Otter Creek Basin

Water Quality Management Plan

May 31, 2012

The Otter Creek Basin - Water Quality Management Plan was prepared in accordance with 10 VSA § 1253(d), the Vermont Water Quality Standards, the Federal Clean Water Act and 40 CFR 130.6.

Approved:

6/1/12

David Mears, Commissioner
Department of Environmental Conservation

Date

6-1-12

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Agency of Natural Resources

Date

Cover photo of Otter Creek entering Lake Champlain after Tropical Storm Irene courtesy of Bill Howland, Lake Champlain Basin Program

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Otter Creek Basin Plan Executive Summary

This river basin water quality management plan (plan) provides an overview of the surface waters in the Otter Creek Basin and a description of ongoing and future steps to restore and protect those waters. With the purpose of improving both water quality and aquatic habitat, this plan presents the recommendations of local watershed residents, stakeholders from varying interests, the Agency of Natural Resources (VANR) and professionals from other State and federal agencies to guide efforts in the basin over the next five years. The primary action items are provided in detail in the Chapter 4 implementation tables. The tables include the strategies that address existing and potential threats to surface waters in the basin. The tables' strategies are expected to be revised over the life of the plan as new information is obtained and priorities identified.

The Otter Creek Basin includes all surface waters that flow into the Otter Creek. The Otter Creek Basin or Basin 3 consists of the Otter Creek watershed plus the watersheds of Lewis Creek and Little Otter Creek, which drain directly to Lake Champlain. The headwaters of the Otter Creek originate in Bennington County where the mainstem is formed by waters flowing down from the Green Mountain National Forest and travels north approximately 100 miles to its mouth in Addison County where it flows into Lake Champlain in the town of Ferrisburgh. The Otter Creek watershed encompasses an area that is 936 square miles draining portions of Bennington, Rutland and Addison counties.

The extensive network of rivers, streams, lakes, ponds, and wetlands in the Otter Creek Basin support many uses including swimming, boating and fishing. Impairments and threats to these uses in the basin include: sedimentation, siltation, turbidity, habitat alterations, nutrients, thermal modifications, flow alterations and metals as well as physical instability and river corridor encroachment.

The top ten priority strategies (unranked) in this management plan follow:

1. Implement steps to address the Bacterial TMDL for the Lewis Creek, Little Otter Creek, Middlebury River, and Otter Creek.

2. Complete stormwater system mapping and illicit discharge detection for Brandon, Middlebury, Pittsford, Rutland Town, Rutland City, and Vergennes.

3. Work with the nine towns that have not received a Better Backroad Grant to apply for funding to address road- related water quality problems.

4. Identify culvert replacement projects for headwater areas, including Class 4 road systems that will improve geomorphic stability of the stream as well as improve fish passage.

5. Promote existing programs such as CREP that provide incentives for fencing, watering tanks and other agricultural best management practices in targeted areas.

6. Work with towns to protect river corridors and promote flood resiliency by establishing Fluvial Erosion Hazard zones and buffer zones in local zoning.

7. Identify wetlands on agricultural lands for phosphorus retention, and in the river corridor for sediment attenuation, prioritize and conserve and/or restore.

8. Hold an annual Vermont Invasive Patrollers (VIP) training to support the establishment of VIP programs for lakes and ponds in the basin.

9. Encourage use of rivers and lakes in the basin to increase people's appreciation.

10. Assist towns to address aging wastewater treatment facilities and associated sewer pipes through the Clean Water Act Revolving State Funds and other funding programs.

The Importance of Basin Planning in the Face of Tropical Storm Irene

The Otter Creek Basin experienced substantial damage during Tropical Storm Irene, including wide-scale damage to major roads and bridges along significant sub-basins, especially within the southern portion of the Otter Creek watershed in Rutland County.

The opportunities presented by Irene for the enhancement of resiliency are presented to Vermonters with limited funding for restoration of flood-ravaged areas. Given the need for protection of critical flood attenuation assets and new pollution control fixes for non-flood related problems, Basin Planning emerges as a critical prioritization tool for Vermont's restoration and resiliency efforts. In recognition of this, DEC planners and river scientists have engaged in a collaborative process with Regional Planning Commissions to map critical infrastructure damage, and prioritize restoration.

The role played by Basin Planning is to bring critical information about prioritization. As an example, while a local road crew may have 25 culverts to rebuild, the planning process, by virtue of its integration of relevant planning processes can provide the information on which replacements will also produce additional pollution control benefits beyond simply rebuilding the road. By strategically prioritizing post-Irene implementation, multiple surface water protection and remediation goals can be met. At present, the Monitoring, Assessment and Planning Program is initiating an improved collaborative approach to enhance Basin Planning with RPC skills and abilities, such that resulting Tactical Basin Plans contain a prioritized combination of fluvial erosion hazard mitigation, sediment and erosion controls, prioritized protection of flood attenuation assets and identification of surface waters characterized by particularly high quality.

Chapter 1-- Otter Creek Basin Planning Overview

Introduction – A brief basin description, purpose of the plan, planning process, and expected implementation process, including an overview of:

The Otter Creek Basin Plan describes strategies to restore and protect surface waters. The surface waters include the Otter Creek mainstem and the many small rivers and streams that drain directly into Otter Creek along with two smaller river basins (Lewis Creek and Little Otter Creek) that flow into Lake Champlain just north of where the Otter Creek enters (see Figure 1 and Appendix A). In conjunction with the Agency of Natural Resources' (ANR) basin plans for the large rivers in Lake Champlain's watershed, including the Winooski, Lamoille and Missisquoi, and other water quality improvement plans for the lake (listed in Appendix B), this plan is part of an overall effort to improve the health of the entire Lake. The implementation of the strategies will help to ensure that swimming, boating and aquatic habitat and the surface waters' other values and beneficial uses can co-exist with economic development, recreational activities and other surrounding land uses.

The majority of strategies are the result of a basin planning process that sought community involvement to identify and build upon existing interest and resources in the basin to protect and improve water quality. The remaining strategies describe the Agency's existing programs and efforts to have all surface waters meet the Vermont Water Quality Standards. In addition to guiding the agency in its work, individuals and groups will be able to use the strategies to help find resources or opportunities to collaborate with others. The plan also includes a proposal to establish or refine management goals for surface waters.

Natural Resource Planning on a Watershed Scale

A watershed, or basin, is a distinct land area that drains into a particular waterbody either through channelized flow or surface runoff. Preparing a plan at a watershed level allows for the consideration of all contributing sources of surface water runoff to the waterbody.

ANR has conducted water quality assessment and improvement efforts at a watershed level since the 1970s. The state is divided into seventeen planning basins for this purpose, with each basin including one or more major river watersheds (Figure 2.). The Agency is responsible for preparing basin plans for each of the 17 major basins and updating them every five years after the plan is originally approved.

In 2010, ANR developed the Vermont *Statewide Surface Water Management Strategy* (SWMS) and will be using the process laid out therein to streamline forthcoming basin plans into "tactical basin plans." The Agency initiated the Otter Creek Basin planning process before completing the SWMS; therefore, this plan will take on attributes of both the old and new basin planning formats. Like the older plans, the majority of strategies address a specific activity that occurs across the landscape or in one specific area and are therefore organized in this plan by land use or land cover. The revision of the plan in five years will use the new approach, tactical planning, to focus efforts on remediating specific water bodies identified as stressed, altered or impaired, while promoting protection activities for specific waters that either promote stream equilibrium or maintains certain high quality characteristics.

This plan does take advantage of the web-based SWMS by providing links to the SWMS sections. The information includes descriptions of surface water stressors and resulting pollutants, as well as tools for addressing the stressors including monitoring and assessment, technical assistance, regulatory, funding, and educational programs. The resulting Otter Creek River Basin plan's predominant focus is the implementation of strategies, leaving the background information accessible to interested readers through the SWMS.

The Agency and others began implementing strategies of this Plan even during the basin planning process and will continue implementation until the planning process begins again in five years, as described by Chapter 4 of the Vermont Surface Water Management Strategy.

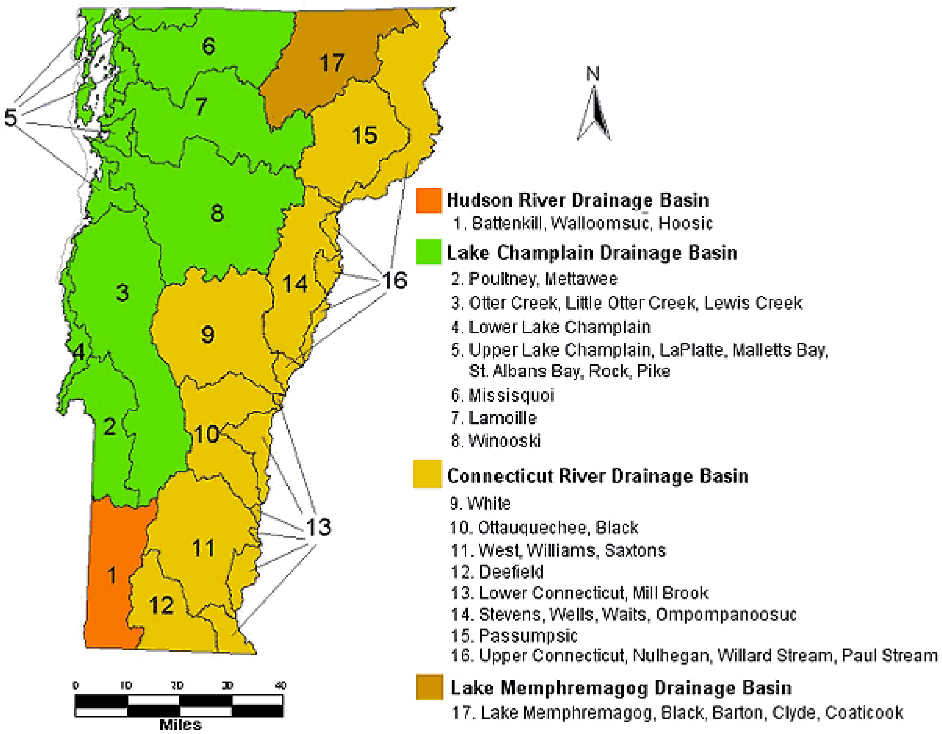


Figure 1. Basin 3, the Otter Creek Basin, is one of the 17 planning basins in Vermont

Importance of Partnerships in the Basin Planning Process

Basin planning is conducted with local communities, state and federal governments, and private organizations because Vermont's water quality problems are, for the most part, the result of diffuse runoff from dispersed activities on the land. Such runoff can be generalized and referred to as nonpoint source pollution.

Water quality protection cannot depend solely on State and Federal regulations to stem the innumerable pollutants. Clean water depends on the interest and voluntary involvement of all residents of the watershed. Vermont already has more than 65 watershed and river groups as well as many local and regional organizations (such as Conservation Districts and Regional Planning Commissions) that have been active in addressing water quality concerns. In the Otter Creek watershed, there are hundreds of landowners working to manage their lands to conserve Vermont's waters. Basin planning can support their efforts by providing technical and financial assistance. Through documentation of community-voiced problems and solutions, funds can be leveraged and resources directed toward the priorities of local communities and landowners.

A fundamental benefit of a collaborative approach is the sharing of information among resource agencies, groups, and individual citizens. In addition, the involvement of the community in identifying problems and solutions increases public awareness of opportunities to promote and preserve water quality in the basin.

Specific Partners in the Basin Planning Process

Many different stakeholder organizations have participated in the Otter Creek basin planning process over the past several years. These interests include, but are not limited to:

- Addison County Regional Planning Commission
- Addison County River Watch Collaborative
- Central Vermont Public Service
- Green Mountain Fly Tiers Association
- Middlebury River Watershed Partnership
- Lake Dunmore/ Fern Lake Association
- Lewis Creek Association
- Middlebury Area Land Trust
- Middlebury College
- Moosalamoo Association
- Municipalities in the Basin
- New Haven River Anglers Association
- Omya (and Vermont Marble Power)
- Otter Creek Audubon
- Otter Creek NRCD
- Rutland NRCD
- Rutland Regional Planning Commission
- Rutland City (Department of Public Works)
- Spring Lake Association
- The Nature Conservancy
- Upper Otter Creek Watershed Council
- USDA-NRCS
- US Fish and Wildlife Service
- US Forest Service
- UVM Extension
- Vermont Agency of Agriculture
- Vermont Agency of Transportation
- Vermonters for a Clean Environment
- Vermont Local Roads Program
- Vermont Marble Power Division
- Vermont Natural AG products
- Vermont Paddlers Association

In order to provide a snapshot of stakeholder water quality interests, the Plan highlights two groups that have conducted extensive water quality monitoring and assessment work in the basin: the Addison County River Watch Collaborative and Upper Otter Creek Watershed Council.

Addison County River Watch Collaborative (ACRWC)

The vision statement of the Addison County River Watch Collaborative (ACRWC) is "*Addison County citizens, businesses and governments incorporate water resource issues in decision-making processes and work together through a coordinated partnership to improve water quality and support the natural ecological functions of surface water systems*."

For more than a dozen years, interested citizen volunteers have gathered on spring and summer mornings to collect water samples from rivers throughout Addison County. Many of Addison County's rivers and creeks are used by local residents for recreation – swimming, boating, fishing and enjoying the natural beauty of the watersheds. ACRWC is one of a number of citizen water monitoring groups in Vermont whose volunteer members work to ensure the ecological integrity and the recreational viability of their communities' watersheds.

The Addison County River Watch Collaborative (ACRWC) was formed in late 1997 to unite stream monitoring efforts by citizens in the Addison County region. ACRWC consists of seven partner groups; Otter Creek Audubon, Otter Creek Natural Resources Conservation District, Middlebury River Watershed Partnership, New Haven River Anglers Association, the Watershed Center, Lewis Creek Association, and the Weybridge Conservation Commission. Staff planners from the Addison County Regional Planning Commission (ACRPC) continue to act in advisory and support capacities to ACRWC. In combining their efforts, the partner groups are creating an integrated watershed approach to natural resource management, and hope to encourage greater citizen responsibility for the ecological integrity of these watersheds. ACRWC's sampling of these streams have involved various water quality parameters, including *E. coli* bacteria, total phosphorus (TP), total nitrogen (TN), turbidity, total suspended solids (TSS), pH and water temperature.

Upper Otter Creek Watershed Council (UOCWC)

The mission of the Upper Otter Creek Watershed Council (UOCWC) is *to bring together citizens and organizations that are committed to improve water quality of the Otter Creek Watershed*.

Since forming in May of 2003, the UOCWC, which consists of 20 core members, has been active and meets on a monthly basis to discuss local and regional water quality issues and develops projects that address these issues.

UOCWC Water Quality Monitoring

Since its inception in 2003, the Upper Otter Creek Watershed Council (UOCWC) has been awarded laboratory analytical services through a grant for volunteer water quality monitoring from DEC. The year 2010 marks the 8th year that members of the UOCWC have collected water quality samples on the Otter Creek and tributaries in need of further assessment. During the summer months, specific waterbodies in the Upper Otter Creek Basin are being sampled twice a month for phosphorus, nitrogen, turbidity, total suspended solids, and E. coli (as an indicator of the possible presence of disease-causing bacteria). Funding for the UOCWC Summer Water Quality Monitoring Program has also been supplemented by the Waterwheel Foundation in recent years.

Members of UOCWC feel that monitoring of the surface waters in the region should continue, both to provide educational opportunities and awareness for the public who may use these rivers and streams for recreation, and also to establish a long-term database of water quality measures for comparative purposes over time.

In addition to the Water Quality Monitoring Program, volunteers attend monthly meetings and have continued to identify immediate projects, prioritize issues and develop strategies that are included in this Basin with guidance from the VT Department of Environmental Conservation as well as technical assistance from other federal, state and local agencies.

The Importance of Basin Planning in the Face of Flooding

Two major flooding events were the climatological highlights of 2011. In April, heavy rains upon snowmelt produced significant flooding in several Vermont watersheds, most notably in the Champlain Basin, where river flows attained 20 to 50 year flood stages, with resulting Lake Champlain water levels attaining previously unrecorded highs. Later, in August, when Vermont citizens thought they had survived the worst flooding they likely would see in any given year, Tropical Storm Irene dumped between four and 10 inches of rain on the river valleys throughout the State. As readers are already well aware, the devastation wrought by Irene in Basins from the Winooski and White River south was only exceeded by the flooding of 1927. With soils already saturated from a wet August, the runoff quickly filled river channels beyond their recognized floodplains and rivers, and with a newly acquired energy, ripped out roads, bridges, culverts and buildings across much of central and southern Vermont. In some instances, new river channels were created when rivers migrated to different locations.

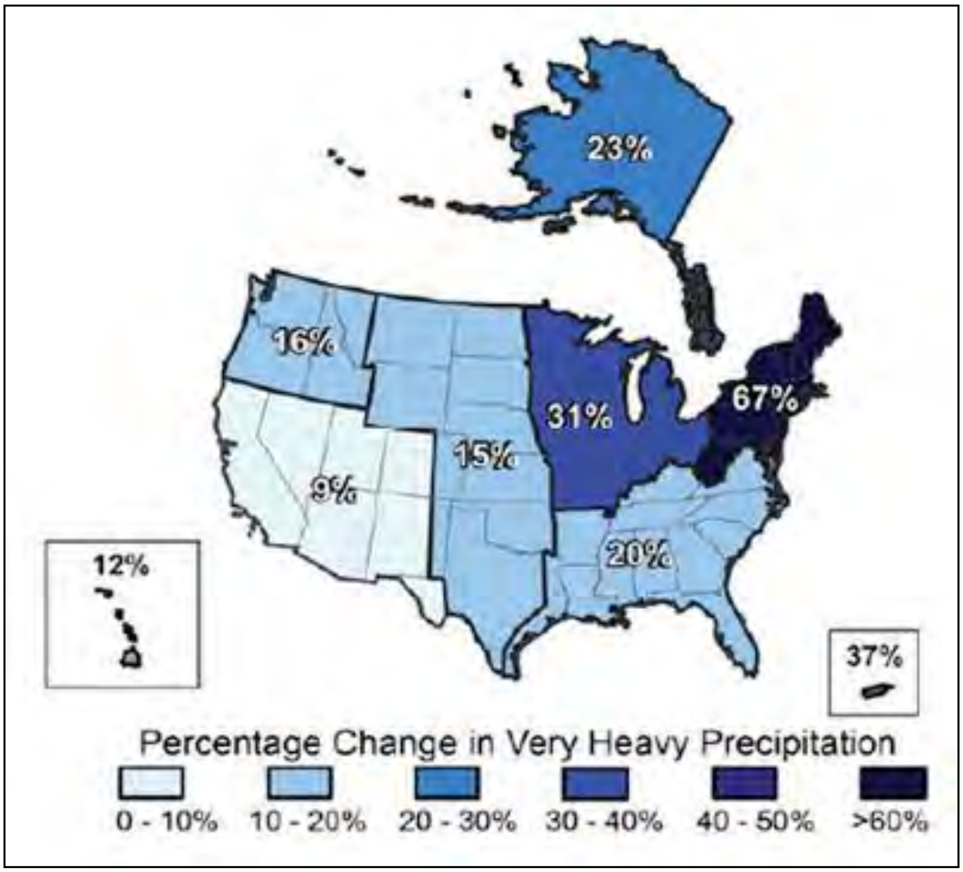


Figure 2. Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy, October 5, 2010.

Vermonters can expect to see the intensity and extensiveness of these storms repeated in the future with greater frequency as Vermont's climate warms, so ANR has been considering how we can best adapt to protect the most vulnerable resources, areas, and sectors in the state by enhancing flood resiliency. The loss of the natural landscape to urbanization and increased runoff from developed lands has resulted in a loss of floodplain connectivity, resulting in significant losses of flood storage along river corridors and floodplains. Enhancing flood resiliency necessarily involves:

- Improving infrastructure to handle more intense storms;
- Minimizing conflicts within the river corridor where possible;
- Re-armoring only areas where critical infrastructure protection is needed; and,
- Protecting and securing flood attenuation assets such as floodplains and green infrastructure[1].

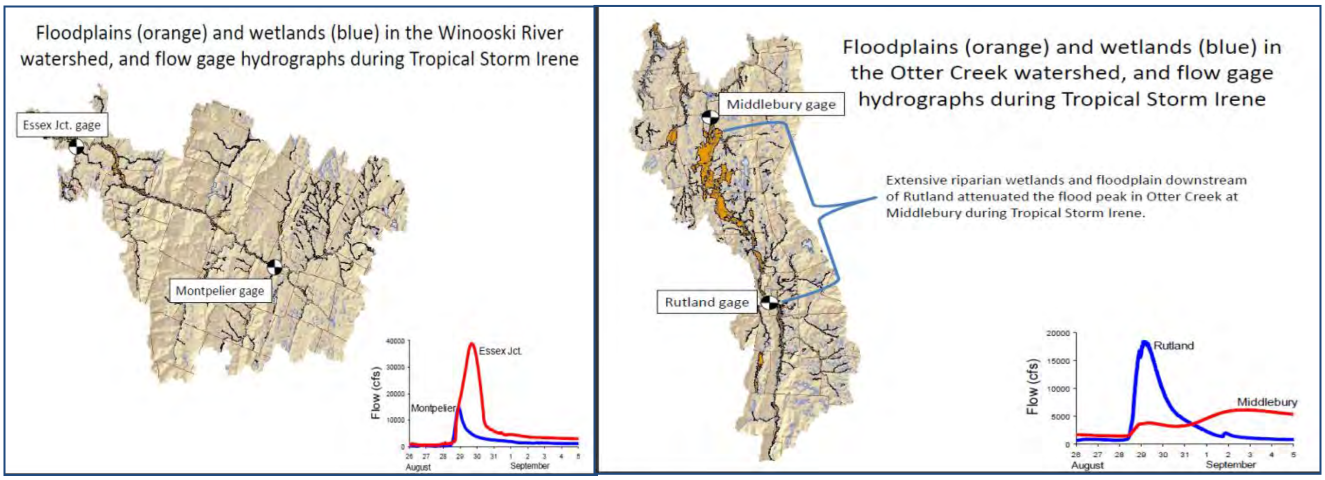


Figure 3. A comparison of upstream and downstream flows during the peak of Irene, for a river basin with few floodplains (the Winooski), and one with extensive floodplains (Otter Creek). Note the flood protections conferred to downstream watershed areas by extensive floodplains in the Otter Creek Basin.

In the face of the destruction wrought by Irene, what types of assistance do communities need to rebuild to reduce damages from the next storm? Development and implementation of hazard identification and mitigation plans are part of the solution and the agency, regional planning commissions and other partners will provide assistance to communities to produce robust plans to reduce conflicts with rivers and improve infrastructure. Vermonters must also consider fluvial geomorphic principles when rebuilding our infrastructure adjacent to rivers. This means rebuilding in a manner that balances protection of infrastructure against the protection of downstream aquatic habitat, property, and infrastructure, while accounting for the legal requirement to support river integrity. State and partner-led actions need to foster protection of critical infrastructure and personal property, while ensuring that new development does not further compromise river corridors and flood attenuation assets. To paraphrase from Barry Cahoon, stream alteration engineer for the Agency of Natural Resources:

[1] Green Infrastructure (GI) manages runoff using distributed and decentralized controls or Best Management Practices (BMPs). GI addresses stormwater through small-scale landscape practices and design approaches that preserve natural drainage features and patterns. GI techniques are most effective when they are incorporated into the design for new development or redevelopment, but both commercial and residential properties can be retrofitted to hold more rainwater on-site. The benefits of using GI in place of more traditional stormwater management practices are many and varied. Some of the benefits include wetland and riparian habitat protection, the reduction of peak runoff flow and rate through the reduction of impervious surfaces, reduced risk of flooding, improved community value and aesthetics, and long term cost savings from reduced water infrastructure maintenance. GI Best Management Practices can be grouped into either structural or non-Structural categories.

