater management plans, land use planning, and zoning regulations have not been developed. This project has worked to develop a comprehensive plan that includes all the components of water resource planning in one document, where all the parts complement and support each other.

This Plan is to be used by the Select Board in conjunction with the Town's Master Plan, capital plans, and all other comprehensive planning documents to guide planning and regulatory decisions. The Water Quality Committee hopes that this Plan will help put water quality impacts on the agenda for considering in connection with any major Town activity. The Plan has been put together as a collaborative effort by the Water Quality Committee, Town staff, and a consultant team, in communication with the Select Board, the Planning Commission, and Recreational Advisory Board.

2.1. Origins of the Strategic Water Quality Plan

The Strategic Water Quality Plan grew out of the decades-old discussion of whether to extend municipal sewer service to the Malletts Bay parts of Colchester. The first engineering plan for Malletts Bay sewers was commissioned in 1970, and the 1996 Wastewater Facility Plan Update recommended sewer as the preferred option for Malletts Bay. In 1999, however, when Colchester voters were asked to approve a bond vote to borrow $10 million from the State Revolving Fund at 0% interest in order to pay for a Malletts Bay sewer, the bond was defeated by a 2-1 margin.

The debate prior to the bond vote showed that proponents and opponents of the sewer project were united in their interest in protecting and improving water quality for Colchester. Following the bond vote, the Select Board decided to appoint a Water Quality Committee to recommend ways to advance protection and improvement of water quality, reflecting the wishes of and protecting the interests of town residents as a whole. Two members of the Select Board, two citizens active in the sewer debate, and the Town's Health Officer reviewed about fifteen applications, from which they selected a nine-member board that represented a broad range of interests.

The newly constituted Water Quality Committee met for over a year to familiarize themselves with what was known about water quality issues in Colchester and options for improving water quality, and they found themselves impressed by the amount of information and plans that the Town had created. After drafting a mission statement which was endorsed by the Select Board, the Water Quality Committee submitted a proposal to the Town to use part of an EPA grant to fund the development of this plan. The Town agreed, and the Public Works Department issued a Request for Proposals. Public Works staff, together with members of the Water Quality Committee, selected a team of consultants to help develop the plan.

2.2. Strategic Water Quality Plan Grows Out of the Town's Vision Statement and the Water Quality Committee's Mission Statement

This Strategic Water Quality Plan is intended to reflect the vision statement of the Town of Colchester and the mission statement of the Water Quality Committee.

After a year-long process, with intensive public involvement and scrutiny, the Colchester Select Board unanimously adopted a vision statement for the Town in January, 2000. The full vision statement appears at the Town's web site at http://town.colchester.vt.us/select/mission.htm. Passages relevant to this SWQP include:

- Colchester will offer all citizens "the highest quality social, educational, recreational, economic and housing opportunities"
- "Colchester values its quality of life and it will be maintained and enhanced through efforts and investments such as...[i]mproved public access to a clean Bay and Lake Champlain."

The Water Quality Committee's mission statement, endorsed by the Select Board and consistent with the Town's vision statement, appears on the Town's web site at http://town.colchester.vt.us/water/. The entire mission statement has guided the formation of this SWQP; a couple particularly relevant passages are:

- "The Colchester Water Quality Committee's charge is to study, analyze, and make recommendations to improve the quality of Colchester's waters."
- "Colchester's citizens value the environmental, recreational, aesthetic, human and aquatic health, and economic importance of clean water in Malletts Bay and all of Colchester's waters."

2.3. Role of the Consultant Team

The consultant team chosen to guide this project is led by Stone Environmental, Inc., and also includes David Spitz, Forcier Aldrich & Associates, and Green Mountain Institute. Stone Environmental brought a technology-neutral approach to assessing and solving difficult wastewater management problems, for which it has an international reputation. David Spitz, a land-use planner with 25 years of experience in planning for communities in

Vermont, including extensive work in Colchester, ensured that land use, zoning, and other planning issues were integrated into the plan. Forcier Aldrich & Associates contributed its engineering expertise in wastewater and stormwater management throughout Vermont to the plan's conception. Green Mountain Institute supplied its unique public outreach skills as well as an understanding of watershed planning gained from working in collaborative environmental projects in eighteen states and overseas.

The Town's Request for Proposals detailed the process that was expected to be followed in developing this Plan. The consultant team's interpretation of that request was spelled out in the proposal and guided the planning process throughout. Communication was kept open with Town staff and the Water Quality Committee to ensure that the Plan reflected their interests.

2.4. Constructing the Plan

To introduce team members to each other and share concerns, as well as to confirm the steps outline in the Request for Proposals and the consultants' proposal, meetings were held in March and April, 2002 with Water Quality Committee members and Town staff. In April through August, members of the consultant team and Town staff met with the Select Board, the Planning Commission, and the Recreational Advisory Board to appraise them of the planning process and gather any input they might wish to make.

Public input was gathered in a number of ways. Articles publicizing the planning process appeared in the Colchester *Chronicle*. A meeting was held with representatives of marinas and boat clubs. The Water Quality Committee produced a float for the Fourth of July parade and staffed an information booth that day in Bayside Park. A survey was distributed at public places like Burnham Library, the Town Offices, Chittenden Bank, the July 4 festivities, and the polls for the November 2002 election. (The survey form and results are contained in an appendix.) And a public meeting, publicized in the *Chronicle* and in a mailing to every household in town, was held July 18, 2002 at the Meeting House.

The goals of the public meeting were to increase awareness and understanding of local water resource issues among participants and to listen to participants, in order to develop a list of prioritized concerns for the plan to address. A description of the method used to identify these priority concerns and a complete list of the concerns is found in an appendix to this report.

Representatives of subwatershed areas volunteered to lead further public involvement activities during the planning, but the Water Quality Committee decided later to give other planning work priority over making use of the subwatershed volunteers.

The consultants, together with Town Staff and Water Quality Committee members, decided to note that public access to the waters of Colchester is a concern that Colchester residents raised both during the public meeting and on the survey forms, but that it falls outside the scope envisioned for this Strategic Water Quality Plan, as well as outside the expertise of the consultants. The other concerns were used as the basis for generating alternatives for action and criteria for evaluating those alternatives.

The criteria for evaluating alternatives in the Plan were revised after discussion with Town staff and members of the Water Quality Committee. The six criteria decided upon were:

- Cost
- Promotes economic vitality
- Fairness to property owners
- Fosters stewardship/participation
- Improves water quality
- Preserves water quality

The initial, long list of alternatives considered was narrowed through six months of discussions among Water Quality Committee members, Town staff, and the consultants. Some of the intermediate milestones during these discussions are provided in the appendices.

Finally, an implementation table was constructed, a timetable for accomplishing the prioritized alternatives over the next six years. The implementation table was given to Town staff for review.

2.5. Acknowledgement

The Town of Colchester and the Water Quality Committee wish to thank the US Environmental Protection Agency for the funding which made this plan possible, and to thank Senator James Jeffords and his staff for their help in procuring the funding.

3. THE STATE OF WATER QUALITY IN COLCHESTER

This literature review was completed early in the planning process. New information gathered since then includes:

- Update on the Agency of Natural Resources' determination of impairmed watersheds. The portion of Indian Brook in Colchester has been removed from the list of impaired watersheds, as the monitoring data are insufficient to determine that there is an impairment. While Morehouse Brook is impaired in Colchester, none of the sources of impairment have been identified as coming from Colchester.
- Radionuclides. Levels of radionuclides which exceed State standards for drinking water have been found in private wells in northern Colchester, as well as across the town line in Milton. The State is working with Colchester and Milton to determine the extent of this issue and suggest remedies. The radionuclides can be removed with a filter, but it is a violation of State regulations to dispose of the filter's flush water in private onsite wastewater treatment systems. This regulation is not being enforced, pending greater understanding of the issue and possible solutions.
- Drinking water from private wells. A number of inquiries found no one on the Town staff or at the State who had an overview of the quality of water from private wells, or even the proportion of shallow wells (which are more prone to contamination from nearby sources like wastewater treatment systems) to deep wells in Colchester. In order to scope the potential contamination of private wells from onsite systems, an inquiry was made to the Vermont Department of Health about test results from Colchester. Of the twenty samples for coliform bacteria, four showed detection of total coliform, and two of those also showed detection of E. coli. Of the sixteen samples tested for nitrates, none exceeded the drinking water standard of 10 ppm, and only two exceeded the test's detection limit of 0.5 ppm. The 20% rate of total coliform exceedances for private wells, while drawn from a relatively small sample, indicates that further study of this issue could lead to improvements in drinking water quality for many Colchester residents.

3.1. Introduction

This document has been prepared as part of the Strategic Water Quality Plan development process for the Town of Colchester, Vermont. The Strategic Water Quality Plan is being spearheaded by the Department of Public Works in coordination with the Water Quality Committee and other members of the public, and it will include priorities for maintaining and improving the quality of Colchester's water resources.

This report is intended to be a quick guide to what is known in the literature from the previous five to ten years about water resources and water quality in Colchester, and it is written to be accessible to those with no previous training in water quality evaluation. It presents basic information on water resources, degradation of their quality, and recommendations for future policy.

The next section presents water resources in Colchester identified in the literature consulted. The following section, Section 3.3, discusses impairments to or issues with those water resources. Section 3.4 shows the human impacts on the water resources—the causes of the impairments identified in the previous section—and Section 5 compiles various recommendations that have been made to improve water quality. There is an appendix with annotations for the most significant studies consulted.

3.2. Water Resources

Surface water is highly significant in Colchester. The Town of Colchester has an area of 37.0 square miles (Center for Rural Studies 1998) and about thirty miles of shoreline on Lake Champlain. The shores of Malletts Bay nearly surround almost ten square miles of the lake (Town of Colchester Vermont 2001). Its southern border has about nine miles of frontage on the Winooski River, and the northwestern border has about three miles of frontage on the Lamoille River. Numerous streams and wetlands are also in the town.

On the large scale, all watercourses flowing through Colchester ultimately arrive in Lake Champlain, which flows into the Atlantic Ocean at the Gulf of St. Lawrence, via the Richelieu River in Quebec and the St. Lawrence River. On a smaller scale, a recent report (Griffin International 2002) identifies 35 subwatersheds in Colchester and classifies them as discharging into one of five destinations (Figure 1, Table 1): Lake Champlain (broad lake), Winooski River, Lamoille River, outer Malletts Bay, and inner Malletts Bay. By this classification, most of the town's area and nineteen of the town's thirty five subwatersheds drain into inner Malletts Bay, with the Winooski River receiving much of the rest.

Eight of the watersheds extend outside of town, and this includes many of the watersheds emptying into inner Malletts Bay. The major ones are: Allen Brook, Malletts Creek, Pond Brook, Indian Brook, and Sunderland Brook. Most of the water in the Lamoille and Winooski Rivers also originates upstream of Colchester.

Inland from Lake Champlain, 186-acre Colchester Pond is the major open water body. The pond is the result of a dam, and it has been used as potable water supply in the past. Most of its shoreline is pasture and undeveloped woodland. Vermont's Fisheries Biologist says that the pond has excellent pike and bass fishing, based on anglers' surveys, and in 2002 has been described in Vermont Outdoors magazine as a "premier northern pike fishery" (Vermont Department of Environmental Conservation 2002). It is designated a Class A2 water supply for the Village of Colchester and, though not used since 1974, it is reserved for emergency purposes (Vermont Department of Environmental Conservation 2002).

Wetlands form significant other water resources. The National Wetland Inventory identifies 165 wetlands, ranging in size up to 458 acres, with 3066 acres total in wetlands (National

Wetland Inventory n.d.). These are designated as Class II wetlands, that is, they are "significant and merit protection" under the Vermont Wetland Rules. In addition, there are many unmapped Class III wetlands (Soboslai, pers. comm.)

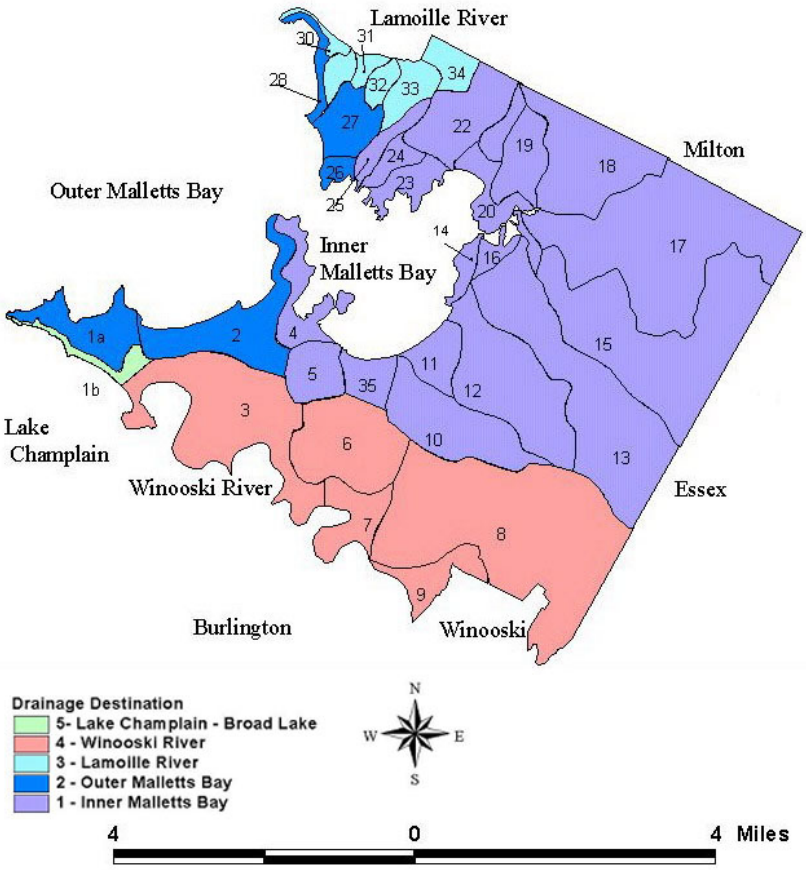


Figure 1. Subwatersheds in Colchester, grouped by destination. Source: (Griffin International 2002)

Watershed number	Watershed name	Area (acres)*	Destination
1a	Colchester Point North	486.	Outer Malletts Bay
1b	Colchester Point South	179.	Lake Champlain (broad lake)
2	Malletts Head West	850.	Outer Malletts Bay
3	Halfmoon Cove	173.3	Winooski River
4	Malletts Head East	405.	Inner Malletts Bay
5	Diversity Hill	20.2	Inner Malletts Bay
6	Shipman Hill	16.	Winooski River
7	Pine Island	3.2	Winooski River
8	Sunderland Brook	327.1	Winooski River
9	Winooski West	29.1	Winooski River
10	Smith Hollow Stream	890.	Inner Malletts Bay
11	Lake Shore Drive	293.	Inner Malletts Bay
12	Crooked Creek	56.8	Inner Malletts Bay
13	Indian Brook	166.1	Inner Malletts Bay
14	Malletts Bay Point East	118.	Inner Malletts Bay
15	Pond Brook	151.	Inner Malletts Bay
16	Interstate 89	7.3	Inner Malletts Bay
17	Malletts Creek	51.1	Inner Malletts Bay
18	Allen Brook	29.5	Inner Malletts Bay
19	Chimney Corner	28.3	Inner Malletts Bay
20	Interstate 89 North	14.8	Inner Malletts Bay
21	Chimney Corner West	150.	Inner Malletts Bay
22	Walnut Ledge East	647.	Inner Malletts Bay
23	Braeloach Camp	9.6	Inner Malletts Bay
24	Braeloach Camp West	153.	Inner Malletts Bay
25	Red Rock East	184.	Inner Malletts Bay
26	Red Rock Point	94.	Outer Malletts Bay
27	Camp Norfleet	18.2	Outer Malletts Bay
28	Wissiquam Orchard	0.9	Outer Malletts Bay
29	Camp Kiniya	3.4	Lamoille River
30	Camp Kiniya North	61.	Lamoille River
31	Winnisquam Orchard East	81.	Lamoille River
32	Camp Norfleet East	120.	Lamoille River
33	Walnut Ledge	13.8	Lamoille River
34	Walnut Ledge North	184.	Lamoille River
35	Malletts Bay	38.7	Inner Malletts Bay
* indicates area contained within Town of Colchester			

Table 1. Subwatersheds in Colchester and their area, Colchester, Vermont. Source: **(Griffin International 2002)**

Many of these have the potential to be designated a Class One wetland (i.e., "exceptional or irreplaceable in [its] contribution to Vermont's natural heritage" (Water Resources Board 2001)), but Class One status requires that someone petition the State, and no one has done so for Colchester's wetlands (Moulaert, pers. comm.). Table 2 shows the "priority wetlands," that is, those "with high functional significance and with moderate to high threats of future

degradation," which the Vermont Department of Environmental Conservation (1997) has identified in Colchester.

TABLE 2. PRIORITY WETLANDS IN COLCHESTER, VERMONT

Wetland	Area (acres)	Rare/ threatened bird species	Rare/ threatened fish species	Rare/ threatened plant species	Natural communities	*Recommendations*
Sandbar, Lamoille River Delta	1700[1]	X		X	"[O]ne of the impressive floodplain forests in Vermont"[2]	"Because of its exceptional quality, the floodplain forest at the Lamoille delta merits special protection and recognition within the state lands as an ecological reserve or natural area. It should be excluded from all timber harvest and protected from other environmentally degrading human activities such as river control structures."[2]
Malletts Creek Marsh (west of Munson Flats and east of Malletts Bay)	425	Likely	X	X	"[G]ood examples of deep rush marsh, floodplain forest, and red maple swamp"[3]	Little fieldwork done; "natural communities should be defined and mapped, and both plants and animals need a more complete survey."[3] "This wetland could be severely degraded in a relatively short time due to development in the adjacent buffer areas. The Fish and Wildlife Department, which owns [20 acres], should acquire the remaining wetland acreage and acquire conservation easements or management leases on the wet meadows to protect adequate northern pike spawning sites."[4]
Colchester Point Rush Meadow (north shore of tip of Colchester Point)	1			X	"[G]ood example of an uncommon lakeshore grass/rush meadow"[3]	

TABLE 2. PRIORITY WETLANDS IN COLCHESTER, VERMONT

Wetland	Area (acres)	Rare/ threatened bird species	Rare/ threatened fish species	Rare/ threatened plant species	Natural communities	*Recommendations*
Colchester Bog (On Colchester Point, between Mills and Porter Points, intersected by railroad bed)	150			X	"[O]ne of two large peat bogs…along the shores of Lake Champlain"[3]	Because suburban housing is encroaching on adjacent land, the owners (UVM) should consider purchasing adjacent parcels as a buffer, if they come up for sale.[3]
Delta Park (Winooski Delta)	75	X		X	"[A] unique and productive ecosystem" with "good examples of the following…communities: lakeshore grassland, lakeshore sand beach, deep rush marsh, and cattail marsh."[3]	The Northshore Wetland in Burlington "is part of the same delta and should be included in the Delta Park site."[3]
Half Moon Cove (west of Rt. 127, immediately north of highway bridge across the Winooski River)	275[5]			X	"A-ranked examples of lakeside floodplain forest and riverine floodplain forest (silver maple-ostrich fern type)."[2] "Important site for wildlife, especially lake fish (spawning area) and waterfowl (both as nesting area and migratory stopover)."[3]	"Derway Island and Halfmoon Cove should be considered a single ecological system…[T]hese sites should be protected as conservation lands of the highest quality."[2]

TABLE 2. PRIORITY WETLANDS IN COLCHESTER, VERMONT

Wetland	Area (acres)	Rare/ threatened bird species	Rare/ threatened fish species	Rare/ threatened plant species	Natural communities	*Recommendations*
Pine Island Shrub Swamp (next to Winooski River, south of WVMT studios and north of Pine Island)	375				"Extensive and mostly undisturbed shallow shrub swamp…[with] important habitat for wildlife—birds as well as aquatic animals."[3]	"A policy of no development should be adopted for the Pine Island Shrub Swamp."[3]
School #4 Wetland (West of Prim Road and south of Lakeshore Drive)	100				Hardwood/cedar, seasonally flooded. Land use has highly degraded the wetland, but it still has moderate levels of: flood storage, recreation, wildlife, water purification, open space[6]	"Current landowners should be made aware of its Class Two status and protection so that there is no further encroachment; buffers should be clearly delineated and maintained."[6]
Rosetti Wetland and Beach (on lakeshore, east of Holy Cross Camp)	15			X	"Buttonbush swamp and maple/ash forest with emergent wetland and open water"[6]	Increase the buffer zone to 100 feet.[6]
Indian Brook Corridor	Narrow band 4.5 miles long			good potential[6]	Riverine system of shrub and emergent communities. "[P]otential for major wildlife corridors…with a wide range of animal life."[6]	"Zoning should consider increasing the buffer to 100' and should carefully examine proposals that require further road crossings or cutting or mowing of brookside vegetation."[6]

TABLE 2. PRIORITY WETLANDS IN COLCHESTER, VERMONT

Wetland	Area (acres)	Rare/ threatened bird species	Rare/ threatened fish species	Rare/ threatened plant species	Natural communities	*Recommendations*
Sunderland Brook mouth and wetland complex	4 miles along entire length of brook				Riverine wetland system of shrub and emergent communities. Two silver maple floodplain forests at mouth. "[P]otential as important wildlife habitat."[6]	The Town should consider zoning that would extend the buffer along the course of the brook to 100', measured from the top of the bank, in order to protect it as a corridor. The property on the military reservations should be required to adhere to wetland regulations...The floodplain at the mouth...has the potential to be an excellent site for...wetland restoration if it is taken out of agricultural use. The functions of the floodplain forest would be enhanced if logging was kept to a minimum."[6]
Niquette Bay wetland and beach	25				"Bayside emergent marsh and shrubland extending inland into a maple/ash swamp"[6]	"Property owners should be made aware of wetland regulations and buffer zones should be maintained...Any requests for upgrading of the beach homes should be considered in light of possible direct and indirect wetland impacts."[6]

1. Primarily in Milton
2. (Sorenson et al. 1998)
3. (Vermont Fish and Wildlife Department 1992)
4. (Binhammer 1994)
5. The latest delineation (Vermont Department of Environmental Conservation 1997) reports 260 acres but has not corrected the total acreage for its inclusion of 15 acres east of the 127 bridge.
6. (Vermont Department of Environmental Conservation 1997)

Table 2. Priority wetlands in Colchester, Vermont

3.3. Degradation in Water Quality

Many of the studies consulted focus on water quality issues in Colchester. Here, water quality is discussed in terms of three hydrogeographic areas: outer Malletts Bay, inner Malletts Bay, and the rivers, streams, and large pond inland from Lake Champlain. Degradation, i.e., diminished quality, in these areas are described below.

3.3.1. Outer Malletts Bay

3.3.1.1. Nutrients

Phosphorus has been identified as a major degrading factor in Lake Champlain (Smeltzer and Quinn 1996), (Lake Champlain Basin Program 2002). Phosphorus is a nutrient which, in overabundance, can lead to undesired algae blooms, hypoxia (lack of oxygen) in bottom waters, and change of plant and animal species distribution, composition, and abundance. According to the Lake Champlain Basin Program (1998), Malletts Bay is near but not over the goal set for it: the average total phosphorus concentration is 9.8 parts per billion (ppb), while the goal is 10 ppb or less. However, the input to Malletts Bay is still greater than target levels set for maintaining under 10 ppb phosphorus. Phosphorus loads to Malletts Bay dropped from 32.9 metric tons per year (mt/year) in 1991 to 29.7 mt/year in 1995, the latest year for which data are available (Lake Champlain Basin Program 2002). This is still 1.1 mt/year over the target. Furthermore, "based on the 2000 LCBP report of the Phosphorus Reduction Task Force, it appears that phosphorus loads generated by land use changes in the Basin are offsetting some of the gains achieved by point and nonpoint source reduction efforts. As the population within the Basin increases, more land is becoming developed. Because developed land generates more phosphorus than other land uses, nonpoint source phosphorus loads may be increasing in parts of the Basin where the land use change is occurring" (Lake Champlain Basin Program 2002).

3.3.1.2. Toxins

In Lake Champlain in general, mercury appears in such high amounts that the Vermont Department of Health has issued an advisory suggesting strict limits on consumption of fish from the lake: "The Vermont Department of Health advises that people should eat not more than one meal per month of walleye...and six meals per month of all other fish caught in Vermont state waters. Women of child-bearing age and children under 6 are advised to not eat any walleye...and limit consumption of all other fish caught in Vermont state waters to two meals per month" (Lake Champlain Basin Program 2000). Because pollution from PCBs in Lake Champlain adds to the toxicity from mercury, the Department of Health advisory for lake trout from Champlain is stricter than for other waters (Bress 2002). The

Department of Health advises that "[a]dults should limit their consumption of lake trout (over 25 inches) caught in Lake Champlain to one meal per month, and women of childbearing age and children under 15 should not eat any lake trout from Lake Champlain" (Lake Champlain Basin Program 2000).

The upper layer of lake bottom sediments in outer Malletts Bay is contaminated with arsenic, manganese, and nickel. A Lake Champlain Basin Program technical report (McIntosh, Watzin, and Brown 1997) concluded, "Concentrations of As [arsenic], Mn [manganese], and Ni [nickel] in the surface sediments of Outer Malletts Bay exceeded either the NOAA [National Oceanographic and Atmospheric Administration] ER-M [Effects Range-Medium; contamination greater than the ER-M value indicates adverse benthic impacts in more than 50% of cases studied] or the Province of Ontario SEL [Severe Effects Level; concentrations above the SEL are predicted to cause adverse effects to bottom-dwelling organisms] at many sites, but especially at the deepest locations." In addition, concentrations of arsenic and magnesium are high enough that the report recommends careful evaluation of the water quality before using outer Malletts Bay water as a drinking water source. Finally, the zebra mussel infestation has the potential for increasing problems related to sediment toxicity, as the mussels can mobilize more of elements bound in sediment.

Malletts Bay is on the Department of Environmental Conservation's Part A list of 303(d) waters, those which require a Total Maximum Daily Load plan, for mercury and PCBs found in the fish. Because of arsenic, manganese, and nickel in the sediments, Malletts Bay is on the Department of Environmental Conservation's Part C list of waters which may require a Total Maximum Daily Load plan if further investigation shows them to be in violation of water quality laws (Vermont Department of Environmental Conservation 2000).

3.3.1.3. Invasive Species

Further degradations of Lake Champlain which affect Malletts Bay include the invasive species sea lamprey (*Petromyzon marinus*), zebra mussel (*Dreissena polymorpha*), and Eurasian milfoil (*Myriophyllum spicatum*). Lampreys have been identified as threats to the lake's native lake trout and salmon fisheries and its introduced rainbow (steelhead) trout fishery. An eight-year program to control lampreys resulted in a significant reduction in the scars from lampreys, and the Fisheries Technical Committee of the Lake Champlain Fish and Wildlife Management Cooperative recommended the program continue (Nashett et al. 1999). Zebra mussels are small mollusks whose dense growth encrusts solid objects and allows them to outcompete native mussels. They have had an impact on native

mussel populations in outer Malletts Bay (Vermont Department of Environmental Conservation 2000).

Eurasian milfoil is a highly invasive and aggressive aquatic plant which outcompetes native plants and clogs waterways with its dense growth. The Vermont Department of Environmental Conservation has identified a Eurasian milfoil infestation in Malletts Bay, but notes that weevils, which can control the milfoil, are present in Lake Champlain (Vermont Department of Environmental Conservation 2000). The Town's Master Plan says that Eurasian milfoil is "present but not pervasive" (Town of Colchester Vermont 2001).

3.3.1.4. Other

Muskellenge and northern pike in Lake Champlain have fallen victim in increasing numbers to what appears to be a viral disease, esocid lymphosarcoma, which produces large tumors. The Vermont Department of Fish and Wildlife has warned fishermen not to eat fish with tumors. This is termed a precautionary measure; no human health effects are known from eating infected fish (Associated Press 2002).

3.3.2. Inner Malletts Bay

Degradations affecting outer Malletts Bay also affect inner Malletts Bay. (However, much less is known about sediment contamination in inner Malletts Bay, as the study consulted (McIntosh, Watzin, and Brown 1997) had only one sampling location in all of the inner bay.) In addition, the waters of inner Malletts Bay are affected by pathogen contamination near the shore, which may cause swimmers to become ill. The Town of Colchester has been taking water quality samples, mostly at outlets to tributaries and at recreational areas, during the summer for over ten years. The annual reports on these data are a rich source of information on Malletts Bay water quality. Many of the sites sampled have fecal coliform and/or *E. coli* densities greater than Vermont state safety limits for recreational waters. (The current standard is 77 MPN *E. coli*/100 ml; MPN stands for Most Probably Number and refers to the number of bacteria that are capable of forming colonies under specified conditions in the laboratory.) Table 3 shows figures for some "hot spots" during eight years of sampling (Gabos 2000); the author comments, "This is a rough method of comparison, since the exact location a sample is taken will change from year to year and within the year, depending on height of the lake and flow in streams."

Sample site	1991	1992	1993	1994	1995	1998	1999	2000	Avg. %
The Moorings Stream	30	31	35	42	92	19	27	31	38
Smith Hollow Stream	11	23	75	88	71	69	96	68	69
60 Lakeshore Dr. Stream	na	25	15	5	32	25	23	21	21
28 Lakeshore Dr. Stream	11	46	25	10	39	50	23	55	32
Crooked Creek	60	23	65	64	52	38	100	90	61

Table 3. Percentage of summer sample dates on which fecal coliform and/or *E. coli* densities exceeded Vermont state safety limits for recreational waters, for selected sampling spots in inner Malletts Bay. Source: (Gabos 2000)

Before the 2001 summer season, a baffle box to catch stormwater sediment was installed in the stream at The Moorings marina. In 2001, the percentage of samples for which state *E. coli* limits for recreational waters were exceeded at that spot dropped to 17% (4 out of 24), much lower than the average in Table 3 of 38% and somewhat lower than the previously recorded low of 19% (Foley 2001). The low rainfall in 2001 may have played a role in the reduction, as well.

In 2001, a study was performed to find a connection between wind and *E. coli* levels high enough to lead to beach closings (Foley 2001). No correlation was found.

E. coli and fecal coliform bacteria are indicator organisms, so they do not directly translate into information about pathogens coming from humans or those which are capable of infecting humans. Identifying the species from which *E. coli* bacteria come from helps indicate to what extent they may be correlated with human pathogens, and it also gives a clue as to what sort of control measures are likely to bring about reduced *E. coli* levels. To identify the origin of bacteria found in Malletts Bay and the Winooski River, a microbial source tracking study was undertaken in 2001 (Jones 2002). A process called DNA ribotyping was used to determine what species the *E. coli* sampled had originated from.

The DNA of *E. coli* found in water samples from Malletts Bay and the lower Winooski was compared with that from *E. coli* taken from the feces of a number of mammal species in the areas—seagulls, raccoons, cats, cows, mallards, and humans (septic tank and wastewater treatment plant samples). This emerging technology gave limited results, with only 28% of the 176 *E. coli* which were found successfully matched with a host species, even at the lowest threshold of similarity used to identify a positive match (80%).

For the thirty isolates successfully matched in Colchester, deer were the most frequently identified host species, with six isolates; i.e., six *E. coli* bacteria from all the water samples were matched with those known to originate from deer. Humans and raccoons each had five isolates. Of the samples of water draining to Malletts Bay, three of the fifteen successfully identified isolates came from humans, and of

the samples of water draining to the Winooski River, two of ten successfully identified isolates came from humans. The human isolates were found in the storm drain outfall at 60 Lakeshore Drive (1), the mouth of Smith Hollow Creek (2), and Sunderland Brook at the Pines Island Road crossing (2). In addition to the human isolates, the storm drain outfall at 60 Lakeshore Drive had isolates from cat, gull, raccoon, and two unknowns. Smith Hollow Creek had isolates from cat, coyote, deer, mallards, and raccoon, with one unknown. Sunderland Brook had isolates from chicken and muskrat, with seven unknowns.

Jones explains that there is no basis in the data or the literature to speculate on what the distribution of unknowns might be (pers. comm.). In other words, while the data indicate that a number of organisms are contributing to *E. coli* counts in Colchester's waters, 72% of the *E. coli* found were not successfully matched to any host organism, so a large degree of uncertainty about the magnitude of any organism's contribution remains.

3.3.3. Rivers, Streams, and Colchester Pond

While the Lamoille River contributes a large quantity of water to outer Malletts Bay and the Winooski River drains and borders a significant fraction of Colchester, most of the water in the rivers comes from upstream of Colchester. Colchester can do relatively little to influence water quality in the rivers, so relatively little effort was put into finding studies on the river water quality. More effort was put into finding information on the streams and Colchester Pond.

3.3.3.1. Winooski River

The Winooski River conveys a large load of phosphorus to the broad lake of Lake Champlain, 83.8 metric tons in 1991. Vermont's Department of Environmental Conservation (DEC) has identified a mercury impairment in the lower 6.5 miles of the river (Vermont Department of Environmental Conservation 2000) and put this section of the river on the 303(d) Part A list (impaired waters, for which a Total Maximum Daily Load plan must be developed).

3.3.3.2. Lamoille River

The Lamoille River carries nearly all of the phosphorus load to Malletts Bay. In 1991, a total of 32.9 metric tons of phosphorus was transported to Malletts Bay (Lake Champlain Basin Program 2002), and 29.6 metric tons of this total was transported by the Lamoille River (Vermont Department of Environmental Conservation 2000). Vermont's DEC has identified a possible nutrient impairment at the mouth of the river and put the mouth of the river on the 303(d) Part C list. Designation on the Part C list means that the river will be included in the next

303(d) list (Part A: Impaired Waters) if assessment results show it to be in violation of water quality standards.

