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1. AHEAD OF THE STORM

In 2014, members of the Charlotte Congregational Church and the Lewis Creek Association (LCA) joined together to discuss the serious decline of Lake Champlain's health and water quality, and to identify steps communities could take to reduce their contribution to that decline. ***Ahead of the Storm*** **(AOTS)** grew out of this meeting: a group of concerned citizens from Charlotte, Hinesburg, and Shelburne representing municipal, school, church, and civic organizations, with representatives from state agencies.

AOTS is committed to helping communities change the way stormwater is managed on properties in order to reduce water pollution and to be more prepared for extreme weather events. Stormwater runoff from driveways, fields, parking areas and lawns is a major factor in the deterioration of our water quality. Heavier and more frequent rainfalls are contributing to increased erosion and the flow of pollutants into our lakes and streams.

Project Description

The goal of **AOTS** is to showcase examples of positive land stewardship throughout the LaPlatte watershed region, including the McCabe's Brook, the LaPlatte River, and adjacent smaller streams draining to Lake Champlain. According to the South Chittenden River Watch stream monitoring program, this region has documented overall poor water quality conditions. To accomplish the **AOTS** goal, 14 municipal, commercial and private properties were selected to become demonstration sites on which to study more optimal or robust conservation practices in a variety of landscape settings across our watershed region. Sites were chosen because of the documented poor water quality in their catchment, and stressors and pollution issues in each catchment inform the design at that particular site.

With state and local funding (see below), LCA and **AOTS** hired engineers from Milone and MacBroom, Inc. to assess each property and to design the most optimal plans to address stormwater runoff issues. To date, many of the sites have design proposals and some have been constructed. Where landscape conditions allow, these plans use more "Optimal Conservation Practices" or OCPs. OCPs allow runoff from larger weather events, and/or from the entire neighborhood catchment area, to slow down, spread out and seep into the ground, reducing or eliminating sediments and other pollutants flowing into rivers and lakes. OCPs aim to increase flood resiliency during Vermont's more frequent and extreme storm events.

The public will be invited to tour many of these sites, to learn about the ways in which stormwater moves on a particular site, and to see how, without proper treatment designs, stormwater degrades nearby streams and the Lake. The public will be able to view the proposed plans for changing the flow and absorption of the runoff, and/or the completed projects. Printed materials describing the engineer assessment and design process are available for each AOTS site.

These demonstration sites serve many purposes, all for the benefit of improving our water resources and storm resiliency:

- Community members will learn more about Optimal Conservation Practices and how they can apply these practices to their own properties and/or advocate for OCPs on public lands.
- Municipal officials will be encouraged to assess town properties, to promote OCPs in the management of public lands, and to support OCPs in town plans and regulations.
- As a result of the installation of OCPs, there will be a reduction of stormwater runoff inputs into local streams and the Lake, with the long-term benefit of improving water quality and flood resiliency.
- The sites will model high quality stewardship of the land, influencing current and future generations to improve management of stormwater in ways that more greatly reduce pollution and the accelerated eutrophication of Lake Champlain.

Future Plans

AOTS continues to work with demonstration site owners to determine the best design options for their properties and to develop implementation plans. AOTS is actively assisting property owners to seek funding sources for the implementation and stewardship phases of their projects. In addition, AOTS materials aim to assist interested property owners who were inspired by the demonstration sites to design their own OCPs.

Project Partners and Funders

Lewis Creek Association
Milone and MacBroom, Inc.
Charlotte Congregational Church
Charlotte Library
Town of Shelburne
Town of Hinesburg
Town of Charlotte
South Chittenden River Watch
LaPlatte Watershed Partnership
Place Creative Company
AOTS Demonstration Site Property Owners
Kelsey Trust, Vermont Community Foundation
Vermont Agency of Natural Resources
Winooski Natural Resources Conservation District
Lake Champlain Basin Program
VTrans Better Roads Program
UVM Lake Champlain Sea Grant
The Nature Conservancy, Vermont Chapter

Surface Water Conditions & Ahead of the Storm Project Location

LaPlatte River & Direct Drainage Watersheds
Hinesburg, Shelburne, & Charlotte, Vermont

Introduction

Data collection over the past 10 years in the watersheds of the LaPlatte River, Thorp Brook, Kimball Brook, and Holmes Brook has improved understanding of water resource conditions and led to the identification of water quality, stream channel stability, and habitat improvement projects. This project summarizes the data on a map and prioritizes the projects in a list for each Town – Charlotte, Hinesburg, and Shelburne. An annotated bibliography has been provided to connect each recommendation to the data and report from which it originated.