“We cannot isolate ourselves from rivers, confine rivers to where we perceive they are ‘supposed to be, belong, or always were’, or ignore the message we have been given, that the rivers often need the space we have chosen to take away from them. With all that we have invested over generations, in our homes, our commerce, and our public infrastructure, we have created tremendous conflict with the physical imperatives of rivers when rivers are energized by storm events, now of increasing frequency and magnitude. Some strategic separation and confinement of these incredibly powerful and dynamic natural systems is needed to protect these investments, but this work must be done in a way that embraces an informed recognition and implementation of fluvial conflict reduction options for the benefit of this and future generations, and the rivers themselves.”

Figure 4. US Route 4 and Mendon Brook shortly after Tropical Storm Irene, showing how a small confined river channel created new meanders at the expense of critical infrastructure, along a highly armored section of road. Figures 3 and 4 illustrate the importance of securing river corridor protections and floodplain assets to protect infrastructure while supporting goals of clean water and intact aquatic habitat.

The opportunities presented by Irene for the enhancement of resiliency are presented to Vermonters with limited funding for restoration of flood-ravaged areas. Given the need for protection of critical flood attenuation assets and new pollution control fixes for non-flood related problems, Basin Planning emerges as a critical prioritization tool for Vermont’s restoration and resiliency efforts. In recognition of this, DEC planners and river scientists have engaged in a collaborative process with Regional Planning Commissions to map critical infrastructure damage, and prioritize restoration. The role played by Basin Planning is to bring critical information about prioritization. As an example, while a local road crew may have 25 culverts to rebuild, the planning process, by virtue of its integration of relevant planning processes can provide the information on which replacements will also produce additional pollution control benefits beyond simply rebuilding the road. By strategically prioritizing post-Irene implementation, multiple surface water protection and remediation goals can be met. At present, the Monitoring, Assessment and Planning Program is initiating an improved collaborative approach to enhance Basin Planning with RPC skills and abilities, such that resulting Tactical Basin Plans contain a prioritized combination of fluvial erosion hazard mitigation, sediment and erosion controls, prioritized protection of flood attenuation assets and identification of surface waters characterized by particularly high quality.

Chapter 2 -- Identifying and Resolving Water Quality Concerns

General Water Quality Issues in the Basin

There are many surface water quality concerns that have been identified throughout the Otter Creek Basin, both from scientific as well as qualitative assessment.

ANR uses scientific methods to identify water quality problems, including the analysis of macroinvertebrate (aquatic insects) communities, water chemistry, and river geomorphology. In contrast, the many community members rely on a sensory-related approach, for example, the smell or the look of the water or shoreline, which is then related to people's ability to use the water. Using the complementary approaches, the Agency has identified the predominant stressors in the Otter Creek Basin that are causing community identified problems.

While a scientifically based assessment is necessary for an effective permitting and regulatory process, a community's assessment is the best one to use for attracting people's interest. In the basin planning process, the Upper Otter Creek Watershed Council and the ANR were better able to engage the community in the basin planning discussion by inviting them to discuss water quality concerns relevant to the community, rather than through the use of unfamiliar terms associated with a scientific assessment. The benefit to the Agency's planning process is that in addition to the work the Agency can do on its own, it has also gained the interest and energy of the community to further water quality improvement efforts. Additionally, several other pre-existing watershed organizations have been engaging their communities in watershed planning, restoration, and protection work for several years, including the Lewis Creek Association, the New Haven Anglers Association, and the Smokey House Center.

Public forums were held in the Otter Creek watershed over several years of this planning process. Examples of priority water quality concerns from the numerous public forums include:

- General water quality and human health issues (e.g. *E. coli*)
- Agriculture runoff
- Phosphorus loading (in general and as per the Lake Champlain TMDL).
- River corridor management issues and streambank erosion
- Road infrastructure and gravel road runoff
- Stormwater runoff – developed land runoff
- Lack of riparian buffers
- Protection of headwaters
- Establishing local (municipal) goals and objectives to protect water quality
    - Protection of wetlands
    - Floodplain protection
- The need for enhanced recreation and public access

These issues were defined, prioritized, and ranked according to both the degree to which topics were discussed from all public forums and meetings pertaining to Otter Creek water quality concerns, and to findings from surface water monitoring data. These issue areas are described specific to the Upper, Mid, and Lower Otter Creek regions, in the following pages.

VTANR Surface Water Monitoring Data

ANR maintains a robust surface water monitoring program. Described completely in the SWMS (see http://www.vtwaterquality.org/wqd_mgtplan/waterqmstrat.htm), the monitoring program is designed to assess physical, chemical and biological integrity of surface waters, in support of specific goals and objectives. In fulfillment of those, ANR has established 194 river/stream sampling stations representing 88 river reaches, 56 lake/pond sampling stations representing 37 waterbodies, and 4 wetland sampling stations in the Otter Creek Basin. In aggregate, ANR has conducted hundreds of sampling events in the Otter Creek Basin that have been used, in concert with citizen monitoring and other data sources, to assess the Basin using the Surface Water Assessment and Listing methodology (see http://www.vtwaterquality.org/mapp/htm /mp_assessment.htm).

Stream Geomorphic Assessments

Geomorphic assessments are mission critical tools that ANR and partner groups use to understand the physical integrity of rivers, and develop management strategies in support of stream equilibrium. As described by the SWMS (see Chapters 1 and 2), maintenance of equilibrium conditions and avoiding additional development within river corridors and floodplains provides simultaneous protection of surface water quality while protecting public health and safety. The Agency has developed a planning methodology which results in a prioritized river corridor plan for a given river basin. This basin plan combines the results of the geomorphic assessments and corridor plans generated to date (Table 2-1), in support of prioritized project rosters that support stream equilibrium basin wide.

Table 2-1. Geomorphic Assessments in the Otter Creek Basin, 2003-2011.

River	Date issued	Title
Cold River	1/1/2008	Cold River Phase 2 SGA
East Creek	3/1/2007	East Creek Watershed Phase 2 SGA
Lemon Fair	3/1/2006	Lemon Fair Phase 1 SGA
Lewis Creek	5/1/2004	Pilot Project- SGA
Lewis Creek	7/1/2004	Lewis Creek Phase 1 and 2 SGA Updates
Lewis Creek	3/1/2008	Lewis Creek M14-M18 Corridor Plan
Lewis Creek	3/1/2010	Lewis Creek River Corridor Conservation and Management Plan
Lewis Creek tributaries	9/1/2007	Lewis Creek tributaries Draft Phase 1 SGA
Little Otter Creek	7/1/2006	Little Otter Creek and Mud Creek Phase 1 SGA
Lower Otter Creek		Lower Otter Creek Phase 1
Middlebury River	8/1/2003	Middlebury River Phase 1 and 2 SGA
Middlebury River	8/1/2006	Middlebury Watershed Phase 1 SGA
Middlebury River	10/1/2008	Middlebury River Corridor Conservation Plan
Mill River	2/1/2007	Mill River Phase 1 SGA
Mill River	12/1/2007	Mill River Phase 2 SGA
Mill River	2/1/2009	Mill River Corridor Plan
Moon Brook	1/1/2006	Moon Brook Watershed Phase 1 and 2 SGA
Moon Brook	3/1/2008	Moon Brook Watershed Corridor Plan
Neshobe	7/1/2011	Neshobe River Corridor Plan
New Haven	10/1/2003	New Haven River Phase 1 SGA
New Haven	8/1/2004	New Haven River Phase 2 SGA

River	Date issued	Title
New Haven	2/1/2006	New Haven River Corridor Plan Draft
New Haven	1/1/2008	New Haven River Phase 2 Addendum
New Haven tributaries	6/1/2007	New Haven tributaries Phase 2 SGA
New Haven tributaries	9/1/2008	New Haven tributaries Phase 1 SGA
Otter Creek tributaries	2/1/2007	Otter Creek tributaries Phase 1 SGA
Otter Creek tributaries	1/1/2009	Otter Creek Watershed tributaries Phase 1 SGA
Upper Otter Creek	11/1/2005	Upper Otter Creek Phase 1
Upper Otter Creek	2/1/2006	Upper Otter Creek Phase 2
Upper Otter Creek	1/1/2009	Upper Otter Creek Phase 2

Lower Otter Creek Water Quality and Aquatic Habitat

The Lower Otter Creek flows northerly from the confluence with the Middlebury River through the town of Middlebury passing over the dam in the town and then dropping some 75 feet over two more dams downstream before the New Haven River enters from the east. Following a large meander south then north, the Lemon Fair River joins the Otter Creek from the south. This confluence is 6.3 miles downstream from the New Haven River confluence. The Otter Creek then flows in a northerly direction after the Lemon Fair confluence forming the eastern border of the towns of Addison and Panton and the western border of Waltham. In the City of Vergennes, the Otter Creek passes over a dam dropping 37.5 feet. Below this point, the Otter Creek is influenced by Lake Champlain.

Surface water quality

Surface water conditions in the Lower Otter Creek Basin are generally good. However, excessive sedimentation and pathogens are a predominant cause of impairment and the largest threat to rivers and streams in the Basin. Six waterbodies are considered “impaired” (indicating that they currently do not meet Vermont Water Quality Standards[2]) and several more are considered “stressed” and in need of further assessment.

The (Lower) Otter Creek is listed as impaired on the 2010 303(d) List of Impaired Waters (Part “A”) for contact recreation due to pathogens from agricultural runoff and possibly failed septic systems from the confluence with the Middlebury River downstream to the Pulp Mill Bridge (approximately 6 miles). In addition, aquatic biota, habitat, and aesthetics are considered “stressed” for the entire length of the Lower Otter Creek due to aquatic weeds, turbidity, nutrient & organic enrichment, sedimentation and pathogens caused by agricultural land uses (especially agricultural waste management, field nutrient management, cropland erosion, and lack of buffer strips) as well as streambank erosion.

The Otter Creek mainstem at the confluence with the Lemon Fair in Weybridge is considered “stressed” due to impacts on aquatic biota or habitat, non-contact recreation, and aesthetics, due to flow alterations, and thermal modifications due to hydro-electric facilities. In addition, this portion of the Otter Creek does not fully support contact recreation (swimming) due to high sediment loads, turbid conditions, suspended solids, nutrients & organic enrichment, and pathogens caused by agricultural land uses.

[2] The Vermont Water Quality Standards (VWQS) serve as the foundation for protecting Vermont’s surface waters. The VWQS are regulations that classify each waterbody, establish uses (e.g. swimming and fishing) that must be protected, and set minimum chemical, physical and biological criteria that must be met in all of Vermont’s waters. The VWQS are promulgated by the Vermont Water Resources Panel and are used by the Department in its planning, management and regulatory programs to protect Vermont’s surface waters. The general water quality policy for Vermont is set forth in §1-02 of the VWQS.

ACRWC recommends researching and identifying land use activities that might be influencing *E. coli* readings on the Lower Otter Creek in particular. Many of the high *E. coli* readings do not correspond with high river flows, suggesting that there may be causes other than run-off from non-point sources. ACRWC suggests developing a program to track ongoing land use activities on the Otter Creek, and correlating this information to data findings from this water quality monitoring program. These types of assessments are on-going or have been completed with partnership funding in the Little Otter Creek and Lewis Creek watersheds.

Stream Geomorphic Assessments

A Phase 1 Stream Geomorphic Assessment was conducted on the Otter Creek mainstem and Leicester River in 2005 and 2006 by the Addison County Regional Planning Commission. Results from this remote sensing phase indicate that the remaining reaches may be in adjustment and may be highly impacted from flood-plain modification, in-stream modifications and surrounding land uses. Overall, the impact category with the greatest total score is Floodplain Modification (39.6%). The most influential potential channel modifications affecting the Otter Creek are dams. The final products of the assessment are the condition of each reach, the channel adjustment process that may be underway, and the sensitivity of the reach to change from anthropogenic and/or natural sources.

The Lewis Creek and New Haven Rivers have had extensive geomorphic assessment and corridor planning. Prioritized recommendations for these streams are provided in Chapter 3.

Lakes and Ponds

There are dozens of lakes and pond in the Lower Otter Creek watershed that are publicly accessible and support existing uses such as swimming, fishing, and boating.

There are several high elevation ponds, especially in the Green Mountain National Forest such as Abbey Pond. Abbey Pond supports a rich natural community of marsh plants and animals. This area is sometimes closed to protect nesting great blue herons. Other high elevation ponds include North Pond in Bristol, a very pristine wilderness pond and Lake Pleiad. Located at the northern end of the Moosalamoo region on a shoulder of Worth Mountain, Pleiad Lake is one of the highest lakes in Vermont and is the only large natural waterbody used for snowmaking at the Middlebury College Snow Bowl ski area.

The major cause of non-support of uses and values on lakes in the Otter Creek Basin is due to lake level manipulation. Lakes and ponds in the basin listed as stressed due to artificial water level fluctuation include Lake Dunmore and Silver Lake. Other causes affecting a large number of lake acres include metals (mercury and its effect on fish consumption), nutrients, dissolved oxygen levels and excessive amounts of aquatic plants (especially invasive plants such as Eurasian watermilfoil). The major sources of impairment are the manipulation of water level on those lakes with artificial control, atmospheric deposition, unspecified sources and agricultural runoff (e.g. Richville Pond in Shoreham).

Aquatic life support is the most affected designated use of the lakes in the Otter Creek watershed as is the case with river miles. There are 249 lake acres (70%) impaired for this use. Another 509 acres are considered threatened for aquatic life support. Secondary contact recreation (boating and fishing) is the second most affected existing use with 1237 acres (36%) of the assessed acres in the basin not fully supporting one or both of these recreational activities.

On a positive note, the Town of Leicester and the Lake Dunmore/Fern Lake Association (LDFLA) have demonstrated that it is possible to control Eurasian watermilfoil in an environmentally friendly way by handpulling plants by a certified SCUBA team. Eurasian watermilfoil is a non-native invasive aquatic plant that invades lakes and ponds nationwide, forming dense beds that outcompete beneficial native aquatic plants, and degrade fish habitat and overall lake ecology. Traditional methods of control include herbicides, mechanical harvesters and benthic barriers, all of which may have adverse effects on the environment. The Leicester and LDFLA program utilizes a small team of well-trained divers to remove watermilfoil plants by hand, the use of suction harvesters and benthic mats.. The success of this program on both a small and large lake demonstrates the effectiveness of this program and its value as a model for the rest of the region. To that end, the project has produced extensive documentation and has shared this with other lake organizations in New England. In 2004, the US EPA awarded an Environmental Merit award to the Lake Dunmore Fern Lake Association for their exemplary watermilfoil management program (EPA, 2004).

Upper Otter Creek Water Quality and Aquatic Habitat

Surface water quality

The surface waters monitored through the Upper Otter Creek water quality monitoring program are generally in very good condition. Specifically, Weatherby Brook in Danby, Freeman Brook in Shrewsbury, and the Mill River consistently exhibit very high water quality conditions. While it’s no surprise that Weatherby Brook and Freeman Brook are in such good condition given their location as headwater tributaries and with an extensive forested watershed, it is a surprise that the Mill River exhibits such good water quality given its much larger size and apparent stressors within the system.

Other surface waters monitored have shown some degree of consistency over the years of monitoring and show some predictability with respect to their geographic location and stressors due to land use and development. Specifically, urban streams such as Moon/Mussey Brooks and East Creek continue to exhibit impacts from stormwater runoff.

The most troubling results of recent water quality monitoring data analysis have been from Baker Brook in Danby and Cook Brook in Wallingford. These two streams consistently show poor water quality conditions which appear to be a function of nonpoint source pollution and inadequate water quality protection practices. Additional monitoring and assessment work in these watersheds should be conducted to identify problem areas and seek solutions that will abate and restore good water quality.

Stream Geomorphic Assessments

The Upper Otter Creek has been significantly impacted by historic channel straightening and floodplain encroachment by railroad tracks, roads, and commercial and residential development. In response to these and other watershed stressors, the Upper Otter Creek is undergoing varying degrees of channel adjustment, predominately planform (or lateral migration), widening, and aggradation. Damages to these streams as a result of Tropical Storm Irene are clear to residents and visitors. Despite the severe hardships imposed by this storm, the communities of Brandon, Clarendon, Danby, Mendon, Mount Holly, Rutland City, Rutland Town, Shrewsbury, and Wallingford all have the opportunity to provide long-term protection to the river corridor and encourage the reestablishment of functioning floodplain and healthy in-stream habitat through river corridor management, protection, and restoration.

Though most historic state permit records do not record the location or length of rip-rap installed along the channel, the reaches surveyed during the buffer and phase 2 assessments showed that the occurrence of rip-rap along the Otter Creek mainstem is relatively common, reflecting historic reliance on a technique that does not always work. In many places, where rip-rap had been applied to the banks, it has failed or caused erosion elsewhere. Alternative forms of bank stabilization or system-wide stabilization may prove effective in decreasing erosion and sediment transport, while maintaining the width of the channel and floodplain access. According to NRCS, revetments that are installed along the banks of the Otter Creek will need to withstand extensive ice-scour as well (Eugair, 2005).

In addition, many of the reaches in the river valleys showed long stretches with minimal buffers, which contributes to the increased sediment and potentially increased nutrient levels in the water from erosion and runoff. Tree planting and other buffer enhancement projects in these areas are recommended to lessen to the susceptibility to erosion due to the lack of robust root systems.

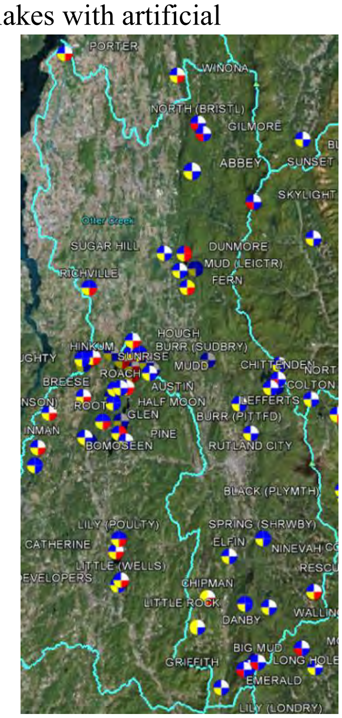
While the effect of berms and roads on the channel morphology appears to be high, the pressures from development are not yet significant in many reaches. Planning within the Otter Creek watershed could include objectives for decreasing runoff from impervious surfaces, managing runoff for nutrients and planting riparian buffers to help protect and restore the functionality of basin streams.

Lakes and Ponds

There are dozens of lakes and pond in the Upper Otter Creek (UOC) watershed that are publicly accessible and support existing uses such as swimming, fishing, and boating.

There are several high elevation ponds, especially in the Green Mountain National Forest such as Little Rock Pond. The pond is surrounded by hills and large boulders, and is a very popular area for swimming, fishing, and camping. Other high elevation ponds include Wallingford Pond in Wallingford, a very pristine wilderness pond and Griffith Lake, a 15 acre lake that has an excellent Brook Trout fishery.

The major cause of non-support of uses and values on lakes in the Otter Creek Basin is lake level manipulation. This is especially true for East Creek which is identified on the State List of Impaired Waters (2010 303(d) List of Impaired Waters) because of low dissolved oxygen due to hypolimnetic withdrawals in Chittenden Reservoir. Other lakes and ponds listed as threatened due to artificial water level fluctuation include Lefferts Pond and Patch Pond. Other causes affecting a large number of lake acres include metals (mercury and its effect on fish consumption), nutrients, dissolved oxygen levels and excessive amounts of aquatic plants (especially invasive plants such as Eurasian watermilfoil). The major sources of impairment are the manipulation of water level on those lakes with artificial control, atmospheric deposition, unspecified sources and agricultural runoff.



Vermont Lakes Scorecard

The Vermont Watershed Management Division's Lakes and Ponds Section developed the Lake Score Card to provide a method for conveying the large amount of data gathered through our monitoring efforts. The Score Card answers the commonly asked question "how is my lake doing?" Monitoring data is analyzed and reported out in a simple, visual interactive format. The Score Card rates Vermont lakes in terms of:

- Water Quality
- Aquatic Invasive Species
- Atmospheric Pollution
- Shoreland and Lake Habitat

To access Lake Score Card information on a specific lake or pond in the Otter Creek Basin, use the link below:
http://www.anr.state.vt.us/dec/waterq/lakes.htm

Water quality issues throughout the Otter Creek Basin

Pathogenic bacteria as measured using *E. coli* as an indicator

The Agency of Natural Resources, the Addison County River Watch Collaborative, the Upper Otter Creek Watershed Council, lake and pond associations, and communities in the basin consider pathogens as an important problem in the Basin. The level of pathogens present in waters is only part of the information needed to identify water quality problems and associated health risks from contact recreation. ACRWC and UOCWC, in concert with the ANR's Department of Forests, Parks, and Recreation, comprise the primary source of monitoring information for *E. coli* as an indicator of pathogenic bacteria in the Otter Creek Basin.

The SWMS contains a comprehensive chapter on pathogens as a stressor to surface waters, which provides substantial background information on monitoring and assessment approaches, regulatory, funding, and technical assistance tools, and educational opportunities associated with pathogens. In addition, ANR provides technical guidance via the Citizen's Guide to Bacteria Monitoring in Vermont Waters, and has recently issued a Statewide Total Maximum Daily Load for *E. coli* bacteria that outlines a general approach to addressing *E. coli* impacts in specific impaired waters. These waters are identified in Chapter 3 of this Plan. See:

SWMS Chapter 2 –
http://www.vtwaterquality.org/wqd_mgtplan/stressor_pathogens.htm
Citizen's Guide to Bacteria Monitoring in Vermont Waters -
http://www.vtwaterquality.org/lakes/docs/lp_citbactmonguide.pdf
Statewide TMDL for *E. coli*
http://www.vtwaterquality.org/mapp/htm/mp_tmdl.htm

Vermont Statewide Total Maximum Daily Load (TMDL) for Bacteria-Impaired Waters

The recently established Statewide Total Maximum Daily Load (TMDL[3]) for bacteria-impaired waters provides a framework for addressing bacterial pollution in the streams and rivers of Vermont. Bacterial contamination of surface waters may result from a variety of sources including waste from humans, farm animals, pets, and wildlife, such as large congregations of birds and small mammals. Bacterial contamination can negatively affect public health and may ultimately result in closures of swimming areas, drinking water supplies, and shellfish areas (USEPA, 2001a).

The bacteria TMDL establishes the allowable bacterial loadings (expressed as concentrations) for Vermont's surface waters (including the Lewis Creek, Little Otter Creek, Middlebury River, and Otter Creek mainstem within Basin 03) provides documentation of impairment, and outlines the reductions needed to meet water quality standards. One goal of this TMDL process is to promote, encourage, and inform local community action for water quality improvement and protection of public health by addressing sources of bacterial contamination. To this end, this TMDL also provides information to help communities, watershed groups, and other stakeholders to

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[3] A TMDL or Total Maximum Daily Load is the calculation of the maximum amount of a pollutant that a waterbody can receive and still meet Vermont Water Quality Standards. In a broader sense, a TMDL is a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards and develops a means to implement those reductions. TMDLs can be calculated for correcting water pollution from specific point source discharges or throughout a watershed and balance the location and amount of needed pollution reductions.

implement the TMDL using a phased, community-based approach that will ultimately result in attainment of water quality standards.