Vermont's Department of Environmental Conservation (DEC) has identified a mercury impairment in the lower 6.5 miles of the river (Vermont Department of Environmental Conservation 2000) and put this section of the river on the 303(d) Part A list.

The DEC has also identified the lower Lamoille River as possibly impaired (303(d) Part C) for swimming by high levels of pathogens, possibly coming from failing septic systems. Dams on the lower Lamoille lead to an "artificial and poor flow regime [which] impairs all uses," according the DEC (Vermont Department of Environmental Conservation 2000).

The Lamoille River is also a primary contributor of trace metals to Malletts Bay, concluded a report on sediment toxins (McIntosh, Watzin, and Brown 1997). While the report did not attempt to quantify the present contribution of the Lamoille River, the studies found high levels of arsenic and other metals at the mouth of the Lamoille, where they had presumably come from upstream sources like surface mines and mine tailings piles, atmospheric deposition, and erosion of soils and rocks.

3.3.3.3. Streams

The Vermont Department of Environmental Conservation has issued a report card on the water quality in Colchester's streams, using measures of biological integrity, including counts of insects, other aquatic invertebrates, and fish. The latest results are given in Table 4.

A collection of small streams called "direct smaller drainages to inner Malletts Bay" have been placed on the 303(d) Part A list for *E. coli* levels. Indian Brook is on the Part A list from the lake upstream 9.8 miles to Butlers Corner, because of its poor biological condition and habitat degradation. The length of Sunderland Brooks is on the Part A list for toxins and undefined pollutants. Morehouse Brook is currently on the Part A list but has been suggested for delisting, as stormwater management plans are in place (Vermont Department of Environmental Conservation 2000).

In addition, the DEC has found a number of possible impairments in Indian Brook, Malletts Creek, and "direct small drainages leading to Malletts Bay;" all of these are on the 303(d) Part C list (Vermont Department of Environmental Conservation 2000).

Stream/% of Watershed Impervious	Site	Nutrient Index	Clean Water Species	Insect Diversity	Insect Density	Insect Community Assessment	Fish Community Assessment
Allen Brook	Above	No data	No data	No data	No data	No data	No data
% 3.0*	Below	E	P	G	918	Passes	Passes
Indian Brook	Above	VG	F	E	1098	Passes	Fails
% 6.3	Below	E	P	G	2532	Fails	Passes
Malletts Creek	Above	G	G	F	444	Fails	Fails
% 2.0*	Below	VG	VG	E	1642	Passes	No data
Morehouse Brook	Above	E	P	F	969	Fails	No data
% 13.6	Below	E	P	P	133	Fails	No data
Colchester Pond	Above	No data	No data	No data	No data	No data	No data
%7.0*	Below	G	P	VG	1016	Fails	Passes
Sunderland Brook	Above	G	P	F	1638	Fails	Fails
% 11.4	Below	F	P	P	34	Fails	Passes

* Measurement only includes area within Colchester town line

Table 4. Vermont Department of Environmental Conservation's water quality report for Colchester. E=Excellent VG=Very Good G= Good F= Fair P=Poor An upward (blue), downward (red), or not apparent (yellow) trend in water quality is indicated where three or more years of data exist. "Above" refers to the upstream sample station and "below" refers to the downstream station; exact locations are not specified. Source: (Vermont Department of Environmental Conservation, n.d.)

In Malletts Creek, possible pollutants include nutrients at the mouth and, for 3.5 miles upstream, sediments, nutrient and organic enrichment, and pathogens. The possible pollutants are listed as land development, erosion/sedimentation, and urban runoff, with a note that the creek delivers 1.7 metric tons phosphorus to Malletts Bay each year.

In Indian Brook, pathogens are listed as possible pollutants, possibly originating in failed septic systems.

The direct small drainages to Malletts Bay are listed as possibly having sediment, nutrient and organic enrichment, and pathogens as pollutants, arising possibly from urban runoff and septic system failures.

3.3.3.4. Colchester Pond

Results from the Winooski Valley Park District (WVPD) from monitoring in 2001 show that the State *E. coli* standard for contact use of 77 MPN/100 ml was exceeded three times out of thirty one sampling events at a site at the south edge of the lake. At the southwest shore, however, closer to the visitor parking lot, the maximum value out of 39 samples was 23 MPN/100 ml. WPVD's phosphorus measurements showed the pond to be mesotrophic (medium level of nutrients), with median measurements of 18 ppb P. The Vermont Department of Environmental Conservation (DEC) designates the pond as eutrophic (high level of nutrients), based on five years of spring phosphorus readings averaging 36 ppb P. The DEC has also designated the pond's aesthetics, aquatic life, secondary contact use, and swimming uses as threatened, based on potential algal blooms and oxygen depletion in the deep water and some shoreline periphyton (attached algae) (Vermont Department of Environmental Conservation 2002). Thirty-three acres of the pond are threatened by Eurasian milfoil, reports the DEC, as the pond is near an infested Lake (presumably Lake Champlain).

3.4. Human Impacts on the Watersheds

This section sketches what is known about human uses that affect the watersheds in Colchester, which may be causes of some of the impairments described above.

3.4.1. Drinking Water and Wastewater

In 1997, a wastewater facility plan update (Forcier Aldrich & Associates 1997) was delivered to the Town, and this also contains some information about drinking water. Geographically, much of the town is served by private water supplies (i.e., fewer than ten service connections, serving fewer than twenty five people, or operates fewer than sixty days per year) coming from groundwater (Figure 2). Much of the population, however, is served by public water distributed by Fire Districts 1-3 or directly by Champlain Water District. Fire District 2 gets their water from Burlington, which takes it from an inlet 4200 feet out from the Coast Guard station at the Burlington waterfront, in 50 feet of water (Dion, pers. comm.). Fire Districts 1 and 3 get their water from Champlain Water District, which has an intake in Shelburne Bay, in 75 feet of water, half a mile offshore (Fay, pers. comm.)

Wastewater treatment and dispersal in most areas of town are predominantly accomplished with individual, onsite systems. Exceptions include the Exit 16 area, the Route 15 area, the Breezy Acres trailer park, and Severance Corners, from which municipal wastewater is pumped to the City of South Burlington Airport Parkway Water Pollution Control Facility, on the south side of the Winooski River. Creek Farm Plaza is also in this sewer service area, but onsite systems are also in use on some properties there. The other exception is the Fort Ethan Allen

Complex, where the Town of Essex' sewage collection system takes the wastewater to the Tri-Town Wastewater Treatment Facility in Village of Essex Junction.

The wastewater facility plan update divides Colchester into eleven wastewater management units, based on site suitability for onsite wastewater treatment, existence of wetlands or floodplains, type of potable water supply and distribution system, and current land use and zoning (Figure 3).

The Forcier Aldrich & Associates report concludes:

- Existing development is concentrated in areas favorable for individual onsite wastewater treatment systems.
- Many of the onsite systems in town are approaching the end of their useful life.
- Onsite systems seem to fail where site conditions are marginal.
- There is a public perception that seasonal camps' systems are polluting Malletts Bay.
- Telephone surveys have indicated that most home owners do not pump their septic tanks every four years; this can cause premature system failure.
- Onsite systems represent the lowest cost strategy in areas where soils and site conditions are favorable for it. Drinking water contamination may be minimized in areas of dense residential development by installing municipal water if there are individual wells in use for potable water.
- The user costs for centralized systems would be higher than in nearby communities, since US EPA subsidies are not available to the same extent as when those were constructed.

When water is imported into an area via municipal water lines and then infiltrated on site, the additional water will raise the local water table. This can affect stream flow and other local conditions. No mention of this issue was found in the literature examined.

3.4.2. Stormwater

Stormwater consists of runoff during and shortly after rainfall, and a large portion generally comes from impervious areas, like roofs, roads, and parking lots. Stormwater constitutes a potential threat to water resources in three ways: 1) During a rainstorm, a higher percentage of the precipitation runs off impervious areas than pervious areas. This means that peak flows in streams are increased, which increases their erosive power or even their potential for flooding. 2) Increased runoff from impervious areas means that the water is not infiltrating into the ground to recharge the water table. This can aggravate the effects of a drought on

plants, stream base flow, and groundwater-based drinking water supplies. 3) Stormwater can carry with it a wide range of pollutants, from lawn fertilizers and pesticides to oils, organic compounds, and metals from roads to fecal matter from domestic animals and wildlife.

No figures on the effect of stormwater on water quality in Colchester have been found. As indicated in 3.3.3.3, the recent stormwater plan (Griffin International 2002) rates relative degradation of subwatersheds from stormwater. An empirical indication of the effects of stormwater is found in the 2001 Water Quality Inventory Report for Malletts Bay (Foley 2001), which noted numerous cases where rainfall seemed to be followed by elevated levels of *E. coli*, in streams and even in Malletts Bay and the broad lake. No statistical analysis is presented in this report, however.

Despite the lack of firm quantification, several factors indicate that stormwater-based degradation is and will continue to be of concern in Colchester. First, there is a strong correlation between the amount of developed land and the amount of phosphorus and other pollutants in the streams and rivers which flow to Lake Champlain (Lake Champlain Basin Program 2002, Budd and Meals 1994). Second, urban runoff and land development have been identified by the Vermont DEC as possible sources of pollution in Allen Brook, Indian Brook, Malletts Creek, Sunderland Brook, and direct smaller drainages to Malletts Bay. Third, the Vermont Agency of Natural Resources has indicated that the National Pollutant Discharge Elimination System (NPDES) Phase II stormwater standards will soon be applied to the densely populated parts of Colchester (Soboslai, pers. comm.).

No description of current stormwater infrastructure has been found. In the summer and fall of 2002, the Town is performing a comprehensive inventory of the stormwater outfalls, noting their location with GPS (Global Positioning System) technology and noting properties like the condition, downstream erosion, etc. (Soboslai, pers. comm.).

3.4.3. Land Use

As mentioned above, the amount of developed land in a watershed correlates well with water pollution. In order to reduce this impact, Colchester has a Watercourse Protection District within 85 feet of "the center of the main channel of Allen Brook, Indian Brook, Malletts Creek, Pond Brook and Sunderland Brook and from the center of all tributaries of the above named streams and all other minor streams" (Colchester Zoning Regulations, Sec. 301). In this buffer strip there are restrictions on building structures and on what may be done there. A buffer strip like this protects waterbodies from water pollution by providing an area where soil and plant roots can filter out some of the pollutants from stormwater. They also provide an

area where rising waters encounter only vegetated soil, which slows down flooding effects and often resists erosion better than human-made structures, in the long run.

As with stormwater, no figures have been found on the effect of land use on Colchester's water quality. The following comments clarify how land use affects water quality, directly and indirectly.

Land use affects water quality directly through wastewater and stormwater impacts. Wastewater from onsite systems, if not properly treated and dispersed, can carry nutrients and pathogens to groundwater or surface water. All other things being equal, stormwater quantity increases and its quality decreases with development that increases impervious areas.

Land use, together with transportation policy, affects water quality indirectly, through the number of roads in town and car trips made. Land use patterns where houses, retail sales, and commercial areas are close together encourage short commutes and walking or cycling instead of driving. Land use clustered around a good mass transit system is another way to discourage driving. Since water quality is degraded by salt, sand, oil, gasoline, other organic compounds, and other substances that accumulate on roads, increasing roads or road use tends to decrease water quality. Increased road use by commercial vehicles also increases the danger of tanker spills of hazardous chemicals, a single one of which could severely affect water quality locally or even regionally.

While urban land contributes disproportionate amounts of polluted runoff to watersheds, the contributions from agricultural land can also be significant. Sixty six percent of the average annual phosphorus load to Lake Champlain comes from agricultural sources (Budd and Meals 1994).

3.4.4. Recreational Use Of Waters

No major water quality issues stemming from recreational use of waters in Colchester have been identified in the literature search. There are potential concerns. Boat motors add oil and gas to the water both during use and during fueling. Boat sewage adds pathogens and nutrients to the water, if not properly emptied at a receiving station. Boats can transport exotic, invasive species from one waterbody to another.

At a meeting conducted as part of this Strategic Water Quality Plan process, local marina representatives indicated that boat owners policed themselves pretty well now. Two or three people a year are fined for pumping their sewage overboard, mostly non-locals. A nearby island that is crowded with boaters has very clean

water. And the new engines, even two-stroke engines, are much cleaner than before. As the old engines get replaced, pollution from them will be less of a problem.

Fueling remains a problem, they acknowledged, and fuel spills are "almost unavoidable."

3.5. Recommendations

These recommendations have been drawn from the literature consulted. They are organized to roughly follow the order of the presentation above. Some of the recommendations would have an effect on more than one waterbody, but they have only been listed once. The recommendations for mitigating degradation to waterbodies also overlap some with recommendations pertinent to the specific human uses of the water.

Some of the literature consulted establishes water quality degradation without recommending actions to mitigate it, and some is comparatively heavy in recommendations. The recommendations below have been compiled from the literature consulted, but no attempt has been made to match the number or reach of the recommendations to severity of water quality degradation in Colchester. Some of the recommendations are on a lake-wide basis for Lake Champlain and not intended for Colchester's particular array of water quality issues.

Note: These recommendations were those found in the literature which was consulted in an early stage of the Strategic Water Quality Planning process. They were considered when compiling the alternatives which were selected from for this Strategic Water Quality Plan. However, inclusion of a recommendation in this section by no means constitutes an endorsement of the recommendation by this Plan.

3.5.1. Outer Malletts Bay

3.5.1.1. Nutrients

The following recommendations are quoted from the 2002 draft plan for Lake Champlain (Lake Champlain Basin Program 2002):

- Collect and analyze land use information in order to estimate the increase in phosphorus load that occurs with new development and to help target improved stormwater management to those areas experiencing the most rapid growth.
- Develop new options to offset the phosphorus load generated by new development.
- Increase efforts to reduce phosphorus loadings from new development by assisting local efforts to promote land use planning and innovative subdivision practices that discourage urban and suburban sprawl.
- Implement retrofitted stormwater management systems and other measures to reduce phosphorus loads from existing urban and suburban areas.

- Work with the state and local stormwater management programs to minimize the phosphorus load generated by new development and reduce the phosphorus load from existing areas undergoing redevelopment, including providing assistance for local compliance with USEPA Phase II stormwater rules.
- Increase training opportunities for local road supervisors and crews to encourage implementation of BMPs for road construction, repair and maintenance, according to the standards in state backroads, stormwater management, and erosion and sediment control handbooks.
- Encourage implementation of erosion and sedimentation control practices for construction activities.
- Encourage nutrient management on commercial and residential properties.

3.5.1.2. Toxins

The Lake Champlain Basin Program Technical Report on sediments contaminated with metals in outer Malletts Bay concludes that there is little to be done that has much effect (McIntosh, Watzin, and Brown 1997). Reducing metal inputs is one option the authors mention, though they caution, "Even with loadings reductions, changes in the bay would likely be extremely slow because of existing conditions."

Because levels of arsenic in some portions of the bay are near the proposed federal standards for drinking water, "any use of Outer Malletts Bay for drinking water purposes needs to be carefully evaluated."

Additional analyses of the ecological effects of arsenic and magnesium in the littoral (near-shore) sediments is recommended, following up on the toxicity on fathead minnow eggs and larvae found in this study.

Noting that zebra mussels in large numbers could mobilize more toxic metals from the sediment, the authors recommend "that this concern be addressed as the zebra mussel invades Outer Malletts Bay in large numbers." It is unclear how they wish the concern to be addressed.

3.5.1.3. Invasive Species

No recommendations appropriate for action at the town level were found in the literature. The Lake Champlain Basin Program web site (http://www.anr.state.vt.us/champ/action.htm#nuistips) recommends actions for individuals. Education around the quoted actions could be the basis of a local program:

- Each time a boat or other item is used in water bodies infested by zebra mussels or other nuisance aquatic species, the boat, trailer, and equipment should be carefully inspected for evidence of these species. Remove any mussels or vegetation and dispose of them in the trash.
- Drain all water from the boat, including the bilge, live well, and engine cooling system.

- Dry the boat and trailer in the sun for at least five days, or if you use your boat sooner, rinse off the boat, trailer, anchor, anchor line, bumpers, engine, etc. with hot water or at a car wash.
- Leave live aquatic bait and bait used in infested waters behind- either give it to someone using the same water body, or discard it in the trash.
- When recreating in areas infested with Eurasian watermilfoil, be careful not to break apart the plant since milfoil spreads by plant fragments.
- Contact the Vermont Department of Environmental Conservation, the Lake Champlain Basin Program, and the New York Department of Environmental Conservation to find out how to become involved in monitoring and outreach activities to help prevent the spread of nuisance nonnative aquatic species in the Lake Champlain Basin.

3.5.1.4. Other

For esocid lymphosarcoma in muskellenge and northern pike, no recommendations were found for action, other than that individuals refrain from eating the fish with tumors.

3.5.2. Inner Malletts Bay

The following list of recommendations is drawn from several years of reports by the Town's Water Quality Coordinators. Recommendations already acted on have been omitted:

- The Town should develop a septic maintenance ordinance and septic system management program
- The Town should have stronger enforcement of leash laws and pooper scooper laws, with signs to explain why this is being done.
- Investigate better ways to manage stormwater (use "low impact development")
- "Wish list" studies include:
    - Inventory of streams to Malletts Bay, using a variety of biological, chemical, and physical parameters to monitor health
    - Land use study of human impacts in entire watershed, or at least impacts adjacent to watercourses
- Education
    - Pamphlets and/or signs to educate people on problems caused by feeding ducks, placed adjacent to Malletts Bay and marinas
    - Public education about non-point source pollution. In particular, more educational outreach to homeowners about individual practices and their effect on the lake: particularly runoff.
- Since beach closures coincide closely with rain events, use rain to pose advance warning of beach closings before the results of fecal coliform tests are available, which takes around 27 hours after sampling. (This could mean either warning people of increased risk without closing the beach or risking closing the beach when fecal coliform limits not exceeded.)
- Install a riparian buffer strip for Bayside Beach.

3.5.3. Rivers and Streams

Among the recommendations in the current draft of the Lake Champlain Basin Program's plan for the lake (Lake Champlain Basin Program 2002), the following are directly relevant for rivers and streams:

- Expand programs for streambank restoration and the installation of vegetated buffer areas along eroding streams and rivers
  Studies have shown that vegetated areas along streams and rivers can effectively filter sediment and phosphorus from runoff and reduce streambank erosion, while creating habitat for wildlife. Stream geomorphology concepts can be used to determine where and how to address problems with erosion so that the entire stream system remains more stable over time.

  a) Use geomorphic assessment and other techniques to target reaches where significant phosphorus loading may be occurring as a result of erosion.
  b) Develop or expand programs which cost share or offer tax incentives for voluntary restoration or protection of buffer strips on perennial streams, rivers and lakes in the Basin.
  c) Develop a GIS database of reaches needing buffer areas for use by programs such as the NY and VT Conservation Reserve Enhancement Program (CREP) and the USDA Environmental Quality Incentives Program (EQIP)....
  f) Increase programs aimed at informing professionals working on streams (e.g., municipal officials, landscape architects, etc.) about the value and importance of buffers and stable streams.
  g) Identify additional funding sources for streambank restoration.

- Develop Incentives for Local Municipalities and Private Land owners to Restore, Enhance and Maintain Wetlands and Stream Corridors.
  Tax incentives are another way to encourage private wetlands and stream protection and restoration efforts. Under this option, a task force could be established to develop legislation to alleviate part of the tax burden for landowners who practice habitat conservation.

- Increase funds and technical resources for local governments to implement BMPs for new development which will protect wetlands, stream corridors and riparian habitat
  Encourage local governments to:
  a) Improve stormwater management through local zoning and subdivision regulation and appropriate use of the National Pollutant Discharge Elimination System (NPDES) and State Pollution Discharge Elimination System (SPDES) permit system, including EPA Phase 2 stormwater regulations.
  b) Emphasize erosion hazards, floodplain functions, sedimentation controls, habitat protection and use of natural vegetation as requirements in local zoning and subdivision regulations.
  c) Apply infiltration and other BMPs in new developments.
  d) Apply surface water setbacks and buffer strips in new developments.
  e) Employ appropriate growth management options.
  f) Assess cumulative impacts of new development.
  g) Promote innovative site design that reduces creation of impervious surfaces.
  h) Promote road maintenance standards for sediment control and initiate training programs for town highway departments to minimize impacts of

road maintenance activities on water quality, streambank stability and native wetland species.

3.5.4. Wastewater

The 1997 wastewater facility plan update makes a number of detailed recommendations for each wastewater management unit. The recommendations are based on a screening analysis, using nine criteria. Weights were assigned to the criteria in cooperation with Town staff and the Colchester Wastewater Management Steering Committee. Consequently, the recommendations may no longer represent today's needs, if preferences of today's townspeople are different than those of the Town staff and the Wastewater Management Steering Committee at the time this weighting was done. Nonetheless, the most general recommendations are presented here:

- The Town should consider more stringent design and construction standards for onsite wastewater systems.
- The Town should implement an expanded onsite wastewater management program.

3.5.5. Stormwater

The recent stormwater management plan (Griffin International 2002) contains recommendations for best management practices (BMPs) to use in each subwatershed. These are too detailed to be included here; the reader is referred to pp. 61-72 of that report. Non-structural BMPs recommended for the town as a whole are:

- revision of town zoning laws
- update of highway codes
- public education initiatives
- town programs unspecified

  In addition, the following non-structural BMPs are recommended for many of the subwatersheds:
- ending illicit connections and discharge
- stormwater credits (non-structural BMPs used on a new construction site reduce the requirement for structural BMPs)

A stormwater ordinance has also been drafted for the Town's consideration. The consulting team says that it "will satisfy a significant portion of the requirements of the EPA NPDES Phase II Stormwater Regulations."

3.5.6. Land use

The current draft of the Lake Champlain Basin Program's plan for the lake (Lake Champlain Basin Program 2002) calls for estimating "the nonpoint source

phosphorus load that is being generated by developed land uses (urban and suburban land, roads, etc.) in the basin and work[ing] aggressively to reduce this load." The plan continues:

> Based on an LCBP analysis in 2000, it appears that increased phosphorus loads generated by land use changes in the Basin are offsetting some of the gains achieved by point and agricultural nonpoint source reduction efforts. Other studies have shown that developed land typically contributes more phosphorus per unit area of land than other land use types. As the population within the Basin increases, there is the opportunity to encourage growth away from the land-intensive suburban sprawl-type development and to better manage the resulting polluted urban stormwater to minimize increases in phosphorus loads to the Lake.

The work put into the Strategic Water Quality Plan will be important to the land-use decisions in Colchester, according to the present Draft Master Plan (Town of Colchester Vermont, 2001):

> Planning should drive infrastructure (as opposed to available infrastructure determining planning). As soon as the Water Quality Committee makes its recommendations to the Town, Colchester needs to review its plans for utilities, facilities, and services to ensure they are compatible and coordinated with any recommendations.

3.5.7. Recreational Use of the Waters

No specific recommendations for reducing impact from recreational use of the receiving waters were found in the literature consulted.

3.6. Conclusion

This report has, on the basis of a number of studies consulted, identified water resources in Colchester, degradation they exhibit, and the impact of specific human activities on the water resources. It has also presented selected recommendations for actions to maintain and improve water quality.

No one report or study attempts to prioritize these water resources according to their value to the town or townspeople or to prioritize recommendations for actions to improve Colchester's water quality. The Lake Champlain action plan (Lake Champlain Basin Program 2002) does prioritize its recommendations in various categories of action, but priorities for Lake Champlain may not directly translate into priorities for Colchester.

The Strategic Water Quality planning process will identify tasks for closer examination, and townspeople will be given the opportunity to prioritize them. These priorities will emerge out of public meetings and other input processes, which Colchester's Water Quality Committee will use to set priorities for the future. We hope that this report will prove useful in that process.

4. GOALS FOR THE STRATEGIC WATER QUALITY PLAN

Goals related to water quality were identified as part of creating this plan. These goals, suggested by the consultants and endorsed (with revisions) by the Water Quality Committee, were meant to reflect what Colchester residents desire for the town's waters. It was recognized that for some of these goals, we are not aware of any means to achieve them in the short run and/or with the resources of Colchester alone. For example, health advisories are issued on fish in Colchester because of contamination with mercury and PCBs, and the mercury originates primarily with coal-fired electrical power plants west of Vermont, while PCBs originate elsewhere in Lake Champlain.

More context for the goals is found in the literature survey section of this plan.

Goals were classified as having very high priority, high priority, and medium priority. The order of appearance within each section does not necessarily reflect a finer priority scale.

4.1. Very High Priority Goals

Reduce bacterial contamination to and in Malletts Bay in order to eliminate closures of public beaches and ensure that water at major recreation areas meets contact recreation standards throughout the recreation season. This was the most important goal, as perceived by members of the Water Quality Committee and judging from public comments.

Reduce phosphorus loads to Malletts Bay to levels recommended by the Vermont Agency of Natural Resources (ANR). The ANR is part of an international agreement to reduce phosphorus loads to a level where Lake Champlain no longer is found to be impaired because of eutrophication (over-fertilization) caused by excessive phosphorus inputs.

Improve the water quality in Sunderland Brook to achieve good or better on all of Department of Environmental Conservation's(DEC's) biological assessments. The DEC conducts a number of biological assessments of water quality in streams. These results are presented on a five-point scale: Excellent, Very Good, Good, Fair, or Poor. Sunderland Brook was judged not to meet water quality standards, i.e., to be impaired, based on recent data.

Ensure no increase in invasive species in Malletts Bay and no entry of invasive species to Colchester Pond. Colchester Pond is not known to harbor in invasive species, also known as aquatic nuisance species, but its proximity to Lake Champlain makes it vulnerable to invasive species.

Improve water quality so that fish caught in Colchester's water are edible, with no restrictions. Health advisories are currently in effect for all fish, especially walleye and lake trout.

Reduce sediment loads to Colchester streams, river, and the lakes. Sediment is the principal pollutant of concern on impaired Sunderland Brook and has been identified as a pollutant of concern in other streams.

4.2. High priority goals

Improve the water quality in non-impaired creeks and Colchester Pond to achieve good or better on all of Department of Environmental Conservation's biological assessments. Monitoring data are now available for Allen Brook, Indian Brook, Malletts Creek, Morehouse Brook, Sunderland Brook, and Colchester Pond.

Ensure no net loss of Class I, II, or III wetlands. Class I and II wetlands are protected by Federal and State regulations; some Class III wetlands are protected by Federal regulations. "No net loss" can be defined as maintaining existing wetlands but allowing development which disturbs wetlands in some cases, if an equally valuable wetland is created or reclaimed elsewhere.

Where surface water and ground water quality now meets standards, ensure that no degradation occurs. The Plan is designed not only to improve water quality where it is degraded, but maintain the quality of waters which are not degraded.

4.3. Medium priority goal

Improve water quality by eliminating contamination by oil and fuel from boats. Contamination comes both from fueling operations and the use of older, inefficient motors.

5. ACTIONS PRIORITIZED IN EACH CATEGORY

5.1. Wastewater

Wastewater can be loosely defined as "used" water. Although most people think of wastewater as what goes down the drains or the toilet and out of a house, wastewater can also include water used in car washes, hair salons, industrial plants, and many other applications. Treating wastewater before releasing it to soils or surface waters benefits human and environmental health.

Many different types of systems and techniques are used to treat wastewater and return it to the environment. These can be generally divided into "centralized" and "decentralized" wastewater treatment systems. Centralized treatment systems collect wastewater from a large number of homes and businesses, treat the wastewater in a central plant, and discharge the treated water into surface waters. Decentralized wastewater treatment systems treat sewage from homes and businesses that are not connected to centralized treatment systems. Decentralized systems include conventional septic systems, cluster systems (conventional systems that collect wastewater from a number of homes and businesses), and "advanced" wastewater treatment technologies like trickling filters, textile filters, or recirculating sand filters. Advanced systems are generally installed at sites where conventional soil-based disposal systems cannot be used because of inadequate soils, excessive slopes, high seasonal ground water tables, or other factors. Even using advanced systems, however, there may be some properties where onsite treatment may not work (particularly if initial lot sizes are too small or if a residence is too close to a waterbody).

5.1.1. Description of current and ongoing activities

Wastewater treatment and dispersal in most areas of town are predominantly accomplished with individual, onsite systems. There are approximately 6,200 onsite wastewater treatment systems in Colchester. Areas served by municipal sewer include the Exit 16 area, the Route 15 area, the Breezy Acres trailer park, and Severance Corners; the wastewater is pumped to the City of South Burlington Airport Parkway Water Pollution Control Facility, on the south side of the Winooski River. Creek Farm Plaza is also in this sewer service area, but onsite systems are also in use on some properties there. The other area with sewer is the Fort Ethan Allen Complex, where the Town of Essex' sewage collection system takes the wastewater to the Tri-Town Wastewater Treatment Facility in Village of Essex Junction.

Forcier Aldrich & Associates' 1996 Wastewater Facility Plan Update divides Colchester into eleven wastewater management units, based on site suitability for

onsite wastewater treatment, existence of wetlands or floodplains, type of potable water supply and distribution system, and current land use and zoning (Figure X).

The Forcier Aldrich & Associates report concludes:

- Existing development is concentrated in areas favorable for individual onsite wastewater treatment systems.
- Many of the onsite systems in town are approaching the end of their useful life.
- Onsite systems seem to fail where site conditions are marginal.
- There is a public perception that seasonal camps' systems are polluting Malletts Bay.
- Telephone surveys have indicated that most homeowners do not pump their septic tanks every four years; this can cause premature system failure.
- Onsite systems represent the lowest cost strategy in areas where soils and site conditions are favorable for it. Drinking water contamination may be minimized in areas of dense residential development by installing municipal water if there are individual wells in use for potable water.
- The user costs for centralized systems would be higher than in nearby communities, since US EPA subsidies are not available to the same extent as when those were constructed.

From 2001 to 2003, Stone Environmental, Inc. and Forcier Aldrich & Associates investigated the feasibility of using locations near the Exit 17 growth center for cluster systems, i.e., decentralized wastewater treatment systems. Sufficient soil-based capacity for the growth center was preliminarily identified, so that the growth center may be built out without centralized wastewater collection and treatment systems.

In the Bellwood subdivision, drainage was installed in 2002 to lower the local water table. The water table levels are being monitored now to assess the effects. Lowering the water table will hopefully provide conditions for more effective treatment by the neighborhood's onsite wastewater treatment systems, and will also protect area basements from flooding.

At Mills Point, a pilot program was launched to establish a wastewater management program that has since been expanded to include the rest of the town. The program also allows residents to convert camps to year-round residences, after inspection and, if necessary and/or possible, upgrade of the onsite wastewater treatment systems.

In connection with the Mills Point pilot program, the Town has purchased a wastewater management database program and is entering wastewater permit information into it. The data from Mills Point are currently being entered into the database, and data for the rest of the town's systems are planned to be entered subsequently. This database will facilitate monitoring of the onsite wastewater treatment systems, e.g., what operation and maintenance are performed on advanced systems, how often septic tanks are pumped for all systems, etc. Details of how this capability will be used for analyses and managing onsite systems for better wastewater treatment have yet to be worked out.

In 2002, the EPA awarded Colchester a $1.3 million grant for a program to address nonpoint source pollution. Part of that grant is planned to set up a revolving fund for residents to use to upgrade their onsite wastewater treatment systems with the help of low-interest or no-interest loans. Public education and outreach related to onsite wastewater treatment are also planned as part of this EPA-funded program.

An infiltration/inflow (I/I) study of the Town sewer collection system was initiated in February 2003. The objective of this work is to investigate the contribution of groundwater infiltration and stormwater inflow into the sewer system. The preliminary analysis, nighttime flow gauging, and manhole inspections have been recently completed. Locations of excessive I/I have been identified, and television inspection will be performed of these areas to identify the sources of flow and other deficiencies. Recomendations will be developed regarding appropriate techniques for rehabilitation of manholes and pipelines to reduce the excessive I/I flows. While data on the effect of sewer leakage are sparse, if I/I is occuring in places where the sewer line is above the groundwater table, contamination of the groundwater by the sewer line may occur. Identifying and fixing I/I will not only help increase the amount of wastewater Colchester may send to the South Burlington treatment plant, it may also protect groundwater quality.

5.1.2. Priorities for future action: Top ranked priorities

5.1.2.1. a. Needs assessment for onsite wastewater treatment systems

Action: The top wastewater-related priority for water quality protection in Colchester is to develop a knowledge base of the potential and actual failures of wastewater treatment systems through a townwide needs assessment using planning-level data, with limited field verification. Much of the knowledge base is already in place through previous studies. In addition, the Planning and Zoning Office plans to enter new permit information into a database and set up procedures for managing systems that are installed.

Phase I of a needs assessment builds the knowledge base necessary to make management decisions. Phase II, which could also be called a feasibility study, looks at options for meeting needs identified in Phase I.

A townwide needs assessment using planning-level data centers on a comprehensive, parcel-level inventory of all onsite wastewater treatment systems, in a database importable to GIS. This can be as simple as indicating for every parcel whether an onsite system is present or absent and whether the parcel is in commercial or residential use. Information on factors affecting design flow rates (number of bedrooms for residences, number of seats for restaurants, etc.) would also be helpful.