Legend

Water Quality

- Poor
- Moderate
- Good

P	Solids
Cl	E.Coli

Baseline conditions at South Chittenden River Watch sampling stations (2004 to 2015) compared to VT Water Quality Standards (2014). Poor Water Quality can degrade local habitat and downstream receiving waters such as Lake Champlain.

P = Total Phosphorus
Solids = Turbidity
Cl = Chloride
E. Coli = Indicator of coliform bacteria

Stream Channel Stability

- Poor
- Moderate
- Good

Likelihood of excessive channel change, such as erosion, deposition, or suddenly changing paths, during a flood.

Landcover

- Developed- Medium to High Density
- Rural Development- Low Density
- Agriculture
- Shrubs and Grasses
- Forest
- National Wetland Inventory
- Lakes and Ponds

The type of landcover influences stormwater runoff, with more runoff from urban and agricultural areas than from forested and naturally vegetated landcovers. Data from 2006 NLCD, corrected by MMI based on field observations 2013.

Streams (By Order)

1 2 3 4 5

- Railroad
- Roads
- Town Boundary
- Watershed Boundary

- Ahead of the Storm Project

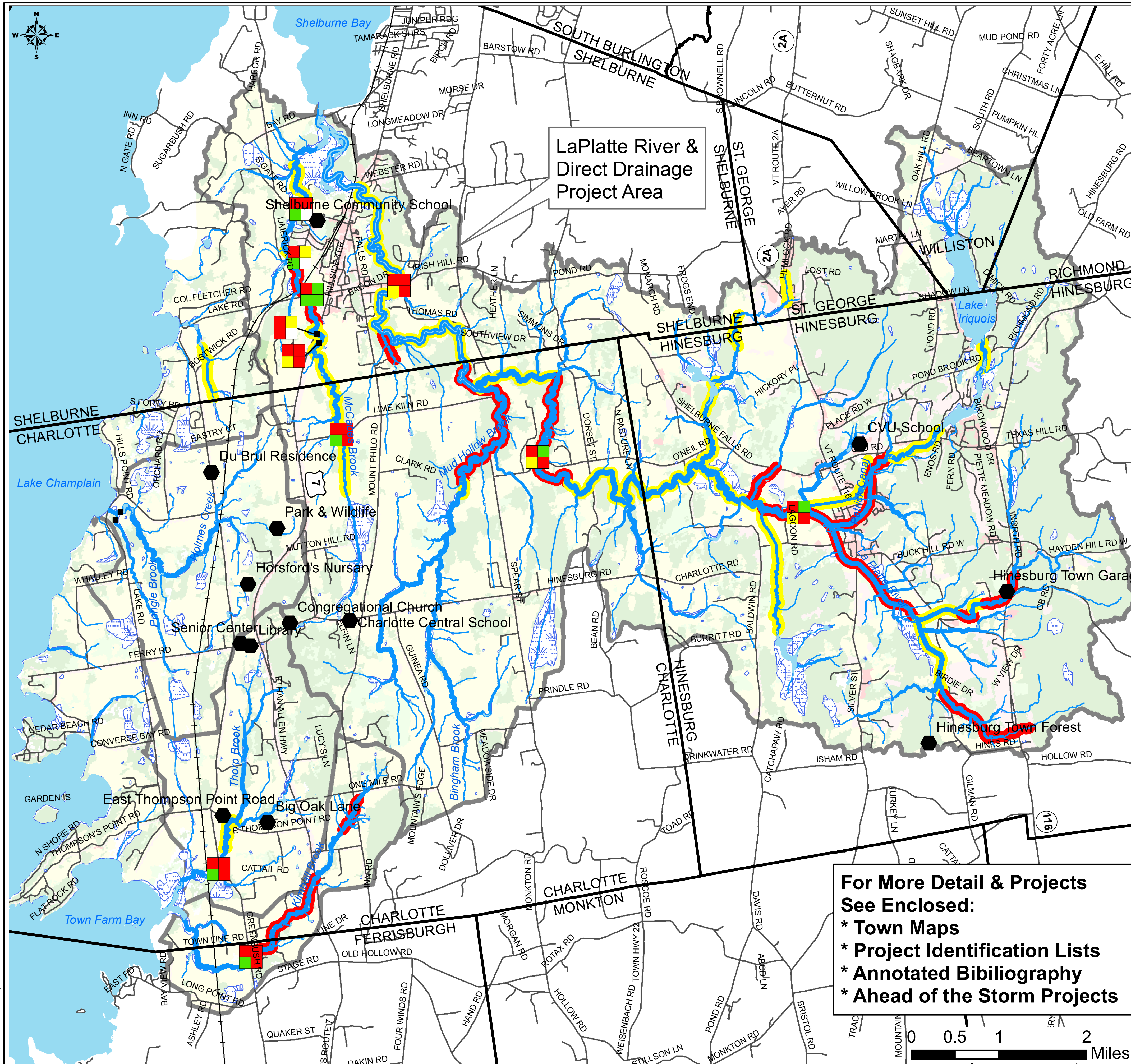
For More Information:

Lewis Creek Watershed Association
www.lewiscreek.org

LEWIS CREEK ASSOCIATION

This project was funded by an agreement awarded by the Great Lakes Fishery Commission to the New England Interstate Water Pollution Control Commission in partnership with the Lake Champlain Basin Program. NEIWPCC manages LCBP's personnel, contract, grant, and budge tasks and provides input on the program's activities through a partnership with the LCBP Steering Committee.

Lake Champlain Basin Program
NEIWPCC New England Interstate Water Pollution Control Commission
MILONE & MACBROOM®



3. AHEAD OF THE STORM (AOTS) DEMONSTRATION SITES

Shelburne, Charlotte and Hinesburg demonstration sites showcase a variety of optimal storm water and water quality conservation practices designed for more extreme weather events, increased water quality treatment and river corridor protection. See section 6 for site information.

Treatment Area Size, Ownership, Town, Funding Source	Demonstration Site Name Watershed	Site Description/ Stormwater Problem to Address	Potential Implementation Practices
Small Scale, Public Charlotte ERP design	Charlotte Library 115 Ferry Rd., Charlotte Holmes Brook Watershed	Increased flow and inundation from impervious surfaces in hydric soil location	Rain barrels, swales, wetland enhancement, rain garden
Small Scale, Public Charlotte ERP design	Charlotte Senior Center 212 Ferry Rd., Charlotte Holmes Brook Watershed	Increased flow and inundation from impervious surfaces in hydric soil location	Rain barrels, swales, bioretention area, rain garden
Small Scale, Public Charlotte ERP design	Charlotte Park & Wildlife Refuge North Greenbush Rd., Charlotte Holmes Brook Watershed	Runoff and erosion from ditches in agriculture land use flowing toward town beach and Lake	Soft gully fixes, check dams, swales
Small Scale, Private Charlotte ERP design	Horsford Gardens and Nursery 2111 Greenbush Rd., Charlotte Holmes Brook Watershed	Runoff and erosion from ditches in commercial land use	Soft gully fixes, check dams, swales, rain garden
Large Scale, Public Charlotte ERP design	Charlotte Congregational Church 403 Church Hill Rd., Charlotte McCabe's/Thorp Brook Watersheds	Increased flow and erosion from impervious surfaces and steep headwater slopes	Rain garden, swales, wetland enhancement
Large Scale, Private Charlotte ERP design	Big Oak Lane neighborhood Big Oak Lane, Charlotte Thorp Brook Watershed	Increased flow and erosion from impervious surfaces in lacustrine soils location near stream	Swales, stormwater pond, vegetation plan, check dams, riparian buffer
Large Scale, Private Charlotte ERP design	Dubrul home 845 Greenbush Rd., Charlotte Holmes Brook Watershed	Increased flow from town ditch and high water table location	Rain garden vegetation plan, check dams, swales
Large Scale, Private Charlotte ERP design VTrans BR implementation	Mack farm and ETP Road ROW E. Thompson's Point Rd., Charlotte Thorp Brook Watershed	Increased flow and erosion from ag fields, undersized road ditch, direct discharge to Brook	Swales, right size culvert, vegetation plan, check dams, riparian buffer