Agricultural Runoff

Agriculture, as a working landscape, provides many benefits to the environment. Fields and pastures provide large tracts of open space and are habitat for many species of birds and mammals. As field soils absorb rain water more readily than paved and other impervious surfaces, fewer nutrients are released from an acre of agricultural land than from an acre of developed land.[4] Farms recycle farm-produced wastes, such as manure and spoiled feed, into soil amendments. Farms also work to prevent runoff of soil, nutrients and pathogens through land management practices like cover cropping, grass filter strips, no-till farming and strip farming. The SWMS provides detailed information on agricultural runoff in Appendix C (http://www.vtwaterquality.org/wqd_mgtplan/swms_appC.htm).

Agricultural land use in the Otter Creek Basin remains a source of water quality impacts. It is estimated that almost 75 miles of rivers and 403 acres of lake water in the entire Otter Creek watershed are adversely affected by agricultural runoff. Although these figures represent only 20.1% of the total impaired river miles and 9.6% of the total impaired lake acreage in the watershed, the effects of agriculture on water quality should not be ignored. Excess nutrients, pathogens and sediments all can leave the farm when erosion control methods fail or heavy rains and floods inundate fields.

The Otter Creek and some of its tributaries are on the 2010 Vermont 303(d) List of Impaired Waters in the Otter Creek Basin where agriculture has been identified as the surface water quality problem. In 2012, the Agency of Natural Resources and Agency of Agriculture, Food, and Markets are embarking on the development of a TMDL specific to agriculturally-impaired waters in Vermont. All agriculturally-impaired waters in the Otter Creek Basin will be part of this analysis. Specific agriculturally-impaired waters are described in Chapter 3 of this Plan.

The 2010 State of Vermont 303(d) Part A list of Impaired Surface Waters in Need of a TMDL lists no agriculturally impaired surface waters within the UOC. This should be celebrated as testimony to the excellent stewardship by the residents of the watershed and encouragement to remain off this list. That said, the Part C list of Priority Surface Waters Outside the Scope of the Clean Water Act Section 303(d) does note two river sections within the UOC that are in need of further assessment due to agricultural impacts.

Phosphorus Loading

Phosphorus pollution from point and non-point sources results in surface water quality issues and loss of use in Basin waters, and in downstream Lake Champlain. The SWMS describes the impact of phosphorus pollution in Appendix B, and articulates strategies to address this pollution in four specific stressor chapters of the SWMS.

The Lake Champlain Phosphorus TMDL Implementation Plan (2010) includes a Vermont-specific implementation plan describing a suite of action items and attendant funding needs to reduce the phosphorus load delivered annually to Lake Champlain. That implementation plan was developed as a second revision of the original 2002 Lake Champlain Phosphorus TMDL and Implementation Plan. The 2010 Implementation Plan articulated an aggregate financial need of approximately $800M to achieve full implementation. Since 2002, the state has invested more than $50 million dollars in its

[4] USGS. 1996. Nutrients in the Nation's Waters: Identifying Problems and Progress. Fact Sheet FS-218-96. http://pubs.usgs.gov/fs/fs218-96/ .

efforts to improve water quality in the lake, and in turn has leveraged these dollars to obtain an additional $52 million in federal funding; a respectable component of the overall need.

EPA disapproved the Vermont 2002 Lake Champlain Phosphorus TMDL on January 24, 2011, obliging EPA to prepare a new TMDL. VTDEC is collaborating with EPA on this endeavor. Work includes development of a watershed model to estimate phosphorus loads and potential reductions achievable within major tributary watersheds, including the Otter Creek, to Lake Champlain. VANR and partners will then identify programs and requirements that will provide reasonable assurance that reductions identified will meet the TMDL. Finally, EPA will develop load and wasteload allocations (including stormwater WLAs) for sources or categories of sources in each lake segment. The timeline for the completion of EPA's TMDL report is 2013. Vermont will be responsible for implementation.

At present, EPA is considering adopting an implementation model developed for the Chesapeake Bay watershed that identifies subwatershed-level load caps for point and non-point sources, by land-use sector, to achieve identified reductions. The approach envisioned by EPA would first develop an initial load reduction estimate based on modeling, and then rely upon VTDEC's Tactical Basin Planning approach to identify geographically explicit subwatershed-level actions to achieve the TMDL. An adaptive management approach is envisioned of incremental implementation with monitoring to verify progress. Direct implementation, augmented regulation, and targeted funding are all being discussed by EPA, VTDEC, and stakeholders as tools to implement the TMDL. This is a substantial undertaking, but the work will improve targeting of management practices. Strategies or actions arising out of the TMDL revision that are applicable to the Otter Creek basin will augment efforts initiated through the Otter Creek Basin planning process. As EPA's TMDL is finalized, the implementation tables of this Otter Creek Basin Plan will be augmented to identify and sequence implementation of the subwatershed-specific actions needed to achieve the TMDL load reductions.

See:

SWMS Appendix B – Phosphorus and Nitrogen:
    http://www.vtwaterquality.org/wqd_mgtplan/swms_appB.htm
SWMS Stressors; Channel Erosion, Land Erosion, Non-Erosion Nutrients, Encroachment
    http://www.vtwaterquality.org/wqd_mgtplan/swms_ch2.htm
Lake Champlain TMDL Implementation Plan – 2010
    http://www.anr.state.vt.us/cleanandclear/

Vermont Surface Water Management Strategy

River Corridor Management

A "channelized" river is one that has been straightened and typically dredged, and can have structural measures, such as bank armoring and berming, applied to keep it from moving laterally. Initially rivers in Vermont were channelized into straightened forms to hasten runoff and maximize the use of valley-bottom land. Structural measures and channelization have been used for decades to protect those investments and have created the public perception that rivers should not be allowed to move. The misperception that deeper rivers can contain larger quantities of floodwaters has led to widespread channelization that in fact can exacerbate flooding and cause continuing erosion from channel adjustment.

The vast majority of flood damage suffered in Vermont in recent years, and also as a result of Tropical Storm Irene is caused by fluvial erosion, not inundation. While inundation-related flood loss is a significant component of flood disasters, the predominant mode of damage is associated with the dynamic, and oftentimes catastrophic, physical adjustment of stream channel dimensions and location during storm events due to bed and bank erosion, debris and ice jams, structural failures, flow diversion, or flow modification by manmade structures. Channel adjustments with devastating consequences have frequently been documented wherein such adjustments are linked to historic channel management activities, floodplain encroachments, adjacent land use practices and/or changes in watershed hydrology associated with conversion of land cover and drainage activities. Examples of this can be seen throughout the Otter Creek Basin in the aftermath of Tropical Storm Irene, most particularly along the New Haven, Middlebury, Neshobe, and Cold Rivers, and in the East and Mill Creeks.

Without the expertise and tools to manage fluvial erosion hazards, towns have been helpless to break out of this cycle of repetitive and costly flood damages.

The SWMS provides detailed information on fluvial erosion hazards, and provides detailed descriptions of programs in place to address this major stressor to surface waters of the Otter Creek Basin. See:

SWMS Introduction; Physical Integrity
    http://www.vtwaterquality.org/wqd_mgtplan/swms_ch1.htm
SWMS Stressors; Channel Erosion, Flow Alteration; Encroachment
    http://www.vtwaterquality.org/wqd_mgtplan/swms_ch2.htm
SWMS Appendix C; Hydrologic Modification; Encroachment; Flood and Erosion Hazard Mitigation
    http://www.vtwaterquality.org/wqd_mgtplan/swms_appC.htm

Developed Land Runoff

Transportation infrastructure

Stormwater runoff from highways and transportation-related activities is a well-known impediment to good water quality. Approximately half of the land area in and around cities consists of roads and motor vehicle infrastructure, according to the Natural Resources Defense Council (NRDC, 1999). These impervious surfaces collect pollutants from tailpipe emissions and brake linings along with other contaminants including nutrients, heavy metals, road salts, rubber, pathogens, hydrocarbons (oil and gas), and sediments. They also prevent rainfall from soaking into the ground, altering the local hydrologic cycle and resulting in destructive stream flows, stream channel degradation, higher water temperatures, and reduced groundwater recharge. When most of the roads and other impervious surfaces in this country were constructed, virtually no stormwater controls were in place to protect water quality. In Vermont for example, it is estimated that more than three-quarters of the roads were constructed prior to any requirements for managing stormwater runoff. It is not surprising, therefore, that polluted stormwater is the leading cause of impairments for nearly 40% of the nation's waterways (EPA, 2012).

A study of pollutants in highway runoff from two urban sources in Wisconsin concluded that: "…streets were the single most important source area for urban pollutants in residential, commercial, and industrial areas. Not only did streets produce some of the highest concentrations of phosphorus, suspended solids, bacteria, and several metals, but they also generated a disproportionate amount of the total runoff volume from the watershed. Consequently, streets typically contributed four to eight times the pollutant load that would have been expected if all source areas contributed equally[5]."

Back Road Runoff

The backroads of Vermont are integral to the state's rural image and quiet, tranquil nature. Hidden from view is the fact that these rural roads, whether gravel or paved, can be a significant source of

[5] *Using Federal Surface Transportation Programs to Restore Water Quality Degraded by Highway Runoff*: A Legislative Proposal, Chesapeake Bay Commission, March, 2003.

phosphorus if they are not properly maintained. The Better Backroads Program enables towns to fix chronic erosion problems in an optimal way so towns can avoid annual repairs and reduce phosphorus and sediment pollution. Approximately two thirds of the 44 towns that are wholly or partly in the Otter Creek Basin have received Better Backroads funding since the inception of the program.

Gravel roads can be a significant phosphorus source depending on how the roads are maintained and upgraded. The majority of gravel road miles are maintained by municipalities, and Vermont towns are limited in their ability (both financially and technically) to address these extensive back road networks. Vermont's roads effectively become part of the stream network during a rainstorm or spring melt, with the roadside ditches more often than not discharging directly into streams, lakes or wetlands. Eroded material contains significant amounts of phosphorus and thus, as with all eroded soil, is a source of phosphorus and sedimentation to surface waters in the Otter Creek Basin and eventually Lake Champlain.

Addressing stormwater impacts to water quality and stream channels from road runoff is a costly endeavor. While new road construction incorporates improved stormwater management techniques, states must find ways to address impacts from existing roadways in order to bring waterways up to standards required by the Clean Water Act. This is doubly evident in the aftermath of Tropical Storm Irene, where wise investments made in the coming years on road reconstruction may yield major dividends in terms of infrastructure longevity and surface water integrity. Since roads are a major contributor to the impairment of waterways, transportation funding should be an integral part of the strategy.

Stormwater Runoff

The management of stormwater runoff is at once a simple concept and a complex problem. Precipitation runs off impervious surfaces rather than infiltrating naturally into the soil. The cumulative impact resulting from the increased frequency, volume, and flow rate of stormwater runoff events can lead to destabilization of downstream channels and can also result in increased wash-off pollutant loading to receiving waters.

Stormwater runoff has a significant environmental impact because it:
- causes flooding which results in erosion/property damage,
- endangers or destroys aquatic wildlife and wildlife habitats,
- causes unhealthy algal blooms and
- endangers public health via contact recreation sports and by contaminating drinking water.

In addition to the streams listed as impaired on the ANR 303(d) list, there are numerous examples across the state of natural resource degradation and threats to public health due to stormwater runoff. These more localized problems are not restricted to typical urban areas of the Basin such as Rutland, Middlebury, or Vergennes; they also occur where growth areas have encircled traditional Vermont towns and villages or where runoff from developments was improperly directed onto unstable soils or slopes. Examples of such problems can be found in villages and towns such as Brandon and Bristol. Any watershed or subwatershed subject to intensive land development can be degraded by stormwater. Stormwater problems occur more frequently and with more regularity in Rutland City but no town or county in the state are immune from them.

Developed Land

The Otter Creek Basin is still primarily rural but the continued development of lands in the watershed threatens to increase nonpoint source pollution if precautions are not taken. Developed land has the highest levels of phosphorus runoff compared to other land uses, as shown by a recent study of land use in the Lake Champlain watershed which estimated that 53% of phosphorus entering the lake came from urban lands covering just 6% of the watershed (Troy 2007). NPS pollution results from the initial construction of houses, commercial buildings, parking lots, and driveways, during which the rate of erosion is between 20 to 2000 times the rates of erosion from other land uses (Vermont Geological Survey, 1987). Even when the construction is finished, developed land can cause an ongoing discharge of sediment and NPS pollution from increased areas of compacted and impervious surface if not properly designed, stabilized and maintained. This stormwater runoff can be reduced by the installation of effective stormwater treatment systems and by using low impact development techniques such as careful siting, minimization of site clearing and the inclusion of rain gardens and other pollution abatement techniques.

The use of fertilizers on lawns is another source of phosphorus to surface waters in the watershed. This source can be reduced by using phosphorus free fertilizers, or eliminating the use of fertilizers altogether, since most lawns have sufficient phosphorus and only need nitrogen for full growth. The proper maintenance of healthy lawns can also reduce phosphorus pollution since bare soil in a poorly maintained lawn can result in the erosion of sediments into surface waters. Roads associated with development are also a source of NPS pollution, and are discussed in detail in this section.

The SWMS provides detailed descriptions of the programs in place to address runoff from roads and developed lands. See:

SWMS Stressors; Land erosion
http://www.vtwaterquality.org/wqd_mgtplan/swms_ch2.htm
SWMS Appendix C; Land Conversion, Runoff from Developed Lands
http://www.vtwaterquality.org/wqd_mgtplan/swms_appC.htm
Stormwater Regulations and Programs:
http://www.vtwaterquality.org/stormwater.htm

Lack of Riparian Buffers

A riparian buffer is a band of vegetation between human land uses and surface waters that serves in many ways to protect the water quality and aquatic habitat of the adjacent river, stream, lake, pond, or wetland. A buffer needs to have certain characteristics in order to provide a phosphorus removal function. The most effective buffer is a natural, diverse, multi-layered plant community with a well-developed duff layer, uneven and uncompacted ground surface, natural obstacles (e.g., downed trees, rocks, branches), and no eroded or channelized routes for water to take through the buffer zone.

The phosphorus removal effectiveness of vegetated buffers depends on the width of the buffer zone, the hydrologic soil group within the buffer, the average slope of the buffer area, and the type of vegetation in the buffer. There is no minimum statewide setback or buffer requirement in Vermont. Vegetated buffers are required on projects adjacent to surface waters that go through the Act 250 land use permit review process, but for most development activity, buffer protection depends on local decisions.

Towns have clear legal authority under state statute (Chapter 117 of Title 24) to regulate riparian buffers and should adopt a minimum setback and buffer requirement on all rivers, streams, lakes, and ponds. This requirement can be included as one of the general regulations in the zoning bylaws, and then would apply to all projects town-wide. Alternatively, a buffer requirement could be included as a district standard, and the setback and buffer distance could vary depending on the nature of the district.

The Agency of Natural Resources Riparian Buffer Guidance (12/9/05) recommends a buffer zone width of 50-100 feet for streams and 100 feet for lakes, with greater or lesser widths possible when on-site evaluations are conducted by appropriate staff. The recommendations in the draft buffer procedure are directed at projects subject to Act 250 permitting or other Agency of Natural Resources regulatory programs. However, similar provisions would be appropriate to implement at the local level in order to reduce phosphorus loading to surface waters in the Lake Champlain Basin.

The Vermont League of Cities and Towns has produced a model riparian buffer ordinance and technical paper to offer guidance to towns that are interested in adopting regulations that protect and conserve riparian buffers. The model riparian buffer ordinance can easily be modified and incorporated into existing land use regulations. It can also dovetail with the objectives of the National Flood Insurance Program and River Corridor Protection discussed below.

Collected data and buffer analysis have indicated that implementation of riparian buffers would benefit the Otter Creek's health and its surrounding environment. Water quality monitoring and geomorphic assessments have revealed that the Creek's conditions can be improved at certain point locations, as human-made structures and channelization have restricted river flow and caused erosion. Agricultural land abuts the water's edge in some places, leaving the Creek susceptible to environmental degradation due to agricultural runoff and accelerated erosion. Where development has encroached close upon the river corridor, infrastructure is deteriorating, as witnessed in Vergennes. Implementation of a buffer could not only alleviate some of these stresses, but it could also potentially mitigate the need for the extensive bank stabilization project that is in Vergennes' near future. Further degradation could be prevented as rip-rapping and installing steel pilings could injure the riparian environment more than it helps.

Economic analysis indicates that the value of the ecosystem services that would be protected by riparian buffers is much greater than the costs of implementing the buffer (VRC, 2005). This means that it is a worthwhile investment. (*Middlebury College Environmental Studies Senior Seminar Spring 2005 Report on River Conservation Planning with the Vermont River Conservancy*).

New Haven Headwaters Conservation Project

The New Haven River Headwaters Conservation Project is a grassroots project initiated by Lincoln landowners. Its goal is to maintain the character and traditional uses of the town's landscape (as articulated in the Lincoln Town Plan) by enabling interested landowners to collaboratively seek long-term land conservation through conservation easements to protect the headwaters area of the New Haven River.

Vermont Family Forests (VFF) has a decade of experience with forest conservation and education outreach work in Addison County. Because of this, Lincoln landowners who developed the idea for the New Haven River Headwaters Project asked VFF to oversee the outreach and administration of the project (from the VFF website).

According to the phase 2 stream geomorphic assessment (ANR, 2003) of the New Haven River, "restoration and preservation of forested riparian buffers in the watershed will help to restore and maintain equilibrium in the channel and reduce streambank erosion and downstream sedimentation" (South Mountain Research and Consulting, 2004). In addition, the River Corridor Plan (SMRC, 2006) for the New Haven River recommends that wetlands which are contiguous to the mainstem channel have been identified that have the potential for sediment and nutrient attenuation. "With the willingness of landowners, these sites may be good candidates for conservation, particularly where existing land uses do not appear to be in conflict with channel adjustment processes."

Water Quality Protection in the Otter Creek Watershed

Protection of Headwaters

A river begins at its headwaters, a network of small upstream tributaries. When most people think of headwaters, they think of mountain creeks. In addition, headwater streams can be intermittent or perennial. Intermittent streams are those that contain flowing water only during wet periods, while perennial streams contain water year-round. Headwater streams comprise the largest total number and most linear miles of streams in the Vermont. Because they occupy a broad range of climatic and geological conditions found in the Vermont, headwater ecosystems collectively represent enormous diversity.

Headwaters supply food and critical nutrients: the headwaters are a critical food source for the entire river. Because of their intimate connection to the surrounding landscape, headwater streams deliver nutrients and organic material-like fallen leaves-to downstream regions, sustaining aquatic life downstream.

Headwaters influence downstream conditions in a number of ways. In addition to food, the headwaters provide other materials like water and sediments, essential to river health. Natural sediment delivery to streams begins with the hill slopes above intermittent and headwater stream channels. Interconnected with wetlands and groundwater, headwaters help regulate natural river flow.

While headwaters are important for their downstream influences, they are also important in their own right as geologically and biologically distinctive and diverse ecosystems. Headwaters support rich and varied communities of plants and animals. While the in-stream fauna may be relatively simplified and commonly characterized by pollution intolerant animals, the biological diversity of certain groups such as amphibians is greater in headwater regions than anywhere else within a drainage basin.

A number of headwater restoration projects have either been implemented (see sidebar story) or are currently underway in the Otter Creek Basin. Additionally, the USFS has implemented a number of headwater restoration projects in the Green Mountain National Forest portion of the Otter Creek Basin. Recently, the Forest Service has proposed yet another headwaters project, the Otter Creek Headwaters Large Woody Debris Stream Restoration Project in the White Rocks National Recreation Area of the Green Mountain National Forest.

Protection of Wetlands

Wetlands in Vermont need to be identified and protected because they provide many valuable and irreplaceable functions that benefit the public. Some functions and values that wetlands provide include surface and ground water quality maintenance, flood water storage, fish and wildlife habitat, erosion control, threatened and endangered species habitat, open space and aesthetics, recreation, and education. More than 35% of the original wetlands in Vermont have been lost.[6] In recent years, residential, commercial and industrial development has been the primary causes of wetland loss.

The term wetland refers to those areas of the state that are inundated by surface or ground water with a frequency sufficient to support plants and animals that depend on saturated or seasonally saturated soil conditions for growth and reproduction. These areas are commonly known as ponds, bogs, fens, marshes, wet meadows, shrub swamps, and wooded swamps. In Vermont, only 220,000 acres, or 4% of the land area in the state, have been identified as wetlands on the National Wetlands Inventory Maps. We estimate that an additional 80,000 acres of wetlands exists in Vermont that has yet to be identified.

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[6] Vermont Wetland Fact Sheet # 1

The need for strong wetland protection has been widely recognized in the last few decades throughout the country. As a result, wetlands are currently regulated at the state and federal levels and, in some towns in Vermont, at the town level. The true importance of wetlands, however, is most felt at the local level. It is the landowners near the wetlands that are affected by the loss of that wetland, whether by increased flooding of their property, contaminated wells, polluted streams and lakes, loss of neighboring wildlife or loss of scenic beauty. It is, therefore, critical that wetland protection begin at the local level. Most landowners would rather interact with local commissions than with state or federal government officials. Also, developers often seek local approval as the first step of a project. If proposed impacts to wetlands are identified and addressed early in the process, there is the greatest chance of resolving them with the least cost.

Local planning commissions and citizens should not assume the state or federal agencies can protect every wetland. The state's principal authority is to protect wetlands mapped on the Vermont Significant Wetland Inventory maps and wetland areas contiguous to mapped wetlands. Many ecologically productive small wetlands may not be protected under the state's protection program. Also, some landowners may not be aware that a wetland is protected at the state level and unknowingly violate the state rules. Local officials often have more direct contact with landowners than state employees, and therefore can be very effective in providing landowners with the information they need.

Municipalities in Vermont have the regulatory tools to effectively protect wetlands. These include the municipal plan, zoning and subdivision regulations, shoreland protection bylaws, health ordinances and flood hazard regulations. Check 24 V.S.A. Chapter 117 for a complete description of the statutes governing municipal and regional planning in Vermont or call the Vermont Wetlands Office for more information.

Floodplain Protection

A floodplain is the flat land adjacent to rivers and streams that is periodically inundated to varying depths during periods of high water. Small floods

Tinmouth Channel

In 2001, the Vermont Water Resources Board supported a petition submitted by the Vermont Natural Resources Council and the Town of Tinmouth, represented by both the Selectboard and Planning Commission, to reclassify the Tinmouth Channel Wetland Complex from a Class 2 to a Class 1 Wetland under the Vermont Wetland Rules. The majority of citizens of Tinmouth came out in support of greater protection for the 1,450-acre Tinmouth Channel wetland, of which 1200 acres is state-owned. This extensive wetlands complex, just north of Danby, now contains a buffer zone that is 300 feet on the North End, and 100 feet on the southern end as part of its having been granted Class One status.