Combining numerous data sources in a geographic information system (GIS) format allows very much information to be compiled about the potential for lots to support well-functioning onsite wastewater treatment systems. Some field verification of some of the data, e.g., on soil types, is probably necessary. While this type of study—without a lot-by-lot assessment—does not give detailed information about the condition of existing systems, it does show where an off-site wastewater treatment solution is likely to be needed. It also can show where the highest priority areas are for managing or, if necessary, upgrading onsite wastewater treatment systems.

To accomplish Phase I:

- Establish which parcels are served by onsite systems.
- Estimate which parcels have limitations, based on soils, lot size, flood plains, surface water, wellhead protection areas, and setbacks. This gives an indication of which parcels may have inadequately sited onsite systems. (Inadequately sited onsite systems do not necessarily have an adverse impact on water quality, but they are more likely to do so.) Other information that will emerge is which developable parcels may not be able to site an onsite system.
- Perform a build-out analysis to see which developable parcels have limitations and to estimate nitrogen loading to groundwater.
- Estimate failure rates for existing systems.
- If feasible, examine water consumption records for those parcels with onsite wastewater systems and municipal water to see whether there are systems that may be significantly overloaded.
- If feasible, determine which parcels have had their septic tanks pumped with excessive frequency, e.g., four or more times per year. This is an indicator of a possibly failing onsite wastewater treatment system. (This is probably not feasible in Colchester now, due to lack of data on pumping rates.)

In addition to the study of the onsite treatment systems themselves, an assessment of wastewater contamination in private wells would show what impact, if any, onsite wastewater treatment systems have on drinking water. Tests for coliform bacteria, nitrate, caffeine, optical brighteners, and/or other substances could be used. Possible methods include:

- Request a review of Vermont Department of Health data from testing of private wells. The results of tests submitted to the Department of Health's laboratory are public data and may be used in investigations of this type.
- Institute a free, voluntary testing program for residents on private wells.
- Investigate whether there are state-regulated community water supplies in Colchester and what testing data from those are available.

A possible component of a needs assessment is also a GIS-based estimate of relative phosphorus loadings in watersheds. This is a low priority, however, since onsite wastewater systems are thought to contribute less than 5% of total phosphorus loading to Lake Champlain (Budd and Meals 1994, as cited in Lake Champlain Basin Program 1996).

The needs assessment with planning level data may identify parts of town for possible follow-up with a lot-by-lot needs assessment. This could be areas of town with large numbers of onsite systems located near critical water resources. In contrast to needs assessment using planning-level data, a lot-by-lot needs assessment involves coordination with and permission from property owners. Resources will be used most effectively when the importance of the lot-specific information is balanced against the difficulty of receiving permission to do the studies, the time necessary to do so, and the time and cost of doing the lot-by-lot investigation itself. A well-planned public input and public involvement program in connection with the lot-by-lot assessment will be crucial to its success.

Note: We recommend, below, a lot-by-lot needs assessment for the Lakeshore Drive area, because that level of investigation gives important information on which alternatives are most viable for handling wastewater from Lakeshore Drive residences and businesses.

Phase II of a needs assessment identifies options for handling the wastewater needs found in Phase I. The options may include constructing a sewer, an aggressive onsite wastewater management program, and cluster systems for offsite but decentralized wastewater treatment.

Responsible Party: The Planning and Zoning Office is managing current programs which are related to Phase I of the needs assessment, like the database for onsite systems and the review of replacement system design. For this reason, Planning and Zoning may be the right office to coordinate the needs assessment. The Public Works Department manages the Town's sewers and centralized wastewater treatment, which will likely be part of the solutions considered in Phase II, the feasibility study. Involving Public Works in Phase I will help ensure results from Phase I are most useful to the Phase II work.

Estimated effects: In the 1996 Wastewater Facility Planning Update, a number of areas of town were identified where onsite systems were old and apparently poorly maintained; e.g., the septic tanks were pumped infrequently or never. This leads to more likely conditions for surfacing of untreated effluent or inadequate treatment in the soil of the effluent, contaminating surface water or ground water. Of course, the water quality improvements achievable by addressing the needs found in a needs assessment cannot, by their very nature, be quantified before the needs assessment is performed. Similarly, present human health effects from poorly operating wastewater treatment systems may not be quantifiable without much more detailed health statistics than are routinely kept. However, the needs assessment is not only a step to improving water quality, it is also a critical step for focusing efforts to ensure that Colchester residents are protected from exposure to untreated or poorly treated wastewater.

SWQP goals potentially more easily addressed after Phase I, in Phase II:

- Reduce bacterial contamination to and in Malletts Bay
- Improve the water quality in non-impaired creeks and Colchester Pond
- Where surface water and ground water quality now meets standards, ensure that no degradation occurs

Necessary conditions: For a Phase I needs assessment with planning-level data, much of the data necessary have already been generated. The new project at Planning and Zoning to enter permit information from all systems into a database will also help the needs assessment. The cost of a Phase I needs assessment for the onsite systems conducted by a consultant is estimated at $120,000 to $150,000. Investigating the extent of contamination of drinking water, if any, may cost $2,000 to $10,000, depending on the method used.

The results of Phase I will strongly influence the costs of Phase II. In an extreme (and unlikely) scenario, if Phase I concludes that all onsite systems in town seem to be well constructed on favorable sites and well maintained, then the scope of Phase II would be limited to exploring ways to accomodate future growth.

5.1.2.2. b. Develop and adopt a townwide onsite wastewater management program.

Action: At present, homeowners in Colchester are required to get a permit from the Town for their onsite wastewater treatment system before it is installed. After installation, there is no further oversight from the town or any other authority to ensure that the systems are adequately maintained and performing satisfactorily. The 1996 Wastewater Facilities Update Plan reports that telephone surveys had indicated that many homeowners are not aware of the need for regular maintenance measures like pumping the septic tank. This suggests that many systems may have had little or no maintenance, possibly resulting in failed leachfields or failures of other components. Many older wastewater treatment systems on sites with high groundwater are also believed not to meet present design standards, so they may be performing inadequately.

An onsite wastewater management program is the tool that many jurisdictions are using to provide oversight of existing systems and help ensure that the systems receive adequate maintenance and perform properly. A management program can also be used to accelerate the replacement of inadequately performing systems and thereby increase the use of advanced treatment systems where necessary to achieve adequate treatment.

The management program could be part of Phase II of the onsite wastewater needs assessment (see above). As such, it could be targeted especially to identified needs. However, enough is known today to recommend certain basic measures, like educating residents on the advantages of regular septic tank pumping and tracking the frequency of pumping for each system. The initial management plan could work from universal management needs and local needs already identified, and then be modified when the results of the townwide needs assessment become available.

Possible measures that could be included in a management plan include:

- A general public education program on maintenance needs of onsite systems
- A special program to manage alternative systems
- Town-level operating permits for systems, at least those using pumps, blowers, or other mechanical equipment
- Required inspections of onsite systems at time of sale or at regular intervals
- Town-level certification of wastewater system service providers (designers, installers, maintainers, pumpers)
- Replacing inadequately performing system types (e.g. cesspools), at least in critical areas

- Requiring or encouraging regular pumping of septic tanks
- Financial incentives for upgrading onsite systems, e.g., through a revolving loan fund
- Promote water conservation, e.g., through increased information to the public and/or financial incentives.

5.1.2.3. Public involvement in the onsite wastewater management program

The most significant change for homeowners may be the adoption of an onsite wastewater management program that could include requirements to carry out regular inspections and/or a pumping schedule that is different than current practices. It is also possible that the onsite wastewater management strategy will ultimately identify certain onsite systems that need upgrading or replacing.

An effective wastewater program has the greatest prospects for success if town members play the primary role in its development. For this reason, it is important to put a significant effort into involving community members in the management program development program. Such a process has recently been completed in places like LaPine, Oregon and, closer at hand, Warren, Vermont, and Concord and Holliston, Massachusetts. The basic steps in that process are:

- A public event that focusses on local wastewater management issues (e.g., for Colchester, focus on Malletts Bay) as a way to initiate a wastewater management program
- Broad representation on an advisory committee (in Colchester, possibly a subcommittee of the Water Quality Committee)
- Clear decision making for critical parts of the strategy
- Several updates provided to the general town population
- Consideration for oversight and monitoring of implementation

5.1.2.4. Public Involvement: A water stewardship program

The Water Quality Committee should explore the possibility of establishing a voluntary water stewardship program. After some of the other involvement strategies identified in this section have been implemented, the Committee should seek volunteers to pilot the program. Such a stewardship program could identify particular steps for volunteers to take on their own property, to demonstrate exemplary wastewater and stormwater practices. These would include:

- Working with the Town to ensure that the town has on file the location and description of the onsite system
- Carrying out inspections and septic tank pumping on a scheduled basis
- Receiving regular updates on progress in developing and implementing the onsite wastewater management strategy

- Implement "lake-friendly gardening" practices for their lawns and gardens

Responsible party: Planning and Zoning Office

Estimated effects: The US EPA says in its recent publication, Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems, "Unfortunately, many of the [decentralized wastewater treatment] systems in use are improperly managed and do not provide the level of treatment necessary to adequately protect public health and surface and ground water quality." Since Colchester's 1996 Wastewater Facility Planning Update identified a number of areas of town where onsite systems were old and apparently poorly maintained, e.g., the septic tanks were pumped infrequently or never, it is likely that they are not performing adequately. A management plan is not only a step to improving water quality, it is also a critical step for focusing efforts to ensure that Colchester residents are protected from exposure to untreated or poorly treated wastewater.

"Lake-friendly gardening" is a term used by University of Vermont Extension to describe garden and lawn care which will "reduce the amount of potential contaminants, fertilizers, and pesticides introduced into the environment and to minimize the amount of water that runs off" the property. A number of committed property owners who demonstrate lake-friendly gardening could become the core group for advising the town on how to set up a strategy for reaching a larger percentage of property owners. Colchester could, then, follow the lead of the Elizabeth River (Virginia) Restoration plan, which set out an eight-year plan for establishing "pollution prevention and/or sustainable landscaping practices among 25 percent of the residential, commercial, and governmental land users in the watershed."

SWQP goals potentially addressed by a management plan for onsite wastewater treatment systems:

- Reduce bacterial contamination to and in Malletts Bay
- Improve the water quality in non-impaired creeks and Colchester Pond
- Where surface water and ground water quality now meets standards, ensure that no degradation occurs

Necessary conditions: A completed Phase I needs assessment will show management priorities. Before that, the Town can begin EPA Management Model 1, "Homeowner awareness," for all systems first and adopt more rigorous programs for parts of town or types of systems as the needs become documented.

The Planning and Zoning Office currently plan to devote nearly one full-time equivalent to beginning a management program. Beyond this, it would be possible to implement a minimal version of Management Model 1 for $20,000 startup costs and $5,000-$15,000 per year subsequently. This includes homeowner education on the care and maintenance of onsite systems, starting to track septic tank pumpouts, and sending reminders to homeowners to pump their septic tanks. More rigorous management would cost proportionately more. Cost for developing this program ranges from $20,000 to $70,000, depending on how much public input is desired and how intricate the program is.

Public involvement in the onsite wastewater management program is estimated to cost $1,000 per year in meeting support costs for a wastewater management advisory committee, 200 staff hours per year for the first two years, and 500 staff hours per year for years three and four. A voluntary water stewardship program is estimated to cost 100 hours staff time per year and have no additional monetary costs.

5.1.2.5. Design and implement increased bacterial monitoring and microbial source tracking at Bayside Beach to determine the main sources of bacteria found there.

Action: Colchester has detailed data on bacterial monitoring around Malletts Bay since the Water Quality Coordinator position began in 1990. However, different people have held the Water Quality Coordinator position over the years, and there has not been a standardized protocol for the testing. *E. coli*, the bacterium monitored currently, varies significantly over the course of a day and over small spaces, including at different depths. In order to get results that are meaningfully comparable, it is important to establish standards for the Water Quality Coordinator to use in testing: time of day, exact location of the sampling point, depth of water, and sampling method.

An interesting approach to identifying the pollution source at Bayside Beach has three tiers: 1) Determining *E. coli* variability over time and space, 2) source investigations, and 3) molecular methods (Boehm et al. 2003). The three tiered approach, by giving data on background variability of *E. coli* before closer investigations are made of possible sources and using expensive molecular methods, uses less expensive tests to focus the investigation on significant sources.

Another way to focus the use of molecular methods is to concentrate on samples in which high levels of *E. coli* occur in periods of dry weather. Levels of *E. coli* exceeding State water quality standards for Class B waters have been found during and after wet weather even in forested, undeveloped watersheds in Vermont. Using

molecular methods, like the ribotyping which was previously used, to fully characterize samples showing high *E. coli* levels during periods of dry weather could help explain where these are coming from.

One of the main questions about the bacterial levels at Bayside Beach is whether they come from wastewater or stormwater. Wstewater indicators other than bacteria, like caffeine or optical brighteners, could be tested for in samples gathered near the shore in both directions from the beach.

If prioritized, these studies could be run relatively quickly, so that the results could be used in deciding whether to accelerate measures in wastewater or stormwater treatment.

Responsible party: Public Works Department.

Estimated effects: Determining the source of the high bacteria levels found at Bayside Beach will help focus efforts to reduce their levels and prevent beach closures. The goal of the plan addressed by this action is:

- Reduce bacterial contamination to and in Malletts Bay in order to eliminate closures of public beaches

Necessary conditions: Outside funding is probably necessary for most of these monitoring options, though standardization of the sampling protocols for the Water Quality Coordinator could be accomplished by the person holding that position.

- Three-tiered approach: This type of study was carried out on a recreational beach in California that is comparable in size to Bayside Beach, for a budget of $150,000. Costs are expected to be comparable in Colchester, unless volunteers or students are used for the sampling.
- Molecular ribotyping of dry weather high *E. coli* samples: $8,000 per sample, for 2-6 samples per year.
- Whatever approach is taken, some effort will be necessary for study design. This may cost up to $5,000.

5.1.2.6. Public Involvement: A volunteer monitoring program

The Water Quality Committee should work with the Lake Champlain Basin Program, the Vermont Department of Environmental Conservation and River Network to establish a volunteer monitoring program for the purpose of determining the sources of bacterial contamination to Malletts Bay and the streams that feed the Bay. Not only will such a program provide valuable information to structure wastewater strategies, but the involvement of local citizens will expand the general support for wastewater and stormwater management in the Town.

Responsible party: Water Quality Coordinator, Public Works Department

Necessary conditions: Coordination of volunteers is estimated to cost $5,000, with funding possibly available from Lake Champlain Basin Program.

5.1.3. Priorities for Future Action: Second rank priorities

5.1.3.1. Prioritize Lakeshore Drive for special wastewater management attention

Action: The Lakeshore Drive area is no longer considered a growth center in the current Master Plan. However, concerns have been raised about the performance of the onsite wastewater treatment systems there, and the area is not served by municipal sewers. The systems' proximity to inner Malletts Bay makes good performance very important to maintain water quality there. The literature search during this project turned up no data definitively establishing whether or not there is a link between water quality problems in Malletts Bay and failing onsite systems.

According to the Town's 1996 Wastewater Facilities Plan Update (WFPU), the onsite wastewater treatment systems on Lakeshore Drive that are within 300 feet of lakeshore are singled out as providing "insufficient residence time in the soil to adequately remove nutrients and other contaminants prior to indirect discharge into the lake or groundwater. As a result, these areas require special management to prevent contamination and eutrophication of Malletts Bay." The recommended alternative for the facilities plan's two mapping units including Lakeshore Drive was construction of a new conventional centralized collection and treatment system for the lakefront properties, with individual onsite systems used elsewhere.

If a centralized collection system is installed, it will likely have the most positive effect on water quality for Malletts Bay, per dollar spent on it, if connections are concentrated to areas very near the lake or with high water tables. Our review of the alternatives presented in the WFPU found some alternatives where centralized collection served areas we believe are unlikely to be degrading Malletts Bay's water quality. There may be other arguments for serving these areas, however, once a collection system is already nearby.

As this SWQP has been put together, the Planning and Zoning Office has led a series of public meetings to plan future land use for Lakeshore Drive. This is crucial to any decision on how to handle wastewater needs in the area, since different future scenarios may be better fit by different wastewater treatment systems. This new land use plan for Lakeshore Drive calls for moderate growth in the form of

residences and small commercial facilities that tie in to recreation on the bay, e.g., restaurants, bait and tackle shops. Residents are sharply divided on the question of whether to install a sewer or to continue using decentralized wastewater treatment. The following series of steps can clarify the issues around the decision of which type of system to approach:

- Perform a buildout analysis to show the lots and uses that this type of moderate growth would bring.
- Based on that buildout analysis, investigate the possibility of using a combination of onsite and cluster systems to handle the wastewater generated.
    - Inspect all onsite systems and their soil conditions within 300 feet of Malletts Bay for the entire length of Lakeshore Drive. This study will show how much, if any, wastewater treatment offsite is required to protect public health and the environment, under the buildout scenario.
    - Investigate how much of the offsite wastewater treatment needs can be met by cluster systems in the area, where they would be located, and the cost of building and operating them.
- Also based on the buildout scenario, revisit and update cost estimates for a number of likely sewer alternatives. Concentrate on alternatives that would minimize the possibilities of induced growth and which would serve areas near the lake or with high water tables.
- Based on the sewer alternatives, develop zoning rules that would minimize possibilities of induced growth.
- At this point, the Town will know whether the wastewater treatment needs of the buildout scenario can be met by decentralized (onsite or onsite plus cluster) treatment, and, if not, what percentage of the buildout can be accommodated by decentralized treatment and what that will cost. The Town will also know the current costs for a sewer. With this information, the Town will have a firm basis for deciding whether to use onsite, onsite plus cluster systems (even if that possibly means less development than is desired), or to install a sewer.

5.1.3.2. Public involvement to support the Lakeshore Drive wastewater options decision

The decision on which wastewater option to pursue for Lakeshore Drive is going to be challenging. To minimize the conflict and ensure a decision that meets the needs of town citizens, the Town should establish a public information and outreach strategy. On a regular basis, the town and its consultants should provide information on the following topics:

- Results from the needs assessment

- A description of the options for addressing Lakeshore Drive
- A list of opportunities for town members to participate in decision making
- Progress in the decision and implementation of the sewering options

- The mechanism to communicate this information should be consistent and the Town should consider the following:Host a public event that focusses on wastewater issues in Malletts Bay
- A regular feature in the Colchester *Sun*
- A quarterly document to circulate to all town residents through mass mailing
- Select Board meetings including an item on the agenda for public comment quarterly
- Specific town sponsored meetings (when appropriate) that focus on the wastewater treatment issue

The focus of these outreach activities should be on the wastewater treatment issue for Lakeshore Drive. However, the same mechanisms can be used to provide some additional information regarding water quality as described in Section 8.5.

Responsible party: This is a joint project for the Planning and Zoning Office, which has jurisdiction over onsite systems, and the Public Works Department, which has jurisdiction over sewers.

Estimated effects: Since many of the onsite systems on Lakeshore Drive are on small lots in area that has been characterized as providing "insufficient residence time in the soil to adequately remove nutrients and other contaminants prior to indirect discharge into the lake or groundwater," replacing many of them with more adequately functioning wastewater treatment—centralized or decentralized—is likely to improve water quality near the shore. Regardless of any effect on water quality, this series of steps will help the Town achieve its goals for the growth of the Lakeshore Drive area.

Necessary conditions: This entire process may be completed independent of definitive characterization of the source of *E. coli* at Bayside Beach or other parts of Malletts Bay. It may also be completed independent of the town-wide wastewater needs assessment, although some of the data gathering and analysis will overlap.

Costs: Buildout analysis: $12,000
Inspect all wastewater treatment systems on Lakeshore Drive, near the lake: $110,000 (assuming about 200 systems, including some commercial)
Investigate possibilities for cluster systems: $20,000 - $25,000

Revisit and update sewer alternatives: $25,000
Summarize results of recent work and recommend an alternative: $15,000
Develop zoning rules: $5,000-$10,000
Public involvement: $20,000

5.2. Stormwater

Developed land in the Lake Champlain basin contributes more phosphorus runoff per unit of area than agricultural or forest land, according to a recent study (Hegman, Wang, and Borer 1999), as cited by (Vermont Agency of Natural Resources and New York State Department of Environmental Conservation 2002)). The phosphorus management plan for Lake Champlain recommends that "phosphorus runoff generated by new development must be minimized through proper site design, construction techniques, and stormwater treatment, and phosphorus load reductions from existing developed areas must be achieved sufficient to offset the effects of new development" (Vermont Agency of Natural Resources and New York State Department of Environmental Conservation 2002).

The US EPA defines stormwater as, "storm water runoff, snow melt runoff, and surface runoff and drainage." Impervious surfaces, by blocking absorption of precipitation into the ground, increase the volume of stormwater in a watershed. Percentage impervious cover—the area in a watershed covered by roofs, roads, and other impervious surfaces divided by the total watershed area—is one of the most significant indicators of watershed health, according to a recent review of hundreds of research studies (Center for Watershed Protection 2003). While large variations in stream health can be found for different watersheds with the same percentage of impervious cover, the trend between increasing impervious cover and decreasing watershed health is clear.

Best management practices (BMPs) aimed at reducing the effects of impervious surfaces, lawns (sources of pesticides and fertilizers), and other sources of water pollution are an important part of preserving and improving water quality. This section reviews BMPs outside of land use practices, which are reviewed in a separate section.

Subwatersheds may be prioritized for implementation of BMPs. The Town's *Stormwater Management Plan* offers one suggestion for prioritization. We present another suggestion in an Appendix to the plan.

5.2.1. Current and Ongoing Activities

The Town of Colchester recently completed several actions related to better understanding of the current locations and condition of its stormwater infrastructure. Mapping of the existing stormwater systems within the Town using Geographic Information System (GIS) technology was recently completed through a grant by the Chittenden County Regional Planning Commission (CCRPC).

Development of the GIS mapping consisted of documentation of existing stormwater permits, review of as-built drawings, and limited field verification of the location of catch basins and outfalls using GPS. A separate townwide stormwater outfall assessment was completed in February 2002 to investigate approximately 129 outfalls. This study consisted of field identification, data analysis and prioritization, and prevention and inspection of the outfalls. The outcome of the study included specific recommendations for improvements, costs, priorities, and an inspection schedule.

The Town also has an ongoing program for highway maintenance that is described in the MS4 Notice of Intent (discussed in detail below). This program includes procedures for snow removal, street sweeping, basin cleaning, stormwater outfall inspection, ditch maintenance, and dust control.

The Town is also taking steps to ensure that it is in compliance with all relevant general and specific stormwater permits. The Town submitted a Phase II Municipal Separate Storm Sewer Systems (MS4) Notice of Intent (NOI) on March 5, 2003 to comply with the requirements of the State General Permit 3-9014 for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems. The stormwater management plan outlined in the NOI addresses the following six minimum control measures:

1) Public Education and Outreach on Stormwater Impacts
2) Public Involvement and Participation
3) Illicit Discharge Detection and Elimination
4) Construction Site Stormwater Runoff Control
5) Post-Construction Stormwater Management in New Development and Redevelopment
6) Pollution Prevention/Good Housekeeping for Municipal Operations

Under each minimum control measure, a five-year implementation plan with best management practices and measurable goals is provided to address each control measure.

The Town of Colchester is also affected by the Sunderland Brook watershed improvement general permit (WIP), #3-9012, which is to be issued. In addition, it may be affected by the Morehouse Brook WIP (#3-9008, effective July 1, 2002), if the implementation of stormwater treatment practices in Winooski does not result in improvement of the water quality in the brook. While there is a WIP on Indian Brook (#3-9009, effective September 24, 2002), the Town is not currently affected

by it, as the segment of Indian Brook in Colchester is not currently designated as impaired by stormwater.

Publicly owned areas that are located within previously permitted stormwater discharges or are a designated selected discharge may potentially involve the Town as an applicant. Maintenance and/or addition of stormwater treatment practices may be required to comply with the requirements of the WIPs.

Note: On June 2, 2003, the Vermont Water Resources Board (WRB) issued a decision on the WIPs for Morehouse Brook, Englesby Brook, Centennial, Brook and Bartlett Brook which has been interpreted to halt work on all WIPs in Vermont. The Vermont Agency of Natural Resources (ANR) may reissue the WIPs in a form acceptable to the WRB, or it may take another approach. Careful monitoring of ANR actions will give valuable information about what Colchester will be required to do.

The Town's Public Works Maintenance Facility will be subject to the requirements of the Multi-Sector Industrial General Permit #3-9003. Implementation of this permit is still pending to regulate both public and private industrial facilities to prevent and minimize contamination of stormwater runoff. Environmental audits of this facility have been recently completed and the Town continues to maintain the recommended improvements and procedures.

A model Stormwater Management Ordinance was prepared in January 2002 in draft format for public debate and input. The Town has taken no further action on this ordinance, which was prepared to address the requirements of the MS4 Phase II for illicit discharges and post-development stormwater management.

5.2.2. Mandated Activities

1. Further investigate any outfalls identified as receiving illicit discharges

Actions: Under the MS4 program requirements, implementation of a monitoring program is required to detect non-stormwater discharges under the illicit discharge detection and elimination (IDDE) plan. As a first step, the Town has completed the mapping of public storm sewer systems. In addition, a comprehensive inventory of existing stormwater outfalls has been completed (both of these studies are discussed above in Current and Ongoing Activities).

The priority areas for monitoring the illicit discharges may be in the designated impaired watershed areas of Sunderland Brook and Morehouse Brook.

Approximately fifty-four outfalls are located in the Town within these watershed areas and consist of both public and private systems. The existing outfalls were visually inspected during the Stormwater Outfall Assessment and will continue to be checked. The information gathered and documented during the outfall inspections will be useful in the investigation of the potential illicit discharges. The majority of the storm sewer infrastructure within the Town is not old compared to that of other municipalities, except for infrastructure in the Fort Ethan Allen area. Many of these systems were constructed in the past 30 years, making it less likely that illegal connections will be detected.

We recommend that identifying priority areas for monitoring purposes focus on the following criteria:

- Commercial/industrial areas
- Older areas of the system
- Areas of repeated complaints
- Locations identified from water quality sampling data
- Observations of outfalls documented for the Stormwater Outfalls Assessment

We recommend that monitoring for illicit discharges begin in the commercial areas of the impaired watersheds. Since land use was noted for each outfall during the Stormwater Outfalls Assessment, the outfalls located in commercial areas can be checked first. Once the monitoring of Sunderland Brook and Morehouse Brook has been completed, monitoring can be extended to the other priority watersheds. The next priority will be the stormwater infrastructure located in the watersheds adjacent to inner Malletts Bay and the designated MS4 area:

- Malletts Head East
- Diversity Hill
- Malletts Bay
- Lake Shore Drive
- Smith Hollow Stream
- Crooked Creek

The optical brightener test has been used as an initial indicator in other communities with good success. This test is a simple and inexpensive method to determine the presence of a non-stormwater discharge. An untreated cotton pad is placed at the storm drain outlet, manhole, or catch basin for a period of time. A blue color indicates the presence of detergents, signifying illegal dumping, a direct illicit connection, a leaking sewer, or contamination from a failed septic system. If the test is positive, further tests should be performed to determine the source. In

addition, the Town plans to utilize other techniques as appropriate to trace the source of the illicit discharges. These techniques and methods are discussed in the MS4 Phase II Notice of Intent.

Depending on the type of suspected contamination, water quality testing can be performed. Additional testing may include the parameters listed in Table 5.

Table 5
Water Quality Test Parameters

Water Quality Test	Application
Conductivity	Indicator of dissolved solids
Ammonia	Indicator of presence of sanitary sewer or septic system effluent
Surfactants	Indicates presence of detergents
pH	Extreme values may indicate commercial or industrial flows
Temperature	High temperature indicates presence of sanitary sewer
Total Chlorine	Indicator of potable water source
E. Coli or Fecal Coliform	Indicator of presence of sanitary sewer or septic system effluent, or warm blooded animals

A model stormwater management ordinance was developed for the Town in January 2002. Illegal discharges and illicit connections are prohibited in the draft ordinance as a mechanism used to enforce remediation of the illicit discharges. No action has yet been taken on an ordinance, but implementation of an ordinance is scheduled in year two of the MS4 program.

Responsible Party: The Public Works Department would implement this action as described in the Town Notice of Intent to comply with the MS4 Phase II program.

Estimated Effects: Illicit discharges to stormwater systems can contain elevated levels of bacteria, phosphorus, and other nutrients. Therefore, identification and elimination of illicit connections improves water quality throughout the Town by reducing the levels of the pollutants transported to the stormwater outfalls and discharged to the receiving waters. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing bacterial contamination to and in Malletts Bay.
- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Improving the water quality in non-impaired creeks.

Necessary Conditions: Town staff will be required to develop, inventory, and maintain the IDDE program. Extensive fieldwork will be required in addition to the monitoring. To supplement the monitoring, completion and implementation of an ordinance is required to provide the mechanism to enforce the prohibition of the illicit connections. This portion of the draft ordinance needs to be finalized, and adopted by the Town.

2. Determine and implement the most effective methods to control sediment runoff from construction sites.

Actions: Any project with a land disturbance greater than 1 acre will be subject to State regulations and will require preparation of a sediment and erosion control plan. Implementation of this general permit has been delayed, but is due to become effective in the spring of 2003. Under the MS4 Phase II requirements, implementation of erosion and sediment controls is required for those projects not subject to State regulation. However, the draft Stormwater Management Ordinance doesn't specifically address erosion and sediment control.

The Town is planning to regulate erosion and sediment control plans for any land disturbance less than one acre through an erosion and sediment control ordinance. It is moving to remove the exemption from Town permitting that currently exists for private driveways, so that any land disturbance will either require a building permit or review by the Development Review Board. Each of these processes will trigger a review of the erosion and sediment control plans for the site. The Town may wish to set a level of disturbance for which no erosion and sediment control plan is necessary, a decision which will balance water quality issues with level of effort the Town wishes to mandate for small projects.

We recommend that:

- Within the impaired watershed areas and other priority watersheds, the Town require an erosion and sediment control plan for all land disturbance projects.
- The most effective approaches to control sediment and reduce runoff from construction sites be incorporated into the Public Works Standards, as outlined in the interim, revised Vermont Handbook for Soil Erosion and Sediment

Control on Construction Sites (found at http://www.vtwaterquality.org/docsoilerosion.htm).

- The Town performs regular inspections of all projects with a local sediment and erosion control permit.

Responsible Party: The Planning and Zoning Office and the Public Works Department would implement this action jointly.

Estimated Effects: Land disturbance activities can be a significant contributor to the degradation of water quality. Providing a plan for phasing of land disturbance activities, temporary and permanent stabilization, sediment controls, and regular inspections can greatly minimize the impacts to receiving waters. If land disturbance activities are not properly managed, sediment is transported to streams by stormwater runoff, causing a reduction in water quality. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing bacterial contamination to and in Malletts Bay.
- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Monitoring the water quality in non-impaired creeks.

Necessary Conditions: Requirements will be incorporated into the Town ordinances for the erosion and sediment control permit, and technical requirements will be updated in the Public Works Standards.

5.2.3. Priorities for Future Action

5.2.3.1. Top Priorities

1. Implement structural best management practices (BMPs) based on those recommended in the Town's *Stormwater Management Plan* for priority subwatersheds. Suggestions for priority subwatersheds are found both in the *Stormwater Management Plan* and in an appendix to this Plan.

Actions: Develop an implementation plan for new development and redevelopment projects that do not have an existing permit or require a State Stormwater Discharge Permit. This implementation plan will apply specifically to small projects and existing development that are not covered under existing stormwater regulations, and will incorporate the structural best management practices (BMPs) recommended in the *Stormwater Management Plan*. The implementation plan could exempt the following types of projects:

- Any project with an impervious area greater than one acre that is subject to the requirements of the State *Stormwater Management Manual*;
- Agricultural land management activities;
- Non-contiguous developments that do not disturb over 5,000 square feet of land area in any one-year period; and
- Development of private roads that serve fewer than two homes or are less than 400 feet in length.

The structural BMPs are applied in conjunction with the non-structural BMPs identified in the land use section to implement better site design and stormwater treatment practices. Application of the BMPs should take into account the updated watershed prioritization discussed within this Strategic Water Quality Plan. The following structural best management practices were recommended in the *Stormwater Management Plan*, and are briefly described in the following narratives. These BMPs need to be assessed further by the Town to determine the applicability to each watershed area.

Catch basins: Catch basins can be used as temporary detention systems by means of a sump for retention of sediment. Other heavy debris that enters the inlet prevents sediment and debris from accumulating in downstream storm sewers and basins. Inlet interceptors can be provided to collect sediment prior to reaching the sump. If maintained, these interceptors can be effective in reducing sediment, total phosphorus, hydrocarbons, etc. depending on the type of unit installed.

Ditch maintenance: Roadside ditches accumulate sediment and debris from the street and parking lot surfaces. High runoff rates cause channelization and erosion. Cleaning and stabilization of ditches helps to reduce pollutant loadings from these sources. Reducing the length and slope of ditch runs and reducing the velocity of runoff using check dams helps prevent excessive channelization and erosion.

Detention chambers: This practice provides temporary storage of stormwater runoff in an underground facility. Detention systems are designed to empty out between runoff events so that storage capacity is available for subsequent runoff events. The main purpose of a detention chamber is quantity control by reducing the peak flow rate of stormwater discharges. Treatment efficiency is usually limited to removal of suspended solids and associated contaminants due to gravity settling.