Large Scale, Public Hinesburg ERP design	Hinesburg Town Garage 907 Beecher Brook Road, Hinesburg LaPlatte Watershed	Increased flow and erosion from impervious surfaces associated with Town Garage/ Gravel Pit and CSWD Drop Off Center	Vegetation plan, erosion runoff controls, Bio- Retention pond or Rain Garden.
Large Scale, Public Hinesburg ERP design	LaPlatte Headwaters Town Forest Gilman Road, Hinesburg LaPlatte Watershed	Accelerating head cut from past forest and river management practices	Professional evaluation on causes of erosion and establishment of management plan
Med Scale, Public Charlotte LCBP design	Charlotte Central School 408 Hinesburg Road McCabe's Brook Watershed	Increased flow and inundation from impervious surfaces in hydric soil location	Rain barrels, swales, wetland enhancement, rain garden
Med Scale, Public Shelburne LCBP design	Shelburne Community School 345 Harbor Road, Shelburne McCabe's Brook Watershed	Increased flow and ponding from impervious surfaces in hydric soil location at gateway to Shelburne Bay	Rain barrels, swales, wetland enhancement, rain garden
Medium Scale, Public Shelburne ERP design LCBP implementation	Sally Thomas home and Brook Lane ROW 41 Pinehurst Drive, Shelburne Munroe Brook Watershed (stormwater impaired)	Increased flows and ditch erosion from ditch network	Right size ditch, swale enhancement with vegetation and check dam
Medium-Large Scale, Public Hinesburg LCBP design	CVUHS 369 CVU Rd, Hinesburg LaPlatte/Patrick Brook Watershed	Increased flows and erosion from impervious surfaces	Swale enhancement with vegetation and check dam, bioretention area

4. DESIGN PRINCIPLES FOR OPTIMAL CONSERVATION PRACTICES

The goal of the Ahead of the Storm (AOTS) Project, led by the Lewis Creek Association, is to define and implement Optimal Conservation Practices (OCPs) that establish treatment levels above permit requirements necessary to protect ecosystem functions where feasible and cost effective. Recent climate trends show increasing storm frequency, intensity, and magnitude[1][2]. AOTS recognizes a need for greater emphasis on water retention, infiltration and filtering. Recommended OCP practices will naturalize the movement of stormwater runoff across the land, enhance flood resiliency, and protect water quality in receiving lakes and streams. This approach is recommended for Vermont headwater forest protection [3] and is also applied here in the LaPlatte watershed region of the Champlain valley.

OCPs do a more complete job of slowing down runoff, spreading out runoff, and promoting infiltration[4].

SLOW IT DOWN
Increase Roughness of Land Surfaces
Decrease Slopes
Dissipate Energy

SPREAD IT OUT
Disperse Flow Paths
Interrupt Flow Paths
Direct to Infiltration

SOAK IT IN
Increase Infiltration
Minimize Disturbance
Minimize Impervious Surfaces & Soil Compaction