The state Water Resources Board granted the Vermont Natural Resources Council's petition to upgrade the wetland's classification from Class Two. The Tinmouth Channel wetland complex is now the third wetland in Vermont to receive Class One status. The petition which the Water Resources Board accepted stated that the wetland is "exceptional and irreplaceable in its contribution to Vermont's natural heritage." The petition pointed out that the Tinmouth wetland was an important habitat for migratory birds as well as threatened and endangered species of animals and plants. It also provided "aesthetically satisfying" open space, and possibilities for education and research. The petition gained the endorsement of Tinmouth's Select Board, Planning Commission, Vermont Land Trust and the Vermont Public Interest Research Group. Under Class One designation, no proposals for "conditional uses" of any sort are considered. The only uses allowed are those predating 1990, such as logging (stumps must stay in) or raising the same crops as before.

The Tinmouth Channel wetland runs from the Danby-Tinmouth line, north of Danby Pond, to North End Road, where the Channel flows into the Clarendon River, and between East Road and Otis Road.

tend to be more frequent than large ones. The "100-year" flood frequency is used as the standard for delineating flood hazard areas by the Federal Insurance Administration. The 100 year flood will have a one percent chance of being equaled or exceeded in any given year. The large 1927 flood is estimated to be a 100-year frequency and was used as a standard for mapping Rutland Town's floodplains. Nationwide, in light of increasing levels of flooding, scientists are beginning to re-evaluate the accuracy of flood-recurrence predictions. What is clear is that, as a result of a more active climate, coupled with increased channelization and imperviousness in the past several decades, the likelihood of extreme flooding has increased.

An important function of floodplains is the storage and conveyance of flood waters. New development and the associated fill placed in a floodplain can obstruct flood flows and reduce the ability of the floodplain to store water, which can subsequently cause floodwaters to rise to higher levels on upstream and adjacent properties. Municipalities should consider the effects of floodplain encroachment on all properties when making land use planning and management decisions.

The most cost-effective way for towns to mitigate flood hazards is avoidance: limiting building and other investments in river corridors. In addition to preventing future flood losses to structures built in hazardous areas, this approach avoids constraining a river, allowing the stream or river, over time to become more stable. Vermont Statute 24 §4424 specifically authorizes towns to adopt zoning for shorelines, floodplains, and other hazardous areas, including fluvial erosion zones. Municipalities are uniquely enabled to apply local land use planning and regulations to preventing fluvial hazards and can do so by applying local knowledge and historical perspective to craft approaches that can work for each particular municipality. Although adopting land use regulations to mitigate flood hazards are likely to be controversial or even unpopular in some communities, municipal officials have a responsibility to consider these measures, as they can have important long-term public health and safety benefits, as well as the economic benefits of reduced flood losses.

Unfortunately, most communities in Vermont rely solely on the minimum standards of the NFIP to protect their communities from flood hazards. However, all communities should recognize that floodplain management based solely on NFIP minimum regulations allows for development in floodplains that will reduce the floodplain's ability to convey and store water and will cumulatively result in increases in the 100-year flood elevation. A rise in floodwaters not only can cause properties that were once flood-free to now be flood-prone but can also cause increases in the velocity of floodwaters, thereby increasing the potential for erosion of stream banks during flooding. Examples of this are evident throughout the Upper Otter Creek watershed as a result of Tropical Storm Irene.

In addition to not preserving the floodplains' flood storage and conveyance functions, NFIP minimum standards do not preserve other natural and beneficial functions of the floodplain, such as water quality maintenance and protection, groundwater recharge and discharge, and biologic resources and functions, which can have negative impacts on a community's economic and other resources. Therefore, communities should consider adopting flood hazard area regulations that are more stringent than the minimum requirements of participation in the NFIP, for example increasing the elevation requirements for structures above base flood conditions. Municipalities can also prohibit or restrict development within floodplains by developing permitted, conditional use and prohibited use standards that are more restrictive than NFIP. Communities that adopt more stringent regulations are eligible to receive insurance premium discounts for their residents through participation in the Community Rating System.

The SWMS Stressor Chapter on encroachment addresses the impacts of development and infrastructure within river corridors and floodplains. See: http://www.vtwaterquality.org/wqd_mgtplan/swms_ch2.htm.

Establishing local (municipal) goals and objectives to protect water quality

State programs do not cover all activities that may cause phosphorus and other discharges to Vermont waterways. However, municipal plans, programs, and regulations can work to reduce phosphorus loading and other water quality and aquatic habitat impacts tailored in ways that make sense to a particular community.

Regulations requiring measures such as the protection of wetlands, floodplain protection, vegetated riparian buffers, building setbacks from water, and appropriate erosion control provisions can be implemented at the local level to ensure that all projects meet minimum water quality protection standards.

Some of the specific measures that can be implemented at the town level to control phosphorus and generally protect water quality include the following:

- Protection of wetlands not identified on the Vermont Significant Wetland Inventory (VSWI)
- Floodplain protection
- Streambank and lakeshore setback requirements
- Vegetated buffer protection
- Standards that minimize the creation of new impervious surfaces.
- Small construction site erosion control standards to minimize site disturbance and erosion
- Non-regulatory options such as the purchase of conservation easements, the re-planting of streambanks and shoreline, and educational events.
- Requirements for use of low impact development (Green Infrastructure) practices.

Vermont DEC, in partnership with the VT League of Cities and Towns continually reviews town zoning provisions for the existence of water quality protective language; a project supported under the Municipal Actions efforts of ANR's Ecosystem Restoration Program. The criteria used to evaluate zoning regulations include: streambank and lakeshore setback and buffer requirements, permitted and conditional uses in the buffer and setback, the existence of zoning districts relevant to water quality protection, flood hazard regulations with water quality protections above the standards necessary for NFIP coverage, steep slope development restrictions, impervious cover limitations, stormwater treatment criteria, erosion and sediment control standards, low impact development standards and highway/driveway curb cut standards. This review can be subjective to some extent, due to the considerable variation in how zoning regulations are written and organized. In addition, a town's status with regard to water quality protections is a dynamic process, as zoning regulations are amended periodically. As of this writing, five Basin Towns are identified as having excellent zoning protections, while 13 have good protections, and 23 towns could have strengthened provisions. The current detailed evaluation of town zoning regulations is provided in Appendix C.

Use of Surface Waters in the Otter Creek Watershed

The Need for Enhanced Public Access

The rivers and lakes in the Otter Creek Basin are popular for swimming, boating, tubing, and fishing by both residents and tourists as described in the section on Existing Uses. Maintaining these uses, especially access, is a prevalent concern in the community and one that goes beyond the legal right to reach the water. According to an inventory of access sites used by the public conducted by the public and private organizations, including the US Forest Service (in the Green Mountain National Forest Plan, 2006 and ANR (Jenkins) in 1988), a majority of the access sites to the Otter Creek are not maintained for public use and are becoming degraded as a result.

Public access to water for recreation was identified as a concern during the Otter Creek basin planning public forums. The Rutland Regional Plan also identifies the need to increase and protect public access. That plan recognizes that undeveloped recreation areas (including swimming holes) "serve important recreational needs in almost every town in the Region. Loss of access to private lands is increasing due to liability concerns and the reluctance of landowners to keep their land open to unknown users. Loss of these private lands threaten to eliminate many of the recreational opportunities available across the Region, especially in smaller towns that do not have the resources to provide municipal recreational facilities." In addition, that plan specifically calls out the loss of access to water resources as a concern, as "towns with important water resources recognize the need to maintain public access points to these resources for those not owning shoreline properties" (Rutland Regional Plan, 2008). The project below highlights improvement in public access in the Basin:

Otter Creek Basin Redevelopment Project - Vergennes

In 2003, the City of Vergennes obtained a Scenic Byways Grant and additional funding from Green Mountain Power to plan for the redevelopment of the "Otter Creek Basin" (in Vergennes). The redevelopment of this historic area is designed to improve access to the area for recreational purposes. Improvements on both the west shore and east shore are planned. Otter Creek West Shore City Park is located off Mechanic Street. Redevelopment efforts for this specific park area include the construction of new sidewalk, landscaping, picnic benches, signage, and handicap accessible restrooms. East Shore redevelopment requires the removal of chain-link fencing, overgrown vegetation, and antiquated utility stairs to make way for construction of a new stairway and walking path, parking lot improvements, a canoe landing, signage, landscaping, and the addition of a crosswalk on Vermont Route 22A. Many of the West Shore improvements are complete, while construction of the East Shore access is underway as of the writing of this Plan.

Vermont Department of Fish and Wildlife Access Areas

There are dozens of federal, state and locally managed fishing access areas to the Otter Creek tributaries, the Otter Creek mainstem and many lakes and ponds throughout the Basin. The following is a complete list of fishing access areas maintained by the Vermont Department of Fish and Wildlife in the Otter Creek Basin:

Otter Creek Mainstem (town)

- Otter Creek WMA (Danby/ Mount Tabor)
- Pomainville WMA (Pittsford)
- Route 73 (Sudbury)
- Brandon Swamp WMA (Brandon)
- Cornwall Swamp WMA (Cornwall)
- Lower Otter Creek WMA (Ferrisburgh)
- Fort Cassin (Ferrisburgh)
- Otter Creek (Weybridge)

Otter Creek sub-basins (waterbody and town)

- Star Lake WMA (Mill River, Mount Holly)
- Tinmouth Channel WMA (Clarendon River, Tinmouth)
- Chittenden Reservoir (East Creek, Chittenden)
- Richville Pond (Lemon Fair River, Shoreham)
- Lake Dunmore (Leicester River, Salisbury)
- Dead Creek WMA (Addison, Panton and Bridport)
- Lemon Fair WMA (Bridport)
- Lewis Creek WMA (Ferrisburgh, Starksboro)

- Little Otter Creek WMA (Ferrisburgh)
- Winona Lake (also known as Bristol Pond, Lewis Creek, Bristol)
- Cedar Lake (Lewis Creek, Monkton)

The Green Mountain National Forest

There is virtually unlimited access to surface waters in the Green Mountain Forest for the purposes of fishing, swimming, and even boating on Otter Creek tributaries and ponds within the Green Mountain National Forest portion of the Otter Creek Basin. An incomplete list of these surface waters identified for fishing includes the following:

Table 2-2. River and Stream Fishing Areas featured within the Green Mountain National Forest of the Otter Creek Basin

Waterbody	Tributary	Road access	Species Present
New Haven River		Forest Road 201	Brook Trout
Middlebury River	Alder Brook	Forest Road 68	Brook Trout
Middlebury River	North Branch	Forest Road 235	Brook Trout, Brown Trout
Middlebury River	South Branch and Middle Branch	Forest road 214	Brook Trout
Leicester River	Goshen Dam	Forest Road 32	Brook Trout
Neshobe River	Brandon Brook	Route 73	Brook Trout, Rainbow Trout, Brown Trout
East Creek	Chittenden Reservoir: (Dam Road)	Dam Road	Walleye, Yellow Perch, Largemouth Bass
Upper Otter Creek	Mt Tabor Brook	Forest Road 10	Brook Trout, Brown Trout
Upper Otter Creek	Big Branch Brook	Forest Road 10	Brook Trout, Brown Trout
Mill Brook	Wallingford Pond	Forest Road 20	Smallmouth Bass, Chain Pickerel, Yellow Perch, and Sunfish

Chapter 3 -- Strategies to Address Priority Waters (Restoration and Protection)

This chapter provides the status of surface waters in the Otter Creek and related strategies to address restoration and protection actions.

- Identifying and Restoring Impaired Waters in the Otter Creek Basin
- Strategies to Restore Impaired Waters (e.g., *E. coli* sediments, nutrients, stormwater)
- Strategies to Address Specific Concerns and Geographic Areas in the Otter Creek
- Strategies for Stressed Waters including Waters in Need of Further Assessment
- Strategies for Waters in Need of Greater Protection
- Classification of surface waters

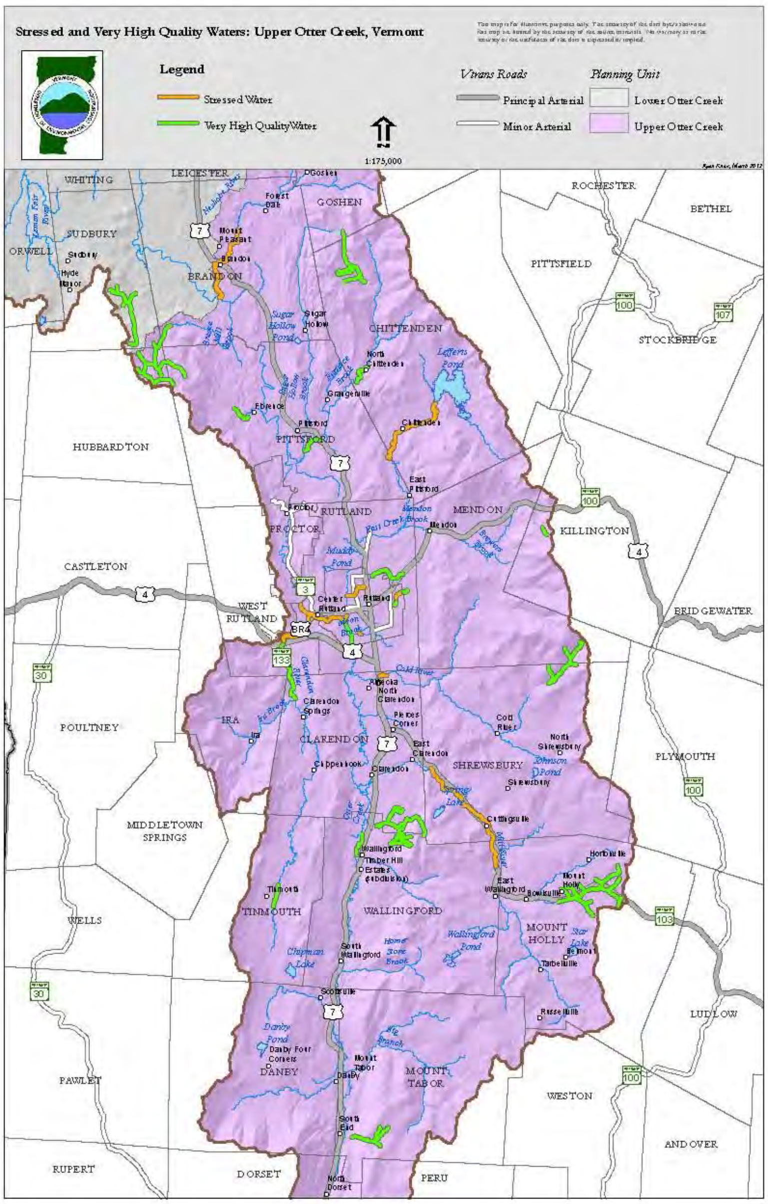

Figure 5. Stressed and Very High Quality Waters in the Upper Otter Creek Basin

These maps (figures 5 and 6) present both "stressed waters[7]" as well as waters that are significantly above Class B criteria thresholds. Specific waters discussed in the following chapter reflect the known conditions of various waters and recommendations for their management.

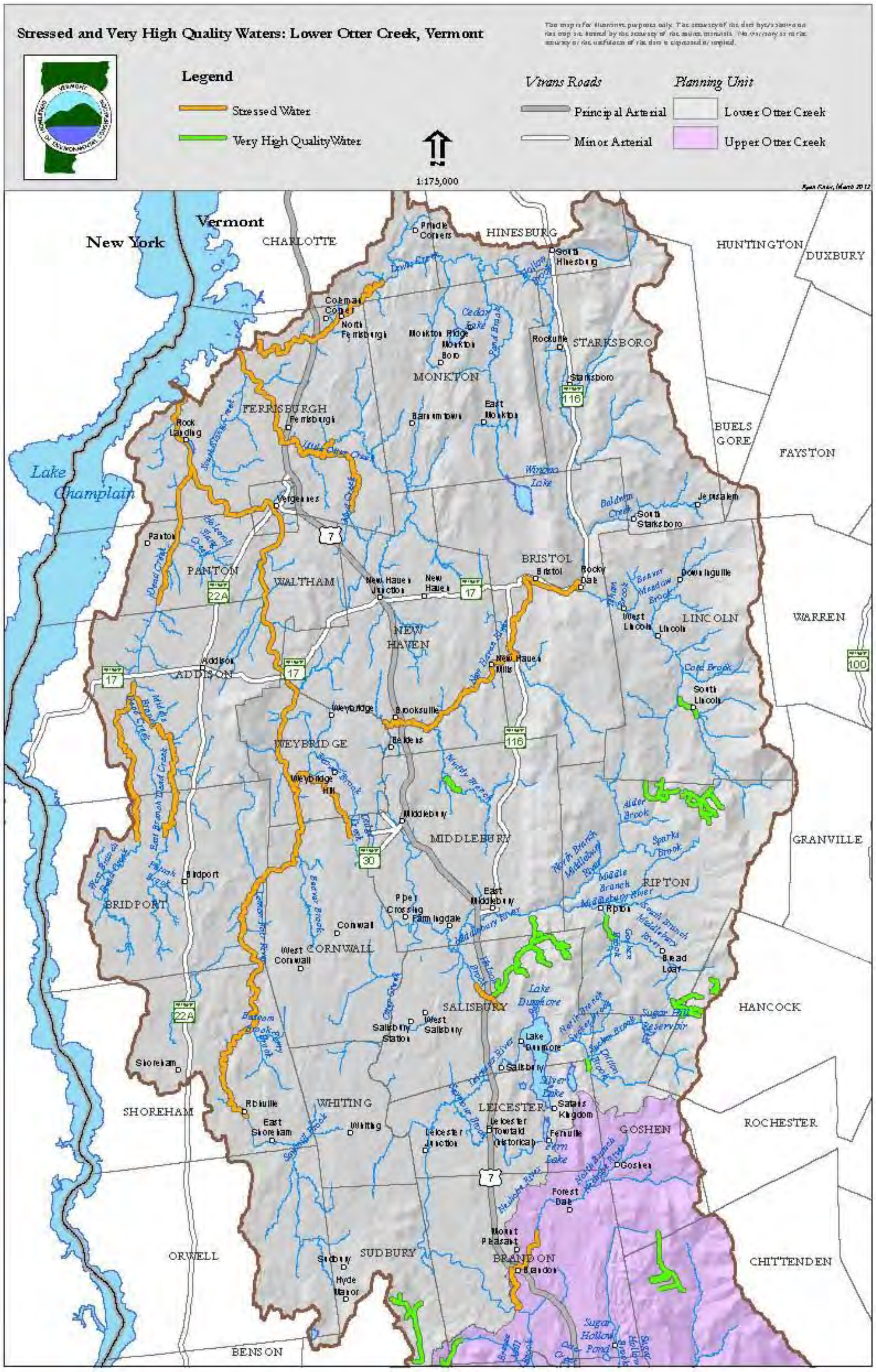

Figure 6. Stressed and Very High Quality Waters in the Lower Otter Creek Basin

[7] "Stressed" waters are those where surface water quality and/or aquatic habitat at risk or somewhat diminished, but standards are met.

Identifying and Restoring Impaired Waters in the Otter Creek Basin

Using monitoring and assessment data, many waterbodies within the Otter Creek Basin have been identified as not meeting Vermont Water Quality Standards by the Agency of Natural Resources. The Otter Creek Basin was evaluated in the 2002 Lake Champlain Phosphorus TMDL as requiring significant total phosphorus load reductions. The Otter Creek watershed was one of the top three watersheds in the State targeted for substantial phosphorus reduction. The 1991 phosphorus load to Lake Champlain from Otter Creek was 121.7 metric tons/year (Lake Champlain Diagnostic-Feasibility Study). The point source contribution was 62.8 metric tons/year and non-point source contribution was 58.9 metric tons. A decrease of 14.76 metric tons per year of NPS runoff and ~51 metric tons per year on point sources was determined to be necessary to meet the phosphorous reduction goals set in the 2002 Lake Champlain Phosphorous TMDL (Table 11, p.37). At present, the point source total phosphorus load from the Otter Creek to Lake Champlain has been reduced by 4.3 metric tons per year – a substantial achievement.

In addition the Otter Creek Basin features several surface waters on Vermont's 2010 303 (d) List of Impaired Waters. Sedimentation and nutrient enrichment are the primary causes of these water quality impairments in the Otter Creek Basin. To address this, many of the important tributaries to the Otter Creek have been assessed and monitored for their geomorphic, water quality, and biological condition, and more data is available to direct resources towards watershed improvement initiatives. Table 3-1 shows the list of impaired waters in the Otter Creek Basin.

Table 3-1. List of Impaired Waters in the Otter Creek Basin (2010 EPA approved 303(d) List, Part A)

Part A. Waters appearing below have documentation and data indicating impairment and do not meet VT Water Quality Standards according to the methodology described in the Vermont Surface Water Assessment and Listing Methodology. Required or needed pollution controls have yet to be fully implemented and further pollutant loading determinations (i.e. TMDLs) are necessary - unless remediation will be completed prior to the scheduled TMDL.

Waterbody ID	Segment Name/ Description		Pollutant(s)	Use(s) Impaired	Surface Water Quality Problem(s)	TMDL Completion Priority
VT03-01	01	OTTER CREEK, MOUTH OF MIDDLEBURY RIVER TO PULP MILL BRIDGE (4.0 MI)	E. COLI	CR	AGRICULTURAL RUNOFF, POSSIBLE FAILED SEPTIC SYSTEMS	H
	02	LOWER OTTER CREEK, BELOW VERGENNES WWTF (APPROX 7 MILES)	E. COLI	CR	PERIODIC & RECURRING OVERFLOWS AT LAGOONS OF WWTF; PARTIALLY TREATED	L
VT03-05	01	OTTER CREEK, VICINITY OF RUTLAND CITY WWTF	E. COLI	CR	RUTLAND CITY WWTF COLLECTION SYSTEM PASSES CSOs	L
VT03-07	01	LITTLE OTTER CREEK, MOUTH TO RM 7.8	E. COLI, UNDEFINED	ALS, CR	ELEVATED E. COLI MONITORING RESULTS, AGRICULTURAL RUNOFF	H
	02	LITTLE OTTER CREEK, RM 15.4 TO RM 16.4	E. COLI, UNDEFINED	ALS, CR	AGRICULTURAL RUNOFF	H
VT03-08	01	LEWIS CREEK, FROM LOWER COV'D BRIDGE UPSTRM TO FOOTBRIDGE (12.3 MI)	E. COLI	CR	AGRICULTURAL RUNOFF	H
	02	POND BROOK, FROM LEWIS CREEK CONFLUENCE UPSTREAM (1.5 MILES)	E. COLI	CR	AGRICULTURAL RUNOFF	H
VT03-12	01	MIDDLEBURY RIVER, FROM MOUTH UPSTREAM 1 MILES	E. COLI	CR	AGRICULTURAL RUNOFF, LIVESTOCK, POSSIBLE FAILED SEPTIC SYSTEMS	H
VT03-14	01	EAST CREEK, MOUTH TO 0.2 MI (BELOW CSO DISCHARGE PTS #2 AND #9)	E. COLI	CR, AES	RUTLAND CITY COLLECTION SYSTEM CSO	L

Specific Strategies to Restore Impaired Waters

All waters listed in this section are assessed as "impaired" and require the development of a TMDL as described in 40 CFR 130.7. Impaired waters that do not need a TMDL (Part B of Section 303(d)) are those where other pollution control requirements (such as best management practices) required by local, state or federal authority are expected to address all water-pollutant combinations and the Water Quality Standards are expected to be attained in a reasonable period of time. These waters correspond to Category 4b of EPA's Consolidated Assessment Listing Methodology.