Sand filtration systems: This practice uses some combination of granular filtration media such as sand, soil, organic material, carbon, or a membrane to remove constituents found in runoff. Filtered runoff may be collected and returned to the surface water or infiltrated into the soil. Filters are primarily a water quality control

device designed to remove pollutants. High efficiency removal rates of sediment, biochemical oxygen (BOD), and fecal coliform are provided by these practices. Routine maintenance is required, but the applicability of this type of BMP in cold weather climates is still being investigated.

Grass swales: This practice conveys and treats shallow flow. Grass swales are a type of broad, shallow channel with dense vegetation. Swales can be either wet or dry and trap pollutants, in addition to promoting infiltration. Solids removal efficiencies are high, as well as BOD removal and metals. These systems are not very effective in wet or poorly draining soils.

Vegetated filter strips: This practice conveys and treats sheetflow runoff. Vegetated filter strips are densely vegetated, uniformly graded areas that intercept sheet runoff from impervious surfaces. Vegetated filter strips are frequently planted with turf grass, or utilize natural vegetation. Sediments are trapped and the vegetation provides partial infiltration of the runoff. Filter strips are typically used in combination with other types of treatment BMPs.

Bioretention system: This practice consists of a grass buffer strip that collects runoff and then passes through a planted soil bed. This practice typically treats runoff from impervious surfaces as the stormwater runoff passes through these layers and infiltrates into the surrounding soil. Bioretention may be applied in cold weather climates as a secondary treatment measure, but is not effective when the ground is frozen. Quality of runoff is increased, and the quantity of runoff is reduced through bioretention.

Detention basins: This practice intercepts a volume of stormwater, temporarily impounds the water, and releases it shortly after the storm event in an above ground basin. Detention systems do not retain a significant permanent pool of water between runoff events. The main purpose of a detention basin is quantity control by reducing the peak flow rate of stormwater discharges. Treatment efficiency is usually limited to removal of suspended solids and associated contaminants due to gravity settling.

Street and parking lot cleaning: Proper maintenance of streets and parking lots can significantly reduce the amounts of pollutants washed off during storm events. Streets and parking lots comprise a significant portion of the total impervious areas within a watershed area and are usually directly connected to the storm drain system. Regular sweeping of these areas to remove a portion of these materials can significantly reduce the pollutant load contributions.

Oil/grit separators: This BMP is used to settle sediment such as grit from runoff, allowing oil and other fluids to float on the water surface. These materials may be skimmed off the top and the treated runoff can pass to the drainage system.

Roof disconnect and swales: This practice consists of on-lot treatment of stormwater in areas with well draining soils. This BMP primarily manages the rooftop runoff, since this type of runoff generally has low pollutant concentrations compared with other urban sources. The most common practice is to direct runoff to pervious lawn areas or to a dry well and/or infiltration trenches.

Responsible Party: The Planning and Zoning Department and the Public Works Department would implement this action jointly.

Estimated Effects: Incorporation of structural best management practices for new development and redevelopment projects provides treatment of stormwater runoff from impervious areas. Treatment of stormwater runoff to provide reduction of suspended solids and phosphorus is necessary to preserve and maintain water quality. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing bacterial contamination to and in Malletts Bay.
- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Improving the water quality in non-impaired creeks.

Necessary Conditions: The Town could adopt the requirements of the State *Stormwater Management Manual* and incorporate the applicable structural BMPs for the Town into the Public Works Standards.

Cost of developing a work plan for implementing the BMPs and seeking funding for the effort is estimated at $10,000-$15,000.

2. Upgrade the six high priority stormwater outfalls as recommended in the Town's Stormwater Outfalls Assessment.

Actions: The "Stormwater Outfalls Assessment" was recently completed and prioritized the needs for each existing outfall. Six outfalls were designated as high priority due to existing deficiencies using a priority action score. The names of the high priority outfalls are 118 Orchard, Eagle Park, Malletts Bay, and Troy Avenue

#1, #2, and #3. Outfalls in this high priority category bypassed the decision process due to conditions that are of imminent threat.

Responsible Parties: The Public Works Department would implement this action.

Estimated Effects: The discharge of stormwater at outfalls that are designated as deficient degrades the water quality of the downstream receiving waters. If the soil and embankments in the area of the outfalls are not stable, eroded soil is transported downstream by the stormwater discharge. This sediment is deposited in the streams and rivers causing a reduction in the water quality. Upgrading the outfall stabilizes the bank at the point of discharge, reducing the sediment carried load carried downstream. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Improving the water quality in non-impaired creeks.

Necessary Conditions: Conceptual costs were developed in the Stormwater Outfalls Assessment Study but the Town is planning to revisit them. Prior to finalizing the costs, preliminary engineering of the improvements needs to be completed, in addition to identifying any easement acquisition and permits required. This upgrade work can be included in the Town capital plan for implementation.

3. Upgrade the six moderate priority stormwater outfalls as recommended in the Town's Stormwater Outfalls Assessment.

Actions: The Stormwater Outfalls Assessment was recently completed and prioritized the needs for each existing outfall. Six outfalls were designated as moderate priority due to existing deficiencies using a priority action score. The names of these outfalls are East Lakeshore Drive, 201 Hollow, Valleyfield, Village, Canyon Estates Drive, and Troy Avenue #2. Outfalls in this moderate priority category will continue to deteriorate but the resulting damage is not likely to be significantly threatening.

Responsible Parties: The Public Works Department would implement this action.

Estimated Effects: The discharge of stormwater at outfalls that are designated as deficient degrades the water quality of the downstream receiving waters. If the soil

and embankments in the area of the outfalls are not stable, eroded soil is transported downstream by the stormwater discharge. This sediment is deposited in the streams and rivers causing a reduction in the water quality. Upgrading the outfall stabilizes the bank at the point of discharge, reducing the sediment carried load carried downstream. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Improving the water quality in non-impaired creeks.

Necessary Conditions: Conceptual costs were developed in the "Stormwater Outfalls Assessment" Study but the Town is planning to revisit them. Prior to finalizing the costs, preliminary engineering of the improvements needs to be completed, in addition to identifying any easement acquisition and permits required. This upgrade work can be included in the Town capital plan for implementation.

4. Establish an outfall inspection program that includes the prioritized inspection schedule and maintaining the inspection checklist as recommended in the Town's Stormwater Outfalls Assessment.

Actions: An inspection program was developed under the Stormwater Outfall Assessment described in the Current and Ongoing Activities section above. This program is recommended to ensure the Town maintains documentation on the conditions of its outfalls. The priorities for the inspection were developed using an inspection algorithm through a database that assigned an inspection frequency to each outfall. Each outfall is to be visited at least once every five years as a minimum and more frequent inspections are recommended for critical locations. The algorithm prioritized each outfall based on the following criteria:

- Soils
- Zoning
- Watershed Impaired Status
- Priority Score

A customized inspection checklist was prepared for each outfall. The checklist for each outfall contains the name, location, inspection frequency, and a photograph. The ongoing condition of each outfall is documented for each inspection on the individual sheets contained in Volume 4 of the Stormwater Outfall Assessment.

The detailed inspection schedule for each outfall is provided in Appendix B of the Stormwater Outfall Assessment and is briefly summarized as follows:

Table 6
Stormwater Outfalls Assessment
Inspection Schedule

Inspection Frequency	Number Of Outfalls
Annual	8
Biannual	23
Every 5 years	98

Responsible Party: The Public Works Department would implement this action.

Estimated Effects: Regular inspection provides a program to identify problems early on and a mechanism to prioritize and upgrade the outfalls identified with deficiencies. If the problems are addressed as needed, the sediment loadings transported to the receiving waters are reduced, preserving the water quality. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing bacterial contamination to and in Malletts Bay.
- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Improving the water quality in non-impaired creeks.

Necessary Conditions: Performing and maintaining the inspection program may require additional staff within the Public Works Department. As shown in Table 6, eight of the outfalls should be inspected annually and 23 biannually. Splitting up the inspections is recommended so that 50% of the biannual inspections are performed each year, and at least 20% of the remaining outfalls are inspected each year. Using this approach, approximately 40 outfalls will require inspection each year with Town staff. In addition, observations should be documented regarding potential illicit discharges for incorporation into the illicit discharge detection and elimination (IDDE) program.

5.2.3.2. Second Rank Priorities

1. Inventory the existing public stormwater systems and develop a program for regular inspection of stormwater structures.

Action: Performing a comprehensive inventory of the existing public stormwater infrastructure located within the Town is a critical step to management of the stormwater systems. It is also crucial for assessing the need for assessment and development of a plan for maintenance and repairs. The Town is currently performing several of the initial tasks to gather the information needed for the inventory.

The comprehensive inventory under this priority action only includes public stormwater systems located within the Town. Mapping of the public systems is a requirement of the MS4 Phase II General Permit and has been completed by CCRPC. Beyond the basic mapping, inventory includes gathering of existing stormwater permits, review of as-built drawings, and field investigation of each system.

The inventory builds on the mapping and is performed for all public stormwater infrastructure, including manholes, catch basins, culverts, stormwater ponds, and other facilities. A database organized by subwatershed is developed to include each stormwater structure and includes field verification of the location of each structure using GPS. This information will be used to prioritize the inspection frequency, as well as maintenance and repair needs. Examples of the information that can be documented for each structure are listed below:

Manholes and Catch Basins

- ID#
- GPS location
- Watershed
- Date
- Owner
- Street name
- Location
- Development plan reference sheet
- Year built
- Structural data
- Condition
- Maintenance history

Culverts

- ID#
- GPS location
- Watershed
- Date
- Owner
- Street name
- Location
- Development plan reference sheet
- Year built
- Type
- Diameter
- Length
- Material
- Structural condition
- Debris accumulation
- Ditch condition

Responsible Party: The Public Works Department would implement this action.

Estimated Effects: Inventory and documentation of the existing public infrastructure provides the Town with a useful tool to identify needed maintenance and repairs of the stormwater infrastructure. Performing the inventory does not directly improve water quality; however, performing the maintenance and repairs recommended from the inventory protects water quality. Properly maintaining catch basins, culverts, and other stormwater infrastructure reduces sediment and other pollutants from being transported to the receiving waters. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing bacterial contamination to and in Malletts Bay.
- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Improving the water quality in non-impaired creeks.

Necessary Conditions: This inventory is typically performed by Town staff and may require additional staffing. A minimum of two persons will conduct the field inspections and complete the inventory sheets for each structure. In addition, maintaining of the database will be required to document existing conditions, identify and prioritize deficiencies, determine cleaning frequency, and develop a

plan to implement the necessary maintenance and repairs. Cost is estimated at $12,000-$15,000.

2. Implement the prevention measures and approaches into the Town review process for new development projects as recommended in the Town's Stormwater Outfalls Assessment

Action: In the Stormwater Outfalls Assessment, prevention was discussed to improve failing outfall conditions. As-builts, outfall design criteria, and site design were identified as general approaches to improve the design, siting, and maintenance of newly constructed outfalls. Each of these approaches is discussed in detail below.

As-Built Drawings:
For new development projects, the Town requires that as-built drawings be provided for private utilities that become the responsibility of the Town. These plans document the final layout of the infrastructure and function to certify that construction was completed in accordance with the approved plans. These drawings need to be submitted and accepted by the Town for both public and private stormwater systems. They provide the Town with permanent documentation of all systems and ensure that the infrastructure meets the Town's requirements.

Outfall Design Criteria:
The widely varying soil conditions throughout the Town make standard design approaches to outfalls difficult. Sandy soils are prevalent in many areas and are very sensitive to the erosive force of runoff. Heavy clay soils are common in the northern portion of the Town and are more stable.

Primary design features that are documented to commonly cause deterioration of outfalls include:

- Excessive design slope;
- Excessive receiving channel slope;
- Excessive vertical drop from conduit to channel.

Due to the varying soil types throughout the Town, standard approaches to outfall stabilizing are not adequate for all conditions. In the Stormwater Outfalls Assessment, sample designs are provided for various outfall conditions. These sample designs should be incorporated into the Public Works Standards and applied to all new outfall designs.

Site Design:
The southern half of the Town consists of natural sand ravines and drainage ways that are surrounded by relatively flat plateaus. As land is developed, surface water flow is diverted and discharges at a single point within the ravine. This approach has effectively removed water from portions of the stream channel and overloaded the channel at other locations.

Many of the conditions encountered during the inspection could be avoided if stormwater discharge were evenly distributed throughout the receiving waterway. It is recommended that development projects maximize the number of discharge points instead of using a single point of discharge to better protect existing streams.

Responsible Party: The Planning and Zoning Department and the Public Works Departments would implement this action jointly.

Estimated Effects: Applying the design improvements for outfalls will preserve the water quality of the receiving waters. Better design of outfalls reduces the sediment loadings transported downstream to maintain the health of streams. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing bacterial contamination to and in Malletts Bay.
- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Improving the water quality in non-impaired creeks.

Necessary Conditions: We recommend that the requirements be incorporated into Town regulations and the Public Works Standards for the as-builts and certifications of stormwater infrastructure on all public and private projects, outfall design criteria, and site design of discharge points.

3. Clean catch basin structures located in public areas, prioritizing impaired watersheds and those draining to Malletts Bay

Action: Catch basins structures are currently cleaned on an as-needed basis and are inspected during cleaning. The Town does not have the equipment available in-house to perform the cleaning and utilizes a contractor to provide this service.

The comprehensive inventory of catch basins, recommended above, includes developing and maintaining information for each structure. The data on the

accumulation of material will be used to examine the frequency of cleaning. Cleaning of the catch basins reduces the accumulation of material in downstream pipelines, ponds, outfalls, and streams. Catch basins located in the impaired watersheds and those watersheds draining to Malletts Bay will be prioritized for increased cleaning.

Interceptors are now considered an acceptable best management practice to collect sediment at the inlet to the structures. These units are suspended under the frame and grate and collect sediment and other material. Removal and cleaning of the basket is easier for maintenance than emptying the catch basin sump of sediment. Units are being installed locally to determine the effectiveness and applicability during cold weather conditions.

Responsible Party: The Public Works Department would implement this action.

Estimated Effects: Catch basins sumps are designed to collect sediment and other materials in the base of the structure. Frequent cleaning and removal of this material from the structure reduces the sediment and organic material transported downstream to improve the water quality of the receiving waters. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing bacterial contamination to and in Malletts Bay.
- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Improving the water quality in non-impaired creeks.

Necessary Conditions: Additional cleaning of catch basins will utilize existing staff, but will require increased use of a contractor to provide a vacuum truck ($110/hour). Depending on the frequency and success of the cleaning program, the Town may want to consider long-term purchase of the cleaning equipment.

5.2.3.3. Third Rank Priority

1. Complete a comprehensive inventory of the existing private stormwater systems, prioritizing impaired watersheds and those draining to Malletts Bay.

Action: Performing an inventory of all existing stormwater infrastructure located within the Town is a critical step in assessing the long-term maintenance, repair, and capital needs for a stormwater management program. The Town is currently performing several of the tasks needed to gather information for the comprehensive inventory. Projects mapping the public stormwater system and assessing stormwater

outfalls were recently completed. Under the second rank priorities, inventory of the public stormwater systems is recommended prior to implementing this action.

This inventory includes both public and private stormwater systems located within the entire Town. The process includes gathering existing stormwater permits and as-built drawings, and requires field investigation of each system. The information should be organized by watershed area and include the total number of existing permits. For each system, the following information should be documented:

- Permit # (Some older systems may not have a previous permit)
- Permittee
- Site Name/Location
- Watershed
- Landowners
- General Condition
- # of Catch Basins
- Type of Treatment System
- Discharge Waterway
- Maintenance Requirements
- Was System Built to Original Approvals?

Responsible Party: The Public Works Department would implement this action.

Estimated Effects: Many of the private stormwater systems are typically not inspected and properly maintained. Mapping and inventory of these systems provides the Town with useful information on the adequacy of these systems. If they are not being properly maintained, sediment and other pollutants are being transported by the stormwater runoff to the downstream receiving waters. Regular inspection, proper maintenance, and performing needed repairs keeps these systems in good working order to reduce the impacts on the receiving waters. Implementation of this action helps to fulfill the goals of the Strategic Water Quality Plan by:

- Reducing bacterial contamination to and in Malletts Bay.
- Reducing phosphorus loads.
- Improving the water quality of Sunderland Brook.
- Reducing sediment loads to Colchester stream and rivers.
- Improving the water quality in non-impaired creeks.

Necessary Conditions: Town staff would typically perform this inventory. Once the information gathering is completed, determinations for each individual system can

be made on ownership, Town responsibilities, adequacy of maintenance, and system deficiencies.

5.3. Land Use

Town planning and development review in Vermont take place in a well-defined series of steps. First, a municipal plan is prepared. One of the ten required elements of that plan, as listed in the Vermont Municipal and Regional Planning and Development Act, is preparation of a land use plan. The land use plan consists of a map with present and prospective areas for development, forestry and agriculture, and open spaces reserved for flood plain, wetland protection, or other conservation purposes. The process of adopting a municipal plan includes preparation by the Planning Commission, solicitation of public input including formal public hearings, and approval by the legislative body.

The second step is preparation of bylaws to implement the municipal plan. The most common bylaws are zoning and subdivision regulations; though others, such as a capital budget and plan, also may be adopted. Zoning regulations include district boundaries that normally match the proposed land use boundaries of the municipal plan. For each district, zoning details are established including permitted and conditional uses, intensity of use (e.g. density or lot coverage), and dimensional standards. Zoning regulations also may include such town-wide standards as overlay districts and buffer requirements that are oriented towards the protection of natural resources.

Zoning and subdivision regulations also establish the standards under which specific development proposals are reviewed. Requirements for street widths, sidewalks/paths, drainage systems, parking spaces and other development details commonly are found under site plan or subdivision review standards.

The third step is review of specific development proposals under the standards established in the second step. While some standards are clearly defined, others require some subjective determination by a reviewing board. The board determines whether a proposed development meets the standard, will meet the standard with project modifications, or fails to meet one or more standards, which leads to a denial of the permit.

Currently, water quality standards are included only to a modest degree in the three steps described above. There is little mention of water quality, other than "flood plain, wetland protection or other conservation purposes," in the ten required elements of a municipal plan. In site plan and subdivision regulations, some municipalities recently have established stream buffer requirements and/or stormwater review requirements. Where such regulations are in effect, they are applied as part of the review of specific development applications.

An early step in this Strategic Water Quality Plan was preparation of a list of options for prioritization. Several recommendations from that list relate to the land use planning process. In connection with the first step, preparation of a municipal plan, one recommendation is to "increase consideration of water quality impacts in planning for growth centers." This option is not included on the priority list. Existing growth centers in Colchester are considered to be appropriately located, even though water-quality issues were not central in the initial determination of their boundaries.

Two recommendations relate to the second step of the land use planning process, preparation of zoning and subdivision bylaws. The first recommendation focuses on zoning standards including uses, density and dimensional standards. The second recommendation focuses on subdivision and site plan review standards. They are described in greater detail under the "top priority" section below.

The same two recommendations also impact the third step of the land use planning process. Once water-quality related zoning and subdivision standards are in place, they are used during the review of individual development applications.

5.3.1. Description of current and ongoing activities

The 2002 Colchester Town Plan includes goals, policies and implementation steps for seventeen individual areas within the town. Several of these areas are particularly important for growth center planning, infill development, and protection of water quality.

Exit 17 is one of three Colchester growth centers. A year 2000 master plan for the area was followed by a build-out analysis and study of wastewater availability. One moderately high-density residential development is under construction, and the town is working with several other landowners concerning wastewater availability and development options. One large parcel in this growth center is located east of a tributary of Allen Brook and will require crossing of a steep ravine. To minimize adverse water-quality impacts, the Town has encouraged a single crossing of that ravine. Engineers for the landowner have explored suitable locations and grades for the crossing. We recommend that the crossing be designed initially with sufficient capacity to meet projections for full build-out of that area.

A second designated growth center is located at Severance Corners. The town has reviewed proposals for two large developments in this area. Both projects include relatively concentrated development with perimeter open space. Developers are responsible for meeting State standards for stormwater treatment, including avoidance of impact on Sunderland Brook—an impaired stream that one proposed development is in the watershed of—and Smith Hollow Brook—an impaired

stream that the other development is in the headwaters of. Municipal sewer service is planned for this area, and the Town is exploring options for increasing its capacity at the South Burlington treatment plant, which would be necessary in order to meet projected needs at Severance Corners. The NRCS soil map for the area indicates that good onsite wastewater treatment possibilities may be available in the area.

West Lakeshore Drive is not designated as a growth center but is a likely location for moderate growth. Recently, the Planning and Zoning Department conducted a series of public forums to determine desired growth patterns and growth-related issues. Stormwater concerns affected both land use and transportation options, due to the close proximity to Malletts Bay. Options for continued use of septic systems vs. extension of municipal sewer also were discussed.

Similar public forums are planned in the near future for Prim Road/Heineberg Drive, another area with extensive existing commercial and residential uses and potential for further infill development. Forums are likely to address growth limitations caused by wastewater disposal and wetland proximity.

Town-wide, a recent zoning amendment established a watercourse protection district affecting land development within 85 feet horizontal distance from stream centerlines. All development subject to review by the Development Review Board is restricted within this area. However, avoidance of disturbance is voluntary for applications that are subject solely to review by the Zoning Administrator.

Town-wide, the Planning and Zoning Department has begun to review additional development review standards related to use of Best Management Practices in stormwater treatment.

5.3.2. Priorities for future action

5.3.2.1. Top priority

1. Upgrade review standard for new development throughout the town. Focus on zoning standards. Address uses, density and dimensional standards.

Action: Colchester has been a rapidly growing suburban community for the past 40 years. Residential units increased by over 2,000 between 1980 and 2000. Extensive non-residential development has occurred at Exit 16 and elsewhere in town. With expectations that similar growth rates will continue over the next 20 years, density and other zoning standards will be critical in shaping the form of growth and resulting impacts on land use and water quality.

Density is a minimal concern in Colchester's lower-density zoning districts. In growth center and infill areas, there are two conflicting objectives. First, it is desirable to allow high density on individual lots to minimize sprawl. On the other hand, if density in the overall district exceeds the area's capacity to treat stormwater runoff, water quality will be degraded. A recent review of studies on the effect of impervious cover on watersheds shows that sensitive species can be affected by impervious cover of less than 10%, and that a high water quality is almost never found in watersheds where impervious cover exceeds 25% (Center for Watershed Protection 2003).

Currently, Colchester permits lot coverage of 60% with onsite septic systems or 70% with municipal sewer in several high-density districts – Commercial, GD1 and GD2. Even greater lot coverage is permitted in GD3 as part of a Planned Unit Development (75%) and in the Industrial District (80%). As these districts continue to develop, including expansion and infill on partially developed parcels, greater attention to potential adverse stormwater impacts will be crucial to maintaining water quality.

Densities in the range of 60% to 70% may be accommodated on an individual parcel basis, but are not consistent with high water quality if found district-wide. In districts such as Commercial, GD1 and GD2, a density change probably is not needed. However, to avoid adverse cumulative impacts, any proposed development must be individually reviewed for stormwater impacts either onsite or downstream. As noted below, designing the development review process to require appropriate use of Best Management Practices and other stormwater management techniques, can contain these cumulative impacts.

In the GD3 District, 75% PUD lot coverage may be accommodated in targeted locations, again subject to appropriate site development review. However, we recommend that zoning standards clarify that lot coverage for the overall parcel or area may not exceed the base lot coverage of 60% to 70%.

The current lot coverage standard of 80% in the Industrial District is aggressive, and we recommend that the Town consider reducing it. A more specific study of this district would identify current lot coverage on individual parcels and any existing problem areas related to stormwater management.

An alternate to high lot coverage is moderate lot coverage combined with high floor-to-area ratios (FARs). FARs calculate total building square footage on multiple levels in relation to overall lot square footage. Use of this density standard

may increase vertical development while avoiding excess lot coverage. Taller structures may include parking garages in addition to principal uses. This zoning approach is very usable in mixed-use districts such as GD1, GD2 and GD3. It likely would have less success in districts such as Industrial where uses typically are one-level.

The most pertinent dimensional standards are setbacks. Reductions in required front yard setbacks may allow driveways and sidewalks to be shorter by moving development closer to the street. Often, base zoning standards for a district establish fairly high setbacks but allow them to be reduced in proposals for Planned Residential Developments (PRDs) or Planned Unit Developments (PUDs). While flexibility in a PRD/PUD is desirable, lesser setbacks also would reduce impervious area in conventional subdivisions, and we recommend that they be permitted without requiring waivers or variances.

An illustration of how zoning standards may impact the extent of impervious surfaces is given in an appendix. This example shows various combinations of setbacks, single-story vs. multi-story construction, parking requirements, etc. and resulting impervious surface area per dwelling unit.

A more important type of setback is a required buffer to natural features, most notably stream setbacks. As noted above, Colchester has established a minimum stream setback standard. However, a later recommendation (see land use, second rank priority) is that a more detailed look be given to stream setbacks under varying conditions.

Some consideration also may be given to permitted and conditional land uses. Identification as a conditional use allows site-specific review of an individual proposed use. Typically, such review is based on a traditional zoning category, e.g. automobile service or truck terminal. However, conditional use review also could be based on geographical considerations or performance standards, e.g. proximity to an impaired stream or type of wastewater and form of treatment.

Responsible Party: Planning Commission and Planning/Zoning Department.

Estimated Effects: Greater attention to water quality issues in establishing density and dimensional standards and permitted uses will reduce the difficulty of dealing with water quality impacts when specific development proposals are reviewed. Careful advance planning and establishment of zoning standards will accomplish more efficient development and reduce the pressure of finding engineering solutions to stormwater treatment.

SWQP goals potentially addressed by a focus on zoning standards with water quality issues in mind:

- Reduce bacterial contamination to and in Malletts Bay
- Reduce phosphorous loads
- Improve the water quality in Sunderland Brook
- Reduce sediment loads to Colchester streams and rivers
- Improve the water quality in non-impaired creeks and Colchester Pond
- Where surface water and ground water quality now meets standards, ensure that no degradation occurs

Necessary Conditions: Time and effort to determine revised zoning standards including public hearings to gauge impacts on specific locations. Some outside financial assistance may be helpful in studying specific standards and their impacts. The Town may be able to obtain planning grants in the range of $10,000 to $15,000.

2. Upgrade review standards for new development throughout the town. Focus on site plan, subdivision, and public works standards.

Action: A basic goal is reduction of existing standards related to the amount of impervious area. A number of communities have adopted new regulatory sections specifically addressing stormwater impacts. As one example, Columbus, Ohio includes requirements for maximum street widths, replanting with approved species, and minimization of commercial parking in its "Standards for Minimizing Stormwater Generated." Colchester may consider a variety of possible revisions to subdivision, site plan, and public works standards:

Streets:

- Reduce required road widths. Narrower widths, in the range of 20' to 24', may be feasible for minor streets.
- Encourage shorter roads in subdivision design via clustering and reduced lot frontage requirements. Lot frontage is one of the main factors in determining required length of streets. We recommend that the Town explore lesser frontages in both rural districts (consider reduction from current 300' to 200' or 250') and higher-density districts (consider reduction from 100' and 150' to 75' and 100'). Clustering as part of good PUD design may accomplish further efficiencies in street layout.
- Prohibit circular cul-de-sacs. Where dead-end roads are necessary, use a hammerhead design.

- Continue permitting private drives serving a low number of dwelling units, perhaps three or less. Standards for road widths and turn-around areas may be lower for a private drive. Evaluate extending the use of private drives, through having them serve more houses than they do now or broadening the conditions under which they are permitted.

Storm drainage:

- Encourage use of open vegetated swales instead of closed curb and gutters systems.

Parking:

- Review all existing requirements for minimum number of parking spaces. Current requirements for uses such as shopping centers, banks and offices are higher than found in other nearby communities. We recommend that these standards be applied during development review as "target" levels rather than as "minimums." A developer may justify a lesser parking requirement under certain conditions. Also, we recommend that no increase in parking spaces be permitted without a satisfactory explanation by the developer.
- Reserve unsurfaced areas for overflow or future parking.
- Reduce the size of parking spaces. While this is a good theoretical goal, Colchester's current standards for parking space dimensions appear to be appropriate.
- Encourage one-way or angle parking to reduce required aisle widths. Colchester already includes this option in its parking standards, and we recommend that developers be encouraged to take advantage of this space-saving option.
- Encourage mixed-use land development that may take advantage of shared parking.
- Minimize parking demand via use of alternate transportation, carpooling, flexible work hours and work-at-home.

Sidewalks/paths:

- Reduce number of required sidewalks/paths—e.g., no sidewalks or surfaced paths in rural developments, sidewalks/paths on one side of street in suburban developments—while maximizing their utility by following the Vermont Pedestrian and Bicycle Facility Planning and Design Manual (National Center for Bicycling and Walking 2002).
- Design sidewalks/paths for multi-purpose use.

- Minimize sidewalk/path widths. The current standard of 10' width for asphalt multi-use paths is appropriate for highly traveled corridors. However, lesser widths may be considered when serving individual neighborhoods.
- Encourage unsurfaced paths where feasible.

Fire access:

- Balance public safety needs with planning goals for vertical development and for reduced impervious surfaces. It is difficult to argue against the desire of public safety officials to gain access to all sides of all buildings and to have wide streets for easy access by large fire vehicles. However, such requirements do cause significant increases in total surfaced area. We recommend that the Town research site design and fire safety guidelines in other communities to determine standards that are appropriate in Colchester.

A second goal is promotion of better site design and other non-structural Best Management Practices as part of stormwater review procedures. One progressive approach is cited in "Low-Impact Development Design Strategies, An Integrated Design Approach," prepared by Prince George's County, Maryland, Department of Environmental Resources, June 1999. This approach requires analysis of site hydrology and stormwater treatment options as direct elements of development review. Each individual site is evaluated, including a complete submission by the developer and technical review by the Town, according to steps such as the following:

- Define a development envelope that excludes protected areas, setbacks, easements, topographic features, etc.
- Use drainage/hydrology as a design element. Conduct a hydrologic evaluation early in the process to understand and take advantage of site conditions.
- Depict any flows that may impact impaired streams or other critical water resource.
- Minimize the total site impervious area.
- Integrate the site layout plan with identified hydrology conditions.
- Minimize directly connected impervious areas. Disconnect roof drains and direct flow to vegetated areas. Also direct driveway/paved area flows to vegetated areas. Break-up flow directions from large paved surfaces. Locate impervious areas so that they drain to natural systems.
- Modify/increase drainage path flows. Maximize overland sheet flow, increase and lengthen flow paths, and lengthen and flatten site and lot slopes.
- Compare pre-and post-development hydrology.

A third goal is use of structural Best Management Practices in stormwater review. Again, we recommend that the developer be required to submit details that satisfy State and any local standards. Town staff will be expected to have the technical expertise to review these stormwater treatment details.

All stormwater standards and review procedures described in this section will apply to redevelopment of existing sites as well as proposed new development.

Responsible Party: Planning and Public Works.

Estimated Effects: Clearly written subdivision and site plan standards improve opportunities for maintaining satisfactory water quality. While development will necessarily increase lot coverage, standards for streets, storm drainage, parking lots, sidewalks/paths, and fire protection will minimize the extent of required improvements and the resulting amount of impervious surfaces. Good subdivision and site plan standards also address the process of development review and will ensure that proper attention is given to existing hydrology conditions, routing of stormwater flows, and methods for stormwater treatment.

SWQP goals potentially addressed by a focus on subdivision and site plan standards with water quality issues in mind:

- Reduce bacterial contamination to and in Malletts Bay
- Reduce phosphorous loads
- Improve the water quality in Sunderland Brook
- Reduce sediment loads to Colchester streams and rivers
- Improve the water quality in non-impaired creeks and Colchester Pond
- Where surface water and ground water quality now meets standards, ensure that no degradation occurs

Necessary Conditions: Studies to review new standards and their impacts. The Town may be able to obtain planning grants in the range of $10,000 to $15,000. Engineering studies may require additional funding. Cost may be reduced by "piggy-backing" on similar efforts in other towns.

5.3.2.2. Second rank priority

1. Identify lands with high impact on water quality and determine regulatory, financial and management techniques to protect those lands. Examine stream setbacks, with environmental studies that relate setbacks to the specific characteristics of the watercourse and to the density of adjacent development.

Both recommendations in the "top priority" category are town-wide actions. Their high ranking is because we see a great need for water quality issues, especially related to stormwater, becoming more integrated into the Town's zoning and development review standards. This second rank priority supplements the town-wide actions by "targeting" actions towards specific locations.

The first "high impact" land category is priority subwatersheds, which are described in an appendix. The same development review process will apply in these areas as throughout the town, but the identification of a priority watershed suggests a higher degree of caution in conducting development review. We recommend that particular attention be paid to the following locations:

Location	Planning Status	Priority Subwatershed
Exit 16	Growth Center	Sunderland Brook
Severance Corners	Growth Center	Smith Hollow Stream
		Sunderland Brook
Exit 17	Growth Center	Allen Brook
		Chimney Corner
Lakeshore Drive	Village/Moderate growth	Malletts Head East
West		Malletts Bay
		Malletts Head West
		Lake Shore Drive
		Diversity Hill

A second high impact land category is streams and appropriate buffers. The Town recently took a good first step in its zoning regulations by establishing an 85 foot stream buffer requirement. However, many water quality experts believe that greater stream buffers are needed, at least in some places, and that continuity of the buffer zone along a stream is highly important. A number of studies have indicated that diversity of fish and aquatic insect species correlates with a high level of continuity in the buffer zone (Center for Watershed Protection 2003). Recent work by the River Corridor Management Section of the Vermont Department of Environmental Conservation suggests that very large buffers, in the range of 300 feet or more, are appropriate in some areas to deal with issues of stream movement. Streams are constantly undergoing change, often in response to channel, flood plain or watershed changes imposed in years past by human activity.