GUIDING PRINCIPLES IN DESIGNING OCPS FOR WATER QUALITY PROTECTION & FLOOD RESILIENCY

- ✓ Slow the rate of water flow
- ✓ Increase the amount of infiltration
- ✓ Reduce soil movement and erosion
- ✓ Enhance the capacity of naturally vegetated land to trap sediment
- ✓ Maintain water quality even during storm events
- ✓ Consider stream stability and water quality of the greater river system
- ✓ Reverse cumulative impacts from multiple problem areas
- ✓ Use practices known to reduce phosphorus-rich runoff
- ✓ Use practices that are cost-effective and feasible for landowners
- ✓ Go beyond the minimum design requirements to achieve OCPs

EXAMPLES

- 100-foot buffer from surface waters, instead of the minimum requirements
- When possible, design for larger stormwater flow volumes than are required by state permits
- Where possible, design for the channel protection volume (CPv) standards for optimizing the stormwater practice. These standards are designed to help avoid incremental impacts to the stability of nearby stream corridors by slowing and treating stormwater runoff on site.
- If redeveloping a site, account for the amount runoff from the entire impervious and natural areas.
- Design for no net water volume runoff when changing land use and land cover.

REFERENCES

[1] Armstrong, W. H., M. J. Collins, and N. P. Snyder, 2012. Increased Frequency of Low-Magnitude Floods in New England. Journal of The American Water Resources Association 48(2):306-320.

[2] Collins, M. J., 2009. Evidence for Changing Flood Risk in New England since the Late 20th Century. Journal of The American Water Resources Association 45(2):279-290.

[3] Underwood, K. L. and D. Brynn, 2015. Enhancing Flood Resiliency of Vermont State Lands (Draft). Prepared for Vermont Forests, Parks & Recreation by South Mountain Research & Consulting and Vermont Family Forests, Montpelier, VT.

[4] USEPA, 2014. Planning for Flood Recovery and Long-Term Resilience in Vermont: Smart Growth Approaches for Disaster-Resilient Communities. EPA 231-R-14-003. Office of Sustainable Communities, Smart Growth Program, U.S. Environmental Protection Agency, Washington, DC.

GLOSSARY

Channel Protection Volume (CPv): The stormwater treatment standard that requires that stormwater from a given land use after a 1-year, 24-hour rainfall event be contained in a stormwater management structure for a certain amount of time before it enters the nearest water body. For cold water fish habitats, stormwater must be contained for 12 hours, and for warm water fish habitats, 24 hours, to meet the standard of channel protection volume.

Climate Resilience: The capacity for human communities and surrounding ecosystems to absorb stresses and maintain function in the face of external stresses imposed upon it by climate change (e.g., flooding, drought, etc).

Hydrology: The movement of water in relation to land.

Headwaters: A tributary stream that is close to or forms a part of its source river.

Infiltration: The downward movement of water into soil.

Stormwater Infrastructure: the basic physical structures designed to capture, store, and treat stormwater runoff. Stormwater infrastructure includes (but is not limited to) retention ponds, ditches, swales, rain gardens, and constructed wetlands.

Riparian Buffer: Vegetated areas along river banks that filter pollution, protect riverbank stability, and provide habitat.

Water Quality Volume (WQv) and Treatment Standards: The stormwater infrastructure must be designed to capture 90% of the annual storm events (referred to as the **90% rule**), and remove 80% of the annual post-development total suspended solids load, and 40% of the total phosphorus load.

1-year, 24-hour storm: A storm volume that could be expected to hit Vermont any given year over a period of 24 hours (i.e., a 100% chance). Currently, the Vermont Stormwater Manual defines this as a roughly 2 inches of rainfall in 24 hours. This value varies slightly across the state. In Chittenden County, a 1-yr, 24-hr storm is defined as bearing 2.1 inches of rainfall.

10-year, 24-hour storm: A storm volume that could be expected to hit Vermont once every ten years over a period of 24 hours (i.e., a 10% chance). In Chittenden County, a 10-yr, 24-hr storm is defined as bearing 3.2 inches of rainfall.

100-year, 24-hour storm: A storm volume that could be expected to hit Vermont once every one-hundred years over a period of 24 hours (i.e., a 1% chance). In Chittenden County, a 1-yr, 24-hr storm is defined as bearing 5.2 inches of rainfall. **Note**: When considering climate change (think Tropical Storm Irene), 100-yr, 24-hr storms are projected to occur far more frequently than a 1% chance would suggest.