E. coli Bacteria

There are five individual waterbodies that are considered to be impaired[8] by *E. coli* (an indicator of the potential presence of pathogenic bacteria) within the Otter Creek watershed: Lewis Creek, Little Otter Creek, Middlebury River, East Creek, and the Otter Creek itself (VTDEC, 2010).

The primary indicator of fecal material in water used in most freshwater monitoring efforts is *Escherichia coli* (i.e., *E. coli*). Since *E. coli* is a constituent found in the intestines of humans and other warm-blooded animals, when found in rivers, lakes, ponds, streams, or drinking water, it means that somehow fecal material has made its way into the water. *E. coli* is therefore used as an indicator of potential fecal contamination of the water.

GOAL: To identify surface waters with regular or episodic elevations of *E. coli* and disseminate this information to the public.

Objectives (Listed from highest priority)

1. Determine locations of chronically elevated levels of E. coli in surface waters (with regular or episodic elevations) and make these results public.

   <u>Strategies:</u>

Identify public swimming beaches at lakes and ponds (either municipal swimming areas or state parks and other public lands). Work with communities, lake and pond associations, and others who are testing for indicators of pathogens and other health threats.

   a. Develop a database for public notification and information regarding water quality monitoring efforts in the basin, specifically how it relates to contact recreation associated with state parks, public beaches and access areas.
   b. Analyze *E. coli* samples according to VTDEC monitoring protocols.
   c. Where possible, conduct sanitary surveys to aid in the determination of whether the pollutant(s) causing the condition is a result of an illicit discharge and not of natural origin.

   Additional Strategies (as per the Middlebury River Improvement Plan)

   d. Supplement data by conducting intensive sampling within impaired sections (e.g. “bracket” suspected contribution areas to ID CSA’s).
   e. Supplement existing data by collecting seasonal sampling over the course of a year.
   f. Connect and communicate with watershed residents.
   g. Post *E. coli* data at popular swimming holes.

2. Eliminate sources of *E. coli* where possible where possible and find solutions for ongoing problem areas that contribute high levels of *E. coli*, as indicators of pathogens.

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[8] A waterbody (i.e., stream reaches, lakes, waterbody segments) is considered “impaired” with chronic or recurring monitored violations of the applicable numeric and/or narrative water quality criteria. An important piece of information required in order for a water to be listed as impaired is the determination that the pollutant(s) causing the condition is a result of human activity and not of natural origin. The pollutant becomes the basis for loading determinations and TMDL development or for the control measures to be implemented. DEC attempts to be as accurate as possible as to causal pollutant determination. Where appropriate, DEC subscribes to EPA’s Stressor Identification Methodology (USEPA, 2000b). In the absence of EPA’s Stressor Identification Methodology or pollutant data, DEC may use biological assessment indicators (refer to previous chapter on biocriteria and biomonitoring) to identify by inference most probable causal pollutants or stressors.

Strategies:

Develop a monitoring program in the Otter Creek basin that will enumerate *E. coli* levels at informal and public swimming holes in the basin. This monitoring program is intended to be used as a routine monitoring tool at swim areas to detect an episodic increase in bacteria levels. Results from such a monitoring program will be used as public notification and information for decision-making for contact recreation activities.

a. Identify the relative abundance of pathogens from human and animal sources. Conduct microbial tracking studies to determine the predominance of certain species' contributions.
b. Analyze land use in the impaired section and correlate changes in land use with *E. coli* data. Through bracketed monitoring, investigate areas indicating high *E. coli* to determine the sources.
c. Analyze lands where agricultural wastes are currently being applied and
    i. Identify sensitive areas that should be avoided,
    ii. Fencing livestock out of surface waters should greatly curtail the amount of pathogens entering surface waters. Livestock should be pastured and excluded as far from surface waters as possible, and should use bridges to cross tributaries wherever possible.

3. Conduct a sanitary survey for domestic wastewater.

Middlebury River (E. coli)

The Middlebury River originates on the western slopes of the Green Mountains as the Middle Branch and South Branch in the towns of Ripton and Hancock. The Middle and the South Branches flow westerly from their origins and join in the village of Ripton forming the Middlebury River. The river flows westerly in a steep, narrow valley paralleled by Route 125. It comes out of the foothills into the Champlain Valley near East Middlebury then meanders generally west entering the Otter Creek upstream of the former Three Mile Bridge.

The Middlebury River appears on the 2010 303(d) List of Impaired Waters (Part "A") for *E. coli* due to agricultural runoff, livestock access to the river, and possible failed septic systems that affects recreation from the mouth upstream approximately two miles. Additionally, stressors to aquatic biota and aesthetics have been identified from the mouth of the Middlebury River upstream approximately four miles due to nutrient enrichment, turbidity, sedimentation, and habitat alterations due to erosion of streambanks from flooding and agricultural land uses (crop production, animal waste management and cattle in and around the river causing erosion). Also, stressors to the coldwater fishery have been identified due to elevated temperatures.

Middlebury River Watershed Improvement Plan[9]

The Middlebury River Watershed Partnership, a group of natural resource professionals, business owners, landowners, and watershed coordinators, developed the "Middlebury River Watershed Improvement Plan" in 2001 based on strategies for reducing *E. coli* levels and to assist communities in determining the most effective implementation of these strategies. Members of the Middlebury watershed community prioritized these strategies according to public acceptability, feasibility, and likely effectiveness. Recently, resource professionals have been targeting more aggressive implementation of agricultural practices in the lower reaches of the Middlebury River, in response to agricultural runoff associated with flooding in early 2011.

[9] Lescaze, Miranda, 2001. Middlebury River Watershed Water Quality Improvement Plan. OCNRCD.

The South Branch of the Middlebury River appears on the 2010 List of Priority Surface Waters (Part "F" – waters altered due to flow regulation), where aquatic habitat has been altered due to artificial flow regulation caused by insufficient flow below the Middlebury Snow Bowl as a result of water withdrawal for snowmaking operations.

Another tributary to the Middlebury River, Halnon Brook, is considered "stressed" due to permitted discharges with elevated organic enrichment from the VDFW Fish Hatchery in Salisbury. Total phosphorus levels in the stream are elevated, presumably due to the discharge from the hatchery. At the lower sampling location in the tributary the macroinvertebrate population fails to meet Class B water quality standards. The Department of Fish and Wildlife is currently conducting a feasibility evaluation to identify treatment options for phosphorus in the hatchery outflow.

Little Otter Creek (E. coli – Agricultural sources)

The Little Otter Creek rises in the towns of Bristol and New Haven in Addison County and drains an area of approximately 70 square miles. The creek is a slow meandering creek for much of its length with the exception of a couple of short waterfalls and bedrock controlled runs along a couple of reaches. Land use in the watershed is composed of a mix of agricultural, forest and urban land, and has been identified as a significant contributor of phosphorus to Lake Champlain given its relative watershed size. The watershed extends from the relatively level Champlain Valley plains in the west to the forested slopes of the foothills of the Green Mountains in the east (Meals et al, 2006).

Two sections of the Little Otter Creek appear on the 2010 303(d) List of Impaired Waters due to agricultural runoff that affect aesthetics, aquatic life support, and recreation from the mouth upstream approximately 9 miles as well as a second impaired section that occurs upstream from the confluence with Mud Creek, between river mile 15.4 and 16.4. These designated uses are considered "impaired" due to nutrient enrichment, siltation, turbidity, and pathogens from agricultural land uses and eroding streambanks. In addition, fish consumption, especially walleye, from the Little Otter is considered impaired from its mouth upstream 1 mile due to atmospheric deposition. Mud Creek, a tributary to the Little Otter, is considered "stressed" due to nutrient enrichment, siltation, and pathogens from agricultural land uses and eroding streambanks.

In the Little Otter Creek watershed, data were collected from two water-quality monitoring stations - one upstream from a 77-hectare dairy farm, and one downstream from the farm. Results from the Little Otter Creek assessment of agricultural BMPs showed annual loads of phosphorus at the downstream monitoring station were significantly larger than loads at the upstream monitoring station, and annual loads of suspended sediment at the downstream monitoring station were larger than loads at the upstream monitoring station for 4 out of 6 years.[10] Monitoring is ongoing to assess the phosphorus and sediment reductions associated with best management practice implementation that occurred in this project area beginning in 2007.

Stormwater

In urban stormwater-impaired streams, the number and scope of stormwater best management practices (BMPs) required to meet the Total Maximum Daily Limit (TMDL) flow reduction targets in these watersheds will be significant. The associated costs will be high and both public and private resources are limited. There is limited environmental data and scientific uncertainty as to the extent of the work necessary and the timing as to when remediation targets will be met, and differing opinions on the efficacy of proposed BMPs to achieve water quality standards. To increase the efficiency in evaluating these watersheds, a BMP modeling tool that considers type, sizing, and placement and produces results that can be compared to the TMDL targets is being developed. This modeling tool is

[10] Medalie, Laura, 2007, Concentrations and loads of nutrients and suspended sediments in Englesby Brook and Little Otter Creek, Lake Champlain Basin, Vermont, 2000–2005: U.S. Geological Survey Scientific Investigations Report 2007–5074,

the Vermont BMP Decision Support System (VT BMP DSS). The VT BMP DSS will help to evaluate where the implementation of stormwater treatment and control will result in the greatest improvements on the flow regime, and ultimately the water quality in stormwater impaired watersheds.

The Agency has been undertaking various projects to collect information to aid in the development of TMDL Implementation Plans (for stormwater impaired streams) and in monitoring to assess the success of the plan as it is implemented and make necessary adjustments to the implementation plan. These projects include stream geomorphic assessment, subwatershed mapping, flow gaging and precipitation monitoring, impervious surface mapping and engineering feasibility assessment

Goal: Reduce stormwater runoff from urban and developed areas within urban tributaries of the Otter Creek Basin. Reduce stormwater pollutants that enter surface waters from urban and residential areas.

Objectives (Listed from highest priority)
Increase construction contractor, developer, municipality and landowner awareness regarding construction site best management practices.

Strategies

Provide training and assistance to municipalities, developers, and landowners on complying with the Erosion Prevention and Sediment Control (EPSCs) guidelines for development to ensure they are implemented and maintained to lessen land use impacts to river stability by minimizing stormwater runoff.
Lead Agencies: VDEC, NRCDs, municipalities
Funding options: DEC staff time, VT Watershed grants, municipal budgets, private foundations
Timeline: 2011-2015

Conduct erosion control workshops for area contractors/developers. Hold a suite of best management practice workshops for municipal officials and landowners in the basin.
Lead Partner(s): DEC, AGC, NRCDs
Potential Funding Sources: NA
Timeline: 2011-2015

Encourage the implementation of stormwater BMPs where stormwater has an impact on surface waters.
Lead Agencies: NRCDs, RPCs, VDEC,
Funding options: VT Clean & Clear, CWA Sec. 319 grants, Vermont Watershed grants
Timeline: 2011/ ongoing

Provide training for development professionals on stormwater management techniques.
Lead Agencies: NRCDs, VDEC, VTrans
Funding options: workshop fees, VT Ecosystem Restoration program, CWA 319 grants
Timeline: 2011/ On-going

Provide education on the effects of development in the watershed and on the value of the working landscape.
Lead Partner(s): DEC, RPCs, NRCDs, Rutland Area Farm and Food Link Program
Potential Funding Sources: NRCD & DEC staff time
Timeline: Ongoing

Objective: Assist municipalities in implementing stormwater management practice implementation and outreach efforts.

Strategies

Assist municipalities with comprehensive town plans and zoning regulations that address erosion prevention and sediment control from construction sites under 1 acre in size. Assist towns with incorporating of goals, strategies and standards that protect water quality into municipal plans and zoning regulations.

Lead Partner(s): DEC, watershed RPCs, VLCT, and municipal officials
Potential Funding Sources: 604(b) grants, DFPR Urban and Community Forestry Program, DEC and VLCT staff time
Timeline: 2011-2015

Approach land development within the context of the smaller subwatershed. Assist municipalities in targeting sensitive areas for protection and allowing for greater density in less sensitive areas. Encourage growth center planning.

Lead Partner(s): VHCA, DEC, RPCs, VLCT, and municipal officials
Potential Funding Sources: 604(b) grants, DFPR Urban and Community Forestry Program, DEC and VLCT staff time
Timeline: 2011-2015

Consider the watershed capacity limits of existing water resources when planning development projects.

Lead Partner(s): DEC, RPCs, VLCT, and municipal officials
Potential Funding Sources: 604(b) grants, Ecosystem Restoration Program, DEC and VLCT staff time
Timeline: 2011-2015

Consider hydrology, soil type and erodibility in planning and zoning regulations.

Lead Agencies: Act 250 Environmental Commissions, RPCs, VLCT, municipal planning commissions
Funding options: 604(b) grants
Timeline: On-going

Objective: Educate the community and provide incentives for implementing urban stormwater best management practices (BMP).

Strategies

Provide residential BMP education that is effective in helping the community adopt the practices. Provide incentives and identify barriers to behavior change. Incentives to continued use of a behavior may include celebrating successful community efforts. Demonstration sites showing the use of rain barrels or other practices helps to provide additional information about installation or effectiveness.

Lead Partner(s): DEC, watershed NRCDs, Lake Champlain Sea Grant, and municipal officials
Potential Funding Sources: EPA pass through, LCBP grants, Lake Champlain Sea Grant Program, DEC and NRCD staff time
Timeline: 2011-2015

Collect data that is specific to a community regarding its impact to water quality to help design effective educational programs, e.g., survey the community about water quality awareness, collect soil sample data to educate people about need for phosphorus application to lawns.

Lead Partner(s): DEC, watershed NRCDs, Lake Champlain Sea Grant
Potential Funding Sources: EPA pass through, LCBP grants, Lake Champlain Sea Grant Program, DEC and NRCD staff time
Timeline: 2011-2015

Encourage landscaping that enhances infiltration of stormwater and reduces export of pollutants such as fertilizer and pesticides. Examples include installation of rain gardens, low input lawn care, protection and enhancement of forest cover.

Lead Partner(s): DEC, watershed NRCDs, Lake Champlain Sea Grant
Potential Funding Sources: EPA pass through, LCBP grants, Lake Champlain Sea Grant Program, DEC and NRCD staff time
Timeline: 2011-2015

Impervious Surface Minimization and Site Design

Impervious surfaces are surfaces which cannot be effectively penetrated by water. Examples include pavement, buildings, and gravel surfaces. There is a direct link between impervious surface coverage and phosphorus export to surface waters. Replacing natural cover and soils with impervious surfaces will lead to greater phosphorus loading (as well as other pollutants) to surface waters, increased runoff volume and velocity, and long-term, adverse hydrologic changes through flooding and channel erosion. Pavement areas such as streets, driveways, and parking lots, produce the most serious phosphorus runoff potential. Commercial, industrial, and high-density residential land uses often contain the most impervious surfaces used by vehicles.

Careful site planning can reduce the impervious area created by pavement and roofs and the volume of runoff and phosphorus loading. Careful site planning can also preserve the natural topography, drainage, and vegetation by preserving intact as much as possible the natural features that help retain runoff. Natural depressions and channels act to slow and store water, promote sheet flow and infiltration, and filter out phosphorus-bearing sediment.

Zoning codes and development standards affect the amount of runoff generated by projects by defining street widths, housing densities, setback distances, and other factors. Development standards should encourage minimization of impervious surfaces and use of open vegetated channels for stormwater runoff. Provisions for narrower streets, shorter or shared driveways, smaller parking spaces, and reduced setback distances from roads should be part of urban or suburban zoning regulations. Alternative modes of transportation such as mass transit, bike paths, and commuter parking areas should also be encouraged in order to reduce the need for new roads and parking.

Towns can use subdivision regulation standards to minimize the creation of new impervious surfaces. Planned unit developments that concentrate development while maximizing open space and Green Infrastructure should be encouraged. Open space preservation should maximize natural surface water corridors, buffers, and infiltration assets. Existing parking ratio requirements should be reviewed to see if lower minimum ratios are warranted and feasible. Maximum parking ratios should be established in order to curb excess parking construction. The initial subdivision proposal should ensure that lots with difficult access are not created.

Low Impact Development

Low Impact Design (LID) reduces stormwater impacts by mitigating stormwater runoff and reducing impervious areas, enhancing natural runoff storage and runoff diversion areas, and maximizing existing vegetation and buffer areas. The primary goal of Low Impact Development methods is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and detain runoff. Use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. By mimicking natural hydrological processes around home and business, LID techniques help minimize runoff and maximize infiltration. The ANR has published a website on LID and incorporation of Green Infrastructure into development projects. See: http://www.vtwaterquality.org/stormwater/htm/sw_green_infrastructure.htm

Objective:
Development standards should encourage minimization of impervious surfaces and use of open vegetated channels for stormwater runoff.

By mimicking natural processes on developed lots, we can minimize runoff and maximize infiltration. Controlling runoff closer to its source (ex: rooftops, driveways, roadways, parking lots) and directing it to vegetated areas can reduce its overall volume, the distance it travels, and the amount of pollutants it collects. The net result is fewer contaminants entering our lakes, rivers, and streams.

Benefits of LID to the environment:

- Maintains natural hydrology
- Maintains stream flows and water levels in wetlands
- Protects streams and fish and wildlife habitat from high storm flows
- Reduces pollution in runoff
- Preserves and restores trees and other vegetation

Benefits of LID to homeowners and developers:

- Reduces flooding and protects property
- Protects drinking water supplies
- Provides new options for site layout, stormwater facilities, and recreation.
- Reduces building costs for stormwater management
- Results in more attractive neighborhoods and can increase market demand
- Reduces stormwater utility fees

Objective: Investigate, provide education on and promote low impact development solutions.

<u>Strategies</u>

Implement demonstration projects using various practices to illustrate and teach about their use including raingardens, swales, sediment basins and ponds.

Lead Partner(s): DEC, NRCDs, developers, contractors, landowners and municipal officials
Potential Funding Sources: EPA 319, Ecosystem Restoration, Watershed Grants
Timeline: 2011-2015

Promote residential stormwater BMPs to local landowner (including lake and watershed) associations, such as rain gardens and small onsite retention ponds.

Lead Partner(s): DEC, NRCDs, RPCs, developers, contractors, landowners and municipal officials
Potential Funding Sources: EPA 319, Ecosystem Restoration, Watershed Grants
Timeline: 2011-2015

Create an outreach program for landowners, contractors, and municipalities that are about to embark on construction projects covering erosion and sediment control site plans, necessary permits, Low Impact Development (LID) practices, and technical assistance that may be available for such projects.

Lead Partner(s): DEC, AGC, NRCDs, developers, contractors, and landowners and municipal officials
Potential Funding Sources: EPA 319, Ecosystem Restoration, Watershed Grants
Timeline: 2011-2015

Implement the recommendations that are promoted in the Rutland City Urban Tree Canopy Assessment Report
Lead Partner(s): Rutland City, DEC, NRCDs, developers, contractors, landowners and municipal officials from surrounding towns (Rutland Town)
Potential Funding Sources: EPA 319, Ecosystem Restoration, Watershed Grants
Timeline: 2011-2015

Acid deposition in the Green Mountain National Forest

Numerous ponds and stream sections within the proclamation boundary of the GMNF were classified as “impaired” by the VTANR (Table 3-2) due to anthropogenic acidification. Green Mountain National Forest management does not contribute to these water quality problems in that the source of the pollution is emissions from distant facilities. Other stream sections outside national forest ownership had water quality problems more readily linked to specific local problems such as low flows, excessive erosion, or toxic substances.

The acid deposition problem in Vermont, and in New England, is responsible for acidification of lakes and streams to the point of rendering some of them incapable of supporting aquatic life. In addition, poor air quality associated with acidic deposition may: impair visibility in our national forest, cause respiratory problems in people, and degrade monuments and buildings. To address acidification effects in Vermont, ANR has promulgated a TMDL for acidified lakes (2003) that determines annual loading limits for 30 of the 37 acid impaired waters. Through regulation under the Clean Air Act Amendments of 1990, sulfur dioxide emissions have declined and nitrogen oxide emissions remain level (EPA, 1999). Improvements have occurred, but there is still much work to be done to totally eliminate the harmful effect of acid deposition on New Englands’ rivers, lakes, and forests.

Table 3-2. Table of acid deposition impaired ponds in the Green Mountain National Forest

Basin 3 - 2010 303(d) List of Impaired Waters – due to acid deposition			
Stream/Pond Name	**Status**	**Watershed Name**	**Water Quality Problem**
Big Mud Pond	EPA APPROVED TMDL SEPTEMBER 30, 2003	**Big Branch Brook**	acid deposition
Griffith Lake		**Big Branch Brook**	acid deposition
Little Mud Pond		**Big Branch Brook**	acid deposition
Long Hole Pond		**Big Branch Brook**	acid deposition
Gilmore Pond		**New Haven River**	acid deposition
North Pond		**New Haven River**	acid deposition

Specific Concerns and Associated Geographic Areas in the Otter Creek

All waters identified in this section have been identified as stressed by local organizations through monitoring and assessment efforts and documented through an EPA approved quality assurance project plan (QAPP). Some of these waters also appear on the List of Priority Waters developed by DEC as being “stressed” as defined by the Consolidated Assessment and Listing Methodology.

Baker Brook (E. coli and nutrient enrichment)

Baker Brook is a relatively small drainage basin to the Upper Otter Creek, located in the Town of Danby in Rutland County. Baker Brook drains predominantly agricultural lands in the headwaters located north and east of Danby Pond. UOCWC monitoring has identified Baker Brook as exhibiting high levels of *E. coli* and nutrient enrichment, possibly as a result of agricultural activity. Agricultural resource specialists have been encouraging agricultural operators in this area to adopt agricultural best management practices through cost share incentives and programs designed to address agricultural impacts to water quality.

East Creek (low dissolved oxygen levels and hydro-modification)

East Creek originates in the town of Mendon and flows northwesterly into Lefferts Pond and Chittenden Reservoir. From Chittenden Reservoir, it flows southwesterly then southerly through Chittenden, the eastern edge of Pittsford and into Rutland Town. It flows westerly then southerly through Rutland Town and finally Rutland City before entering Otter Creek

East Creek experiences episodic events that deplete dissolved oxygen as a result of hydro-electric operations, whereby deep oxygen-poor water is withdrawn from Chittenden Reservoir during generation flows, resulting in low dissolved oxygen in a reach of East Creek. As shown in Figure 3-3, dissolved oxygen drops precipitously as water used for hydro-electric generation is discharged back into East Creek where it was withdrawn from the hypolimnion of Chittenden Reservoir and bypassed via aqueducts to the power station. Recent dissolved oxygen monitoring in East Creek has confirmed episodic periods where the East Creek bypass waters are affected by diminished dissolved oxygen levels prior to re-entering the East Creek mainstem.