Requirements may vary due to soils conditions and slope. At a minimum, we recommend that the 85' buffer be applied to all properties, without the present exemption for single-family and duplex properties. Since the Water Protection District protections only apply to properties permitted since the District took effect

in 2000, we recommend that consideration also be given to requiring stream buffers as a condition on any new redevelopment permit.

If a stream is within a growth center, buffer zones that protect the stream's water quality may cause challenges for achieving a high density. Achieving localized high density while protecting overall water quality is a goal that will take considerable attention and creativity to achieve.

A study to determine where there are hazards to structures, based on the stability of the river or stream, will identify areas where larger setbacks allow room for the watercourse's natural variability.

A third high impact land category is wetlands. Wetlands are provided a significant degree of protection by State and federal regulations. However, they receive added protection when wetland boundaries and values are understood by planners in developing effective plans for such locations as the Heineberg Drive/Prim Road planning area.

An Open Space Plan, prepared for the Town in 1999 to address mitigation efforts for the Circumferential Highway, included various recommendations in the areas of education, regulation and public policy. The plan focused on a variety of natural resources including water quality – floodplain, wetlands, and watercourses. We recommend that the Town review the recommendations of the 1999 Open Space Plan in light of current water quality issues.

Responsible Party: Planning Commission and Planning/Zoning Department.

Estimated Effects: Specific focus on priority subwatersheds, stream buffers and wetlands will address water quality issues in locations where they are most sensitive. Targeting of local resources and outside funding in these locations may be more efficient in protecting existing levels of water quality.

SWQP goals potentially addressed by identifying lands with high impact on water quality:

- Reduce bacterial contamination to and in Malletts Bay
- Reduce phosphorous loads
- Improve the water quality in Sunderland Brook
- Reduce sediment loads to Colchester streams and rivers
- Ensure no net loss of Class I, II or III wetlands

Necessary Conditions: Extensive studies may be needed for site-specific determination of appropriate stream buffers. The cost could be $25,000 or more. Outside funding sources could help pay for part or all of this. Other identification and protection of high impact areas may be accomplished by consolidation of available GIS and other data and supplemental work by town planners.

5.3.2.3. Third rank priority

1. Seek actions by upstream communities to minimize adverse impacts on water quality in the Lamoille and Winooski Rivers and the streams entering Malletts Bay directly.

Action: Colchester can take many steps to improve the connection between water quality issues and land use planning within the town's boundaries. However, impacts on watercourses such as the Lamoille and Winooski Rivers occur largely outside the town's boundaries. The State of Vermont is now facilitating efforts as part of a Lamoille Basin plan to develop watershed planning strategies and to find technical and financial resources and volunteers. A similar planning process is underway for the Northern Lake Champlain Basin, which includes Malletts Bay, and is planned for the Winooski River. The Town could assist in this cooperative process by identifying local issues of concern and offering citizen and staff resources in the development of a basin plan.

Responsible Party: The Water Quality Committee and other Town entities work within the ANR's basin planning framework.

Estimated Effects: Cooperation in a larger State-sponsored effort will improve the Town's ability to increase awareness and to find solutions for water quality issues in lower Lamoille and Winooski Rivers.

SWQP goals potentially addressed by seeking cooperative action on water quality in the Lamoille and Winooski Rivers:

- Improve water quality so that fish caught in Colchester's water are edible
- Reduce sediment loads to Colchester streams and rivers

Necessary Conditions: Available forum for communication between the Town and other public entities.

5.3.3. Public Involvement

As in the wastewater section, there is a great need for the public to get involved in any discussion regarding changing land use restrictions. Unlike wastewater, many of the mechanisms for involving the public already exist. Instead of implementing

many new activities, we recommend that wastewater and stormwater considerations be explicitly included in any future deliberations. There is a need for public involvement at earlier planning stages where land uses, density and dimensional standards are being determined. Public input also is desirable when development review standards are being established. This input will help determine acceptable standards for road widths, extent of sidewalks, parking areas, etc. Public input at these stages is more productive than at the development review stage where abutting property owners are reacting to the details of a specific development.

The study of stream bank stability is one area where public involvement could get a significant number of people much more familiar with the issues of stream variability and show them what Colchester's streams look like close up. A professional is needed to supervise the study, but volunteers who assist with the data gathering have the potential to reduce costs for the Town and/or improve residents' understanding of the challenges.

5.4. Recreational use of receiving water

Swimming is one of the major recreational uses of Malletts Bay, and water pollution can lead to beach closings or significant numbers of swimmers becoming ill. Tests for so-called "fecal indicator bacteria" are used as less expensive alternatives to testing for the pathogens which potentially cause illness. *Escherichia coli*, or *E. coli*, is the indicator bacterium used in Vermont. Where *E. coli* are detected, it assumed that fecal contamination has occured, and the contamination could also contain human pathogens.

Vermont Department of Health's water quality standard for beaches, which is that beaches be closed after a single detection of greater than 77 MPN *E. coli* per 100 ml water, is the strictest in the nation. The EPA recommends a single detection standard of 235 *E. coli*/100 ml or a geometric mean over five samples of 126 MPN/100 ml. Unpublished data from a University of Vermont graduate student show that undeveloped, forested watersheds in Vermont can exceed the 77 *E. coli*/100 ml threshold after rainfall events (Moir, pers. comm.). The Water Quality Division of the State Department of Environmental Conservation is re-evaluating Vermont's standard.

Boating is the other major recreational activity on Malletts Bay. Many non-boaters have raised the concern that fecal matter from boats has caused contamination of Malletts Bay. However, interviews with Colchester's Harbor Master and Vermont State Police, who have worked with the Coast Guard to conduct random checks of boat plumbing, have indicated that cases of boats plumbed in such a way that their wastewater could be pumped overboard are exceedingly rare. Pumpout stations for boat holding tanks exist at Champlain Marina, Malletts Bay Marina, and The Moorings; the boat club also has one, though its use is limited to its members (Germain, pers. comm.).

5.4.1. Description of current and ongoing activities

Beginning in 1990, Colchester has employed a Water Quality Coordinator in the summers, who has sampled surface water—mostly at the edges of inner Malletts Bay—reported on the summer's samples, and made recommendations for improving water quality and refining the sampling program.

In the summer of 2001, the Water Quality Coordinator also took many fecal samples used in a microbial source tracking investigation, where molecular techniques were used to find the source animals for *E. coli* found in the waters of Malletts Bay. This study (described in the literature review), though inconclusive, has shown enough about the power of DNA ribotyping so that the Public Works Department is discussing with the regional EPA office ways to follow up on the study which are likely to be more conclusive and which focus on high, anomalous *E. coli* detections.

Boats can easily spread many aquatic nuisance species, particularly as the boats are transported from one water body to another. There are signs at Colchester Pond and pamphlets at the marinas to encourage boat owners to clean their boats in a way that minimizes the chances of spreading aquatic nuisance species.

5.4.2. Priorities for future action

In order to show where the high levels of *E. coli* at Bayside Beach are coming from, a revised microbial source tracking protocol was recommended as a top priority in the wastewater section, above. Consideration was given to a recommendation that larger-scale inspections of boats be conducted to catch boat owners who are pumping their holding tanks overboard. Since State Police and Colchester's Harbor Master, who conduct such inspections now, indicate that exceedingly few boats are set up to do that, this alternative was judged not likely to lead to much pollution reduction. For those reasons, the only recommendation in this section is directed at aquatic nuisance species.

5.4.2.1. Top priority

Develop a pilot project coordinating actions against aquatic nuisance species to propose to the Lake Champlain Basin Program (LCBP) for possible funding. Consider extending the position of the existing Water Quality Coordinator to include monitoring for aquatic nuisance species.

Action: Build on existing data and public interest by teaming with the Winooski Valley Park District and other local and regional organizations to conduct a biannual survey of major recreational shorelines in Colchester, including Malletts Bay and Colchester Pond. Malletts Bay is one of the monitoring sites identified by

the Lake Champlain Basin Program in their October 2002 "Opportunities for Action" document. One of their stated objectives for the monitoring sites is to "document the introduction, spread, economic impact, and management of aquatic nuisance species".

An initial public outreach effort, using articles in the Colchester *Sun* and other local media, will publicize the survey and ask for volunteers to attend a workshop on identification of native and invasive aquatic species. The workshop would be followed by an aquatic macrophyte survey led by Colchester's Water Quality Coordinator and staffed primarily by volunteers. The survey may be conducted by boat or from land, but it should cover the littoral zone from the shoreline to a depth of 7 or 8 feet, water clarity permitting. Visual observations will be recorded on forms provided by the Coordinator, and the forms will be returned for entry into a database. Results for both native and invasive aquatic plants will be plotted on a GIS map, and will be publicized using newspaper articles and updates to the Town's and other websites.

Responsible party: Water Quality Coordinator / Public Works Department
Estimated effects: Aquatic nuisance species can be spread by the actions of a few individuals, so widespread education about the extent and significance of the species in Colchester can slow down or stop their spread by reminding people to take appropriate precautions. Careful monitoring of the extent of nuisance species can provide the basis for decisions on control measures, and could be used for rapid action to eradicate an invasive species that has established a new, small beachhead in Colchester.

The SWQP goal addressed by this action is:

- Ensure no increase in invasive species in Malletts Bay and no entry of invasive species to Colchester Pond.

Necessary conditions:
Cost: $5,000-$10,000, possibly covered by a grant from Lake Champlain Basin Program

5.5. General description of public involvement

This plan calls for decisions that favor water quality, by town residents at the ballot box, by the Select Board, and by individuals. These decisions will be easier if members of the public are engaged and understand both the changes and the reason why these changes will benefit the Town. In order to accomplish this, we recommend that the Water Quality Committee continue its existence as a citizen committee charged with advising the Town on water

quality issues and promoting public involvement in actions directed at maintaining and improving water quality.

Part of the Water Quality Committee's continuing role may be to seek regular opportunities to provide information to the public regarding water quality in the Town, as well as the relationship of changing conditions to the activities carried out as a part of the Strategic Water Quality Plan. This information may include the results of the community assessment, progress in implementing the Stormwater strategies, and the results of voluntary monitoring. If the Water Quality Committee develops and communicates this information in a consistent fashion, over time, Colchester residents will identify the Water Quality information as a single story and not a random collection of news items.

6. TIME FRAME

The following table suggests a possible time frame for implementing the recommendations of this Plan. The time frame is short; significant action is expected on all recommendations within six years. The short time frame stems from the importance of the recommendations: the recommendations that have emerged from the planning process and made it into this Plan are ones that have been identified as being potentially highly effective or very highly effective in addressing very high priority or high priority goals.

The sequence recommended here is largely based on a logic within each of the categories of actions, i.e., wastewater, stormwater, land use, and recreational use of receiving waters. However, there is some interplay between categories. For example, the results of the microbial source identification work may be used to accelerate or slow down the timetables for the Lakeshore Drive wastewater work or stormwater work, depending on their results.

Section/ Priority	Recommended Action	Immediate Action (1st and 2nd years)	Medium-Term (3rd and 4th years)	Long-Term (5th year and beyond)
Wastewater: Top Ranked Priorities	5.1.2.1.a. Needs assessment for onsite wastewater treatment systems	• Staff from Planning and Zoning, Public Works seek funding (external and internal) for needs assessment • Staff from Planning and Zoning, Public Works issue RFP for needs assessment and select firm to carry it out. COST: Primarily staff hours STAFF HOURS: tbd DURATION: 18 months • Phase I needs assessment begun COST: $120,000 to $160,000 STAFF HOURS: tbd DURATION: 15 months	• Phase I needs assessment concluded • Staff from Planning and Zoning, Public Works seek funding (external and internal) for Phase II needs assessment (feasibility study of recommended options) • Staff from Planning and Zoning, Public Works issues RFP for and select firm to carry it out. COST: Depends on results of Phase I STAFF HOURS: Depends on results of Phase I DURATION: 0-18 months • Phase II needs assessment begun	• If begun, Phase II needs assessment completed COST: Depends on results of Phase I STAFF HOURS: Depends on results of Phase I DURATION: 6-18 months
	5.1.2.2.b. Develop and adopt a townwide onsite wastewater management program.	• Enter current permit information into database • Implement EPA Management Model 1, "Homeowner awareness," for all onsite systems. Primary additional activity is townwide education on maintenance of onsite systems, considering tracking septic tank pumping, and sending pumping reminders COST: $20,000 first year, $5,000 - $15,000 per year subsequently STAFF HOURS: tbd DURATION: 15 months	• Developing a more rigorous management plan, based on the results of the Phase I needs assessment, is likely to be part of the scope of the Phase II needs assessment.	• Implementation of a more rigorus management plan, developed as part of the Phase II needs assessment COST: tbd STAFF HOURS: tbd DURATION: tbd
	5.1.2.3. Public involvement in the onsite wastewater management program. 5.1.2.4. Public involvement: Wastewater stewardship program.	• Establish a wastewater management advisory committee to review the results of the needs assessment and prepare for the development of a comprehensive wastewater management plan COST: $1,000 per year for meeting support costs STAFF HOURS: 200 hrs per year DURATION: 2 years	• Utilize wastewater management advisory committee to ensure that the management program is consistent with the needs of town members COST: $1,000 per year for meeting support costs STAFF HOURS: 500 hrs per year DURATION: 2 years • Initiate a voluntary water stewardship program COST: $0 STAFF HOURS: 100 hrs per year DURATION: continuous	• Evaluate progress in implementation of management plan through the use of the advisory committee COST: $200 per year meeting support costs STAFF HOURS: 50 hrs per year DURATION: 2 years

Section/ Priority	Recommended Action	Immediate Action (1st and 2nd years)	Medium-Term (3rd and 4th years)	Long-Term (5th year and beyond)
	5.1.2.5. Design and implement increased bacterial monitoring and microbial source tracking at Bayside Beach to determine the main sources of bacteria found there.	• Public Works staff, possibly with Water Quality Committee and input from a consultant, design a plan for bacterial monitoring and microbial source tracking COST: $5,000 STAFF HOURS: tbd DURATION: 6-12 months • Bacterial monitoring and microbial source tracking study designed and sampling carried out COST: $100,000 - $200,000 (includes analysis and reporting) STAFF HOURS: tbd DURATION: 9 months	• Bacterial monitoring and microbial source tracking study analysis and reporting COST: (see previous column) STAFF HOURS: tbd DURATION: 6 months • Actions planned, based on study results	
	5.1.2.6. Public involvement: a volunteer monitoring program.	• Establish volunteer monitoring program to expand the geographic and temporal coverage of bacterial monitoring COST: $5,000 for contractor costs (possible funds from LCBP) STAFF HOURS: 50 hrs per year DURATION: 2 years	• Continue volunteer monitoring program COST: $1,000 per year equipment costs STAFF HOURS: 50 hrs per year DURATION: continuous	

Section/ Priority	Recommended Action	Immediate Action (1st and 2nd years)	Medium-Term (3rd and 4th years)	Long-Term (5th year and beyond)
Wastewater: Second Rank Priorities	5.1.3.1. Prioritize Lakeshore Drive for special wastewater management action.	• Staff from Planning and Zoning issue RFP for buildout analysis and select firm to carry it out. COST: Primarily staff hours STAFF HOURS: tbd DURATION: 3 months • Perform a buildout analysis for Lakeshore Drive based on current growth plans COST: $12,000 STAFF HOURS: tbd DURATION: 6 months • Staff from Planning and Zoning, Public Works seek funding (external and internal) for inspecting onsite systems, investigating possibilities for cluster systems, and updating sewer alternatives COST: Primarily staff hours STAFF HOURS: tbd DURATION: 6-12 months	• Staff from Planning and Zoning, Public Works issues RFPs for 1) inspecting onsite systems, 2) investigating cluster systems, and 3) updating sewer alternatives. • Staff from Planning and Zoning, Public Works elects firms to carry projects out. COST: Primarily staff hours STAFF HOURS: tbd DURATION: 6 months • Inspect all onsite systems within 300 feet of the lake for the entire length of Lakeshore Drive COST: $110,000 STAFF HOURS: tbd DURATION: 10 months • Investigate possibilities for cluster systems COST: $20,000 - $25,000 STAFF HOURS: tbd DURATION: 6 months • Revisit and update sewer alternatives COST: $25,000 STAFF HOURS: tbd DURATION: 12 months • Summarize results of recent work and recommend an alternative • Select Board decides outlines (sewer vs. decentralized) of future wastewater treatment for Lakeshore Drive COST: $15,000 STAFF HOURS: tbd DURATION: 5 months	• Develop zoning rules COST: $10,000 STAFF HOURS: tbd DURATION: 9 months • Begin building sewer or implementing decentralized program COST: tbd STAFF HOURS: tbd DURATION: tbd

Section/ Priority	Recommended Action	Immediate Action (1st and 2nd years)	Medium-Term (3rd and 4th years)	Long-Term (5th year and beyond)
	5.1.3.2. Public involvement	• Initiate information process and products regarding the status of wastewater management on Lakeshore Drive COST: $10,000 for contractor support STAFF HOURS: 100 hrs per year DURATION: 2 years	• Continue information development COST: $10,000 for contractor support STAFF HOURS: 100 hrs per year DURATION: 2 years	

Section/ Priority	Recommended Action	Immediate Action (1st and 2nd years)	Medium-Term (3rd and 4th years)	Long-Term (5th year and beyond)
Stormwater: Top Ranked Priorities	5.2.3.1.1 Implement structural best management practices (BMPs) based on those recommended in the Town's *Stormwater Management Plan* for watersheds which are designated as impaired or have a high percentage of impervious surface.	• Planning and public works staff reviews existing standards and procedures for incorporation of appropriate measures. Review needs to be performed concurrently with the nonstructural BMPs evaluated under Land Use recommended action 7.3.2.1. • Planning and public works staff develop a work plan and seek funding through a municipal planning grant to implement the changes. COST: $10,000 to $15,000 STAFF HOURS: tbd DURATION: 12 months	• Planning and public works staff determines specific recommendations for incorporation into existing standards and procedures. The changes need to address the MS4 Phase requirements to regulate new and redevelopment projects that do not require a State stormwater permit. • The public, Planning Commission and Selectboard provide review comments. • The Town adopts the updated standards and procedures. COST: (See previous column) STAFF HOURS: tbd DURATION: 12 months	
	2. Upgrade the six high priority stormwater outfalls as recommended in the Town's Stormwater Outfalls Assessment.	• Public works staff coordinates the engineering design and permitting of the outfall improvements in year 1. • Public works budgets construction funds in capital plan. • Public works manages the implementation and construction of the outfall improvements in year 2. COST: tbd STAFF HOURS: tbd DURATION: 12 to 18 months		
	3. Upgrade the six moderate priority stormwater outfalls as recommended in the Town's Stormwater Outfalls Assessment.	• Public works staff coordinates engineering design and permitting of the outfall improvements in year 2. • Public works budgets the construction funds in capital plan. COST: tbd STAFF HOURS: tbd DURATION: 12 months	• Public works manages the implementation and construction of the six (6) outfall improvements. COST: tbd STAFF HOURS: tbd DURATION: 12 months	

Section/ Priority	Recommended Action	Immediate Action (1st and 2nd years)	Medium-Term (3rd and 4th years)	Long-Term (5th year and beyond)
	4. Establish an outfall protection program that includes the prioritized inspection schedule and maintaining the inspection checklist as recommended in the Town's Stormwater Outfalls Assessment.	• Public works staff conducts the annual inspections in accordance with the prioritized inspection schedule. • Public works staff revises the inspection checklist to document observations and monitoring of potential illicit discharges. • Public works staff updates the inspection checklist for each inspected outfall to maintain the data base. • Outfalls requiring additional maintenance and repairs are identified. COST: Primarily staff hours STAFF HOURS: tbd DURATION: Annual		
Stormwater: Second Rank Priorities	5.2.3.2.1. Inventory the existing public stormwater systems and develop a program for regular inspection of stormwater structures.	• Public works staff expands inventory to include all public catch basins, manholes, culverts, etc. • Public works staff develops a data base to document the results of the inventory. • The storm sewer mapping is updated annually. • Priorities are identified for inspection, repairs, and maintenance. • Based on the results of the inspections, the frequency and effectiveness of cleaning is determined for implementation under recommended action 7.2.2.2.3. COST: $12,000 to $15,000 STAFF HOURS: Inspection can be performed using summer interns DURATION: 24 months	• Public works staff performs annual inspection of storm sewers based on the program priorities. • Public works staff updates the database with the latest inspection results. COST: Primarily staff hours STAFF HOURS: tbd DURATION: annual	
	2. Implement the prevention measures and approaches into the Town review process for new development projects as recommended in the Town's Stormwater Outfalls Assessment.	• Public works staff reviews existing standards and procedures in the Public Works Standards. Review needs to be performed concurrently with recommended action 7.2.2.1.1. COST: Primarily staff hours STAFF HOURS: tbd DURATION: 12 months	• Public works incorporates the requirements for the outfall prevention measures into the updated Public Works Standards. • Town adopts updated Public Works standards. COST: Primarily staff hours STAFF HOURS: tbd DURATION: 12 months	

Section/ Priority	Recommended Action	Immediate Action (1st and 2nd years)	Medium-Term (3rd and 4th years)	Long-Term (5th year and beyond)
	3. Clean catch basin structures located in public areas, prioritizing impaired watersheds and those draining to Malletts Bay.	• Public works staff coordinates the list of structures that require annual cleaning in conjunction with the inspection program developed under action 7.2.2.2.2. • The Town experiments with the addition of interceptors in catch basins to ease the cleaning by reducing the sediment accumulation in the sumps. COST: Rental of cleaning equipment ($110/hr) plus staff hours STAFF HOURS: tbd DURATION: Annual	• Public works staff assesses the need for the purchase of cleaning equipment (vactor truck) based on the annual expense, frequency of cleaning required, and effectiveness of the program. COST: Primarily staff hours STAFF HOURS: tbd DURATION: 6 months	
Stormwater: Third Rank Priority	5.2.3.3.1. Complete a comprehensive site inventory of the existing public and private areas, prioritizing impaired watersheds and those draining to Malletts Bay.		• Public works staff coordinates the field inspection, inventory, and review for each private system. • Public works staff research and determine Town responsibility for maintenance and repairs of each system. COST: Primarily staff hours STAFF HOURS: tbd DURATION: 12 months	• Public works staff develops and maintains an inspection program for the private systems.
Land Use: Top Ranked Priorities	5.3.2.1.1. Upgrade review standards for new development throughout the town. Focus on zoning standards. Address uses, density and dimensional standards.	• Planning Commission reviews lot coverage in high-density districts, e.g. GD3 and Industrial, in relation to overall district density and water quality conditions; it considers the need for lower lot coverage and/or increased use of FAR standards. • Planning Commission considers reduction in front-yard setbacks in all districts. • Planning Commission holds public hearings and adopts first round of zoning revisions. • Planning Staff seeks funding from municipal planning grants or other sources for supplemental studies. COST: $10,000 to $15,000 STAFF HOURS: tbd DURATION: 15 months	• Planning Commission reviews appropriate uses in relation to water quality impacts and results of supplemental planning studies. • Planning Commission approves second round of zoning revisions. COST: $0 STAFF HOURS: tbd DURATION: 12 months	• Planning Staff and Commission regularly consider water quality issues as part of zoning revisions. COST: $0 STAFF HOURS: tbd DURATION: Ongoing

Section/ Priority	Recommended Action	Immediate Action (1st and 2nd years)	Medium-Term (3rd and 4th years)	Long-Term (5th year and beyond)
	2. Upgrade review standards for new development throughout the town. Focus on site plan/ subdivision standards.	• Planning & Public Works Staff reviews currently available standards and review procedures from sample ordinances and other municipalities; they determine items that may be used directly in Colchester. • Planning & Public Works Staff determines specific standards appropriate for Colchester, e.g. road widths. • Planning Commission adopts first round of additional review standards and procedures. • Planning Commission initiates dialogue with other town bodies where conflicting goals may require resolution, e.g. fire access standards. • Planning & Public Works Staff seek funding from municipal planning grants or other sources for supplemental studies. COST: $10,000 to $15,000 STAFF HOURS: tbd DURATION: 18 months	• Following completion of dialogue with other town bodies and supplemental studies, Planning Commission approves second round of additional review standards. COST: $0 STAFF HOURS: tbd DURATION: 9 months	• Planning Staff and Commission regularly consider water quality issues in development review standards. COST: $0 STAFF HOURS: tbd DURATION: Ongoing
Land Use: Second Rank Priority	5.3.2.2.1. Identify lands with high impact on water quality and determine regulatory, financial and management techniques to protect those lands. Examine stream setbacks, with environmental studies that relate setbacks to the specific characteristics of the watercourse and to the density of adjacent development.	• Planning Staff compiles a list of priority subwatersheds for review by Planning Commission and consideration in all planning activities. • Planning Staff begins search for funding sources to do site-specific study of stream buffers. • Planning Commission reviews 1999 Open Space Plan and considers update based on current water quality considerations. COST: $0 STAFF HOURS: tbd DURATION: 12 months	• Planning Staff hires consultant to perform site-specific study of stream buffers. • Planning Commission reviews stream buffer study and incorporates revisions into zoning regulations. COST: $25,000+ STAFF HOURS: tbd DURATION: 18 months	• Planning Staff monitors any changes in Colchester water quality; changes that may affect land use planning are brought to the attention of the Planning Commission. COST: $0 STAFF HOURS: tbd DURATION: Ongoing
Land Use: Third Rank Priority	5.3.2.3.1. Seek actions by upstream communities to minimize adverse impacts on water quality in the Lamoille and Winooski Rivers and the streams entering Malletts Bay directly.	• Selectboard agrees to participate in State's Lamoille Basin plan and other applicable state basin planning processes. • Water Quality Committee leads town's participation in Lamoille Basin plan. COST: $0 STAFF Hours: tbd DURATION: 2 years+	• Water Quality Committee continues to participate in Lamoille Basin plan. COST: $0 STAFF HOURS: tbd DURATION: 2 years+	• Water Quality Committee continues to participate in Lamoille Basin plan. COST: $0 STAFF HOURS: tbd DURATION: Ongoing

Section/ Priority	Recommended Action	Immediate Action (1st and 2nd years)	Medium-Term (3rd and 4th years)	Long-Term (5th year and beyond)
Recreactional use: Top priority	5.4.2.1 Develop a pilot project coordinating actions against aquatic nuisance species to propose to the Lake Champlain Basin Program (LCBP) for possible funding.	• Public Works writes an application to LCBP for funding. • Public outreach and training in aquatic nuisance identification. • Volunteers conduct aquatic macrophyte survey coordinated by Water Quality Coordinator COST: $5,000 - $10,000, possibly covered by LCBP. STAFF HOURS: 100 DURATION: 2+ years	• Aquatic macrophyte survey continued annually, with some training of new volunteers. COST: $3,000 - $5,000. STAFF HOURS: 80 DURATION: 2+ years	• Aquatic macrophyte survey continued annually, with some training of new volunteers. COST: $3,000 - $5,000. STAFF HOURS: 80 DURATION: 2+ ye

7. INDICATOR DEVELOPMENT

7.1. A general description of indicator development

Indicators provide a regular update of progress in implementing the Strategic Water Quality Plan. There are four important steps in developing an indicator process:

- Determining how the measures will be used
- Choosing the measures
- Ensure data collection and reporting
- Use the measures

7.2. Deciding the use of the measures

There are three possible uses for the indicators developed as a part of this Strategic Water Quality Plan. Most simply, the indicators could provide information to the public about the status of implementing the SWQP. The public involvement strategies described in Chapter 6 could be a vehicle for reporting the indicators as information for the Colchester public.

A second possible use of the indicators could be to develop an adaptive management system. In this case, the report on indicators serves as a mechanism to review progress and make changes in the plan or its implementation.

A third possible use of the measures is to provide accountability to the public. In this case, a lack of progress towards benchmarks of success could raise the possibility that the Water Quality Committee, contractors to the Town, and/or the Town Manager could be better performing their tasks related to water quality, and change may be in order. In a variation on the accountability use—a slightly relaxed form of accountability—it would be more important for the responsible parties to be able to report on changes in the indicators and the causes of those changes. Only if the responsible parties fail to report on the indicators, would the Select Board or other appropriate body consider actions to produce the expected reports.

The Water Quality Committee should consider the degree to which these different uses are consistent with their expectations. However, the preliminary decision may change after some of the indicators are reported and trends become apparent.

7.3. Selecting the measures

The starting point for choosing indicators is to use the activities suggested in the Strategic Water Quality Plan.

Some sample indicators:

- Historical trends in beach closures and bacterial test results

- Phosphorus loads (modeled or measured)
- Phosphorus concentrations (and relation to algae occurrences)
- Sunderland Brook biological assessment results
- Number of invasive species in Malletts Bay
- Mercury in fish
- Modeled sediment loads in Colchester lakes and rivers
- Biological assessment results in other creeks and Colchester Pond
- Acres of Class I, II, and III wetlands
- Percent ground water and surface water that meets standards
- Number of incidents of oil and fuel leaks from refueling

The Water Quality Committee should consider this list to determine if it meets their needs and the needs of other prospective audiences. From this list, the committee should add or remove measures as appropriate.

7.4. Data collection

Most of the information incorporated in these indicators exists and forms the basis for this plan. The activities outlined in this Strategic Water Quality Plan should include the monitoring necessary to ensure that progress is tracked. In order to ensure that the data are available, the Water Quality Committee should review each of the measures and the activities that are associated with those measures. In those cases where the data are not readily available, the committee should determine the value of the indicator, and eliminate it from the list, if appropriate.

7.5. Developing the report and forums to promote discussions

Possibly, the most important step in indicator development is the consideration of reporting the data. This includes deciding on the target audience in order to determine how best to deliver the information and to design a specific mechanism for that audience to receive the data and to respond to the messages contained in the data. The optimal mechanism for reporting the indicators would be to include a workshop where the data are central to decisions regarding modification of some of the strategies within the plan.

7.6. Reconsider the measures and their use

After one year of implementation of this water quality plan, the Water Quality Committee or its designee should review the indicators and their use to suggest revisions.

8. THE STRATEGIC WATER QUALITY PLAN AS A LIVING DOCUMENT

8.1. The factors that should lead to change in the Strategic Water Quality Plan

One of the important activities outlined in this plan is the needs assessment for wastewater infrastructure. The results of this study may indicate some specific activities that are not included in this version of the plan. Other types of information that is produced in the future, may also guide changes in the plan.

8.2. The mechanism for making changes

The Water Quality Committee should collect all of comments associated with the adopted plan and place them on file. The committee should review these comments at an appropriate time and consider changes to the plan.

After the first year of implementation, the Water Quality Committee should review the results from the indicators and work in progress, to consider changes in the plan. These reviews should be repeated each year in order to modify the work plans to better accomplish long-term goals.

In general, every five years, the Water Quality Committee may want to repeat a priority-setting exercise and restructure the plan if the priorities have change significantly. Coordination with the five-year cycle of producing Town Master Plans will help produce documents which complement each other. In order to provide useful input into the Master Plan, the Water Quality Committee may wish to produce a finished revision of the Strategic Water Quality Plan at least a year before the Master Plan revision is scheduled to be finished. The next revision of the Master Plan is scheduled to be finished in July 2007, so the Water Quality Committee should consider beginning its revision process in mid-2005 and finishing by mid-2006. If this order of planning revisions—Strategic Water Quality Plan a year prior to Master Plan—proves fruitful, subsequent revisions of this Plan could also be timed to precede revisions to the Master Plan.

9. REFERENCES

Associated Press. 2002. Lake Champlain pike may have viral disease. *Times Argus*.

Binhammer, Jon. 1994. Lake Champlain wetlands acquisition study. Montpelier, Vermont: Vermont Nature Conservancy.

Boehm, Alexandria B., Jed A. Fuhrman, Robert D. Mrse, and Stanley B. Grant. 2003. Tiered approach for identification of a human fecal pollution source at a recreational beach: Case study at Avalon Bay, Catalina Island, California. *Environmental Science & Technology* 37 (4):673-680.

Bress, Bill. 2002. 30 April 2002.

Budd, L., and D. Meals. 1994. Lake Champlain nonpoint source pollution assessment. Boston, Massachusetts: US EPA.

Budd, Lenore F., and Donald W. Meals. 1994. Lake Champlain nonpoint source pollution assessment: Lake Champlain Basin Program.

Center for Rural Studies. 2002. *Socioeconomic Indicators for Vermont Communities* [web page]. Center for Rural Studies at University of Vermont, February 3, 1998 1998 [cited June 25, 2002 2002]. Available from access through http://crs.uvm.edu/indicators/chittend.htm.

Center for Watershed Protection. 2003. Impacts of impervious cover on aquatic systems. Ellicott City, Maryland: Center for Watershed Protection.

Foley, Peter. 2001. Malletts Bay Water Quality Inventory Report: Summer 2001. Colchester, Vermont: Town of Colchester, Vermont.

Forcier Aldrich & Associates. 1997. Town of Colchester wastewater master planning Part II: Town-wide wastewater facility planning update. Vol. 1. Essex Junction, Vermont: Forcier Aldrich & Associates.