5. SITE ASSESSMENT & DESIGN PROCESS

The process and steps for any design process are similar and can be applied to solve problems across a large variety of site conditions and landuses. An AOTS demonstration site involves close participation with the property owner throughout the steps. The following is an overview of the site assessment and design process. Some advanced steps may not be required for a simple project.

PRE-PROJECT DEVELOPMENT

Before a project begins, it needs to be identified and landowners need to be willing to proceed. Steps might include:

- Identify a general problem area based on stream water quality, known flood problems, or other water related issues.
- Discuss possible benefits, project impacts, as well as long-term maintenance requirements with landowners and other stakeholders so that there is a mutual understanding of possible projects.
- Document project buy-in from landowners and move forward with next steps.

MAP CONTEXT & FEATURES WITH EXISTING DATA

During this desktop phase, preparation for a site visit is complete by compiling aerial photography and available data:

- Topography (elevation, peaks, and depressions; contours from LiDAR, if available)
- Soil Map: hydrologic soil groups (A, B, C, D) and floodable soils
- Existing wetlands
- Property lines
- Nearby water quality and subwatershed area
- River Corridors
- Fluvial Erosion Hazard Zones (FEH)
- FEMA floodplains and floodways
- Other known mapped data, possibly from a site plan or existing stormwater permit

SITE ASSESSMENT FIELD VISIT

Visit the site and use compiled basemap data to guide more detailed observations and record:

- Identify and draw arrows showing water flow paths including pipes, swales, and overland
- Record erosion — stream banks, rills, gullies
- Locate existing stormwater infrastructure — pipes, ditches, ponds, catchment areas
- Map impervious surfaces — buildings, parking areas, roads (paved and gravel)
- Note land type and/or ecosystems present — meadow, forest, lawn, paved, gravel
- Photograph site conditions
- Note site constraints such as utilities — electrical wires, poles, manholes, valves indicating water lines, etc.
- Note site opportunities for stormwater treatment (especially wet areas) and consider possible solutions
- Delineate larger subwatershed drainage area and boundaries which are typically drawn to encompass areas where treatment may be done
- Locate site information not otherwise noted, including water quality conditions of the subwatershed
- Record all information on mapping and in notes

DESIGN

Visit the site and use compiled basemap data to guide more detailed observations and record:

- Draw drainage area boundaries to all possible stormwater treatment areas
- Perform hydrology calculations based on soils, land use, and runoff patterns
- Choose and size OCPs based on target storms – maximize treatment capacity to address future climate
- Illustrate OCPs on design plans – include plan, section, profile, and details to define the specific action

IMPLEMENTATION

Discuss OCPs and costs with landowners and work with them on any remaining steps up to and including construction:

- Make plans for additional design and engineering, soils testing, survey, securing funding, and/or permitting, if needed
- Consider volunteer, donation, or education options
- Consider phases if more than one practice designed
- Construction, then ongoing maintenance

GLOSSARY

Analysis of Alternatives (AoA): an analytical comparison of the effectiveness, cost, and risks of any potential OCPs that could fit the site. Factors that go into this analysis include runoff volume, erosion, and other site-specific variables.

Culvert: a tunnel carrying a stream or open drain under a road, railroad, trail, or similar obstruction/impervious surface.

Drainage Area Boundaries: Comparable to the rim of a bowl, drainage area boundaries are the higher elevation points surrounding an area from which water is shed and deposited into points of low elevation.

Erosion: The action of surface processes (e.g., water flow in this context) that remove soil, rock, or dissolved material from location and then transports it to another.

FEMA: The United States Federal Emergency Management Agency, which responds to natural disasters including extreme weather events.

FEMA floodplains: A floodplain is an area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding. FEMA has mapped floodplains by their definition and standards. These areas may differ from local boundaries.

Fluvial Erosion Hazard (FEH) Zones: Formal areas delineated for certain communities based on studies of how far the stream or river reaches during heavy rain/flood events.