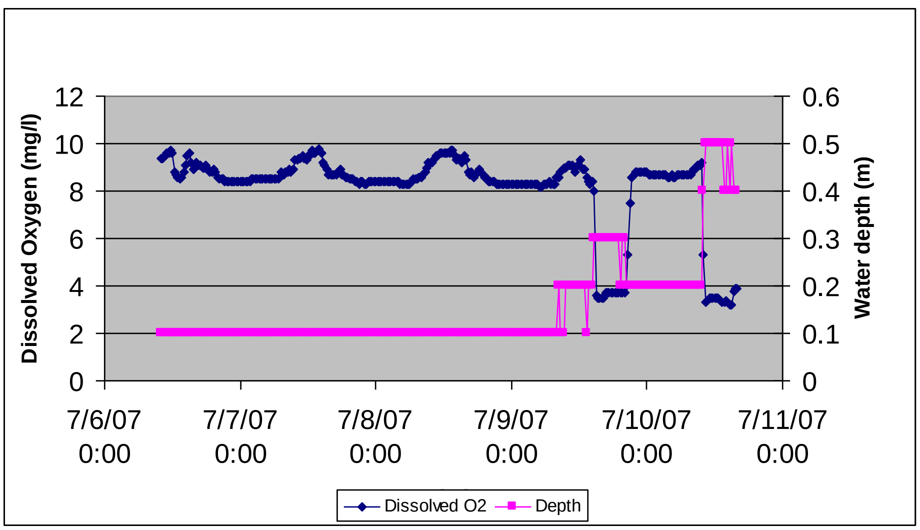

Figure 7. DO monitoring on East Creek shows DO depletion during hydro-power generation as dissolved oxygen depleted from Chittenden Reservoir waters re-enter East Creek. Increases in depth in the bypass reach indicate generation flows.

New Haven River (river instability – geomorphological assessment)

The New Haven River watershed is a flashy watershed, responding quickly to rain and snowmelt events. Several flood events have impacted the basin with the 1927 flood being the one of largest magnitude. However, recent flood events continue to cause significant fluvial erosion and associated damage. As a result, communities in the New Haven and Middlebury River watersheds have embarked on river corridor planning in order to identify and mitigate fluvial erosion hazards that will ultimately lessen sediment inputs and changes in hydrology.

The headwaters of the New Haven River flow down the slopes of Bread Loaf Mountain, Mt. Cleveland and Mt. Grant in Ripton and Lincoln. The New Haven River flows northwesterly through the villages of South Lincoln, Lincoln, and West Lincoln before turning west for a short stretch in the valley through the town of Bristol. In Bristol, the river turns abruptly south and flows in a southwesterly direction through Bristol flats where a great deal of instability causes the river to adjust through mostly agricultural land and Route 116 that runs close to the river in places. The river continues southwesterly to New Haven Mills and Brooksville before joining the Otter Creek. The New Haven River has a drainage of 116 square miles and is approximately 25 miles long. It is the largest tributary to the Otter Creek.

The New Haven River is considered "stressed" as a result of sedimentation and aquatic habitat alterations from the Weybridge town line upstream to the town of Bristol due to morphological instability. In particular, aquatic habitat, secondary contact recreation, and aesthetics are considered "stressed" due to sedimentation and nutrients from streambank erosion, channel instability along certain reaches, and agricultural land uses (crop production and agricultural waste management). ANR continues to support monitoring of E., coli bacteria in the New Haven due to occasionally elevated levels of pathogenic bacteria from the mouth of the river upstream to Lincoln, approximately 13 miles.

Biological monitoring by Vermont DEC biologists was conducted on the Muddy Branch of the New Haven River in 2001. The fish community at river mile 3.3 was in good condition and the macroinvertebrate community at the same site had an excellent-very good assessment for community health and integrity. Biological monitoring data from the mainstem also indicate good to very good conditions based on macroinvertebrate sampling.

While the New Haven River is still regarded as an excellent coldwater fishery, there continues to be concerns over periodic flood events that lead to geomorphic instability. In particular, ongoing adjustment processes along lower reaches of the river through Bristol Flats threaten transportation infrastructure and cause significant property losses and economic hardship for property owners along these lower reaches.

This condition is exacerbated by road infrastructure that is often located in close proximity to these streams. The damaging weather patterns experienced during the summer of 2008, and spring and fall of 2011 demonstrated how susceptible these streams can be to planform adjustment and subsequent damage to public and private property adjacent to these dynamic river systems as well as aquatic systems.

Data are not sufficient to know with certainty whether (and to what extent and in what locations) a given change in the water or sediment inputs to a river corridor will cause the channel to incise or aggrade, widen or shift its planform. However, influences on the hydrology (e.g., past and present river modification activities) of the New Haven River watershed have been identified as a possible contributor(s) to channel disequilibrium, through a review of existing Phase 1 and Phase 2 stream geomorphic data (SMRC, 2004).

Strategies for Stressed Waters and Waters in Need of Further Assessment

All waters appearing in this section are assessed as "stressed" or have been identified as "stressed" but needing further assessment to confirm the presence of a violation of one or more criteria of the Vermont Water Quality Standards. "Stressed" waters are those where surface water quality and/or aquatic habitat at risk or somewhat diminished, but standards are met. "Stressed waters in need of further assessment" are those where information or data is insufficient to confirm that standards are not met and further assessment of some kind is needed.

Table 3-3 provides a list of those waters (as of the date of this Plan) within the Otter Creek Basin that have been identified as “stressed” and/or “stressed in need of further assessment.” Detailed information about stressor impacts, management approaches, and gaps in the Division’s ability to achieve complete management are characterized in the SWMS.

Stormwater (Waters affected include lower Clarendon River and lower Tenney Brooks)

The urban streams listed on Part “C” Priority List of Surface Waters are listed as in need of further assessment. The list of suspected pollutants includes sediment, nutrients, and *E. coli* as a result of stormwater from industrial and urban runoff.

Urban streams, including the Clarendon River and Tenney Brook were moderately high in phosphorus (throughout the summer water quality monitoring seasons conducted by the Upper Otter Creek Watershed Council) with elevated levels of nutrients commonly associated with rainfall events.

In addition, these urban streams may receive fertilizer in runoff from gardens and lawns. Other urban streams showed moderately elevated levels of phosphorus, especially the furthermost downstream site on East Creek, which receives discharges from the combined sewer overflow (CSO) and the Mussey Brook, which also exhibits elevated levels of nutrients and pathogenic bacteria

Clarendon River (urban runoff, agricultural runoff)

The Clarendon River originates at Chipman Lake in the southeast corner of Tinmouth. It flows north as Tinmouth channel, a meandering stream with extensive associated wetlands, through Tinmouth becoming the Clarendon River in the town of Clarendon. It continues north to West Rutland where it then heads northeast and empties into Otter Creek.

The Clarendon River has been identified as "stressed" from its confluence with the Otter Creek upstream for 2 miles due to sediments, turbidity, nutrients, habitat alteration (i.e. stormwater and Eurasian watermilfoil infestations) from urban and agricultural runoff and aquatic nuisance plant infestations. Agricultural resource specialists have focused on the Clarendon River watershed in recent years to provide education and outreach regarding agricultural best management practices, the Accepted Agricultural Practices, and USDA-NRCS and state cost-share programs.

Table 3-3. List of Waters in the Otter Creek Basin that are Stressed and/or Stressed in Need of Further Assessment

Name	River miles affected	Pollutant(s)	Problem	se Impairment or Stresse
Lower Otter Creek	18.1	nutrient & organic enrichment, and pathogens	AGRICULTURAL RUNOFF, URBAN RUNOFF, WWTF overflows	AES, ALS, CR
Neshobe River upstream from confluence with Otter Creek	4.5	sedimentation, turbidity, and habitat modifications	Streambank erosion, ag land use, and developed land/urban runoff	AES, ALS
OTTER CREEK, FURNACE BROOK CONFL UPSTREAM TO MILL RIVER CONFLUENCE	2.0 - from East Creek confluence downstream	SEDIMENT, ORG ENRICHMENT, TOXICS, METALS	NEEDS FURTHER ASSESSMENT & MONITORING ESP. SOURCE(S)	AES, ALS, CR, 2CR, DWS
Moon Brook and Mussey Brook	Moon Brook: rm 3.3 down to pond at rm 3.0; Mussey Brook: 0.1 - upstream from mouth	Sediment, habitat alteration	Urban impacts and onstream ponds	ALS
Little Otter Creek from mouth upstream	7.8	nutrients, siltation, turbidity	Eroding streambanks and AG land use	AES, ALS
MUD CREEK, MOUTH UPSTREAM 4 MILES	4	E. COLI	AGRICULTURAL RUNOFF	AES, ALS, CR
Lewis Creek from the mouth upstream	7.3	E. COLI	AGRICULTURAL RUNOFF	CR
Dead Creek from mouth to upstream and East and West Branches	5 on Dead Creek and 7 on West Branch and 8 on East Branch	suspended solids, nutrient enrichment, pathogens, thermal modifications and	agricultural land uses (cropland erosion, waste management & grazing), streambank erosion, loss of riparian vegetation, impoundments, waterfowl	AES, ALS, CR
Lemon Fair from its mouth upstream and Ledge Creek	Lemon Fair - 20.5, Beaver Brook - 2.5, Ledge Creek - 1.0	high sediment loads and turbidity, suspended solids, nutrient & organic enrichment, and thermal modifications	Agricultural land uses (esp. ag. waste management, animal grazing, & cropland runoff), streambank erosion, and loss of vegetated buffer strips.	AES, ALS, CR
New Haven River upstream	13	E. COLI	Sedimentation and nutrients from streambank erosion, possible channel instability in some stretches and ag land uses (crop production, ag waste	AES, ALS, 2CR, CR
Halnon Brook (tributary to the Middlebury River)	1	organic enrichment	Fish Hatchery - nutrient enrichment	ALS
TRIBUTARY TO EAST CREEK		IRON	HEAVY IRON PRECIPITATE, SOURCES UNKNOWN	ALS
TENNEY BROOK, LOWEST 1 MILE		SEDIMENT, TEMP	LAND DEVELOPMENT, HYDROLOGIC MODIDIFCATION; SOURCE(S) NEED MORE ASSESSMENT; BUGS FAIR AND FISH GOOD	ALS
East Creek from its mouth upstream	0.3	SEDIMENT, TEMP, Iron Precipitate	Temperature and urban environment impacts; Tributary to East Creek:0.3- from mouth upstream - aquatic habitat/biotat and aesthetics at least stressed due to iron precipitate on channel bottom - sources need assessment	AES, ALS
EAST CREEK, FROM CHITTENDEN RESERVOIR TO 4 MILES DOWNSTREAM	4	LOW D.O.	POSSIBLE LOW DISSOLVED OXYGEN LEVELS FROM HYPOLIMNETIC WITHDRAWAL OF UNLICENSED HYDRO DAM	ALS
CLARENDON RIVER	2	SEDIMENT, NUTRIENTS, E. COLI, STORMWATER	AGRICULTURAL RUNOFF, INDUSTRIAL AND URBAN RUNOFF, River modification	AES, ALS, CR, 2CR
Cold River from railroad track to Route 7 downstream	1	Sedimentation, and habitat modifications	Streambank erosion, road and railroad track crossings, land development, channelization, and runoff from industrial and commercial lands	AES, ALS, 2CR
Mill River where it parallels Route 103	5	SEDIMENT, TEMP	Habitat alteration, increased temperatures from shallow, wide channel from dredging and channelization following floods events	AES, ALS, 2CR
Key: AES = Aesthetics, ALS = Aquatic Life Support, CR = Contact Recreation, 2CR = Secondary Contact Recreation, DWS = Drinking Water Supply				

Morphological Instability

GOAL: Encourage stream channel adjustment processes towards a stable regime by encouraging activity that is consistent with the river evolution process and at the same time, work to minimize conflicts, and balance the need to protect economic investments in infrastructure and natural processes while recognizing the dynamic equilibrium of river systems and different phases of adjustment.

Objectives (Listed from highest priority)

1. Based on geomorphic assessments of the Otter Creek, plan, design, and implement riparian restoration projects to restore the stream equilibrium and minimize erosion. Using geomorphic-based solutions, to the greatest extent possible, restore sections of major tributaries identified in stream geomorphic assessments as being unstable. See the workplan section for specific project locations

2. Expand land use practices and programs (Best Management Practices and Accepted Agricultural Practices) that provide a greater emphasis on riparian corridor restoration and protection activities. Encourage stream channel adjustment processes towards a stable regime and improve riparian buffers.

3. Increase participation and involvement of towns in stream corridor protection and conflict avoidance.

4. Develop and implement stream restoration projects that incorporate stable channel design techniques.

5. Conduct comprehensive assessments when replacing infrastructure that is in conflict with natural stream processes, utilizing the recently updated ANR/AOT bridge and culvert assessment protocols.

6. Maintain and enhance relationships among riparian landowners and link riparian corridor restoration efforts where possible. Promote an "Adopt a Stream" program that encourages riparian stewardship by landowners.

Geomorphic studies and landowner outreach efforts conducted to date have identified several opportunities for working toward the objectives of erosion mitigation, water quality improvement, and habitat restoration along the New Haven River and Beaver Meadow tributary.

Site and reach-level management strategies and watershed-level management strategies have been identified in the 2006 New Haven River Corridor Plan (Underwood, 2006). Many resources at the private, municipal, state and federal levels are available to convert these opportunities into action.

Objective:
Identify passive geomorphic alternatives to protect river equilibrium and ecological processes and avoid conflicts

Strategies:

Pursue landowner involvement in conservation of critical river reaches to preserve equilibrium and ecological functions of riparian corridor.

Lead Partner(s): DEC-RMP, VRC, contractors (SMRC), MALT and VLT, landowners and municipal officials

Potential Funding Sources: Ecosystem Restoration – River Corridor Grants, Watershed Grants, VRC/ MALT easements, VLT conservation easements
Timeline: 2011-2015

Protect the New Haven River corridor from future development/encroachments/ berming. Promote corridor easements and riparian buffer enhancement. Facilitate sediment attenuation / lateral adjustments at upstream extent near reach break with M21 - could relieve stresses on Lincoln village reach, M19

Lead Partner(s): DEC-RMP, VRC, contractors (SMRC), MALT and VLT, landowners and municipal officials
Potential Funding Sources: Ecosystem Restoration – River Corridor Grants, Watershed Grants, VRC/ MALT easements, VLT conservation easements
Timeline: 2011-2015

Protect contiguous wetlands at downstream reaches of the New Haven River which could offset consequences of upstream channel management, especially through the Downingsville settlement.

Lead Partner(s): DEC-RMP, VRC, contractors (SMRC), MALT and VLT, landowners and municipal officials
Potential Funding Sources: Ecosystem Restoration – River Corridor Grants, Watershed Grants, VRC/ MALT easements, VLT conservation easements
Timeline: 2011-2015

Conduct alternatives analysis to determine cost/benefit and technical feasibility of stabilizing this landslide to reduce sediment inputs to the New Haven River.

Lead Partner(s): DEC-RMP, VRC, contractors (SMRC), MALT and VLT, VGS, and municipal officials
Potential Funding Sources: Ecosystem Restoration – River Corridor Grants, Watershed Grants, VRC/ MALT easements, VLT conservation easements
Timeline: 2011-2015

GMNF – "Chop and Drop" Restoration Projects (Furnace Brook, Middlebury River)

Forest Service staffs on the Green Mountain, White Mountain, and Monongahela National Forests are currently restoring large woody debris in smaller streams using a technique called "Chop and Drop." Chop and Drop involves selecting and directionally felling whole trees into the stream channel to create large woody debris structures.

The Green Mountain National Forest has been using Chop and Drop primarily on small streams where the trees being felled are considerably longer than the bank full width of the stream. The trees in these situations tend to anchor themselves without the need for large heavy equipment. Some of this wood, however, may subsequently be moved downstream by the high flows of springtime. Forest Service employees are monitoring the movement of large woody debris on a sample of these smaller, second-order streams to better understand where this debris moves to and its effectiveness in its new location.

Since the GMNF staffs have been implementing this approach, these restoration projects have been monitored to document the physical and biological effects of adding woody debris. Each restoration site was paired with an untreated control section for comparison. The monitoring revealed a five-fold increase of large woody debris. This in turn resulted in significant improvements in habitat structure. Pool area, pool quality and pool frequency (spacing and distribution) increased two- to five-fold since the project started. As a result, brook trout and insect populations also increased. So, while intended as an aquatic habitat restoration project, these practices have also been successful in restoring morphological stability to these historically modified streams.

Dissolved Oxygen (DO) (waters effected include the East Creek in Chittenden, Pittsford, and Rutland Town)

GOAL: To identify surface waters with regular or episodic reductions in dissolved oxygen concentrations that can be attributed to human alterations where remedial actions have been determined to be "reasonably attainable."

Objectives

1. Address hypolimnetical withdraws through state re-licensing (Chapter 41 Section 1003) and document this effect via assessment studies.

Strategy:
Operate CVPS Hydroelectric Projects on the East Creek in run-of-river mode where flows below the powerhouse equal inflow to the impoundment on an instantaneous basis. Include conditions requiring this mode of operation in the water quality certification issued as part of the state licensing process.

Lead Agency/Organization: CVPS
Partners: VTDEC, VTDFW
Potential funding sources: n/a
Time frame: 2011-2015
Benchmark: Implementation of run-of-river operation.

Strategy:
Re-establish riparian vegetation along the banks of East Creek in order to keep water temperatures cooler, which will hold more dissolved oxygen.

Lead Agency/Organization: RNRCD, VDEC
Partners: USDA-NRCS, USFW, VYCC, riparian landowners.
Potential funding sources: State (319) and federal (CREP) cost-share programs.
Time frame: Ongoing
Benchmark: Increase in linear riparian buffer planting along East Creek

2. Reduce sedimentation and nutrient enrichment that may heighten biological oxygen demand which would lessen available dissolved oxygen levels.

Strategy:
Activities under this strategy involve a full-spectrum of best management practices for road infrastructure, stormwater (including suburban and residential best management practices), agricultural activities (including silviculture), and to address river instability and disequilibrium. All of these strategies are addressed in other sections in this document.

3. Identify non-functioning dams that are good candidates for removal and pursue alternatives analyses and project scoping to determine viability (for removal).

A) Identify and map all dams in the basin and use this data to update the VANR dams inventory database.
B) Evaluate individual dams with potential for removal projects and develop removal plans in cooperation with the dam owner and local community.
C) Identify dams that provide significant public benefits that can be modified to address environmental impacts rather than be removed.

D) Carry out assessments of dams in the basin where there is expressed interest in potential hydropower development to identify candidates for further investigation of micro-hydropower generation.

Lead Partner(s): DEC-RMP, VRC, USFWS, USACOE, and municipal officials
Potential Funding Sources: Ecosystem Restoration – River Corridor Grants, Watershed Grants, VRC easements
Timeline: 2011-2015

Agricultural runoff (waters effected include the Clarendon River, Dead Creek, Lewis Creek, Lemon Fair, New Haven River, Otter Creek)

GOAL: Reduce and eliminate water quality degradation as a result of agricultural activities

Objective
Selectively apply best management practices and increase outreach programs to reduce non point source pollution from agricultural sources.

Strategies:
Reduce erosion and nutrient runoff from cropland and farmsteads. Erosion reduction techniques include filter strips, riparian buffers, cover crops, conversion to grass based operations, and addressing farm buildings runoff. Livestock exclusion from waterways is a high priority practice for this basin. Cropland susceptible to annual flood inundation and adjacent to waterways adversely impacted by excessive nutrients and sediment should be priority areas for this project.
Lead Partner(s): NRCS, VAAFM, farmers, NRCDs, and UVM Extension
Potential Funding Sources: EQIP, CREP, Partners for Fish and Wildlife Program and CWA Section 319 grants
Timeline: 2011-2015

Assist farmers in complying with current AAPs and BMPs for agriculture and Acceptable Management Practices (AMPs) for silviculture to ensure they are implemented and maintained to lessen land use impacts to river stability by providing training and assistance.

1. Support and promote the NRCD technical assistance programs including the ARS, NMP, and LTP to increase knowledge and understanding of the AAPs and potential funding opportunities to address water quality issues on farms.
2. Encourage development of peer advisory groups for solving agricultural resource concerns.

Lead Agencies: VDEC, NRCS, VAAFM, NRCDs, municipalities
Funding options: 319 grants, DEC River Corridor grants, VT-BMP, EQIP, WHIP, PFW, VT Watershed grants, municipal budgets, private foundations
Timeline:

Develop a cover crop and crop rotation demonstration project for farmland planted to continuous corn within flood plains.
Lead Partner(s): NRCS, VAAFM, NRCDs, and UVM Extension
Potential Funding Sources: CWA Section 319 grants, SARE
Timeline: 2011-2015

Hold equine industry workshops to increase participation in non point source pollution prevention.
Lead Partner(s): NRCDs, NRCS, VAAFM, UVM Extension, horse owners, and equine industry-related businesses.

Potential Funding Sources: EQIP, Partners for Fish and Wildlife, and local partners
Timeline: 2011-2015

Hold sheep and goat farmer workshops to increase participation in non point source pollution prevention.

Lead Partner(s): NRCDs, NRCS, VAAFM, UVM Extension, and sheep and goat farmers
Potential Funding Sources: EQIP, Partners for Fish and Wildlife, and local partners
Timeline: 2011-2015

Develop a compost materials exchange and hauler directory to increase watershed participation in composting projects.

Lead Partner(s) Composting Association of Vermont, Highfields Institute, NRCS, and VAAFM, NRCDs
Potential Funding Sources- CWA Section 319 grants
Timeline- 2011-2015

Continue to work with farmers to develop/implement nutrient management planning regardless of acreage.

1. Increase funding for farmers to create their own nutrient management plans.
   Increase technical assistance for farms to develop nutrient management plans.

2. Exclude livestock from streambank and shoreline areas and establish alternate water sources, particularly in areas that are at high risk for phosphorus loss and soil erosion.
3. Increase technical and financial assistance to farms willing to exclude livestock from surface waters.
4. Provide education on the benefits of livestock exclusion from surface waters.
   Identify and prioritize high risk streambank and shoreline areas.

Classification Strategies for Waters in Need of Greater Protection

Public involvement is an essential component to restoring and protecting river and lake ecology. The Vermont Water Quality Standards state “Public participation shall be sought to identify and inventory problems, solutions, high quality waters, existing uses and significant resources of high public interest.” Citizens who make their living from the land have a special opportunity to contribute to water quality protection or an approach that balances environmental considerations in protecting and restoring water resources with economic interests. Without balance, there will be limited progress in achieving the goals of protecting land from the forces of the rivers and the rivers from the runoff of the land (VTDEC, 2002 – Lake Champlain Phosphorus TMDL). Emphasis on the identification of values and expectations for future water quality conditions can only be achieved through public contributions to the planning process.

One important element of basin planning includes establishing management goals for waters that designate both the beneficial uses and values of surface waters and the level of protection to meet the needs and expectations of each community and the state as a whole. The basin planning process should encourage community involvement in identifying:

(1) Existing uses of surface waters,
(2) Potential candidates for Outstanding Resource Waters (ORW) designation, and
(3) New classifications and water quality management types for waters in their community.

The implementation of these objectives through this basin plan is expected to meet the goals and corresponding objectives identified through the Otter Creek basin planning process, the Addison County River Watch Collaborative, the Upper Otter Creek Watershed Council, lake associations, municipalities, watershed residents, and landowners.

Existing Uses

All surface waters in Vermont are protected to support uses valued by the public including (but not limited to) swimming, boating, and fishing. The degree of protection afforded to these uses in most surface waters is based on the water’s designated use as identified in the classification or class of water. Certain designated uses may be declared “Existing Uses” if they are shown to be present at any time on or after November 28th, 1975. Declaration of existing uses provides a base level of protection in that a use can only be removed from a surface water (or ‘un-designated’) in the event that the use has never been documented to exist since the onset of the Clean Water Act.