Gabos, Ben. 2000. Malletts Bay Water Quality Inventory Report: Summer 2000. Colchester, Vermont: Town of Colchester, Vermont.

Germain, Moe. Personal communication. Germain is a member of the Colchester Water Quality Committee and works at The Moorings Marina.

Griffin International. 2002. Town of Colchester municipal stormwater management plan. Williston, Vermont: Griffin International,.

Hegman, W., D. Wang, and C. Borer. 1999. Estimation of Lake Champlain basinwide nonpoint source phosphorus export. Grand Isle, Vermont: Lake Champlain Basin Program.

Jones, Stephen H. 2002. Microbial source tracking in Vermont using ribotyping of Escherichia coli isolates: Final report to the U.S. Environmental Protection Agency Section 104(b)3. Durham, New Hampshire: Jackson Estuarine Laboratory, University of New Hampshire.

Lake Champlain Basin Program. 1996. Background technical information for *Opportunities for action: An evolving plan for the future of the Lake Champlain basin*. Grand Isle, Vermont: Lake Champlain Basin Program.

———. *Lake Champlain Fish Advisory*. Lake Champlain Basin Program, 15 August 2000 2000 [cited 30 April 2002. Available from http://www.anr.state.vt.us/champ/fishadvs.htm.

———. 2002. Opportunities for action: An evolving plan for the future of the Lake Champlain basin (DRAFT): Lake Champlain Basin Program.

McIntosh, Alan, Mary Watzin, and Erik Brown, eds. 1997. *An assessment of sediment-associated contaminants in Lake Champlain - Phase II*, *Lake Champlain Basin Program Technical Reports*: Lake Champlain Basin Program.

Moir, Megan. Personal communication. Moir is a University of Vermont graduate student.

Nashett, Lawrence J., Jon K. Anderson, Brian D. Chipman, Lance E. Durfey, John E. Gersmehl, Shawn P. Good, Madeleine M. Lyttle, Chet MacKenzie, J. Ellen Marsden, Donna L. Parrish, David C. Nettles, Nick R. Staats, and Lawrence E. Strait. 1999. A comprehensive evaluation of an eight year program of sea lamprey control in Lake Champlain: Fisheries Technical Committee of the Lake Champlain Fish and Wildlife Management Cooperative.

National Center for Bicycling and Walking. 2002. Vermont pedestrian and bicycle facility planning and design manual. Montpelier, Vermont: Vermont Agency of Transportation.

National Wetland Inventory. *Database query: number and area of wetlands in Colchester* [Database]. National Wetland Inventory n.d. [cited.

Program, Lake Champlain Basin. *Lake Champlain Interim Total Phosphorus Criteria and Existing Phosphorus Concentrations* [Web page]. Lake Champlain Basin Program, 10 June 1998 1998 [cited 30 April 2002. Available from http://www.anr.state.vt.us/champ/phostab1.htm.

Smeltzer, Eric, and Scott Quinn. 1996. A phosphorus budget, model, and load reduction strategy for Lake Champlain. *Journal of Lake and Reservoir Management* 12 (3):381-393.

Sorenson, Eric, Marc Lapin, Brett Engstrom, and Robert Papp. 1998. Floodplain forests of Vermont: Some sites of ecological significance: Nongame and Natural Heritage Program, Vermont Fish and Wildlife Department, Agency of Natural Resources.

Town of Colchester Vermont. 2001. Town of Colchester Master Plan (Draft). Colchester, Vermont: Colchester Select Board

Colchester Planning Commission.

Vermont Agency of Natural Resources, and New York State Department of Environmental Conservation. 2002. Lake Champlain Phosphorus TMDL. Waterbury, Vermont.

Vermont Department of Environmental Conservation. n.d. Colchester water quality report: Vermont Department of Environmental Conservation.

Vermont Department of Environmental Conservation. 1997. Vermont advanced wetlands planning and protection project report: Lake Champlain basin. Waterbury, Vermont: Department of Environmental Conservation, Vermont Agency of Natural Resources.

Vermont Department of Environmental Conservation. 2000. List of priority surface water outside the scope of Clean Water Act Section 303(d). Waterbury, Vermont: Water Quality Division, Vermont Department of Environmental Conservation.

———. 2002. General information for: Colchester Pond. Waterbury, Vermont: Vermont Department of Environmental Conservation, Water Quality Division.

Vermont Fish and Wildlife Department. 1992. Wetlands of outstanding ecological significance in Chittenden County, Vermont. Waterbury, Vermont: Nongame and Natural Heritage Program, Vermont Fish and Wildlife Department,.

Water Resources Board. 2001. Vermont Wetland Rules: Water Resources Board.

APPENDIX 1: MEMBERS OF THE WATER QUALITY COMMITTEE

The following Colchester residents served on the Water Quality Committee during the time that this planning process was conceived and the plan was written:

Karen Bates
Betty Carvallas
Moe Germain
Pat Kearney
Steve Kruger
John Nichols
Bill Romond
Renie Peterson
Don Sargent

APPENDIX 2: WRITTEN MATERIALS CREATED FOR THE STRATEGIC WATER QUALITY PLAN (SWQP)

Date	Written Material
June 2002	Public input/outreach materials: Description of planning process, press release, publicity flyer (also advertises July public meeting), comment card
August 2002	*Recent Literature on Water Quality in Colchester, Vermont: A Part of the Strategic Water Quality Planning Process*
September 2002	Public outreach materials: Fact sheet on SWQP Potential municipal actions
December 2002	Colchester Strategic Water Quality Plan: Options for Prioritization (plus emailed addenda; used for multicriteria assessment)
January 2003	Video of presentation at New England Water Environment Association on the SWQP, for broadcast on the public access channel
February 2003	"Endpoints Of Interest For Colchester SWQP"
April 2003	Resource vulnerability assessment documents: Two matrices of prioritized actions, table summarizing results
May 2003	Draft SWQP

APPENDIX 3: PUBLIC MEETINGS HELD DURING PLANNING PROCESS

Date	Meeting Attended/Held
April 10, 2002	First of many meetings with Water Quality Committee. The Water Quality Committee met twice monthly, generally, and at least one member of the consulting team met with them frequently during the planning process.
May 13, 2002	Meeting with representatives of marinas and boat clubs. (Not warned) Presentation to Recreation Advisory Board
July 18, 2002	Public meeting on Strategic Water Quality Plan, Meeting House
August 27, 2002	Presentation to Select Board
Summer 2002	Presentation to Planning Commission
April 22, 2003	Presentation to Select Board
May 6, 2003	Presentation to Planning Commission

APPENDIX 4: ACTIONS CONSIDERED AND PRIORITIZED

Actions Considered

The following table summarizes those actions that were considered in the multicriteria assessment.

COLCHESTER STRATEGIC WATER QUALITY PLAN		
OBJECTIVES AND ALTERNATIVES FOR CONSIDERATION		
WASTEWATER		
Objective 1	**Develop knowledge base of potential and actual failures…**	
		Rank of criterion
Alternatives	1.1	Field-based, lot-by-lot wastewater treatment needs assessment
	1.2	Wastewater treatment needs assessment using planning-level data
	1.3.a	Data collection system: Data collection at time of property transfer
	1.3.b	Data collection system: Data collection by phased mandatory inspections
	1.4	Initial study of older sewers to estimate TV camera / building inspections
	1.5	Full assessment of older sewers with design measures to repair
	1.6	No wastewater treatment needs assessment performed
Objective 2	**Develop and implement a management program for onsite systems**	
		Rank of criterion
Alternatives	2.1	Develop and adopt an onsite wastewater management program
	2.2	Continue current oversight level for onsite systems
Objective 3	**Address needs of growth centers and areas recommended for sewers**	
		Rank of criterion
Alternatives	3.1	Prioritize Severance Corners for special wastewater management attention
	3.2a.I	Lakeshore Drive: inspection program with mandatory replacement
	3.2.a.ii	Lakeshore Drive: inspection program, mandatory replacement, innovative
	3.2.a.iii	Lakeshore Drive: inspection program, no automatically required changes
	3.2.b	Lakeshore Drive: Management plan for all onsite systems
	3.2.c	Lakeshore Drive: Town maintains onsite systems, replaces failures
	3.2.d	Lakeshore Drive: Central collection, treatment in Burlington (WFPU alt. C-2)
	3.2.e	Lakeshore Drive: Central collection, treatment in Burlington (WFPU alt. C-4)
	3.2.f	Lakeshore Drive: Central collection, treatment in Burlington (WFPU alt. C-5)
	3.2.g	Lakeshore Drive: Increase monitoring and source tracking at Bayside Beach
	3.2	Perform needs assessment before prioritizing areas
Objective 4	**Explore innovative fixtures for reducing wastewater flows and concentrations**	

		Rank of criterion
Alternatives	4.1	Explore using separate treatment and/or composting toilets in residences
	4.2	Explore using separate treatment and/or composting toilets in cluster systems
	4.3	Explore an ultra-low volume fixture ordinance
	4.4	Do not pursue flow reduction

STORMWATER

Objective 1 Meet or Exceed the NPDES Requirements

		Rank of criterion
Alternatives	1.1	Meet or Exceed the NPDES Public Education and Outreach Requirements
	1.2	Meet or Exceed the NPDES Public Involvment and Participation Requirements
	1.3	Meet or exceed NPDES Illicit Discharge Detection / Elimination Requirements
	1.4	Construction site runoff control
	1.5	Meet / Exceed NPDES Post-Construction Stormwater Management Requirements
	1.6	Meet NPDES Pollution Prevention/Good Housekeeping Requirements
	1.7	Complete a comprehensive inventory of the existing stormwater systems
	1.8	Investigate the Usefulness of a Stormwater Utility

LAND USE

Objective 1 Increase consideration of water quality impacts in growth center planning

		Rank of criterion
Alternatives	1.1	Revisit the size and location of all growth centers
	1.2	Accept current growth centers but refine content
	1.3	Accept growth center boundaries and goals of moderate to high density
	1.4	Encourage new "infill" development in partially or mostly developed areas
	1.5	"No action"; accept current growth center provisions

Objective 2 Identify sensitive lands; determine techniques to protect those lands

		Rank of criterion
Alternatives	*2.1*	Conduct inventory of sensitive areas from a water-quality perspective
	2.2.a	Review and revise Zoning Regulations affecting sensitive areas
	2.2.b	Relate stream setbacks to specific stream properties and development density
	2.2.c	Implement Transferable Development Rights program as part of Zoning Regs
	2.2.d	Consider impacts from new State wastewater rules on rural development
	2.2.e	Pursue acquisition of easements or title for sensitive lands
	2.2.f	Encourage appropriate management of sensitive lands
	2.2.g	Encourage appropriate levels of public access to sensitive lands
	2.3	"No action"; accept current protection measures

Objective 3	**Upgrade review standards for new development throughout the town**	
		Rank of criterion
Alternatives	3.1	Focus on zoning standards; address uses, density, dimensions
	3.2.a	Focus on site plan/subdivision standards (reduce impervious areas)
	3.2.b	Focus on site plan/subdivision standards (stormwater BMPs)
	3.3	"No action"; accept current standards
Objective 4	**Coordinate with town planners and regional/state officials**	
		Rank of criterion
Alternatives	4.1	Work with Chittenden County Regional Planning Commission
	4.2	Work with adjacent communities, such as Milton and South Burlington
	4.3	Seek actions by upstream communities minimizing adverse impacts
	4.4	"No action"; concentrate efforts at the town level

RECREATIONAL USE OF RECEIVING WATERS

Objective 1	**All Recreational Use Criteria**	
		Rank of criterion
Alternatives	1.1	Support Initiatives that Promote Sustainable Recreational Activity
	1.2	Determine, Monitor and Mitigate the Impact of Increased Recreational Use
	1.3	Increase and Improve Public Access Opportunities to the Lake
	1.4	Conduct a Needs Assessment of the Impact of Boating on Water Quality
	1.5	Increase Availability of Free Pumpout Stations
	1.6	Water Quality and Monitoring

COLLABORATION

Objective 1	**All Collaboration Criteria**	
		Rank of criterion
Alternatives	1.1	Support the State's efforts to control the spread of invasive species
	1.2	Work to prevent invasive species in Colchester Pond
	1.3	Begin collaboration and communication with upstream municipalities
	1.4	Work closely with State and Congressional legislators to influence actions
	1.5	Establish a continuing dialogue with LCBP and other, similar non-profits
	1.6	Encourage collaboration with higher education institutions

Actions Prioritized By Multicriteria Assessment

The following table summarizes those actions which remained on the table after the multicriteria assessment and which were the object of resource vulnerability assessment. The numbering and section heading are taken from the Dec. 16, 2002 report on alternatives, for use in multicriteria scoring.

Wastewater

Recommendation 1: Develop a knowledge base of the potential and actual failures of wastewater treatment systems	
Number in report	**Assigned code**
1.1) The Town performs a field-based, lot-by-lot wastewater treatment needs assessment. Cost: $550,000	W1.1
1.2) The Town performs a wastewater treatment needs assessment using planning-level data (e.g., Natural Resources Conservation Service soils data, assessor's data) with limited field verification. Results will be available for each lot, but lot-specific results will not be verified by field study. Cost: $80,000 - $100,000	W1.2
1.4) The Town performs an initial study of the older sewers to estimate the amount of sewer which needs inspection by TV camera and how many building inspections are necessary. Cost: $6500 - $9000.	W1.4
1.5) The Town performs a full assessment of the state of the older sewers and designs measures to fix them where necessary. Cost: $20,000 to $65,000, depending on how much of the sewer has significant enough wet weather flows that it needs to be inspected by TV camera and how many building inspections are necessary.	W1.5

Recommendation 2 : Develop and implement a management program for onsite systems	
Number in report	**Assigned code**
2.1) The Town develops and adopts an onsite wastewater management program.	W2.1

Recommendation3 : Address the wastewater management needs of growth centers and areas recommended for sewers	
Number in report	**Assigned code**

3.2ai) The Town prioritizes Lakeshore Drive for special wastewater management attention. Immediately begin an inspection program for all onsite systems and require that all systems found to be failing be upgraded or replaced.	W3.2a.i
3.2a.ii) The Town prioritizes Lakeshore Drive for special wastewater management attention. Immediately begin an inspection program for all onsite systems and require that all systems found to be failing be upgraded or replaced. Encourage use of innovative fixtures.	W3.2a.ii
3.2.a.iii) The Town prioritizes Lakeshore Drive for special wastewater management attention. Immediately begin an inspection program for all onsite systems but do not automatically require any changes to failing systems.	W3.2a.iii
3.2b) The Town prioritizes Lakeshore Drive for special wastewater management attention. Immediately begin a management program for all onsite systems.	W3.2b
3.2c) The Town prioritizes Lakeshore Drive for special wastewater management attention. The Town of Colchester maintains individual onsite systems and replaces those which need replacing	W3.2c
3.2d) The Town prioritizes Lakeshore Drive for special wastewater management attention. Construct combined centralized collection and treatment in Burlington, with dual force main	W3.2d
3.2e) The Town prioritizes Lakeshore Drive for special wastewater management attention. Limited central collection with treatment in Burlington. Includes 773 connections.	W3.2e
3.2f) The Town prioritizes Lakeshore Drive for special wastewater management attention. Limited central collection with treatment in Burlington. Includes 454 connections.	W3.2f
3.2g) The Town prioritizes Lakeshore Drive for special wastewater management attention. Increase monitoring and microbial source tracking of bacteria at Bayside Beach.	W3.2g
3.3) Recommend that a townwide needs assessment be performed before any areas are prioritized for special wastewater management attention.	W3.3

Recommendation 4: Explore ways of reducing wastewater flows and concentrations	
Number in report	**Assigned code**
4.1) The Town explores using separate treatment of blackwater and graywater and/or composting toilets in individual homes.	W4.1

4.2) The Town explores using separate treatment of blackwater and graywater and/or composting toilets in cluster systems	W4.2
4.3) The Town explores adopting an ultra-low volume fixture ordinance.	W4.3

Stormwater

Recommendation 3.2.1: Meet or Exceed the NPDES Public Education and Outreach Requirements	
Number in report	**Assigned code**
3.2.1.1) Continue the mandate of the Water Quality Committee after the Strategic Water Quality Plan has been written.	S.1.1
3.2.1.2) Continue the mandate of the Water Quality Committee after the Strategic Water Quality Plan has been written, but find other ways to ensure that the NPDES MS4 requirements for public education and outreach are met or exceeded.	S.1.2

Recommendation 3.2.2: Meet or Exceed the NPDES Public involvment and Participation Requirements	
Number in report	**Assigned code**
3.2.2.1) Continue the mandate of the Water Quality Committee after the Strategic Water Quality Plan has been written	S.2.1
3.2.2.2) Continue the mandate of the Water Quality Committee after the Strategic Water Quality Plan has been written, but find other ways to ensure that the NPDES MS4 requirements forpublic involvment and participation are met or exceeded.	S.2.2

Recommendation 3.2.3: Meet or exceed NPDES requirements for Illicit Discharge Detection and Elimination	
Number in report	**Assigned code**
3.2.3.2) Inventory the existing public stormwater systems within the Town and develop a program for periodic inspection of storm sewer structures.	S.3.2
3.2.3.3) Based on the results of the outfall assessment study, further investigate any outfalls that were identified as receiving illicit discharges.	S.3.3

Recommendation 3.2.4: Meet or exceed NPDES requirements for Construction Site Runoff Control	
Number in report	**Assigned code**

3.2.4) Determine and implement the most effective way to reduce runoff from all construction sites.	S.4

Recommendation 3.2.5: Meet or Exceed NPDES Post-Construction Stormwater Management Requirements	
Number in report	**Assigned code**
3.2.5.4) Implement Structural Best Management Practices (BMPs): Develop an implementation plan for the structural best management practices recommended in the Stormwater Management Plan, taking into account the prioritization recommended in the plan.	S.5.4
3.2.5.5) Once the priorities are identified in the outfall assessment, develop an implementation plan for the repairs with an emphasis on the outfalls located within the impaired watersheds and the direct discharges to Malletts Bay.	S.5.5

Recommendation 3.2.6: Meet NPDES Pollution Prevention/Good Housekeeping Requirements	
Number in report	**Assigned code**
3.2.6.6) Clean catch basin structures located in public areas on a prioritized basis.	S.6.6
3.2.6.7) Perform additional sweeping of public roadways located in the impaired watersheds and inner Malletts Bay area. field study. Cost: $80,000 - $100,000	S.6.7

Recommendation 3.2.7: Complete a comprehensive inventory of the existing stormwater systems	
Number in report	**Assigned code**
3.2.7.8) Complete the comprehensive inventory	S.7.8

Recommendation 3.2.8: Investigate the Usefulness of a Stormwater Utility	
Number in report	**Assigned code**
3.2.8.9) Investigate the feasibility of using a stormwater utility to manage stormwater in Colchester. Focus on a utility where the Town takes responsibility for all public and private stormwater systems.	S.8.9

Land Use

Recommendation 1: Increase consideration of water quality impacts in planning for growth centers.	
Number in report	**Assigned code**
1.1) As part of the master planning process, revisit the size and location of all growth centers.	L1.1
1.2) Accept growth center boundaries from the 2002 Master Plan, but refine the content of those growth centers.	L1.2
1.3) Accept growth center boundaries and goals of moderate to high density in growth centers.	L1.3
1.4) Encourage new "infill" development in partially or mostly developed areas.	L1.4

Recommendation 2: Identify sensitive lands with water quality impacts and determine regulatory	
Number in report	**Assigned code**
2.2a) Review regulatory provisions in the Zoning and Subdivision Regulations that affect sensitive areas.	L2.2a
2.2b) Stream buffers.	L2.2b
2.2c) Implement a Transferable Development Rights program as part of the Zoning Regulations.	L2.2c
2.2d) Consider impacts from new State wastewater disposal rules on land development capability, especially in rural districts.	L2.2d
2.2e) Pursue acquisition of easements or title for sensitive lands.	L2.2e
2.2f) Encourage appropriate management of sensitive lands.	L2.2f
2.2h) Conduct a comprehensive bay-wide study to determine and refine information regarding critical fish and wildlife habitats to be protected. Create Conservation Water Management Zones to reflect the results of this study.	L2.2h

Recommendation 3: Upgrade review standards for new development throughout the town	
Number in report	**Assigned code**
3.1) Focus on zoning standards.	L3.1
3.2a) Focus on site plan/subdivision standards. Reduce existing standards related to the amount of impervious areas.	L3.2a
3.2b) Focus on site plan/subdivision standards. Require implementation of stormwater Best Management Practices as a standard part of development	L3.2b

review.	

Recommendation 4: Cooperate with other town planners and with regional and state officials to support Colchester's growth center and other land use planning goals and to minimize adverse impacts on water quality	
Number in report	**Assigned code**
4.1) Work with Chittenden County Regional Planning Commission to ensure treatment of growth centers in the regional plan is consistent with local designation of growth centers.	L4.1
4.2) Work with adjacent communities, such as Milton and South Burlington, regarding availability of wastewater treatment facilities and implications for land use planning.	L4.2
4.3) Seek actions by upstream communities to minimize adverse impacts on water quality in the Lamoille and Winooski Rivers.	L4.3

Recreational Use of Receiving Waters

Recommendation 1: Support Initiatives that Promote Sustainable Recreational Activity Utilizing Natural, Cultural And Historical Resources in the Basin.	
Number in report	**Assigned code**
1.1a) Develop natural and cultural heritage interpretative trails, such as the existing Lake Champlain Historic Landings Heritage Trail, through wayside exhibits and other informative media.	R1a
1.1b) Continue to encourage the Lake Champlain Paddlers' Trail, Lake Champlain Birding Trail, Lake Champlain Walkways, Lake Champlain Bikeways and similar ecotourism around Lake Champlain and the Richelieu River.	R1b

Rec*ommendation 2: Determine, Monitor and Mitigate the Impact of Increased Recreational Use in Ecologically Sensitive Areas*	
Number in report	**Assigned code**
1.2c) Instruct the Water Quality Coordinator to identify and monitor ecologically sensitive areas potentially affected by recreational use, and establish a monitoring program and mitigation strategy to help avoid these impacts.	R2c

Recommendation 3: Increase and Improve Public Access Opportunities to the Lake for a

Diversity of Water and Non-Water Activities	
Number in report	**Assigned code**
1.3d) Communicate to Colchester's Recreation Commission and Planning Commission that public access to the lake has been a theme that has repeatedly come up during the Strategic Water Quality Planning process and ask them to consider this in their work.	R3d

Recommendation 4: Conduct a Needs Assessment of the Impact of Boating on Water Quality	
Number in report	**Assigned code**
1.4e) Instruct the Harbormaster to work with the Coast Guard and deputized local volunteers to conduct spot checks of the wastewater compliance of 50-100 boats on Malletts Bay. Publicize the results of these spot checks to inform the community what the contribution of boaters is to pollution in Malletts Bay.	R4e

Recommendation 5: Increase Availability of Free Pumpout Stations	
Number in report	**Assigned code**
1.5f) Explore options for encouraging or requiring all facilities which rent out moorings to have pumpout stations available to the general public and to offer these services at a low price.	R5f

Recommendation 6: Continue and Improve Water Quality Monitoring	
Number in report	**Assigned code**
1.6g) Continue funding the Water Quality Coordinator position to extend the length of data recorded for the monitored stations.	R6g
1.6i)Begin a dialogue with the Agency of Natural Resources to clarify why the 77 MPN E. coli/100 ml standard was chosen and what the health effects of using less strict standards employed by other states would be expected to be.	R6i
1.6j) Develop a Malletts Bay Aquatic Nuisance Coordinator pilot project to propose to the Lake Champlain Basin Program (LCBP) for possible funding. Extend the position of the existing Water Quality Coordinator to include monitoring for aquatic nuisance species.	R6j

Actions Prioritized by Resource Vulnerability Assessment

Criterion	Wastewater	Stormwater	Land Use	Recreation	Public Involvement
Water resource of very high importance, action potentially of very high effectiveness	W1.1, W1.2, W2.1, W3.2a.i, W3.2a.iii, W3.2c, W3.2d, W3.2e, W3.2g	S5.4	L3.1, L3.2a, L3.2b	R1.6j	
Water resource of very high importance, action potentially of high effectiveness (alternatives not repeated from cell above)	W3.2b, W3.2f, W3.3	S3.2, S3.3, S5.5a, S5.5b, S5.5d, S6.7	L2.2b	R1.6i	
Water resource of high importance, action potentially of very high effectiveness		S3.2, S3.3, S4, S5.4	L3.1, L3.2a, L3.2b	NA	
Water resource of high importance, action potentially of high effectiveness (alternatives not repeated from cell above)	W1.1, W1.2, W2.1, W3.2d, W3.2e, W3.2f, W3.3	S5.5a, S5.5b, S5.5d, S6.6, S6.7, S7.8	L4.3, L2.2b	R1.6g	
6 or more occurrences of very high or high effectiveness, regardless of the endpoint's priority	W1.1, W1.2, W2.1	S3.3, S4, S5.4, S5.5a, S5.5b, S5.5c, S5.5d	L2.2b, L3.1, L3.2a, L3.2b	R1.6g	

The following table reflects the priorities which were read out of the table above:

Priority rank	Wastewater	Stormwater	Land Use	Recreation	Public Involvement
First (e.g., VH imp/VH eff + ≥6 VH +H eff)	W1.1, W1.2, W2.1, W3.2g	S5.4, S5.5a, S5.5b, S5.5d	L3.1, L3.2a, L3.2b	R1.6j	
Second (e.g., VH imp/VH eff + <6 VH +H eff)	W3.2a.i, W3.2a.iii, W3.2c, W3.2d, W3.2e	S3.3, S5.5c	L2.2b	R1.6g, R1.6i	
Third	W1.4, W1.5, W3.2b, W3.2f, W3.3	S3.2, S3.3, S4	L4.3		

Fourth		S6.6, S6.7, S7.8			

Public Forum and Listening Session:
Colchester's Strategic Water Quality Plan
July 18, 2002 6:30 – 9:00 pm
Meeting House, Main Street, Colchester, VT

AGENDA

The results of this session will help the Department of Public Works and the volunteer Water Quality Committee create a picture of community concerns that will shape the Strategic Water Quality Plan developed over the next several months. Subsequent steps in this process—also with community input—will be aimed at identifying priorities among potential water quality-related tasks and strategies to improve and protect water quality in Colchester. Results represent the priority concerns of the individuals who participated and are not an indication of consensus among groups of attendees.

Desired Outcomes

1. Increased awareness and understanding of local water resource issues among participants
2. Increased awareness and understanding regarding purpose of collaborative strategic water quality planning process
3. Increased awareness and understanding of the concerns and priorities of fellow Colchester residents
4. Prioritized list of concerns related to water quality in Colchester

Setup and Materials

- Large meeting space for entire group
- Five breakout spaces for watershed discussions
- Five flip charts and stands
- Five neutral (non-Colchester) facilitators
- Sign-in sheets for each group
- Sticker dots for prioritizing
- Overhead projector for presentation
- Refreshments

AGENDA

6:30 Setting the Stage (Town, WQC, SEI) [15 minutes]

- Town (Genie) 5 minutes: Welcome / Town's perspective
- Water Quality Committee (Bill) 5 minutes: Introduce WQC and its vision for the SWQP
- SEI Team (Carl) 2 minutes: Introduce team and role in Colchester's process
- SEI Team (Sue) 3 minutes: Emphasize innovative approach taken by Town, national perspective/need for building community-supported water quality strategies, Colchester as pioneer, quick overview of evening's schedule

6:45 Strategic Water Quality Planning (Carl) [20 minutes]

- Context and overview of the SWQP process
- Value of different types of water resources in Colchester
- Tools and functional areas under consideration (e.g., wastewater, stormwater, etc.)
- Define "watershed" and explain rationale for the 5 watershed areas, how they will be used
- Questions and clarifications

7:05 Watershed Breakout Groups (Sue) [65 minutes]

- Describe breakout group exercise and provide instructions for moving into groups
- Move into smaller groups by watershed areas delineated on map (5 minutes)
- Facilitators (Stone team and UVM Extension) lead groups through 60 minute session to record and prioritize issues and concerns
- See attached facilitators' notes for details for 7:10-8:10

8:10 Refreshments and Chart Walk (Sue) [20 minutes]

- Direct participants to refreshments and invite them to browse flip charts
- Flip charts from each group are displayed around the room allowing participants to informally review and discuss other groups' results
- Project team also reviews charts to note any particular issues to highlight in connection with reviewed water quality information
- Move one chart to front of main room for final discussion

8:30 Presentation/Discussion of WQ Information (Carl) [25 minutes]

- Highlights of SEI's review of WQ information
- Tie in with participants' concerns and ideas
- Discussion and additions to lists of concerns (Sue: document on chart as needed)

8:55 Wrap Up (Sue) [5 minutes]

- Outline next steps; use of information from this forum

- Reiterate commitment to working collaboratively and list specific ways to stay involved i.e., sign up for mailing list, participate on a watershed team, visit WQC web site, attend WQC meetings, review materials at library, etc.

9:00 Adjourn

Results from the three breakout groups were as follows:

Colchester's Strategic Water Quality Plan: Rank Ordered Results of July 18, 2002 Public Forum

- Concerns listed in order of total votes received, concerns with equal numbers of total votes are ordered by red votes if applicable, otherwise appear in the order they were originally listed.
- Concerns receiving one or more priority (red) votes are highlighted in bold.

I. Winooski Group: 3 participants: Bill McMaster facilitator

RED Votes	Total Votes	Concerns
2	3	**Inadequate sanitary and storm sewers planning for current and future growth** **Failed septic systems** **Poor control of stormwater**
1	3	**Impact of recreation and development in sensitive areas and wetlands**
0	3	Rules Poor enforcement of existing rules Inadequate rules
0	0	Need for erosion control
0	0	Effect of Camp Johnson, airport, and surrounding towns

II. Inner Malletts Bay South (and North): 8 and (1) participants: Sue Thomas facilitator

RED Votes	Total Votes	Concerns
4	7	**Stormwater** **- uncontrolled, unmeasured, could be significant impact** **water quality problems after rain** **stormwater impacts on septic**
3	7	**Concern for growth; sheer numbers**
2	7	**Failed septic systems (both sides) / prevention of failed systems** **- homeowners expense (septics)**
0	6	Find a way to balance the economic and aesthetics
0	5	Need to establish hard standard (standards change over time as more people move in)
0	4	Balancing access issues (diversity of uses) - capacity - balance access with excess moorings
0	4	Set achievable standard (for everybody involved)
0	4	Managing wastewater
0	3	Need for education
0	3	Amount of impervious surface - how to control
0	2	Concerned with people's concerns: marinas, increase amount of moorings
0	2	(toward Essex end) Erosion control/ impacts on watersheds
0	2	Outboard motors- reduce gasoline in water- 4 cycle vs 2 cycle
0	2	Offer alternatives
0	2	Phosphorus concentration
0	1	Children unwilling to swim in Bay
0	1	Not enough public beach
0	1	Numbers of moorings/need for limit - capacity
0	1	Loss of native species
0	0	Fairness
0	0	Base decisions on facts, data rather than perceptions
0	0	Invasive species

III. Outer Malletts Bay (north and south): 8 participants: Facilitators Carl Etnier and Wayne Elliott

RED Votes	Total Votes	Concerns identified as problems (voted on)
4	6	**Runoff – nutrients, toxics [P]**
1	6	**Increasing bacteria/pathogen levels [P]**
0	5	Lack of understanding of water quality and issues [P]
1	3	**Tree clearing along shoreline – aesthetics and stability [P]**
1	3	**Impervious surfaces [P]**
1	3	**Inadequate monitoring of water quality [P]**
0	3	Slope stability - erodability of soils [P]
0	3	Overuse of areas of shoreline – Thayer Beach, docks [P]
0	2	Phosphorus concentrations [P]
0	2	Non-native invasive species [P]
0	2	Clarity of water [P]
0	1	Boat motors – two-stroke [P]
0	1	Birds – Increasing numbers, gulls and geese, cormorants [P]
0	0	Proliferation of boat moorings [P]
0	0	Old and faulty septic systems
0	0	Toxin levels in fish [P]
0	0	Lamoille River- Outer Bay pollution impacts [P]
Concerns identified as causes of problems (not voted on)		
Lawn care – use of fertilizers and pesticides No increased runoff from new development Change in type of runoff Erosion control measures during construction Pollution from boating Cause and effect of personal activity		

What are YOUR opinions about protecting Colchester's rivers, streams, groundwater, and bays?

What do you consider to be the biggest problems?

_____

_____

_____

_____

_____

_____

What kinds of actions or steps would you support the Town taking?