Gully: A landform created by running water, eroding sharply into soil (typically on a hillside).

Hydrologic soil group: A soil classification system created by the NRCS, ranked A to D. *Group A* consists of sand, loamy sands, or sandy loams, and has the lowest runoff potential and highest infiltration rates. *Group B* consists of silt loams or loams, and has a moderate infiltration rate. *Group C* consists of sandy clay loams, and have low infiltration rates. *Group D* consists of clay loams, silty clay loams, sandy clays, silty clays, or clays, and has the highest runoff potential and lowest infiltration rates.

Impervious surfaces: A surface (such as asphalt) that does not allow water to penetrate or infiltrate through.

NRCS: The United States Department of Agriculture's Natural Resource Conservation Service.

Ponding: Areas where water forms pools or puddles.

Rill: A shallow channel cut into soil by the erosive action of flowing water.

Riparian Buffer: Vegetated areas along river banks that filter pollution, protect riverbank stability, and provide habitat.

River Corridor: Room needed by a stream to maintain its least-erosive form and buffer.

Runoff: The movement of water, and substances carried with it, across a land surface.

Stormwater Infrastructure: Natural and green structures and land features designed to capture, store, and treat stormwater runoff. Stormwater infrastructure includes (but is not limited to) retention ponds, ditches, swales, rain gardens, forests, natural areas and wetlands.

6. AOTS DEMONSTRATION SITE MATERIALS

Site Packet Contents

- AOTS Summary Materials
  - Existing Conditions and Site Assessment with Map and Photo
  - Final Design Concept, Layout Details, Operations and Maintenance Plan
  - Cost Estimate
- Implementation
  - Current Status and Funding
  - Photos

Site Packet Links

Charlotte Library

Charlotte Senior Center

Charlotte Park & Wildlife Refuge

Horsford Nursery, Charlotte

Charlotte Congregational Church

Big Oak Lane Neighborhood, Charlotte

Du Brul Home and Greenbush Road, Charlotte

Mack Farm and East Thompson's Point Road, Charlotte

Hinesburg Town Garage

LaPlatte Headwaters Town Forest, Hinesburg

Charlotte Central School

Shelburne Community School

Brook Lane, Shelburne...coming soon

Champlain Valley Union High School (CVUHS), Hinesburg...coming soon

7. CONTACT INFORMATION AND RESOURCES

Partners and Funders

Lewis Creek Association
Milone and MacBroom, Inc.
Charlotte Congregational Church
Charlotte Library
Town of Shelburne
Town of Hinesburg
Town of Charlotte
South Chittenden River Watch
LaPlatte Watershed Partnership
Place Creative Company
Kelsey Trust, Vermont Community Foundation
Vermont Agency of Natural Resources
Winooski Natural Resources Conservation District
Lake Champlain Basin Program
VTrans Better Roads Program
UVM Lake Champlain Sea Grant
The Nature Conservancy, Vermont Chapter
AOTS Demonstration Site Property Owners (see page 6)

Helpful Resources

The Vermont Rain Garden Manual "Gardening to Absorb the Storm" – general design information and plant info
http://www.uvm.edu/seagrant/sites/default/files/uploads/publication/VTRainGardenManual_Full.pdf
Vermont Low Impact Development Guide for Residential and Small Sites
https://anrweb.vt.gov/PubDocs/DEC/WSMD/stormwater/docs/sw_LID%20Guide.pdf
Vermont Green Stormwater Infrastructure (GSI) Simplified Sizing Tool for Small Projects
http://www.vpic.info/GreenInfrastructureCalculatorsAndSizingTools.html
Vermont DEC Stormwater Program
http://dec.vermont.gov/watershed/stormwater
New Draft Stormwater Manual – this has design information for most of the treatment options
http://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/ManualUpdate/sw_VSMM_VOLUME1_03012016_DRAFT.pdf
University of New Hampshire Stormwater Center
http://www.unh.edu/unhsc/
Vermont Wetland Plant Supply – local plants with lots of information on where they are appropriate
http://vermontwetlandplants.com/