The Agency identifies “existing” uses of particular waters either during the basin planning process or on a case-by-case basis during application reviews for permits. The following factors are considered by the Agency when identifying existing uses (see VWQS Section 1-03 B):

• Aquatic biota and wildlife that use or are present in the waters;
• Habitat that supports existing aquatic biota, wildlife or plant life;
• The use of waters for recreation or fishing;
• The use of waters for water supply or commercial activity that depends directly on the preservation of an existing high level of water quality; and

During the planning process in the Otter Creek Basin, the Department of Environmental Conservation has collected sufficient information to identify existing uses listed in Appendix D. The list is not meant to be comprehensive. The public is encouraged to nominate other existing uses, which may be included in the basin plan or catalogued for a more thorough investigation on a case-by-case basis when an application is submitted for an activity that might adversely affect the use, which is under the

Agency's jurisdiction Petitions for existing use considerations must be filed with the Vermont Water Resources Board if outside the scope of this basin plan.

Exceptional Uses and Values of Basin Rivers and Streams

The entire length of the main stem of Otter Creek, at 100.4 miles, is the longest flatwater boating segment in the state. Much of this boating takes place in scenic segments from Vergennes to Lake Champlain, from Proctor to Middlebury, and from North Dorset to Wallingford. There are some Class II-III rapids for whitewater boating below Huntington Falls, Weybridge Dam and Middlebury Lower Dam. Important Class III summer rapids occur below Beldens Dam. Battell Gorge in New Haven on Otter Creek is one of the two undisturbed gorges on large rivers in Vermont and Battell is the more scenic of the two. A highly used fishing spot is located below Beldens Dam in New Haven.

Boating on rivers in scenic corridors also takes place on the south end of Dead Creek; on Lewis Creek, from No. Ferrisburg to Lake Champlain, and from Prindle Corners to North Ferrisburg; on Tinmouth Channel, from the northern access to Noble Cemetery; and on the New Haven, from Lincoln Gap Road to West Lincoln. Scenic riparian ledges and bedrock and an abundance of swimming holes, cascades and gorges occur on the Middlebury River from Ripton to East Middlebury and on the New Haven River from West Lincoln to Rocky Dale Dam. Scenic ledges and bedrock also occur on the New Haven River, from Dog Team Tavern to the mouth.

There is a number of state owned and managed wildlife areas in the Otter Creek Basin often centered on wetland complexes. These include the Dead Creek Wildlife Management Area, Lewis Creek Wildlife Management Area, Otter Creek Wildlife Management Area, Tinmouth Channel, Brandon Swamp Wildlife Management Area, Cornwall Swamp Wildlife Management Area, Little Otter Creek Wildlife Management Area and Richville Wildlife Management Area.

As mentioned above, numerous swimming holes are located in the upper reaches of the New Haven and Middlebury rivers. Swimming holes are also found on Mill Brook in Danby, Big Branch in Mt. Tabor, Mill River (Clarendon Gorge) in Clarendon, Cold River in Shrewsbury, the South Branch of the Middlebury River in Ripton, Sucker Brook (Lana Falls) in Salisbury, Muddy Branch in New Haven, and on Lewis Creek in Starksboro, Monkton and Charlotte. Only one swimming hole of any significance is found on Otter Creek - in South Wallingford.

The basin also contains many waterfalls, cascades and gorges. In addition to those previously mentioned (Battell and Clarendon Gorges and Lana Falls), there are Sutherland Falls on Otter Creek in Proctor, Middlebury Gorge on the Middlebury in Ripton, New Haven River Gorge on the New Haven in Bristol, Beldens Falls in Weybridge and New Haven, Falls of Little Otter Creek in Ferrisburg, and Bristol Memorial Forest Park Gorge in Bristol.

Protection of Very High Quality Waters

The SWMS refers to several mechanisms to promote further protection of high quality surface waters. These include Class A(1) reclassifications, identification of potential Outstanding Resource Waters, and potentially, incrementally restrictive application of antidegradation for certain very high quality waters. This is discussed in Chapter 4 of the SWMS. See: http://www.vtwaterquality.org/wqd_mgtplan/swms_ch4.htm.

Table 3-4. Candidate surface waters proposed for Class A(1) consideration and/ or Outstanding Resource Water Designation include (identified as very high quality biological, physical, or chemical condition)

Location	Assessed at River Mile	Most Recent Assessment	Biological basis for assessment
Otter Creek	70 – 72 85	2006	Macroinvertebrates and nongame fish
New Haven River, and Muddy Branch Trib.	20 3.0	2006 2001	Macroinvertebrates Macroinvertebrates
Blue Bank Brook, and Trib 6	1.7 0.2	2010 2010	Macroinvertebrates Macroinvertebrates
Halnon Brook	2.5	2009	Macroinvertebrates and nongame fish
Alder Brook	2	2008	Macroinvertebrates
South Branch Middlebury River	1; 5.8	2002	Macroinvertebrates
Dutton Brook	0.1 – 0.6	2010	Macroinvertebrates
Willow Brook	2.3	2003	Macroinvertebrates
Bresee Mill Brook	4.3 - 5	2006	Macroinvertebrates and nongame fish
Smith Pond Brook	1.7	2003	Macroinvertebrates
Furnace Brook	1.9; 5.6	2006	Macroinvertebrates
Baker Brook	1	1998	Macroinvertebrates
Clarendon River	1-4; 14.5	2010	Macroinvertebrates and nongame fish
East Creek	13	2009	Nongame fish
Tenney Brook	Mouth, 1.6-3	2010	Macroinvertebrates and nongame fish
Pico West Brook	1.4	1998	Macroinvertebrates
Moon Brook	3.3	2010	Macroinvertebrates and nongame fish
Sargent Brook	3.3-4.5	1999	Macroinvertebrates
Mill River, tributary	3.1	2006	Macroinvertebrates
Button Brook	0.6	2006	Macroinvertebrates
McGinn Brook	0.7	2006	Macroinvertebrates and nongame fish
Goshen Brook, tributary 2	0.2	2003	Macroinvertebrates and nongame fish
Spring Lake (Shrewsbury)	Entire lake	2011	Chlorophyl a (biological), Chemical water quality (nutrients), clarity
High Pond (Hubbardton)	Entire pond	2011	Chlorophyl a (biological), Chemical water quality (nutrients), clarity

Outstanding Resource Waters

In addition, a portion of the rivers, streams (or portions of them), and lakes (ponds) described above should be considered for either re-classification or designation as an Outstanding Resource Water (ORW) due to their numerous recreational assets, scenic ledges and cascades, abundant wetlands, and aquatic or wildlife habitat. Waters with exceptional natural, recreational, scenic, or cultural values should be designated as ORW for their exceptional characteristics. Recommendations for the surface waters (wholly of part of) that merit potential ORW designation or re-classification include:

- Alder Brook (GMNF headwaters)
- Dutton Brook (GMNF headwaters)
- Goshen Brook (GMNF headwaters)
- Upper Middlebury tributaries (including the South Branch)
- Upper Furnace Brook (including Baker Brook, Kettle Brook, and the Puss and Kill Brook)
- High Pond (Sudbury)
- Spring Lake (Cuttingsville)

Wetland reclassification
Explore opportunities to increase protection for the Cornwall Swamp complex. In addition, consider including or as a separate re-classification process – Brandon, Leicester, and Salisbury swamps complexes, reclassified to a Class One Wetland designation under the Vermont Wetlands Rules.

Reclassification of abandoned surface water supplies from Class A(2) to B waters
Including Tenney Brook, Moon Brook, Young's Brook, Sugar Hollow Brook, Leicester Hollow Brook, Brandy Brook, Unnamed tributary to Lewis Creek, Two unnamed tributaries to Little Otter Creek, and Notch Brook are listed as A(2) waters in the Water Quality Standards but are no longer used as water supplies or emergency water supplies. It is recommended that these two A(2) waters be reclassified to Class B waters.

Warm Water Designation
No additional designations proposed at this time.

Water Management Typing (WMT)
Water Management typing recommendations are not included in the Draft Plan as required in section 1-02 (d)5 of the water quality standards. The revised Water Quality Standards require that all basin plans place Class B waters into one of the three water management types. However, considerable challenges over the past decade have limited ANR's ability to identify proposed water management types, and the Panel's ability to promulgate these designations. These challenges are listed in detail in VDEC's 2010 Report to the Vermont General Assembly on Basin Planning. Consequently, this basin plan contains no recommendations for any Class B water concerning water management types.

The plan contains all federal expectations and requirements (i.e., it is consistent with 303e) and except for the absence of WMT recommendations it complies with all state mandated requirements. The basin planning process did not pursue WMT because these have been held up before the Water Resources Panel in recent years and no resolution to the process for identifying WMT's between interested parties has been developed.

Strategies at the Municipal Level

Stormwater

Municipal policies and actions are needed throughout the Vermont portion of the Lake Champlain Basin in order to protect riparian buffer zones and to reduce the creation of impervious surfaces by new development. These actions are necessary to minimize future increases in phosphorus loading as land is converted to developed uses (see Appendix C of the SWMS).

Simple erosion control measures are possible for one or two family dwellings and accessory uses. These can include setbacks and buffers along surface waters, wetlands, and property lines so that no soil or water move into these areas. They can also include the use of stone check dams, silt fence, stormwater diversion ditches, designated areas of infiltration, seeding, and mulching. The following erosion control policies and requirements should apply to all development activity, including single family and double family residential development with accessory uses. Site visits from local regulatory individuals should be conducted to ensure compliance with these measures during construction, and to take appropriate enforcement steps if necessary.

Since many development projects are sufficiently small to be below regulatory thresholds for State permit programs, simple erosion control measures should be required at the municipal approval level for one or two family dwellings and accessory uses through the permit application process. The applicant should provide the following information on the applicable municipal permit application.

1. The locations of any surface waters and wetlands.
2. How the structure and any disturbed soil will remain at least 50 feet from these features.
3. Where the limits of disturbance will be and how the applicant is minimizing the area of disturbance.
4. Where silt fence or stone check dams will be installed.
5. Where any roof and driveway runoff will go to infiltrate once the house or structure is complete.

Municipal Stormwater Recommendations

– The aforementioned applicant checklist should be considered by town ZA's and DRB's as a precursor to issuing a general construction permit.

– Encourage local municipal regulations for erosion and sediment control during new construction that fall outside of the scope of state stormwater regulations *(Priority towns in the basin include Brandon, Bridport, Bristol, Clarendon, Cornwall, Ferrisburgh, Mendon, Middlebury, Monkton, New Haven, Pittsford, Salisbury, Shoreham, Shrewsbury, Tinmouth, and Weybridge)*

Impervious Surface Minimization and Low Impact Site Design

Careful site planning can reduce the impervious area created by pavement and roofs and the volume of runoff and phosphorus loading. Careful site planning can also preserve the natural topography, drainage, and vegetation by preserving intact as much as possible the natural features that help retain runoff. Natural depressions and channels act to slow and store water, promote sheet flow and infiltration, and filter out phosphorus-bearing sediment.

Zoning codes and development standards affect the amount of runoff generated by projects by defining street widths, housing densities, setback distances, and other factors.

Low Impact Design (LID) reduces stormwater impacts by mitigation stormwater runoff and maximizing reducing impervious areas, enhancing natural runoff storage and runoff diversion areas, and maximizing existing vegetation and buffer areas. The primary goal of Low Impact Development methods is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and detain runoff. Use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. By mimicking natural hydrological processes around home and business, LID techniques help minimize runoff and maximize infiltration.

Municipal Stormwater and LID Recommendations

- Development standards should encourage minimization of impervious surfaces and use of open vegetated channels for stormwater runoff. Provisions for narrower streets, shorter or shared driveways, smaller parking spaces, and reduced setback distances from roads should be part of urban or suburban zoning regulations. Alternative modes of transportation such as mass transit, bike paths, and commuter parking areas should also be encouraged in order to reduce the need for new roads and parking.

- Planned residential and planned unit developments that concentrate development while maximizing open space should be encouraged. Open space preservation should maximize green infrastructure (e.g., natural surface water corridors and buffers). Existing parking ratio requirements should be reviewed to see if lower minimum ratios are warranted and feasible. Maximum parking ratios should be established in order to curb excess parking construction. The initial subdivision proposal should ensure that lots with difficult access are not created.

Riparian Buffers

The recommendations in the Agency of Natural Resources Draft Riparian Buffer Procedure (7/27/01) are directed at projects subject to Act 250 permitting or other Agency of Natural Resources regulatory programs. However, similar provisions would be appropriate to implement at the local level in order to reduce phosphorus loading to surface waters in the Lake Champlain Basin.

Municipal Buffer Recommendations

- Towns should adopt a minimum setback and buffer requirement on all rivers, streams, lakes, and ponds. This requirement can be included as one of the general regulations in the zoning bylaws, and then would apply to all projects town-wide. ***Alternatively, a buffer requirement could be included as a district standard, and the setback and buffer distance could vary depending on the nature of the district.***

Wetland Protection

In order to be classified as a wetland under Vermont law, an area must have wetland soils and wetland plants, in addition to at least seasonal water. Wetland soils are often anaerobic and the plants have adapted to growing in such waterlogged conditions. The Vermont Wetland Rules classify all wetlands into one of three classes. Classes One and Two are considered "significant" and protected under the Vermont Wetland Rules. All three wetland types are protected by Vermont's Act 250.

Municipal Wetland Recommendations

– Class Three wetlands are not within state jurisdiction and should be addressed under municipal regulations.

– Towns can develop a more accurate map of the significant wetlands.

– Towns can create and incorporate their own wetland protection programs into their zoning regulations.

– Towns can require applicants that may have wetlands to contact ANR wetlands office to determine whether project is on land contiguous to a mapped wetland.

Local planning commissions and citizens should not assume the state or federal agencies can protect every wetland. The state's principal authority is to protect wetlands mapped on the Vermont Significant Wetland Inventory maps and wetland areas contiguous to mapped wetlands. Many ecologically productive small wetlands, including vernal pools may not be protected under the state's protection program. Also, some landowners may not be aware that a wetland is protected at the state level and unknowingly violate the state rules. Local officials often have more direct contact with landowners than state employees, and therefore can be very effective in providing landowners with the information they need.

Floodplain Management

The most cost-effective way for towns to mitigate flood hazards is avoidance: limiting building and other investments in river corridors. In addition to preventing future flood losses to structures built in hazardous areas, this approach avoids constraining a river, allowing the stream or river, over time to become more stable. Statute 24 V.S.A. §4424 specifically authorizes towns to adopt zoning for shorelines, floodplains, and other hazardous areas, including fluvial erosion zones. Municipalities are uniquely enabled to apply local land use planning and regulations to preventing fluvial hazards and can do so by applying local knowledge and historical perspective to craft approaches that can work for each particular municipality. Although adopting land use regulations to mitigate flood hazards are likely to be controversial or even unpopular in some communities, municipal officials have a responsibility to consider these measures, as they can have important long-term public health and safety benefits, as well as the economic benefits of reduced flood losses.

Unfortunately, most communities in Vermont rely solely on the minimum standards of the NFIP to protect their communities from flood hazards. However, all communities should recognize that floodplain management based solely on NFIP minimum regulations allows for development in floodplains that will reduce the floodplain's ability to convey and store water and will cumulatively result in increases in the 100-year flood elevation. A rise in floodwaters not only can cause properties that were once flood-free to now be flood-prone but can also cause increases in the velocity of floodwaters, thereby increasing the potential for erosion of stream banks during flooding.

In addition to not preserving the floodplains' flood storage and conveyance functions, NFIP minimum standards do not preserve other natural and beneficial functions of the floodplain, such as water quality maintenance and protection, groundwater recharge and discharge, and biologic resources and functions, which can have negative impacts on a community's economic and other resources. Therefore,

Municipal Floodplain Recommendations

- Communities should consider adopting flood hazard area regulations that are more stringent than the minimum requirements of participation in the NFIP.

- Adopt regulations that exceed the minimum NFIP requirements, for example increasing the elevation requirements for structures above base flood conditions.

- Prohibit or restrict development within floodplains by developing permitted, conditional use and prohibited use standards that are more restrictive than NFIP.

Communities that adopt more stringent regulations are eligible to receive insurance premium discounts for their residents through participation in the Community Rating System.

While participation in the NFIP is one important approach to flood hazard mitigation, NFIP maps are based only on inundation hazards and fail to consider the hazards associated with erosion due to physical adjustments of the stream channel during flooding, which is the cause of the majority of all flood damage in Vermont. The following section (Fluvial Erosion Hazard Regulations) explores supplemental approaches towns can take to more effectively mitigate flood and erosion hazards.

Fluvial Erosion Hazard Mitigation and River Corridor Protection

The Vermont Agency of Natural Resources has sponsored Stream Geomorphic Assessments (SGA) of many rivers and streams within Basin 03. The data indicate that these streams have been highly modified in the past to make room for human investments such as roads and houses. These modifications have led to unstable stream systems resulting in increased flooding and erosion hazards and compromised habitat for aquatic species.

Municipal FEH Recommendations

– Encourage municipal adoption of a Fluvial Erosion Hazard overlay district as one of the best avoidance strategies for fluvial erosion hazard mitigation. An overlay district is an additional zoning requirement placed on a specific geographic area (in this case the FEH zone) without changing the underlying zoning.

– Adopt Fluvial Erosion Hazard (FEH) overlay districts that prevent development in hazardous areas.

– Assist in the development and implementation of a river corridor plan. (ANR River Management Program can help with development and funding.)

Recommendation - The town should take steps to reduce future hazards from occurring by adopting a Fluvial Erosion Hazard Zone overlay district. The zone would be scientifically defined based on the SGA data and would reflect the area needed for the stream to be restored.

Chapter 4 -- Otter Creek Basin Work Plan

The primary goal of this action plan is to reduce the pollutants (sediments, nutrients, pathogens, etc.) delivered to the Otter Creek, its tributaries, and ultimately Lake Champlain. The table below outlines broad objectives for this effort, and then begins to frame-out specific actions to achieve the stated objectives. It is anticipated that the list of action items will continue to evolve based on input from technical and watershed partners, and continually prioritized and refined based on the staff and financial resources available to implement specific actions. The intent of the workplan is to provide a roadmap of actions to pursue during the five-year cycle of this Basin Plan. Consistent with the new "Tactical Planning Process," this workplan will become the template for priority actions and a checklist for completed actions.

Tactical basin implementation plans will fulfill all of the geographically-specific planning requirements in the Water Quality Standards, while the statewide planning requirements, including state-scale strategies, are contained within this Statewide Strategy. This new approach is designed to yield considerable efficiency relative to historic basin planning efforts, where all strategies – statewide, basin-specific, and even local, were listed in a basin-specific plan, and repeated from one basin plan to the next. The Watershed Management Division (WMD) further proposes that tactical basin plans, developed by an ongoing process involving all relevant partner organizations, will become products not of the WMD, but of all of the partner agencies and watershed stakeholders. The WMD has envisioned a structure for this new process to achieve completion of tactical basin implementation plans for all of Vermont's planning basins, every five years, as required by statute. The newly streamlined process for issuing tactical basin plans will facilitate targeting of the strategies and prioritization of resources to those projects that will have the greatest impact on surface water protection or remediation.

Priority actions identified in this workplan include strategies based on the existing and desired condition of priority surface waters in the basin, either for restoration or protection. A good example of how the monitoring and assessment of surface waters is directly linked to priority action lies with the Addison County River Watch Collaborative and their work. The Collaborative analyzes their data and the end of each season to compare with state and federal standards and then to detect trends in surface water conditions in order to strategize for each subsequent monitoring season. They also use this understanding to focus both their programmatic approach to programs as well as to collaborate with partners for project implementation. The Collaborative has conducted outreach with their data to inform water quality planning and zoning to towns within the sub-basins where they conduct monitoring. They also use this data directly to strategize and prioritize project implementation with partners whether it be for river restoration work, back road improvements, floodplain and wetland protection, and other water quality protection efforts.