_____

_____

_____

_____

_____

_____

☐ **I'd like to learn more, please add me to the mailing list**

Name _____

Street Address _____

Phone _____

Email _____

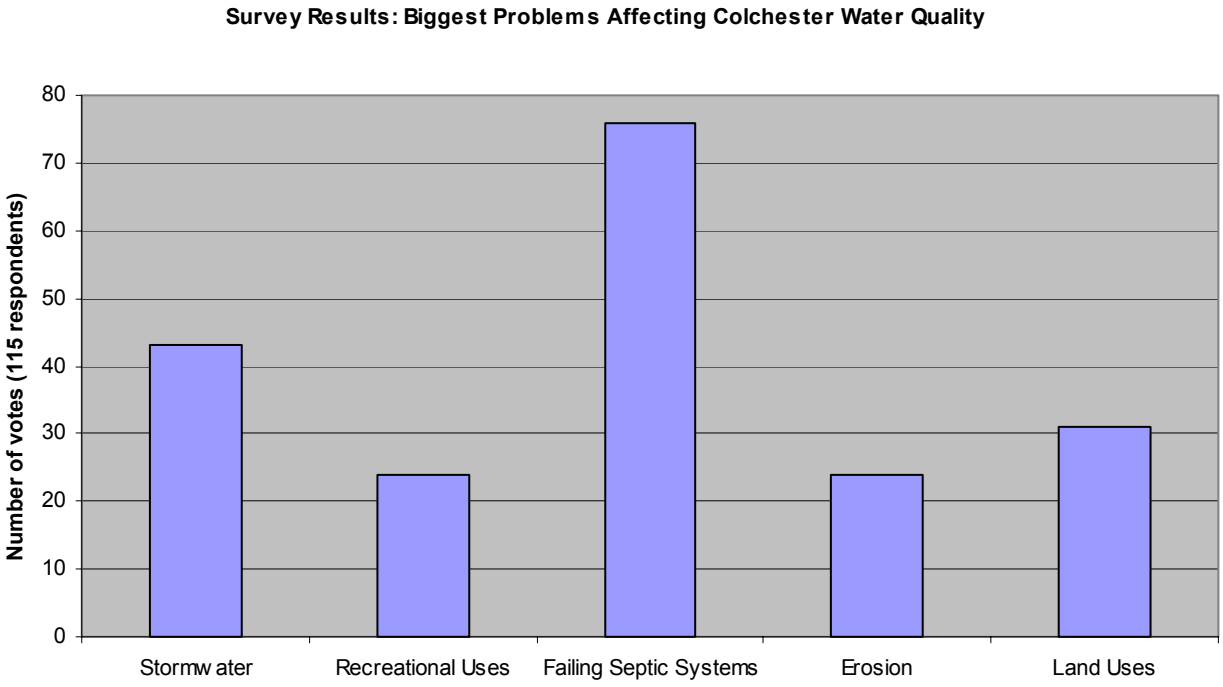
Your responses will help the Department of Public Works and the Water Quality Committee create a Strategic Water Quality Plan that incorporates the values and concerns of community members.

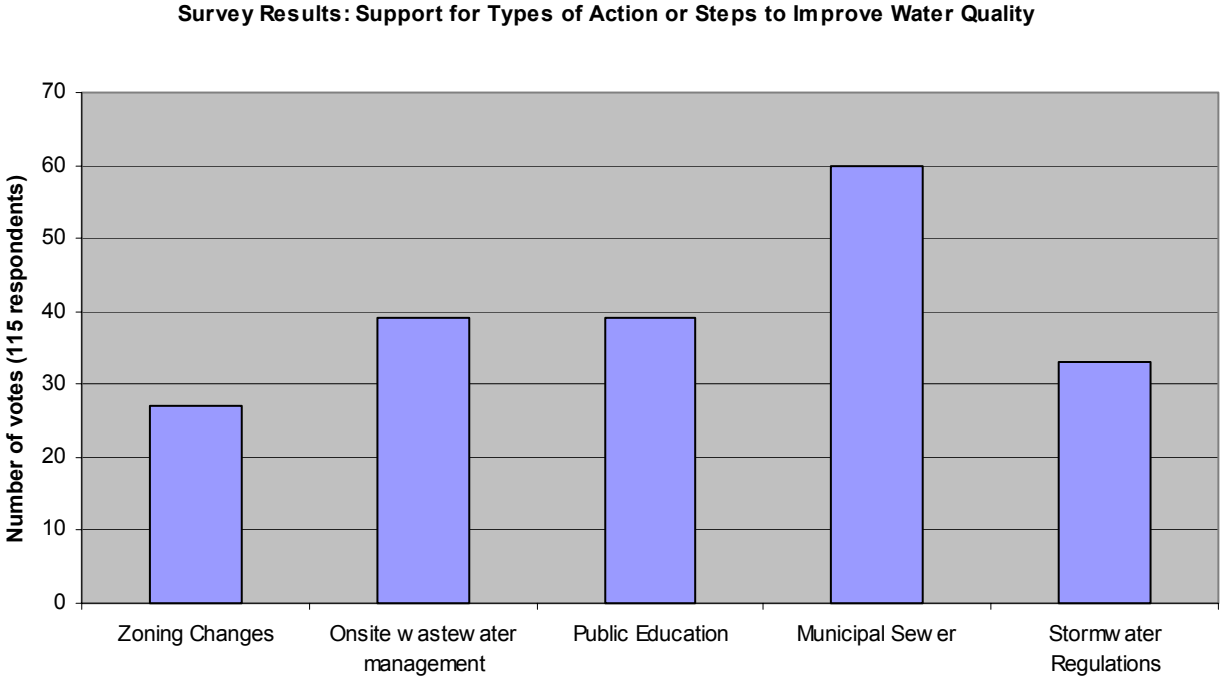
Thank you for participating!!!

Please return this to the Water Quality Committee or
Dept. of Public Works, Attn: Genie Soboslai
PO Box 55
Colchester, Vermont 05446

APPENDIX 7: SUMMARY OF SURVEY RESPONSES

The following figures give a quick summary of the responses on the 115 returned survey forms. A detailed compilation of results is found in the table after it. Personal contact information on the survey forms has been omitted from this compilation.





	Biggest Problems That Affect Water Quality						Action or Steps you support					
Survey Number	Stormwater	Recreational Uses	Failing Septic Systems	Erosion	Land Uses	Others	Zoning Changes	Onsite wastewater management	Public Education	Municipal Sewer	Stormwater Regulations	Others
1	1		1							1		
2			1		1	4 wheelers	1	1	1	1		
3			1	1	1		1	1				
4			1					1		1		
5					1							Business that dump waste into lake
6			1			school septic				1		
7					1	Throwing stuff in river			1	1		
8			1			Existing septic along the lake		1				Replacement systems must meet code
9			1							1		
10		1	1				1		1			
11			1							1		
12			1							1		
13		1	1							1		Regulating Boaters
14			1			Temptation to switch to centralized sewage treatment		1		no		Composting Toilet System
15			1				1	1	1	1	1	
16	1		1					1				
17				1				1	1		1	
18			1			e-coli				1		Something Effective
19						e-coli						
20			1							1		
21		1	1	1		Dumping		1	1	1	1	
22			1							1		
23	1	1	1				1			1	1	
24	1			1	1		1	1	1		1	
25	1					Lampreys					1	Lampricides
26			1	1				1		1		
27	1			1		e-coli						

Survey Number	Biggest Problems That Affect Water Quality						Action or Steps you support					
	Stormwater	Recreational Uses	Failing Septic Systems	Erosion	Land Uses	Others	Zoning Changes	Onsite wastewater management	Public Education	Municipal Sewer	Stormwater Regulations	Others
28	1			1			1	1	1		1	
29	1		1	1				1		1		
30			1			Dye Test on all camps on lake						
31	1				1							Alternative Septic/town buy Lakeshore
32					1							Stop Sprawl
33			1							1		
34	1		1	1	1		1	1	1		1	
35	1		1							1		
36						High Water Table - Shore Acres						
37			1							1		
38			1			Runoff - Animals						
39			1							1		
40	1		1					1			1	
41			1							1		
42	1	1	1				1	1	1	1	1	
43		1	1							1		
44		1	1							1		
45		1	1						1	1		
46	1				1		1	1	1		1	
47	1				1		1	1	1		1	
48	1			1			1	1				
49	1							1			1	
50	1		1	1		Lawn Chemicals			1	1		
51				1					1	1		
52				1	1	Too Many homes on Lake	1	1	1			Sewers would mean more development
53			1				1			1	1	
54			1					1				
55	1	1		1					1	1		
56	1		1		1	Ranked Problem FS>LU>SW		1		1	1	Ranked MS>OS>SR

	Biggest Problems That Affect Water Quality						Action or Steps you support					
Survey Number	Stormwater	Recreational Uses	Failing Septic Systems	Erosion	Land Uses	Others	Zoning Changes	Onsite wastewater management	Public Education	Municipal Sewer	Stormwater Regulations	Others
57	1		1						1	1		
58			1					1	1			
59	1								1			
60		1	1						1			
61	1		1	1	1	Polution		1	1	1	1	
62	1		1		1			1		1		
63	1	1	1	1	1	Over Development	1		1		1	
64			1		1	Farming				1		
65			1							1		
66			1							1		
67						Seagull & Cormorants						Declare an open Season with no limit
68			1					1			1	Inv. Motels & Camp Grds ??
69						Boats Releasing Sewage				1		Free for Boats
70	1	1								1	1	
71	1					Boats emptying Septc Tank						
72	1	1	1					1	1	1		
73		1					1	1	1	1	1	
74			1									Manditory Inspections
75		1							1			
76			1		1					1		
77			1						1			
78					1					1		
79			1		1		1	1	1	1	1	
80	1		1						1	1		
81			1					1	1			Investigate Motels & Camp Grds systems
82			1							1		
83		1	1					1				
84	1			1							1	
85		1	1				1		1			

	Biggest Problems That Affect Water Quality						Action or Steps you support					
Survey Number	Stormwater	Recreational Uses	Failing Septic Systems	Erosion	Land Uses	Others	Zoning Changes	Onsite wastewater management	Public Education	Municipal Sewer	Stormwater Regulations	Others
86	1			1		Motor Boats			1		1	Ban Boat, Abortion & Civil Union
87		1			1		1		1			
88			1							1		
89			1					1		1		
90		1							1		1	
91	1			1	1		1				1	
92			1					1				
93	1			1			1	1	1		1	
94	1	1	1	1	1		1			1		
95		1	1		1	Boats & Wet Land Development	1		1	1		
96	1		1				1				1	
97					1		1					
98		1						1		1		
99	1										1	
100												
101	1	1	1	1	1		1	1	1	1	1	
102	1		1		1							Stop Land Development in Town
103		1	1		1			1	1	1	1	
104			1							1		
105					1				1			
106	1		1								1	
107			1							1		
108			1	1	1					1		Extend Town Water Lines
109	1				1			1			1	
110	1		1									Question too Simplistic
111			1							1		
112			1							1		
113			1	1						1		
114	1										1	

Survey Number	Biggest Problems That Affect Water Quality						Action or Steps you support					
	Stormwater	Recreational Uses	Failing Septic Systems	Erosion	Land Uses	Others	Zoning Changes	Onsite wastewater management	Public Education	Municipal Sewer	Stormwater Regulations	Others
115	1		1		1		1			1		
Count	43	24	76	24	31		27	39	39	60	33	198
% of Total	22%	12%	38%	12%	16%		14%	20%	20%	30%	17%	

APPENDIX 8: ANNOTATED BIBLIOGRAPHY FROM THE LITERATURE SEARCH

The following is an annotated bibliography containing many of the data sources consulted in the literature search performed in the first six months of this planning process.

Reference Type: Report
Author: Budd, Lenore F.; Meals, Donald W.
Year: 1994
Title: Lake Champlain nonpoint source pollution assessment
Institution: Lake Champlain Basin Program
Pages: 140
Date: February 1994
Report Number: Technical Report 6A

Objectives:
"- Estimate nonpoint source loads to Lake Champlain based on existing land use data."
"- Verify the estimates using phosphorus loading data from the Lake Champlain Phosphorus Diagnostic Feasibility Study and small subwatersheds within the LCB.
"- Estimate the relative contributions from major land use categories and from major regions of the Lake Champlain Basin.
"- Make recommendations concerning land use information and water quality data needed to improve this assessment."

Among the results were:
* Nonpoint sources in Lamoille/Grand Isle watersheds (including Malletts Bay) contribute 61.4 mt (metric ton) P /year, of which 70% is from agriculture, 14% is from forest, and 16% is from urban areas.
* Nonpoint sources in Winooski River watershed contributes 77.7 mt P/year, of which 55% is from agriculture, 14% is from forest, and 31% is from urban areas.
* Of nonpoint sources in Lake Champlain as a whole, agriculture contributes 66% of the average yearly total phosphorus load, while 18% comes from urban land and 16% from forests.
* "Because agricultural land contributes the majority of nonpoint source P and N to Lake Champlain, any strategy to reduce nonpoint source loads must deal with agricultural sources. However, urban land, comprising just 3% of the basin, contributed 18% of the estimated load; this disproportionate contribution suggests that relatively high efficiencies in nonpoint source load reductions might be achieved by also addressing urban nonpoint source controls."
* "Impact of septic systems. ...Even under worst-case assumptions, failed septic systems are likely to be responsible for only up to about 5% of the total annual phosphorus load to Lake Champlain...[T]hey appear to represent only a very small portion of the phosphorus load to the lake, comparable to that contributed by direct precipitation."
* "The use of 20-year-old land use data was a major weakness of this study and limits the conclusions that can be drawn regarding specific land uses and areas of the basin to be targeted for nonpoint source management."

Reference Type: Report
Author: Chalmers, A.T.
Year: 1997
Title: Distribution of phosphorus in bed sediments of the Winooski River watershed, Vermont
Institution: United States Geological Survey
Pages: 4
Date: FS-108-98

Objectives:
"1) Assess the distribution of total phosphorus (TP) in bed sediment in the Winooski River watershed
2) Determine the extent to total phosphorus in fine- and coarse-grained bed sediment.
3) Determine the relation(s) between concentrations of total phosphorus in sediment and watershed features such as land use, soil drainage class, basin slope, and stream flow regime...

"Land use appeared to be the dominant factor influencing TP distribution in sediment. Concentrations of TP were higher in bed sediment in heavily urbanized and agricultural areas than in sediments in forested areas."

Reference Type: Report
Author: Foley, Peter
Year: 2001
Title: Malletts Bay Water Quality Inventory Report: Summer 2001
City: Colchester, Vermont
Institution: Town of Colchester, Vermont
Date: 2001

E. coli monitored during drought year. High readings in Crooked Creek throughout summer, with geometric mean 369 MPN/100 ml (beaver dam upstream).

High Bayside Beach *E. coli* levels coincide closely with rain events; recommends using rain to pose advance warning of beach closings. Also recommends riparian buffer strip for Bayside Beach. No correlation found between closures and wind.

Baffle box at Moorings Marina did a great job--negligible E coli found most of the summer. Exceeded 77 MPN/100 ml only 4 times.

Other recommendations:
* Stronger enforcement of leash laws and pooper scooper laws, with signs to explain why and receptacles "emptied in a proper fashion—flushed down the toilet for treatment in a septic tank." [The septic tank must be sized for this load. --Ed.]
* More educational outreach to homeowners about individual practices and their effect on the lake: particularly runoff.

Reference Type: Report
Author: Forcier Aldrich & Associates
Year: 1997
Title: Town of Colchester wastewater master planning Part II: Town-wide wastewater facility planning update. Vol. 1
City: Essex Junction, Vermont
Institution: Forcier Aldrich & Associates
Date: October 1997

---

1 Intent and use

Devised in response to the March 1996 Colchester Master Plan. This is a Phase I conceptual planning document. This plan is not intended to determine the Town's wastewater goals and objectives, but to provide technical guidance.

2 General assumptions and methodology

1) The Town has been subdivided into eleven wastewater management units (WMUs) based on site and soil conditions, existing and future land use, zoning, population density, and environmental sensitivity (among others). For each unit, multiple alternatives for wastewater management have been developed, along with financial information.

2) WMUs have been kept small to make use of decentralized wastewater treatment technologies. Several WMUs have been combined at times, where decentralized technology was determined to be unsuitable. Some WMUs have been combined to make centralized options more affordable.

3) Cost estimates are conservative, not based on detailed design calculations.

4) The cost estimates are for the purpose of comparing the magnitude of costs for each alternative.

3 Conclusions

1) Existing development is concentrated in areas favorable for individual onsite wastewater treatment systems.

2) Many of the onsite systems in town are approaching the end of their useful life.

3) Onsite systems seem to fail where site conditions are marginal.

4) There is a public perception that seasonal camps' systems are polluting Malletts Bay.

5) Telephone surveys have indicated that most home owners do not pump their septic tanks every four years; this can cause premature system failure.

6) Onsite systems represent the lowest cost strategy in areas where soils and site conditions are favorable for it. Drinking water contamination may be reduced in areas of dense residential development by installing municipal water.

7-14) Different options for using centralized systems are presented.

15) The user costs for centralized systems would be higher than in nearby communities, since US EPA

subsidies are not available to the same extent as when those were constructed.

4 Recommendations (highlights)

The recommendations are based on a screening analysis, using nine criteria. Weights were assigned to the criteria in cooperation with Town staff and the Colchester Wastewater Management Steering Committee.

1) The Town should consider more stringent design and construction standards for onsite wastewater systems.

2) The Town should implement an expanded onsite wastewater management program.

3) Onsite wastewater treatment is recommended in the following WMUs: 2A (exclusive of lakefront properties along Lakeshore Drive and the commercial/industrial corridor along Prim Road), 2B (exclusive of lakefront properties along Lakeshore Drive), 2C, 2D, 2E, 6, 9

4) Individual mound systems are recommended in WMUs 3A, 3B, 7, and 8 (with special conditions in 8 to restrict development in flood plains and wetlands)

5) It is recommended that existing, non-complying onsite systems be replaced with mound systems in WMU 4B.

6) Limited expansion of the Exit 16 Wastewater Service Area (WMU 5) appears to be financially viable, but chances are remote that South Burlington will grant the necessary increase in Colchester's capacity allocation at the treatment plant.

7) The best strategy for the following WMUs is to build centralized collection, with treatment at a new plant on the lower Winooski: 1A, 1B, 1C, the portion of 2A adjacent to Prim Road, the portion of 2B adjacent to Lakeshore Drive and along Blakely Road east to and including the Middle and High Schools, 4A

8) For WMU 10 (Exit 17), a new collection system and treatment facility on the lower Lamoille River are recommended.

9) The sooner the Town applies for federal or state funding for centralized programs, the more likely they are to get it.

Reference Type: Report
Author: Gabos, Ben
Year: 1998
Title: Malletts Bay Water Quality Inventory Report: Summer 1998
City: Colchester, Vermont
Institution: Town of Colchester, Vermont
Date: 1998

Recommendations

1. Ordinances
   a. Pooper scooper law
   b. Septic maintenance ordinance and septic system management program
   c. Strengthen town zoning on buffer areas, setbacks adjacent to streams
2. Investigate better ways to manage stormwater
3. Wish list studies:
   a. Inventory of streams to Malletts Bay, using a variety of parameters to monitor health
   b. land use study of human impacts in entire watershed or at least adjacent to watercourses
4. Pamphlets and/or signs to educate people on problems caused by feeding ducks. Place them adjacent to Malletts Bay and marinas

Reference Type: Report
Author: Gabos, Ben
Year: 1999
Title: Malletts Bay Water Quality Inventory Report: Summer 1999
City: Colchester, Vermont
Institution: Town of Colchester, Vermont
Date: 1998

Introduction (drawn from other sources)

Outer bay station 1990-96 found increasing levels of phosphorus (P) and summer P levels exceeding "clear and nuisance free" range

High levels of arsenic, nickel, and chromium have been found in the sediments of the outer bay.

Concern for fuel and oil from personal water craft and other boat motors: over 1 gallon gasoline discharged per hour from personal water craft

Town's primary focus on Malletts Bay water quality is recreation.

Heavy rains followed by runoff from Winooski River made waters in broad lake unsafe to swim in late June, early July previous year.

Recommendations

1. TMDLs. "Direct smaller drainages to inner Malletts Bay" included on List of Impaired Waters for TMDL purposes, thanks to last year's water quality report. Area of broad lake from mouth of Winooski to Colchester Point not deemed impaired but added to Part C of list, "Surface waters in need of further assessment."
2. Ordinances
    a. Pooper scooper law
    b. Septic system management. Town staff currently investigating this.
    c. Strengthen town ordinances regarding buffer areas, setbacks adjacent to streams. Watercourse Protection District now before select board.
    d. Strengthen Shoreland District zoning to be more consistent with Milton's: stricter.
3. Better management of stormwater. Town staff now developing program.
    Use Low Impact Development
4. Wish list studies:
    a Inventory of streams to evaluate their health
    b. Land use study of human impact on watershed, or at least impact of land use adjacent to watercourses
5. Experiment with ways to deter birds from congregating on docs at Bayside Park. Signage/pamphlets about feeding ducks.
6. Reestablish and advertise Colchester Swimming Advisory phone line.

7. Public education about non-point source pollution.

Reference Type: Report
Author: Gabos, Ben
Year: 2000
Title: Malletts Bay Water Quality Inventory Report: Summer 2000
City: Colchester, Vermont
Institution: Town of Colchester, Vermont
Date: 2001

A couple areas of severe erosion noted: small tributaries to Smith Hollow, and on the "Moorings Stream."

E coli found from muskrat and other sources.

Bayside Beach: Closed 12 days. Source unknown, possibly gulls. Await microbial source tracking results.

Reference Type: Report
Author: Griffin International
Year: 2002
Title: Town of Colchester municipal stormwater management plan
City: Williston, Vermont
Institution: Griffin International
Pages: 85
Date: March 2002

The Stormwater Management Plan identifies areas where improved stormwater management is needed. It delineates 35 major watersheds within the Town of Colchester and prioritizes them for stormwater management work. This prioritization method assumes that action will be taken on a watershed-by-watershed basis, rather than on a BMP-by-BMP basis townwide.

The watersheds were prioritized based on a consideration of water quality, cost of improvements, percentage of impervious cover, destination of runoff, and a ratio between runoff volume and watershed area. Watersheds identified as impaired by Vermont state authorities were automatically given high priority. Three watersheds were sampled at three points each during one storm event; water quality was modeled in others, based on percent impervious area. Prioritization was done using an algorithm that was developed during the study and which has not been peer reviewed.

For each of the watersheds, the Plan describes a number of BMPs (Best Management Practices) that would be appropriate to use for reducing stormwater pollution.

The Plan projects that Colchester will be designated a Phase II community for the EPA's MS4 (Municipal Separate Storm Sewer Systems) statutory compliance. Six types of activities are mandated:

1) Public education and outreach
2) Public involvement and participation
3) Illicit discharge detection and removal. The Plan suggests a statement to be added to Town permitting applications, assuring that there are no illicit connections.
4) Construction site stormwater runoff control. The Plan describes a number of methods for reducing stormwater runoff from construction sites. Implementing these is necessary to satisfy Phase II requirements.
5) Post-construction stormwater management. Implementing the BMPs described for each watershed will meet Phase II requirements.
6) Municipal pollution prevention/good housekeeping. The Town is required to establish methods and procedures for performing municipal tasks which minimize pollution, and to train its staff in those methods. Three measurable goals are suggested.

The water quality sampling showed improving water quality on Indian Brook and Malletts Creek, moving downstream from the municipal boundary. This suggests that a significant proportion of the pollution in those streams comes from outside the town. Cooperation with other towns will be important in improving water quality in the streams.

Reference Type: Report
Author: Jones, Stephen H.
Year: 2002
Title: Microbial source tracking in Vermont using ribotyping of *Escherichia coli* isolates
City: Durham, New Hampshire
Institution: Jackson Estuarine Laboratory, University of New Hampshire
Pages: 16 + tables and figures
Date: May 2002

Quoted from Executive Summary

Water and feces samples from a variety of species were collected from two watershed areas adjacent to Lake Champlain in Vermont during August 2000. Escherichia coli strains were isolated from these samples and sent to the University of New Hampshire Jackson Estuarine Laboratory's new ribotyping facility. The DNA of all culturable strains sent from Vermont were processed for ribotype profile analysis to identify source species for isolates from water samples, using the isolates from feces samples as references. The data were analyzed to provide information with a range of degrees of certainty for the relatedness between known source species and water sample profiles.

As expected, the more strict requirements for matching of profiles, the fewer matches. The results provide a guide for what species are significant sources at the thirteen different samples sites in the two watershed areas. Using...New Hampshire source species profiles combined with the Vermont database resulted in more identification of water sample profiles and a different mix of identified source species. Humans/septage was the most common individual source species [overall] and was found in both study areas [although deer was the most common species in Colchester, and humans were tied with raccoons for second place]. Grouping of individual source species into types showed wildlife to be the largest category of identified source species, while avian species diminished in prominence....

This small study should provide useful information for the management of fecal contamination in the two study areas...

Reference Type: Report
Author: Lake Champlain Basin Program
Year: 2002
Title: Opportunities for action: An evolving plan for the future of the Lake Champlain basin (DRAFT)
Institution: Lake Champlain Basin Program
Pages: 137

"Based on the 2000 LCBP report of the Phosphorus Reduction Task Force, it appears that phosphorus loads generated by land use changes in the Basin are offsetting some of the gains achieved by point and nonpoint source reduction efforts. As the population within the Basin increases, more land is becoming developed. Because developed land generates more phosphorus than other land uses, nonpoint source phosphorus loads may be increasing in parts of the Basin where the land use change is occurring. Potential options for achieving the additional phosphorus reductions necessary to account for these increases include both additional point and nonpoint source treatments. Emerging technologies may be applied to further reduce point source phosphorus loads and additional nonpoint source reductions may be achieved through actions such as implementation of innovative BMPs and site designs, conservation buffers and a whole farm approach to agricultural nutrient planning." pp. 15-16.

Table 1 shows 1995 P loads for Malletts Bay down to 29.7 mt/year already from 32.9 in 1991. Still 1.1 mt/year reduction to go before targets achieved.

The following are selected recommendations quoted from the report

3) Estimate the Nonpoint Source Phosphorus Load That Is Being Generated by Developed Land Uses (Urban and Suburban Land, Roads, etc.) in the Basin and Work Aggressively to Reduce This Load.

Based on an LCBP analysis in 2000, it appears that increased phosphorus loads generated by land use changes in the Basin are offsetting some of the gains achieved by point and agricultural nonpoint source reduction efforts. Other studies have shown that developed land typically contributes more phosphorus per unit area of land than other land use types. As the population within the Basin increases, there is the opportunity to encourage growth away from the land-intensive suburban sprawl-type development and to better manage the resulting polluted urban stormwater to minimize increases in phosphorus loads to the Lake.

a) Collect and analyze land use information in order to estimate the increase in phosphorus load that occurs with new development and to help target improved stormwater management to those areas experiencing the most rapid growth.
b) Develop new options to offset the phosphorus load generated by new development.

c) Increase efforts to reduce phosphorus loadings from new development by assisting local efforts to promote land use planning and innovative subdivision practices that discourage urban and suburban sprawl.
d) Implement retrofitted stormwater management systems and other measures to reduce phosphorus loads from existing urban and suburban areas.
e) Work with the state, provincial, and local stormwater management programs to minimize the phosphorus load generated by new development and reduce the phosphorus load from existing areas undergoing redevelopment, including providing assistance for local compliance with USEPA Phase II stormwater rules.
f) Increase training opportunities for local road supervisors and crews to encourage implementation of BMPs for road construction, repair and maintenance, according to the standards in state back roads, stormwater management, and erosion and sediment control handbooks.
g) Encourage implementation of erosion and sedimentation control practices for construction activities.
h) Encourage nutrient management on commercial and residential properties.

---

5) Expand Programs for Stream bank Restoration and the Installation of Vegetated Buffer Areas Along Eroding Streams and Rivers

Studies have shown that vegetated areas along streams and rivers can effectively filter sediment and phosphorus from runoff and reduce stream bank erosion, while creating habitat for wildlife. Stream geomorphology concepts can be used to determine where and how to address problems with erosion so that the entire stream system remains more stable over time.

a) Use geomorphic assessment and other techniques to target reaches where significant phosphorus loading may be occurring as a result of erosion.

b) Develop or expand programs which cost share or offer tax incentives for voluntary restoration or protection of buffer strips on perennial streams, rivers and lakes in the Basin.

c) Develop a GIS database of reaches needing buffer areas for use by programs such as the NY and VT Conservation Reserve Enhancement Program (CREP) and the USDA Environmental Quality Incentives Program (EQIP).

d) Continue to support Coopérative de Solidarité du bassin versant de la rivière aux Brochets in Québec, a group of volunteers with the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ) working to restore stream banks of the Pike River Watershed.

e) Continue to implement Québec's Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains, in cooperation with local and regional governments and the Ministry of Natural Resources for lands in the public domain. The Ministry of Environment implements and coordinates the application of this policy.

f) Increase programs aimed at informing professionals working on streams (e.g., municipal officials, landscape architects, etc.) about the value and importance of buffers and stable streams.

g) Identify additional funding sources for stream bank restoration.

---

7) Develop Incentives for Local Municipalities and Private Land-owners to Restore, Enhance and Maintain Wetlands and Stream Corridors

Tax incentives are another way to encourage private wetlands and stream protection and restoration efforts. Under this option, a task force could be established to develop legislation to alleviate part of the tax burden for landowners who practice habitat conservation.

8) Increase Funds and Technical Resources for Local Governments to Implement BMPs for New Development Which Will Protect Wetlands, Stream Corridors and Riparian Habitat

Encourage local governments to:
a) Improve stormwater management through local zoning and subdivision regulation and appropriate use of the National Pollutant Discharge Elimination System (NPDES) and State Pollution Discharge Elimination System (SPDES) permit system, including EPA Phase 2 stormwater regulations.
b) Emphasize erosion hazards, floodplain functions, sedimentation controls, habitat protection and use of natural vegetation as requirements in local zoning and subdivision regulations.
c) Apply infiltration and other BMPs in new developments.
d) Apply surface water setbacks and buffer strips in new developments.
e) Employ appropriate growth management options.
f) Assess cumulative impacts of new development.
g) Promote innovative site design that reduces creation of impervious surfaces.
h) Promote road maintenance standards for sediment control and initiate training pro-grams for town highway departments to minimize impacts of road maintenance activities on water quality, stream bank stability and native wetland species.

Toxic substances
HIGH PRIORITY ACTIONS (not listed in priority order)
2) Continue Monitoring and Restoration Efforts in Sites of Concern

For sites of concern identified by ongoing research and monitoring (Inner Burlington Harbor, Outer Malletts Bay [arsenic, nickel, manganese], Cumberland Bay, and other sites as appropriate), characterize the extent of contamination, evaluate alternative remedial actions, and make recommendations to the States of New York and Vermont and the USEPA based upon findings. Elements would include:

a) Identify sites based on new research or monitoring data.
b) Characterize extent and severity of contamination, and effects.
c) Consider restoration alternatives that may be applicable to each site, including no action, source identification, pollution prevention, remediation (for example, dredging, containment, in situ treatment, etc.) and other alternatives.
d) Recommend best alternative to local government, states, USEPA and U.S Army Corps of Engineers (USACOE).

Recreation
PRIORITY ACTIONS (not listed in priority order)

4) Pursue Funding Alternatives for Public Access Site Enhancement Improved public access to Lake Champlain would benefit from a dedicated fund to sup-port new access locations and to enhance existing access sites. This should be a lakewide boating facilities program fund to be used exclusively for the enhancement of public access boating sites.

---

p. 63 Alleviating Congestion and Conflicting Uses

Certain areas of Lake Champlain experience high levels of congestion and conflicting uses which can be addressed through user cooperation, education or a combined approach on a site by site basis depending on the severity of problems and the nature of conflicts. Rather than attempting to establish a carrying capacity for the Lake (which research has shown to be ineffective), one option is for communities to develop overall management objectives for areas of concern. In 1995, the LCBP funded a demonstration project that identified solutions to the boating congestion and other problems in Malletts Bay. The Malletts Bay Recreation Resources Management Plan addresses ways to manage the public waters in Malletts Bay, the density of moorings and marinas, and the allocation of recreational uses to reduce conflicts among the various boaters, swimmers, paddlers, etc., who frequent the Bay area. This plan should serve as a model for addressing similar issues in other parts of the Lake.

Reference Type: Edited Book
Editors: Alan McIntosh, Mary Watzin, and Erik Brown
Year: 1997
Title: An assessment of sediment-associated contaminants in Lake Champlain - Phase II

(Quoted from report, pp. D-3 to D-5)

Summary

Concentrations of As [arsenic], Mn [manganese], and Ni [nickel] in the surface sediments of Outer Malletts Bay exceeded either the NOAA ER-M [Effects Range-Medium; contamination greater than the ER-M value indicates adverse benthic impacts in more than 50% of cases studied] or the Province of Ontario SEL [Severe Effects Level; concentrations above the SEL are predicted to cause adverse effects to bottom-dwelling organisms] at many sites, but especially at the deepest locations...[T]he high levels of Mn, and potentially other trace metals, in surface sediments are related to the seasonal stratification in the bay. The late summer hypoxia in the deeper portions of the bay mobilizes Mn and potentially other metals from the sediments to the overlying water column. These metals are oxidized and precipitated during the fall overturn and probably move downslope to the deepest sections of the bay during the late fall and winter. When Mn precipitates, P is also removed from the water column, drawing to the sediments as well. Phosphorus levels in Outer Malletts Bay sediments are among the highest, and water concentrations among the lowest, in the lake...

Substantial increases in As levels in the water column were detected during the late summer and early fall, including measurable levels of the particularly toxic trivalent form of As in the upper layers of the water column, presumably resulting from the conversion of other forms of As by bacteria and/or phytoplankton.

...[P]orewaters extracted from the sediments at a number of locations in Outer Malletts Bay are capable of causing toxicity. While results were most consistent for sediments from the deepest portion of the outer bay, shallower locations also produced significant mortality in some porewater tests. Results of other biological assessments were mixed, with fathead minnow tests generally showing toxicity, whereas midge larvae tests...did not. Evaluation of the benthic macroinvertebrate community documented the existence of stressful conditions in sediments in deeper areas of the outer bay.

...[Manganese has been found to be] the primary cause of the toxicity observed in the porewater toxicity tests using deepwater sediments...It is possible that other trace metals may also contribute to ecological impairment in Outer Malletts Bay, but this possibility requires additional assessment.

Management Recommendations

We believe that the behavior of trace metals in Outer Malletts Bay results from a combination of several factors: the transport of substantial loads of trace elements from the Lamoille River watershed into the bay; restricted flow in the bay which results in the accumulation of substances in outer bay sediments; and the

annual cycle of reducing conditions that occur in the deeper portions of the bay. Given these circumstances, there are very few practical steps that could be taken to reduce the levels of trace metals in the bay. Increasing water exchange with the Main Lake might help the situation in Outer Malletts Bay, but would contaminate that environment as well. Reducing metal inputs would seem a logical management focus. Likely sources of trace metals include runoff from surface mines and mine tailings piles in the watershed; atmospheric deposition of metals throughout the watershed, with subsequent transport to the bay; and erosion of naturally occurring metals from soils and rocks in the watershed. Even with loadings reductions, changes in the bay would likely be extremely slow because of existing conditions.

Measured concentrations of As and Mn in the water column raise some concerns. Given the likelihood that federal drinking water standards for As will be lowered in the near future, any use of Outer Malletts Bay for drinking water purposes needs to be carefully evaluated. Fortunately, the highest levels of As and Mn are found in the deeper waters of the bay, but, even so, some additional monitoring should be done to insure that levels in the shallower layers of the bay do not exceed water quality standards.

While we did find toxicity in some of our porewater toxicity tests on sediments from shallower portions of the bay, including tests run with eggs and larvae of fathead minnows, we do not know whether the presence of As and Mn and other trace metals in the shallow sediments of Outer Malletts Bay has any implications for the littoral zone communities in the bay. Additional analyses of such ecological effects seems justified...

An additional concern is the potential for effects of zebra mussels on trace metal behavior in Outer Malletts Bay. Evidence elsewhere indicates that these mussels are capable of substantially altering the cycling of trace contaminants in lakes and increasing their availability to other organisms in the food web. As zebra mussel populations increase on Outer Malletts Bay substrates, there is the potential for increased contaminant mobilization. We recommend that this concern be addressed as the zebra mussel invades Outer Malletts Bay in large numbers.

Reference Type: Report
Author: Picotte, Amy
Year: 2001
Title: 2000 Lake Champlain lay monitoring report
City: Waterbury, Vermont
Institution: Water Quality Division, Department of Environmental Conservation
Pages: 78

"The Vermont Lay Monitoring Program is a citizen participation program in which volunteers are trained and equipped to conduct periodic water quality sampling on lakes."

Station #10 is outer Malletts Bay, midway between Porter's Point and Robinson Point. Station #11 is inner Malletts Bay, in approximately 75 feet of water.

Parameters monitored were Secchi depth, chlorophyll-a, and total phosphorus.

Outer Malletts Bay

Parameter	Days	Min	Mean	Max
Secchi (m)	13	3.9	4.6	5.5
Chl-a (ug/l)	13	1.2	3.0	5.3
Summer TP (ug/l)	13	10	18	39

Inner Malletts Bay

Parameter	Days	Min	Mean	Max
Secchi (m)	15	3.8	5.2	7.3
Chl-a (ug/l)	15	1.5	2.4	3.7
Summer TP (ug/l)	15	9	13	21

Compared to other lake stations, the 2000 summer means indicate:
Outer Malletts Bay
- Water clarity: moderate
- Algal population density: moderate
- Nutrient enrichment: high

Inner Malletts Bay
- Water clarity: high
- Algal population density: low
- Nutrient enrichment: moderate

All data for 2000 are presented graphically, and tables give annual means and number of days sampled since 1979.

Reference Type: Journal Article
Author: Smeltzer, Eric; Quinn, Scott
Year: 1996
Title: A phosphorus budget, model, and load reduction strategy for Lake Champlain
Pages: 381-393

The paper models what needs to be done to attain the in-lake total phosphorus concentration established in a water quality agreement among New York, Quebec, and Vermont. Total base year (1991) loading was 647 mt/yr, with 29% from point sources, 47% from cultural nonpoint sources, and 24% from natural sources.

A cost-optimization procedure was used to arrive at total reductions of 192 mt/yr distributed among targeted lake watersheds will be needed to attain the in-lake phosphorus criteria. However, full compliance in all lake segments could not be achieved "with any reasonable combination of point and nonpoint source reductions."

For Malletts Bay, the 1991 Base Year Load was 32.9 metric tons, and the target load calculated was 28.6 metric tons, necessitating a 4.3 mt reduction.

These goals were agreed to in June 1996 by the Lake Champlain Management Conference and the states of New York and Vermont.

Reference Type: Report
Author: Taft, Alison M.
Year: 1990
Title: Malletts Bay Water Quality Inventory: Summer 1990
City: Colchester, Vermont
Institution: Town of Colchester, Vermont
Date: 1990

Fecal coliform survey
State limit for recreational waters 200 CFU/100 ml. Exceeded the most at State Access, near Coates Island. Exceed regularly at almost all sampling points, least at Bayside Park.

Septic system leachate screening survey
E coli (limit 77 CFU/100 ml), nitrate, and conductivity monitored.
E coli: 7 of 30 locations over 200 CFU/100 ml
nitrate: 1 location over detection limit of 0.5 mg/l, with 2.03
conductivity: 9 over average of 153. Point 11, by Smith Hollow Stream, all three parameters very high.

Stormwater survey
Monitored: P_{tot}, chloride, fecal coliform during major storm events

Reference Type: Report
Author: Vermont Department of Environmental Conservation
Title: Colchester water quality report
Institution: Vermont Department of Environmental Conservation
Pages: 2

"This is a report card on the water quality health of rivers and streams based on the biological integrity of the stream. The nutrient index is a measure of the level of nutrient enrichment (phosphorus or nitrogen) of a stream. Clean Water Species is a measure of the number of pollution sensitive aquatic invertebrates. Insect richness is the number of different individual insect species. Insect density is a count of the total number of aquatic insects per unit area. The four values are combined to estimate overall stream health. The fish community is assessed using a similar scale which evaluates overall fish community and fish habitat health.

Stream/% of Watershed Impervious	Site	Nutrient Index	Clean Water Species	Insect Diversity	Insect Density	Insect Community Assessment	Fish Community Assessment
Allen Brook	Above	-----	-----	-----	-----	------	-----
% 3.0*	Below	E	P	G	918	Passes	Passes
Indian Brook	Above	VG	F	E	1098	Passes	Fails
% 6.3	Below	E	P	G	2532	Fails	Passes
Malletts Creek	Above	G	G	F	444	Fails	Fails
% 2.0*	Below	VG	VG	E	1642	Passes	-----
Morehouse Brook	Above	E	P	F	969	Fails	----
% 13.6	Below	E	P	P	133	Fails	----
Colchester Pond	Above	------	----	---	----	-----	----
%7.0*	Below	G	P	VG	1016	Fails	Passes
Sunderland Brook	Above	G	P	F	1638	Fails	Fails
% 11.4	Below	F	P	P	34	Fails	Passes

* Measurement only includes area within Colchester town line

"An upward (blue), downward (red) or not apparent (yellow) trend in water quality is indicated if three or more years of data exist. Above refers to the upstream sample station and below refers to the downstream station...

"In order for a stream to meet the Vermont Class B water quality standard it must pass both the insect and fish community assessments if the data are available. In Colchester four streams/rivers fail the Class B standard: Indian Brook, Sunderland Brook, Pond Brook, and Morehouse Brook. Three of these streams are

now listed as impaired and are required to have restoration plans or Total Maximum Daily Load plans."

Reference Type: Report
Author: Vermont Department of Environmental Conservation; New York State Department of Environmental Conservation
Year: 1997
Title: A phosphorus budget, model, and load reduction strategy for Lake Champlain: Lake Champlain diagnostic-feasibility study, final report
City: Waterbury, Vermont
Institution: Vermont Department of Environmental Conservation and New York State Department of Environmental Conservation
Pages: 129
Date: January 1997

Very similar to the much shorter paper by Smeltzer and Quinn (1996), with more detailed data.

Reference Type: Report
Author: Vermont Department of Environmental Conservation Water Quality Division
Year: 1995
Title: Identifying toxic constituents of urban runoff from developed areas within the Champlain basin
City: Waterbury, Vermont
Institution: Vermont Department of Environmental Conservation Water Quality Division
Pages: 46
Date: April 1995

Twelve urban streams in Vermont and two in New York analyzed. Streams in Colchester: Sunderland Brook, Malletts Creek, Indian Brook.

Bioconcentration in caged mussels used to monitor bioaccumulation potential of PCBs (polychlorinated biphenyls), chlorinated pesticides, and PAHs (polyaromatic hydrocarbons). No PCBs or pesticides were detected in any of the exposed mussels at detection levels of 5 ppb wet weight. With the exception of Malletts Creek, PAHs were found at trace levels or greater in mussels from all sites. At Indian Brook and Sunderland Brook, fluoranthene and pyrene were detected but at concentration less than the practical quantitation limit (PQL), so no exact figures are available. None of the other eleven PAHs tested for were found in any of the Colchester streams. "The data suggest a positive relationship between the degree of urbanization within a watershed and accumulation of PAH compounds in caged mussels."

Bioconcentration in algae: "Samples of the alga *Cladophora sp.* were collected at two sites, Indian and Englesby Brooks, and analyzed for metals. Most results were less than detection limits. The only metals detected significantly above detection limits were arsenic in Indian Brook, silver from Englesby, and zinc from both streams. While no conclusions are drawn from these data, it is of interest to note that arsenic is a known contaminant in Malletts Bay, to which Indian Brook drains..."

Bioconcentration in fish: "Fish, primarily creek chubs, were sampled at all sites and analyzed for whole body metal concentrations. Zinc was the most commonly detected metal followed by chromium, copper, and nickel. Arsenic and lead were not detected in any sample. Mercury was detected at two sites, Centennial and Stevens Brooks, at low levels. There appeared to be no correlation between concentrations of metals in sediments and in fish." See selections from Table 15, below.

	Metal/Practical quantitation limit (PQL) in ug/g wet weight							
Stream	Arsenic 0.25	Cadmium 0.1	Chromium 1.5	Copper 1.5	Lead 0.25	Mercury 0.05	Zinc 5	Nickel 1
Indian Brook	<PQL	<PQL	8.22	2.42	<PQL	<PQL	30.1	4.3
Malletts Creek	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	34.9	<PQL
Sunderland Brook	<PQL	<PQL	4.28	1.9	<PQL	<PQL	34.9	2.47

Table 15 (edited to include only Colchester sites). Metals detected in fish tissue from urban streams in Colchester.

Metals in sediments: Sediments were sampled at all sites. Non-exhaustive total metal analyses were conducted on both "whole" sediments which had been passed through a 2mm sieve, and "fine fraction" sediments which had been passed through a 63u sieve. In [the Colchester streams,] with the exception of arsenic...metal concentrations in whole sediments were below detection limits. Whole sediment arsenic concentrations were below detection levels in Malletts Creek and below low level ecological effects criteria in Indian Brook and Sunderland Brook. In fine sediments, see selections from Table 12, below

	Zinc	Nickel	Lead	Copper	Chromium	Mercury	Arsenic	Silver	Cadmium
Sunderland Brook	116* -20	31.5* -2.3	<25	26.0* -5.4	30.0* 0	<0.10	7.9 -12	<0.50	<5
Malletts Creek	102* -4.2	31 0	<25	<25	32 -4.4	<0.10	<2.00	<0.50	<5
Indian Brook	76.5* -4.6	<25*	<25	<25*	<26*	<0.10	5.8 -15	<0.50	<5

Table 12 (edited to include only Colchester sites). Mean metal concentrations in Colchester stream fine (<63u) sediments. ug/g dry weight with Relative Standard Deviation (SD/Mean x 100) expressed as % in ( ). Streams and metals listed in order of sediment criteria exceedence frequency of occurrence, with the three Colchester's streams in 9th through 11th place out of 12 in the original table. Light shaded values are in exceedence of ER-L and/or Ontario No Effects Sediment concentrations. * = Detected in fish. ND = no data.

Organics in sediments: Whole sediment samples were analyzed for PCBs, PAHs, and chlorinated pesticides.

None were found in the Colchester streams.

Passive In-Situ Concentrating Extraction Samplers: Hexane-filled PISCES samplers were deployed at the Vermont screening sites. No PCBs, the primary target analyte, were found in any of the samples. PAHs were found in all samplers at levels and ratios that suggest contamination from sampler components.

Biological Community Analysis: Fifteen sites on the study streams were sampled for benthic macroinvertebrates using semi-quantitative kick net methods. An assessment rating of poor to excellent, based on comparison to a statewide database of relatively naturally occurring stream communities from similar habitat types, was applied to each site. All Colchester sites were rated as either poor or fair. Sites rated as poor or fair do not meet the minimum Water Quality Standards for Class B waters in Vermont.

Eleven sites on nine of the study streams were sampled by electroshocking for fish. Data were evaluated using the Vermont Index of Biotic Integrity, a locally calibrated measure of fish community condition, based on comparisons to conditions expected to be found in unimpacted streams with similar habitat characteristics. Sites were rated as poor to excellent, with sites in the poor to fair categories failing to meet minimum Class B criteria. Blacknose dace and creek chub were the dominant fish species at most sites. Three of the eleven sites were rated as good and were meeting Class B standards. Indian Brook and Sunderland Brook were rated as poor or fair and did not meet Class B standards. Malletts Creek was not sampled in this way.

Compared to other Vermont streams, biological communities in the streams of developed (urban) areas are relatively degraded. Physical habitat degradation resulting from erosion and sedimentation was the predominant factor contributing to observations of impairment. Biological community structure and function analysis imply that, in some cases, nutrient enrichment, high temperatures, and toxicity are also contributing factors in the degradation of these streams.

Reference Type: Report
Author: Williams, Cory
Year: 1995
Title: Malletts Bay Water Quality Inventory Report: Summer 1995
City: Colchester, Vermont
Institution: Town of Colchester, Vermont
Date: 1995

"Approximately 50% of those residences within 150 yards of the inner Bay's shoreline do not have septic system permits on file with the Town of Colchester and it is therefore assumed that professionally designed/installed systems do not exist on these parcels."

He believes a large percentage of onsite system owners ignorant and apathetic about their systems.

E coli serotyping located source of contaminated groundwater approximately 320 yards upstream of mouth.

APPENDIX 9: THE ROLE OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) IN THE PLAN'S ACTIVITIES

Geographic Information Systems (GIS) are computer databases which allow a great deal of information to be stored and retrieved on an area, or, more formally, *a computer program for storing, retrieving, analysing, and displaying cartographic data.*[1] In a GIS, the Earth's features are not only represented in pictorial form, as in conventional paper maps, but as information or data. This data contains all the spatial information of conventional maps, but when stored in a computer, is much more flexible in the way in can be represented. Spatial data in a GIS can be displayed just like a paper map with roads, rivers, vegetation and other features represented as lines on a map complete with legend, border and titles, or it can be represented as a set of statistical tables, which can be converted to charts and graphs. The most important feature of GIS is that spatial data are stored in a structured format referred to as a spatial database. The way spatial data are structured will determine the how easy it is for the user to store, retrieve and analyze the information.

GIS was used in the preparation of this plan—

- to identify which parcels in town belong in which of the 35 subwatersheds which were delineated in the Town's *Stormwater Management Plan*. This information may be used as part of a public outreach program, with representatives from different subwatersheds promoting the plan to their watershed neighbors, or presentations of different parts of the plan tailored to people in different subwatersheds.
- to try to identify where surface water may be most at risk of contamination from onsite wastewater treatment systems. Parcels not on municipal sewer and with the dwelling near surface water features were identified, in several proximity classes from 0 to 300 feet. The thought was that high concentrations of onsite systems near surface water features poses a higher risk of contamination. Unfortunately, the GIS data layer for the extent of the surface water features, like Lake Champlain, proved so imprecise that this method would have required considerable effort to produce reliable results, so it was abandoned.

GIS is or could be an important component of the following recommendations from the plan—

- Needs assessment for onsite wastewater treatment systems. GIS component described in the plan.
- Develop and adopt a townwide onsite wastewater management program. GIS component described in the plan.
- Design and implement increased bacterial monitoring and microbial source tracking at Bayside Beach. GIS would be helpful in recording sample results at different places and times.
- Prioritize Lakeshore Drive for special wastewater management attention. GIS would be an excellent tool for displaying results of the lot-by-lot needs assessment plus the effects of various alternatives.
- Implement stormwater structural best management practices (BMPs). GIS would be useful for keeping track of what BMPs are being installed and where.
- Establish a stormwater outfall inspection program. GIS could be used to display the location of the outfalls and their inspection status.

---

[1] The italicized definition, as well as the rest of this paragraph, are taken from the SAGE Introductory Guidebook, by Robert M. Itami and Robert J. Raulings, published by DLSR, Melbourne, Australia, 1993.

- Inventory the existing public stormwater systems. GIS could be used in connection with a database like the one being initiated for onsite wastewater treatment systems to keep track of the location and condition of the components of public stormwater systems.
- Clean catch basin structures located in public areas, prioritizing impaired watersheds and those draining to Malletts Bay. GIS could be used in connection with a database to track the condition of the catch basin structures and to display that on maps.
- Complete a comprehensive inventory of the existing private stormwater systems. GIS could be used in connection with a database like the one being initiated for onsite wastewater treatment systems to keep track of the location and condition of the components of private stormwater systems.
- All land use recommendations: GIS is already used by the Planning and Zoning Office to track zoning districts and other information that will be affected by these regulations.

APPENDIX10: MULTICRITERIA AND RESOURCE VULNERABILITY ASSESSMENTS

Multicriteria assessment and resource vulnerability assessment were the prime methodologies used in moving from a broad list of alternative actions related to water quality to the list of recommendations contained in the plan. They are briefly described below.

Multicriteria Assessment

Planning processes often produce a great deal of information about the anticipated effects of different courses of action. The wealth of detail, however, can be confusing rather than helpful in the absence of a systematic way to make sense of it. Decision support tools using multicriteria assessment help decision makers structure a problem and systematically express their preferences. Impacts of a decision are broken down into different indicators, which may be evaluated separately and then aggregated into an interpretation of the decision maker's preferences for the alternatives. Multicriteria assessment seems well suited for use in increasingly complex planning decisions.

Multicriteria assessment describes a group of methods for weighting alternatives that have different degrees of fulfillment of three or more criteria. The methods have in common that the alternatives are identified, as are the criteria used to rate the alternatives. Choice of multicriteria assessment method to use depends on whether the criteria are quantitative, qualitative, or mixed; the number of decision makers involved; the number of alternatives being considered; and one's philosophy of decision making.

The decision was made to use the Range of Value method. Some background is necessary to explain why that choice was made:
A simple and frequently used method for calculating overall preference in a multicriteria problem is weighted summation. For each alternative, its score on each indicator is multiplied by an indicator weight, and these weighted scores are added together:

(Eq. 1) $$S = \sum_i w_i j_i$$

where S is the overall score for an alternative, i is an indicator, w is an indicator weight, and j is the alternative's score on the indicator.

However, decision makers may be uncomfortable assigning numerical (cardinal) values to indicator weights. If they are willing to rank the indicators in order of importance (ordinal weighting), much can still be learned about their preferences.

We did not wish to insist that all participants specify whether they weight, for example, "improving water quality" twice as much as costs or only 1.5 times as high. Even if participants were willing to do that, this is so far outside their normal practices that it is not clear how much credence to assign those weights. Instead, an aggregation method was selected which is relatively easy for decision makers to understand and which work with ordinal weights.

The Range of Values (ROV) method computes all the possible combinations of cardinal values for indicator weights which are consistent with the decision maker's ordinal weighting and computes the range of possible values for the final score. The results may be displayed numerically or graphically[2].

The following process was followed for the multicriteria assessment:

- A list of alternatives was developed by the consultants, considering wishes for water quality expressed at public meetings and by the Water Quality Committee
- A list of six criteria to be used in ranking the alternatives was compiled by the consultants, in consultation with Town staff and members of the Water Quality Committee. The criteria were
  - Cost
  - Economic vitality
  - Fairness to property owners
  - Fosters participation/stewardship
  - Improves water quality
  - Preserves water quality
- The list of alternatives was refined in consultation with the Water Quality Committee and Town staff. The alternatives were described in some details, and related to specific objectives to achieve in the plan.
- The alternatives were scored according the ROV method by Water Quality Committee members, Town staff, and the consultants, each acting individually.
- The scores were compiled and presented for discussion. The discussion helped clarify and interpret the results, and led to many of the alternatives being removed from further consideration. The remaining list of alternatives was brought to the next stage of evaluation, resource vulnerability assessment.

Resource Vulnerability Assessment

The following steps were followed in the resource vulnerability assessment:

- Endpoints of interest identified and their importance rated in a draft by the consultants
- Water Quality Committee suggests revisions in endpoints of interest; revisions incorporated per conversation with Bill Romond, chair
- Consultants rate the alternatives which came out of the multicriteria assessment. Alternatives are rated for their effectiveness in achieving each of the endpoints of interest.

---

[2] Further details on the method are available in Yakowitz, D.S. 1998. A multiattribute tool for decision support: Ranking a finite number of alternatives. In *Multiple objective decision making for land, water, and environmental management*, edited by S. A. El-Swaify and D. S. Yakowitz. Boca Raton, Florida: Lewis Publishers.

Effectiveness is rated on a scale of Very High, High, Medium, and Low. No rating means neglible effect or not applicable.

- When there is uncertainty about cause and effect, then the consultants assumed a stronger causal relationship. Where there is uncertainty about follow-up of an investigation, the consultants assumed a more rigorous follow-up. For example, the rating of the two wastewater needs assessment alternatives as Very High in their effectiveness in preventing beach closings at Bayside Beach assumed:
  - Does a significant portion of the E. coli found at Bayside Beach come from onsite wastewater treatment systems? YES
  - Will a needs assessment that identifies the problematic onsite wastewater treatment systems lead to repairing them or replacing them with sewer? YES
- Biological health of The Moorings stream (Diversity Hill) and Smith Hollow creek added as endpoint during this process.
- Sunderland Brook promoted from High to Very High importance, since it is impaired.
- The endpoint relating to phosphorus in Malletts Bay was clarified to indicate that it refers to phosphorus flows from Colchester to Malletts Bay

- For each endpoint, alternatives are lumped together, which achieve the same level of effectiveness.
- The consultants discuss the ratings of the alternatives that at least one person rated as having Very High or High effectiveness on at least one endpoint, to achieve consensus on those.
- Alternatives are prioritized in the areas of wastewater, stormwater, land use, and recreation.
- Based on the prioritized alternative, text describing an implementation process is outlined.
- The final matrices and plan are circulated among the consultants for review.
- The matrices and the implementation text is given to the Water Quality Committee.

A similar process is followed for the public involvement strategies, with Carl Etnier of Stone Environmental and Ken Jones of Green Mountain Institute participating.

APPENDIX 11: PRIORITY SUBWATERSHEDS

Priority subwatersheds were identified in the Town's Stormwater Management Plan, using a formula that took into account impervious cover (IC), receiving water for the watershed, cost of implementing corrective measures, the runoff volume/area ratio, and, for three subwatersheds, one sampling event. We have identified an overlapping but different set of priority watersheds, working primarily from percentage IC. A review of hundreds of studies on the effect of IC on water quality indicates that IC has significant predictive value, and that high water quality becomes increasingly rare in watersheds with over 10% IC (Center for Watershed Protection 2003).

The receiving water for the watershed was also given some consideration in drawing up the list of prioritized watersheds, with greatest priority being given to those draining to inner Malletts Bay. This is consistent with, though not identical to, the use of receiving waters in the Stormwater Management Plan.

The watersheds marked in yellow in the table below are identified as present priorities. The ones marked in blue will become priorities at the time of buildout at Exit 17.

Priority Subwatersheds in Colchester

Number	Name	Area (acres)	Impervious acres	Impervious percent	Destination
4	Malletts Head East	405	75.1	18.5%	Inner Malletts Bay
35	Malletts Bay	248	38.7	15.6%	Inner Malletts Bay
11	Lake Shore Drive	293	40.4	13.8%	Inner Malletts Bay
1a	Colchester Point North	486	57.8	11.9%	Outer Malletts Bay
2	Malletts Head West	850	98.4	11.6%	Outer Malletts Bay
3	Halfmoon Cove	1635	173.3	10.6%	Winooski River
9	Winooski West	282	29.1	10.4%	Winooski River
14	Malletts Bay Point East	118	12.2	10.4%	Inner Malletts Bay
8	Sunderland Brook	3203	327.1	10.2%	Winooski River
10	Smith Hollow Stream	890	76.7	8.6%	Inner Malletts Bay
13	Indian Brook	1990	166.1	8.3%	Inner Malletts Bay
34	Walnut Ledge North	184	15.1	8.2%	Lamoille River
26	Red Rock Point	94	6.9	7.4%	Outer Malletts Bay
15	Pond Brook	2166	151	7.0%	Inner Malletts Bay
19	Chimney Corner	408	28.3	6.9%	Inner Malletts Bay
25	Red Rock Point East	184	12.2	6.6%	Inner Malletts Bay
5	Diversity Hill	349	20.2	5.8%	Inner Malletts Bay
20	I89 North	280	14.8	5.3%	Inner Malletts Bay
33	Walnut Ledge	260	13.8	5.3%	Lamoille River
1b	Colchester Point South	179	8.4	4.7%	Broad Lake
27	Camp Norfleet	387	18.2	4.7%	Outer Malletts Bay
12	Crooked Creek	1273	56.8	4.5%	Inner Malletts Bay
22	Walnut Ledge East	647	27.5	4.3%	Inner Malletts Bay
16	I89 South	176	7.3	4.1%	Inner Malletts Bay
21	Chimney Corner West	150	6	4.0%	Inner Malletts Bay
23	Braeloach Camp	257	9.6	3.7%	Inner Malletts Bay
31	Winnisquam Orchard East	81	2.7	3.4%	Lamoille River
18	Allen Brook	999	29.5	3.0%	Inner Malletts Bay
30	Camp Kiniya North	61	1.7	2.8%	Lamoille River
29	Camp Kiniya	128	3.4	2.7%	Lamoille River
24	Braeloach Camp West	153	3.7	2.4%	Inner Malletts Bay
17	Malletts Creek	2507	51.1	2.0%	Inner Malletts Bay
32	Camp Norfleet East	120	1.9	1.5%	Lamoille River
6	Shipman Hill	1220	16	1.3%	Winooski River
7	Pine Island	407	3.2	0.8%	Winooski River
28	Winnisquam Orchard	123	0.9	0.7%	Outer Malletts Bay

Priority now

Priority for when Exit 17 Growth Center buildout begins

APPENDIX 12: IMPERVIOUS SURFACES RESULTING FROM ALTERNATE DEVELOPMENT ASSUMPTIONS

The following table shows a wide range of variation in the amount of impervious surface created for each dwelling unit (house, townhouse, apartment, etc. where one household lives). By varying the number of stories, setback, garage space and its location, etc. the number of square feet impervious area per dwelling unit can vary from 960 to 4600. This shows what an effect zoning rules and site review can have on impervious area, which is a key factor in predicting water quality degradation.

Impervious Surfaces Resulting from Alternate Development Assumptions

Housing Style	Variations			Building Area					Parking Area				Drives	TOTAL
	Stories	Parking/ Drives	Front Setback	Total Building S.F.	1st Floor Footprint	Total S.F. Per D.U.	1st Floor S.F. Per D.U.	Garage S.F. Per D.U.	Required Parking Spaces	# of Spaces Beneath Building	# of Surface Spaces	Surface Parking Area Per D.U.	Surface Area Per D.U.	Impervious Surface Area Per D.U.
M-F, multi-story with internal hallways and elevator	4	Surface only		28,800	7,200	1,200	300		52.8	0	53	660		960
	4	Beneath		28,800	7,200	1,200	300		52.8	24	29	360		660
	3	Surface only		21,600	7,200	1,200	400		39.6	0	40	660		1,060
	3	Beneath		21,600	7,200	1,200	400		39.6	24	16	260		660
M-F, townhouse style	2	Surface only				1,500	750		2.2		2	660		1,410
	2	1-car garage				1,500	750	280	2.2		2	460		1,490
	2	2-car garage				1,500	750	560	2.2		2	460		1,770
S-F, small	2	1-car garage	40			1,600	800	280					600	1,680
	2	1-car garage	20			1,600	800	280					300	1,380
	2	2-car garage	40			1,600	800	560					960	2,320
	2	2-car garage	20			1,600	800	560					480	1,840
	1	1-car garage	40			1,600	1,600	280					600	2,480
	1	2-car garage	40			1,600	1,600	560					960	3,120
S-F, large	2	2-car garage	40			2,800	1,400	560					960	2,920
	2	3-car garage	40			2,800	1,400	840					960	3,200
	2	3-car garage	100			2,800	1,400	840					2400	4,640
	1	2-car garage	40			2,800	2,800	560					960	4,320
	1	3-car garage	40			2,800	2,800	840					960	4,600

NOTE: This table represents alternatives for residential development and is meant to be used for illustrative purposes only. Actual determination of impervious surfaces under various development assumptions would require more detailed study. S-F = single family, MF = multi-family

APPENDIX 13: POSSIBLE OUTSIDE FUNDING SOURCES

The text below is excerpted and adapted from the Federal Funding Sources for Small Community Wastewater Systems, available at http://www.epa.gov/owm/mab/smcomm/eparev.htm

A broader listing of federal funding sources related to water quality is found in the Catalog of Federal Funding Sources for Watershed Protection, a searchable database at http://cfpub.epa.gov/fedfund/

ABSTRACT
This information, Federal Funding Sources for Small Community Wastewater Systems, is a product of the Small Underserved Communities team in EPA's Office of Wastewater Management, Municipal Support Division. The team's goal is to administer programs through which small, underserved communities can access information, financial resources and technical assistance to achieve adequate and cost effective wastewater systems. The publication contains 10 fact sheets of possible funding sources to help small, rural communities attain adequate wastewater systems. The fact sheets provide information on the types of help each program offers, what projects are funded, who is eligible, and how to reach the program contacts to apply for the funds. To obtain additional copies of the publication, you may contact the National Center for Environmental Publications and Information (NCEPI) at 513-489-8190 or 800-490-9198 and refer to document number EPA 832-F-97-004.

Facts about Federal Funding Sources for Small Community Wastewater Systems

Pooled sewage from failing septic systems still plagues countless neighborhoods and small communities across the country. More than a million homes in America still lack basic indoor plumbing, and many communities with fewer than 10,000 people have central wastewater systems that need extensive repair. All these conditions pose serious health and environmental problems for local residents. Among them are communities and tribes throughout the United States, as well as native villages in Alaska and economically disadvantaged areas along the U.S.-Mexico border.

Working together, federal and state agencies, along with the small communities themselves, can go a long way to help meet the wastewater and drinking water needs in these communities--and to promote economic development at the same time. This publication highlights 10 federal programs that help state, tribal, and local officials identify possible funding sources, whom to contact, and how to apply. Although this publication describes some drinking water programs, it focuses mainly on wastewater.

Ten Federal Programs That Help

The federal agencies listed here offer financial and technical assistance to help small communities plan, design, and build water and wastewater systems. Through these federal programs, thousands of rural and isolated communities have vastly improved their systems.

Environmental Protection Agency

1. Clean Water SRF.
2. Drinking Water SRF.

EPA's Office of Water manages two separate but related water programs: the Clean Water State Revolving Loan Fund for wastewater facilities and the Drinking Water State Revolving Loan Fund for drinking water facilities. Each of these federal programs awards grants to states to "seed" revolving loan funds that provide low-interest loans to eligible communities to build wastewater or water facilities. Community loan repayments go back into the state fund to be loaned to other communities.

3. Hardship Grants Program for Rural Communities.

Many disadvantaged rural communities cannot afford the full cost of SRF loans. These communities can seek help through EPA's Hardship Grants program, which helps small, disadvantaged rural communities with fewer than 3,000 people address their wastewater treatment needs.

4. Colonias Program.

This program makes grants to states along the U.S.-Mexico border to provide wastewater facilities to Colonias. Colonias are low-income, unincorporated communities along the U.S. side of the border.

5. Clean Water Indian Set-Aside Program.

EPA and the Department of Health and Human Services Indian Health Service cooperate to help provide wastewater facilities to tribes and Alaska Native villages. A Drinking Water Indian Set-Aside Program is currently being developed, and is not listed in this publication.

Department of Housing and Urban Development (HUD)

6. Community Development Block Grant Program.

HUD gives block grants to participating states, which allocate the funds to units of local government that carry out development activities principally for people with low and moderate incomes. Funded activities include wastewater, drinking water, and economic development projects.

Department of Agriculture's Rural Utilities Service (RUS)

7. Water and Waste Disposal Program.

RUS provides grants and loans to rural communities with fewer than 10,000 people for wastewater, drinking water, solid waste, and storm drainage projects.

Department of Health and Human Services, Indian Health Service (IHS)

8. Sanitation Facilities Construction Program.

This program gives technical and financial assistance for the sanitation needs of American Indians and Alaska Natives, including water, sewer, or solid waste disposal facilities.

Department of Commerce

9. Economic Development Administration Grants for Public Works and Development Facilities.

Fundable projects include water and wastewater facilities that promote economic development in economically distressed areas.

10. Appalachian Regional Commission's Community Development Supplemental Grants Program.

This program funds water and wastewater facilities in 13 states to create jobs and promote private sector initiatives.