Otter Creek Basin Implementation Table

Rank			Action	Lead	Timeframe	Budget	Geographic scope (applies to: waterbody, town, media, throughout basin, etc) and/ or status
H	M	L					
COMMON GOAL: REDUCE THE AMOUNT OF NPS POLLUTION AND SEDIMENT ENTERING BASIN 03 STREAMS, RIVERS AND LAKES. **(stressors addressed include: channel erosion, encroachment, land erosion, non-erosion nutrients, nutrient loading, thermal stress)**							
Objective: Reduce levels of Non-Point Source Pollution from developed lands and the working landscape							
Developed lands							
X			1. Encourage municipal zoning to protect riparian buffer zones and minimize the amount of new impervious surfaces from new development. Promote LID concepts and practices	VLCT, RPC's, towns	Target town plan and zoning rewrites and revisions	EPA pass-through 604(b)	Throughout basin
	X		2. Develop demonstration projects for techniques to address stormwater and erosion control from homes, businesses, and construction sites	ANR, NRCD's,	Ongoing	EPA 319, Ecosystem Restoration Funds	Urban towns and cities (Brandon, Bristol, Ferrisburgh, Hinesburg, Killington, Middlebury, Pittsford, Rutland City, Rutland Town, Wallingford, West Rutland, Vergennes)
	X		3. Work with State and Federal transportation agencies on implementing water quality BMPs for road infrastructure construction and maintenance	Vtrans, ANR	Ongoing	EPA 319, AOT structures, Better Backroads	Throughout basin
X			4. Identify retrofit opportunities and/or potential new stormwater controls for older developed areas and seek to upgrade or install new controls	ANR, towns	Ongoing	EPA pass-through 319, Ecosystem Restoration Funds	Urban towns and cities (Brandon, Bristol, Ferrisburgh, Hinesburg, Killington, Middlebury, Pittsford, Rutland City, Rutland Town, Wallingford, West Rutland, Vergennes)

X			5. Encourage local municipal regulations for erosion and sediment control during new construction that fall outside of the scope of state stormwater regulations.	RPC's, VLCT	Target town plan and zoning rewrites and revisions	EPA pass-through 604(b), Municipal Planning Grants	Throughout basin
	X		6. Develop a LID building applicant checklist that could be considered by town ZA's and DRB's as a precursor to issuing a general construction permit.	DEC(GI), RPC's, VLCT	2012	EPA pass-through 604(b), ARRA, Municipal Planning Grants	Throughout basin
X			7. Development standards should encourage minimization of impervious surfaces and use of open vegetated channels for stormwater runoff. Provisions for narrower streets, shorter or shared driveways, smaller parking spaces, and reduced setback distances from roads should be part of urban or suburban zoning regulations. Alternative modes of transportation such as mass transit, bike paths, and commuter parking areas should also be encouraged in order to reduce the need for new roads and parking.	ANR, Vtrans, private consultants	Ongoing where towns are receptive	EPA 319, SIWRF (for Moon Brook only), Municipal Planning Grants, Ecosystem Restoration Funds	Throughout basin
X			8. Increase the infiltration of stormwater flows in conjunction with the traditional detention methods used to treat stormwater	ANR, consultants	Ongoing	Ecosystem Restoration Funds, EPA 319	Urban towns and cities (Brandon, Bristol, Ferrisburgh, Hinesburg, Killington, Middlebury, Pittsford, Rutland City, Rutland Town, Wallingford, West Rutland, Vergennes)
X			9. Promote residential practices, especially lawn and garden-related practices that promote the Low Input Lawn Care outreach and demonstration campaign	Rutland NRCD, UVM Sea Grant, DEC(GI)	Ongoing	Lake Champlain Sea Grant	Moon/ Mussey Brook and other urban streams (East Creek, Tenney Brook, etc) in the Rutland area

X			10. Provide outreach to landowners about impacts of over-fertilizing lawns and the importance of establishing and maintaining buffer strips along streams and ponds to reduce NPS pollution. Distribute "Don't P on the Lawn" brochure.	ANR, Lake Champlain Sea Grant, RSEP	Ongoing	Lake Champlain Sea Grant	Urban towns and cities (Brandon, Bristol, Ferrisburgh, Hinesburg, Killington, Middlebury, Pittsford, Rutland City, Rutland Town, Wallingford, West Rutland, Vergennes)
	X		11. Work with the local community and partners to address major sources of phosphorus identified in watershed survey. Likely efforts will include working with watershed residents to improve riparian management practices, improve roads and driveways to reduce erosion, reduce the use of fertilizer, and continued work with the agricultural community to reduce phosphorus loading.	DEC, NRCS, NRCDs, town Selectboard, Planning Commissions, and Road Commissioner	Ongoing	Existing staff and resources	Towns throughout basin Little Otter Creek and the New Haven River have been targeted for implementation efforts based on river corridor planning the recently completed flow monitoring study in the Little Otter
	X		12. Review layouts of municipal garages in the watershed with each municipality to control runoff from salt and sand piles at municipal garages. Develop a set of cost effective management practices and municipal garage layouts that minimize erosion runoff and assist towns in completing these improvements.	Road Commissioners, selectboard members, Local Roads Program, Vtrans	Ongoing	DEC Stormwater program, Existing staff and resources	Towns throughout basin
Working Lands – Forests							
X			13. Build 2-3 portable skidder bridges for loan to timber harvesting projects in the Otter Creek watershed	ANR, NRCD's	Underway. ongoing	Ecosystem Restoration Funds	Throughout basin
X			14. Increase logger education on water quality issues through the VT Family Forests, the LEAP program and the Vermont Loggers Association's Forestry Academy to encourage good forestry practices in the watershed.	NRCS, DFPR, Vermont Coverts, VFF, LEAP program	Underway/ ongoing	ANR Watershed Forestry Program, Ecosystem Restoration Funds	Throughout basin (emphasis on mountain towns – Chittenden, Danby, Goshen, Ira, Killington, Lincoln, Mendon, Mount Tabor, Ripton, Shrewsbury, Wallingford)

X			15. Promote educational workshops for forest landowners and forestry consultants viaVermont Coverts. Promote erosion control techniques for skidder trails, stream and river access points, and proper bridge and culvert construction. Develop a proposal to use a VYCC watershed crew to restore impacted sites including project development and implementation. Identify sensitive areas where access should be limited.	NRCS, DFPR, LEAP Program, VFF, VYCC	Ongoing	ANR Watershed Forestry Program, Ecosystem Restoration Funds	Throughout basin (emphasis on mountain towns)
	X		16. Encourage landowners to develop long term management plans for woodlands with the assistance of a forester. The management plan should prominently include AMPs and provide educational materials that promote responsible management of forest resources.	NRCS, DFPR, Vermont Coverts, VFF, LEAP program	Ongoing	Existing staff and resources	Throughout basin (emphasis on mountain towns)
	X		17. Locate local tree stock appropriate for riparian buffer plantings and engage local volunteers to complete riparian buffer plantings along the Otter Creek and its tributaries.	DEC, NRCS, NRCDs, TNC (Native Plant Nursery), watershed groups, RPCs	Ongoing	Existing staff and resources	Throughout basin
Objective: Manage river corridors to increase river bank and channel stability, protecting water quality, land, and infrastructure							
River Corridors							
X			18. Based on geomorphic assessments of the Otter Creek, select riparian restoration projects have been identified and prioritized to restore stream equilibrium and minimize erosion. Using geomorphic-based solutions, to the greatest extent possible, restore sections of major tributaries identified in stream geomorphic assessments as being unstable. Promote passive restoration principles and corridor/floodplain avoidance where appropriate.	ANR - RMP, towns, watershed organizations	Ongoing	Ecosystem Restoration Funds	See Appendix E for highest priority corridor plan recommendations for specific tributary rivers and streams in the basin
X			19. Expand land use practices and programs (Best Management Practices and Accepted Agricultural Practices) that provide a greater emphasis on riparian corridor restoration and protection activities. Encourage stream channel adjustment processes towards a stable regime and improve riparian buffers.	AAFM, ANR	Ongoing	Existing staff and budget resources	Throughout basin Neshobe River, New Haven River, and Little Otter Creek are specifically targeted during this implementation cycle

X			20. Conduct detailed river geomorphic assessments and corridor planning on priority sub-basins in the Otter Creek watershed	ANR - RMP	Ongoing	Ecosystem Restoration Funds	Priority sub-basins include the Lewis Creek (Pond Brook) and Cold River in 2012
X			21. Use the assessment data to 1) identify opportunities for projects that will increase river stability, 2) evaluate landowner-proposed channel management activities, and 3) target related local, state and federal programs to increase river stability	ANR - RMP, NRCS, NRCD's	Ongoing	Existing staff and budget resources	See Appendix E for highest priority corridor plan recommendations for specific tributary rivers and streams in the basin
X			22. Work with willing landowners, municipalities, regional/watershed conservation organizations, and others to design and implement river corridor protection projects consistent with increasing overall river stability	ANR, NRCD's, watershed organizations	Ongoing	Ecosystem Restoration Funds	Throughout basin See Appendix E for highest priority corridor plan recommendations for specific tributary rivers and streams in the basin
X			23. Provide enhanced incentives and resources for municipalities to permanently protect riparian corridors from new development and to restore existing corridors through municipal land use ordinances and conservation easements	ANR, RPC's, VRC	Ongoing, where there is receptivity	Ecosystem Restoration Funds, conservation easements	See Appendix E for highest priority corridor plan recommendations for specific tributary rivers and streams in the basin
X			24. Establish vegetated buffers and/or filter strips along rivers, streams, and lake shorelines	ANR, NRCD's, towns	Ongoing,	Ecosystem Restoration Funds, SEP	Throughout basin See Corridor Plan recommendations
X			25. Modify existing state and federal programs, or create new ones, to more effectively support riparian corridor protection and restoration, e.g., impacts of ditching and tile drainage	ANR, AAFM, EPA, VT Legislature	Ongoing	Ecosystem Restoration Funds, conservation easements, AAFM-BMPs	Focus on Lewis, Lemon Fair, Little Otter, Otter Creeks
X			26. Use all available good quality data on the physical, chemical, and biological values of the waters, and collect any additional necessary data in the watershed to establish reference reaches.	ANR - RMP	Ongoing	Existing staff and budget resources – as function of tactical basin planning process going forward	Throughout basin

X			27. Protect land along the rivers and streams where there are existing riparian buffers, significant wetlands, or where land is important to maintaining the rivers stability as determined by the geomorphic assessments and future river corridor plan.	RMP, private landowners, VLT, MALT municipalities, NRCDs, CCs, VRC	Ongoing	Ecosystem Restoration Funds , VHCD	See Appendix E for highest priority corridor plan recommendations for specific tributary rivers and streams in the basin
X			28. Create minimum consistent zoning that would protect rivers in the watershed through setbacks and riparian buffer ordinances, and flood hazard zones and overlay districts.	VLCT, RMP, RPCs, Towns, DEC, selectboards, VRC	Ongoing	Municipal Planning Grants	Throughout basin Specific towns include Brandon, Bristol, Chittenden, Danby, Ferrisburgh, Goshen, Hinesburg, Ira, Killington, Lincoln, Mendon, Monkton, Mount Holly, Mount Tabor, New Haven, Pittsford, Proctor, Rutland City, Rutland Town, Salisbury, Starksboro, Sudbury, Wallingford, Weybridge, West Rutland
COMMON GOAL: PROTECT AND RESTORE THE NATURAL ENVIRONMENTS OF WETLANDS, LAKES AND PONDS IN THE BASIN TO SUPPORT WATER QUALITY, RECREATION AND AESTHETICS. **(Stressors addressed include: channel erosion, encroachment, land erosion, non-erosion nutrients, nutrient loading, flow alteration, thermal stress, invasive species)**							
Wetlands and Floodplain Protection and Restoration							
X			29. Using the new Lake Champlain Basin Wetland Restoration Plan as a guide, work with willing landowners to identify opportunities to restore and conserve wetlands and their role in improving water quality	ANR, AAFM, NRCS (WRP)	Ongoing	WRP, WHIP, EQIP, Ecosystem Restoration Program	Highest priority sites identified per the Lake Champlain Basin Wetland Restoration Plan (and verified) – cross-reference with SGA/ RCP See Appendix E for highest priority corridor plan recommendations for specific tributary rivers and streams in the basin
	X		30. Class Three wetlands are not within state jurisdiction and should be addressed under municipal regulations. Municipalities were given a responsibility in the 1986 wetland legislation to notify the state about developments in wetlands in 24 V.S.A. §4409. Encourage municipal oversight and stewardship efforts.	RPC's, towns, VLCT, DEC Wetlands Program, NRCS	Ongoing - Target town plan and zoning rewrites and revisions	EPA pass-through 604(b), Municipal Planning Grants	Throughout basin
	X		31. Work with conservation commissions to map existing wetlands and wetland functions and values for willing towns in the watershed. Use this information to prioritize the protection or restoration of wetlands in the watershed.	Conservation Commissions, VT Wetlands Section	Ongoing	Watershed Grant	Throughout basin Specific towns include Bristol, Charlotte, Ferrisburgh, Hinesburg, Lincoln, Monkton, Ripton, Salisbury, Wallingford, Weybridge

	X		32. Communities should consider adopting flood hazard area regulations that are more stringent than the minimum requirements of participation in the NFIP.	ANR, RPC's	Ongoing	EPA 604(b), Municipal Planning Grants	Throughout basin Specific towns include Brandon, Bristol, Danby, Goshen, Ira, Killington, Lincoln, Mendon, Monkton, Mount Holly, New Haven, Ripton, Shrewsbury, Starksboro, Wallingford
X			33. Encourage municipal adoption of a Fluvial Erosion Hazard overlay district as one of the best avoidance strategies for fluvial erosion hazard mitigation. An overlay district is an additional zoning requirement placed on a specific geographic area (in this case the FEH zone) without changing the underlying zoning.	ANR, RPC's	Ongoing	ANR – RMP existing staff and resources, Ecosystem Restoration Funds , EPA 604(b), Municipal Planning Grants	See Appendix E for highest priority corridor plan recommendations for specific tributary rivers and streams in the basin
X			34. Protect floodplains identified through the geomorphic assessments as important for maintaining the stability of rivers and streams. Work with land trusts to include language in conservation easements that protect floodplains and buffers for maintaining or restoring stream stability.	VLT, MALT, RMP, VRC, conservation commissions	Ongoing	VHCB, Ecosystem Restoration Funds	See Appendix E for highest priority corridor plan recommendations for specific tributary rivers and streams in the basin
Lake and Pond Protection and Restoration							
X			35. Hold a Vermont Invasive Patrollers (VIPs) workshop in the Basin and form survey groups to patrol the watershed to identify and control invasive riparian or aquatic species populations before they are well established	Lake/river associations, ANR, FOVLAP	Ongoing – where receptive	ANC, Watershed Grants, LCBP	Throughout basin Target lake towns in the basin – Bristol, Chittenden, Danby, Leicester, Monkton, Mount Holly, Salisbury, Wallingford
X			36. Encourage the development of locally-run public access "greeter" programs to prevent aquatic invasive species from entering or leaving a lake or pond, and support general public education and outreach about this topic	Lake associations, DEC, DFW, DFPR, FOVLAP	Ongoing – where receptive	ANC, Watershed Grants, LCBP	Throughout basin Target lake towns in the basin

	X		37. Increase the level of communication between lake associations and residents to prevent spread of invasive species into or within the watershed. Distribute information to lake and pond residents about invasive species and other common lake and pond issues, using modern approaches (social media sites, online forums, etc.)	FOVLAP, DEC - AIS, DEC	Ongoing	ANC, local fundraising	Throughout basin
X			38. Continue to support lake - lay monitoring programs in the watershed.	Lake/river associations, DEC, LaRosa	Ongoing	LMP and LaRosa Program	Continue support of citizen scientists on over Basin 03 lakes and associated regions of Lake Champlain
X			39. Maintain existing shoreline vegetation through the creation of shoreline zoning with vegetated buffers for all watershed towns.	State of Vermont, Planning commissions, VLCT.	Ongoing	N/A	Throughout basin
	X		40. Hold a workshop or series of workshops on lakeshore management to cover such topics as buffer restoration and low impact lawn care and landscaping. In addition, continue to promote LID concepts for camp conversions or replacement.	Lake Associations, Land Trusts, DEC, RPCs, and planning commissions	Ongoing	Watershed Grant, 604(b), Municipal Planning Grants	Basin lake towns Target lake towns in the basin – Bristol, Chittenden, Danby, Leicester, Monkton, Mount Holly, Salisbury, Wallingford
X			41. Maintain signs encouraging invasive species spread prevention actions at all public launches in the Basin to prevent spread to or from the waterbody. Include what aquatic invasive species are present.	DEC, DFW, DFPR	Ongoing – where updated information exists	Existing staff and resources	Throughout basin
General Water Quality Issues and Protection							
X			42. Include riparian area protection within town plans. Develop riparian area protection language within town zoning regulations.	VLCT, RPC's, towns	Ongoing – where receptive	EPA 604(b), Ecosystem Restoration Funds , existing staff and resources	Throughout basin
	X		43. Identify surface waters with regular or episodic elevations in pathogens and disseminate this information to the public. Correct obvious runoff issues that may be contributing to this problem.	ANR, towns, watershed groups	Ongoing	Existing staff and budget resources	Throughout basin Focus on these TMDL watersheds: Lewis Creek, Little Otter Creek, Middlebury River, Otter Creek

	X		44. Provide results of water quality testing and information about the water quality of the watershed to the public through towns, schools, the web, and the local library.	DEC Towns, school, libraries, local media	Ongoing	DEC MAPP, Watershed grants	Throughout basin
	X		45. Expand the capacity of volunteer monitoring programs with minimum monthly sampling on all high priority waterbodies throughout the watershed (as resources allow).	ACRWC, UOCWC, DEC LaRosa, EPA	Ongoing	DEC – LaRosa, EPA	Throughout basin Expand monitoring on rotational, priority basis as ACRWC currently administers
X			46. Make annual water quality data easily accessible online and linked to RPC, lake/ watershed association, and town web sites.	DEC, RPCs, ACRWC, UOCWC, towns	Ongoing – as updated	EPA 604(b), watershed grants, Ecosystem Restoration Funds	* Underway via Addison County RPC: http://www.acrpc.org/pages/publications/other.htm IN addition, the State is developing a web-based portal for watershed-specific information. See www.vtwaterquality.org/wqd_mgtplan/waterqmstrat.htm
X			47. Protect and provide public access to unique features throughout the watershed. The Otter Creek and its tributaries have many waterfalls, historical mill sites, and beautiful areas where it is important to maintain public access to help keep people connected with these resources.	DEC, VRC, MALT, VLT, LARC	Ongoing	VHCB	Throughout basin
	X		48. Complete a demonstration project along the New Haven River on control methods for Japanese knotweed, including the proper disposal of Knotweed, to prevent its spread. Encourage landowners to mow or cut areas of knotweed on private property.	TNC, NHRAA, towns, CC's	Ongoing	Watershed Grants, Ecosystem Restoration Funds	New Haven River headwaters
COMMON GOAL: MINIMIZE CONFLICTS BETWEEN STREAMS' NATURAL FUNCTIONS AND TRANSPORTATION INFRASTRUCTURE **(stressors addressed include: channel erosion, encroachment, land erosion, nutrient loading, thermal stress)**							
X			49. Conduct comprehensive assessments when replacing infrastructure that is in conflict with natural stream processes, utilizing the recently updated ANR/AOT bridge and culvert assessment protocols.	ANR, Vtrans, towns	Ongoing	Existing staff and budget resources	Throughout basin Target towns in southern and western areas of the basin hardest hit by Tropical Storm Irene: Brandon, Danby, Mendon, Mount Holly, Rutland City, Rutland Town, Shrewsbury, Wallingford

X			50. Hold a series of Local Roads workshops in the Basin to increase awareness of maintenance measures that will reduce gravel road erosion. Encourage the participation of all town highway managers and road crews in the watershed.	VT Local Roads Program, VT Better Backroads Program, RPC's, RMP, towns	Ongoing	Better Backroads	In concert with RPC Road Commissioner workshops
	X		51. Develop capital road improvement budgets for all towns in the Otter Creek Basin.	town selectboards, road commissioners	2012	Better Backroads grants	Throughout basin
	X		52. Identify Better Backroad grant opportunities by touring watersheds with road commissioners from each town. Apply for Better Backroad grants in all watershed towns to conduct road inventories and address the most serious road-related erosion problems.	DEC, road commissioners, selectboards, Local Roads Program	2012	Better Backroads grants, municipal stormwater mitigation grants, town highway funds	Towns throughout basin
	X		53. Compile guidance on winter sanding and salt application and distribute to towns in the Basin to encourage the development of policies that will reduce salt and sand application in the watershed. Provide outreach to the general public on the impacts of salt and sand application to reduce the pressure for their expanded use.	Road commissioners, VTrans, Local Roads Program, DEC	2010	N/A	Article on this topic in Vermont Local RoadNews.
X			54. Work with road crews in the watershed to put in a grant for a hydroseeder that could be used by all towns in the watershed and possibly landowners to stabilize ditches.	NRCDs, Road crews and commissioners, CC's, and selectboard members in the basin, VTrans	2010	Ecosystem Restoration Funds , Municipal Stormwater Mitigation Grant, Better Backroads grant	Towns throughout basin ACRPC and Cornwall have developed such a program in Addison County Poultney NRCD is developing similar approach in the South Lake Basin (Lower Champlain Direct and Poultney Mettowee Basins)

X			55. Work with all municipalities in the watershed to adopt and actively implement the following programs or standards: A. Town road and bridge standards consistent with or exceeding those listed per Act 110: http://www.leg.state.vt.us/reports/2011ExternalReports/265312.pdf B. Driveway/highway access (curb cut) construction ordinances meeting the standards outlined in the Highway Access Policy and Program Guidance and Model Ordinance, VT Local Roads Program, May 1997.	Road crews and commissioners, CC's, and selectboard members in the basin, VTrans	Ongoing	Town Funds - Increased state match for class 2 road projects and reimbursement for disaster relief	Towns throughout basin Identify Act 110 compliant towns and target those towns that need updating, especially mountain towns and those affected by Tropical Storm Irene
X			56. Compile available bridge and culvert survey data in the basin and present this information to watershed towns and develop a list of priority culverts for replacement based on likelihood of culvert failure, geomorphic impacts and aquatic species passage concerns.	Road crews and commissioners, CC's, and selectboard members in the basin, VTrans, RPCs, RMP, DFW	Ongoing	Better Backroads grants	Towns throughout basin Cross-reference existing VOBCIT data with bridge and culvert assessment data conducted through stream geomorphic assessments
X			57. Work with town road commissioners and selectboard members to replace top priority culverts in each town.	Road crews, CC's, and selectboard members, VTrans, RPCs, RMP, DFW	Ongoing	Better Backroads grants	Towns throughout basin
Identify non-functioning dams and prioritize for removal, partial breaching, and/or improved fish passage. Address effects of hydro-modification.							
X			58. Identify existing dams which are no longer used in the watershed and are candidates for removal. Remove one dysfunctional dam in the Basin and restore the natural flows and riverine habitat.	Dam Task Force, Hydrology Program, private dam owners	Ongoing	USGS grants	Towns throughout basin, willing owners of failing dams that have disrupted sediment regimes and fish passage Current priorities are Combination Pond in Rutland and Kendrick Pond in Pittsford

X			59. Review any large water withdrawal proposals in the watershed to ensure that they do not reduce fish passage, alter sediment regimes, or reduce flows or groundwater levels to significantly impact aquatic habitat.	DEC Hydrology program, NRCS, NRCDs, Stream Alteration Engineer, DFW	Ongoing	Existing staff and budget resources	Work closely with DEC Hydrology program and VDFW fisheries biologists

Acronyms

319 Federal section 319 grants for NPS pollution abatement
604b Federal section 604b pass through funds for regional planning commissions
AAFM Vermont Agency of Agriculture Food and Markets
AAP Acceptable Agricultural Practices
ACRPC Addison County Regional Planning Commission
ACRWC Addison County River Watch Collaborative
AIS Aquatic Invasive Species Program
ALS Aquatic Life Support
AMP Acceptable Management Practices
ANR Vermont Agency of Natural Resources
ANS Aquatic Nuisance Species Program
BASS Biological Assessment Studies Section
BMP Best Management Practices
CC Conservation Commission
C&C Clean and Clean watershed planning funds
CLG Certified Local Government Grants
CREP Conservation Reserve Enhancement Program
DEC Vermont Department of Environmental Conservation
DFPR Vermont Department of Forest Parks and Recreation
DFW Vermont Department of Fish and Wildlife
DHCA Vermont Department of Housing and Community Affairs
DOH Vermont Department of Health
EPA Environmental Protection Agency
EQIP Environmental Quality Incentives Program
FEH Fluvial Erosion Hazard
FEMA Federal Emergency Management Agency
FERC Federal Energy Regulatory Commission
HMGP Hazard Mitigation Grant Program
LaRosa LaRosa Analytical Partnership Program
LEAP Logger Education to Advance Professionalism
LID Low Impact Development
LMP Lay Monitoring Program

MALT Middlebury Area Land Trust
MEG Municipal Education Grants
MPG Municipal Planning Grants
NFIP National Flood Insurance Program
NHRAA New Haven River Anglers Association
NMPIG Nutrient Management Incentive Grant Program
NPS Nonpoint Source Pollution
NRCS Natural Resource Conservation Service
ONRCD Otter Creek Natural Resource Conservation District
ORW Outstanding Resource Water
PFW Partners for Fish and Wildlife Program (USFWS)
RCG River Corridor Grant
RCP River Corridor Plan
RM River Mileage
RMP River Management Program (Agency of Natural Resources)
RNRCD Rutland Natural Resource Conservation District
RRPC Rutland Regional Planning Commission
SARE Sustainable Agriculture Research & Education grant program
SGA Stream Geomorphic Assessment
TMDL Total Maximum Daily Load
TNC The Nature Conservancy
UOCWC Upper Otter Creek Watershed Council
USGS United States Geological Survey
US F&W United States Fish and Wildlife Service
UVM-Ext University of Vermont Extension
VHCB Vermont Housing and Conservation Board
VHCB Vermont Housing and Conservation Board
VIP Vermont Invasive Patrollers
VLCT Vermont League of Cities and Towns
Vtrans Vermont Agency of Transportation
VRC Vermont River Conservancy
VWQS Vermont Water Quality Standards
VYCC Vermont Youth Conservation Corps
WHIP Wildlife Habitat Enhancement Program
WMA Wildlife Management Area

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