The Stormwater & Smart Growth Connection

Planning & Designing Water-Smart Communities in the Lake Champlain Basin




NATIONAL WILDLIFE FEDERATION

LAKE CHAMPLAIN COMMITTEE

VERMONT FORUM ON SPRAWL

WITH SUPPORT FROM

LAKE CHAMPLAIN BASIN PROGRAM

Founded in 1939, the NATIONAL WILDLIFE FEDERATION'S mission is to protect and inspire Americans to protect wildlife for our children's future. NWF's northeast regional office is in Montpelier, VT.

Founded in 1963, the LAKE CHAMPLAIN COMMITTEE (LCC) is the only citizen's group dedicated solely to protecting the natural resources and beauty of Lake Champlain and its surrounding watershed in the states of New York and Vermont and the province of Quebec.

The mission of the VERMONT FORUM ON SPRAWL is to encourage economic vitality in community centers and preserve Vermont's unique working landscape and quality of life. The Forum is devoted exclusively to promoting research-based smart growth action.

CONTENTS

Montpelier, Vermont (Winooski River)

Fair Haven, VT

Port Kent, NY (Au Sable River)

INTRODUCTION

Smart growth and stormwater management go together. There is a common misperception in the ongoing stormwater debate in the Lake Champlain Basin that land development (growth) and water resource protection are incompatible. The reality, however, depends on WHERE and HOW Basin towns develop and grow.

This brief guide explores the connection between land development and water resources—specifically, how "smart growth" can help prevent and reduce stormwater problems that threaten the health of Lake Champlain and other waterways in the Lake Champlain Basin. And, it shows how stormwater management strategies can help support smart growth goals.

Smart growth strategies are an essential component of cost-effective stormwater management in the Lake Basin. Conversely, stormwater management techniques can also help Basin towns to grow smart.

Left: Stormwater is rain and snowmelt that runs off hard, water-impervious surfaces associated with land development—such as roads, roofs, parking lots, and compacted soils. **Right:** Plattsburgh, NY. Compact neighborhoods, conservative use of pavement, and integrated green spaces, are key development features for both smart growth and stormwater management.

The primary tenet of smart growth is a land use pattern of **compact development** surrounded by open, rural landscape; it also promotes the integration of undeveloped, **"green" spaces** *within* town centers and neighborhoods. Smart growth addresses many other aspects of community life—from transportation and housing choices to recreation and employment opportunities; but, for stormwater management, this central focus on compact development and green spaces is the most important feature of smart growth.

This guide provides a framework to help Basin towns plan and design more compact, vital, and livable communities and achieve cost-effective stormwater management at the same time. Intended for local officials, landowners, developers, and others, it describes concepts, analysis, and tools to inform land use planning and design decisions.

Hallmarks of Smart Growth

Compact development patterns

Conservation of natural areas and green spaces

Focus on existing town centers and neighborhoods

Mixed land uses

Distinctive public spaces

Diverse housing choices

Multiple transportation choices

Fair, predictable project review

Water-Smart Development Goals

1. Plan compact development in areas where stormwater impacts can be minimized.
2. Integrate functional green spaces into the design of neighborhoods and town centers.
3. Conserve open space and limit development in water-sensitive areas.

Basin towns have multiple tools available to them to promote such water-smart development. This booklet highlights four major types of measures that can be used in combination to implement both growth and stormwater management goals.

Growth issues vary across the Lake Champlain Basin. Many Basin towns are striving to spur development, while others wrestle with constant growth pressures. In either case, planning and design strategies that address both smart growth and stormwater management issues have numerous direct benefits.

Such strategies can augment existing stormwater and smart growth policies to form a comprehensive, minimum-cost approach to promoting *water-smart* communities in the Lake Champlain Basin. The term *smart growth* evokes images of vibrant town and village centers, traditionally-designed neighborhoods, pedestrian-friendly streets, and lively public spaces. Water-smart growth simply means looking at smart growth in a watershed context and stresses the importance of integrating green spaces and stormwater management practices into those familiar scenes.

This booklet is based on leading research in smart growth and stormwater management as well as input from local officials, planners, water resource professionals, and citizens from around the Lake Champlain Basin. This information was synthesized to develop a basic, flexible approach to planning and design that is applicable to the diversity of towns across the Basin. Using available local information, Basin towns can tailor this approach to meet their own goals.

We hope you find this information useful for your town.

Tools & Strategies

Modified land use regulations

Incentives for landowners and developers

Direct public investment

Technical assistance

Benefits

Enhanced community character and vitality

Cost savings for municipalities and landowners

Healthier streams, rivers, and lakes

STORMWATER & GROWTH: WHAT'S THE CONNECTION?

Stormwater runoff has been a major impediment to restoring the health of Lake Champlain and many of its tributary streams and rivers. Water quality improvements for Lake Champlain in recent decades have been achieved largely through sewage treatment plant upgrades and reductions of other point sources of pollution. Following those improvements, however, non-point sources--including stormwater and farm runoff--have continued to add nutrients, sediment, bacteria, and other pollutants to the Basin's waterways, and have emerged as the leading water pollution issue for the Lake Champlain Basin.

Growth in the Basin presents both challenges and opportunities for towns to manage stormwater from existing and new development. Growth also poses a variety of other social, economic, and natural resource issues. But regardless of whether a town is trying to stimulate or control growth, all towns should be as concerned with HOW they change and develop as well as how much. ***Smart growth*** aims to ensure that growth brings change for the better, on all fronts.

While there are concerns about how growth affects water resources, many landowners, businesses, public officials and others also have concerns about how regulations to manage stormwater may, in turn, affect growth. This booklet shows ways that stormwater management strategies can be used to support community goals to "grow smart."

Common Goals

Smart growth and stormwater management share four major common goals. First, smart growth promotes **compact development.** It also emphasizes **redevelopment** of existing, but underused, built areas before extending development into outlying areas. Compact development, however, does not mean only roofs, pavement, and other water-impervious surfaces. Smart Growth also includes **green spaces**—parks, gardens, landscaping, and other undeveloped and vegetated areas—within built-up areas. Finally, smart growth stresses the importance of **design** to integrate buildings, streets, green spaces, and other elements into a well-functioning and attractive whole.

A quick overview of stormwater management basics shows why these four goals—compact development, redevelopment, green space, and integrated design—are also fundamental to managing and minimizing stormwater impacts.

COMPACT DEVELOPMENT = Buildings clustered to create vital neighborhoods and town centers. (Ticonderoga, NY)

REDEVELOPMENT = Re-design and re-use of existing building sites. (Plattsburg, NY)

GREEN SPACE = Undeveloped, vegetated areas within and surrounding compact developments. (Fair Haven, VT)

DESIGN = Integration of buildings, streets, and green spaces into a functional, attractive whole.

Water Has To Go SomeWhere

When rain falls or snow melts, the water has to go somewhere. Under natural conditions in the Lake Champlain Basin, most of it is initially intercepted by vegetation (trees, plants, fallen debris), stored in puddles, or absorbed into the ground. A minor portion—less than 10% on average—travels slowly overland as runoff, eventually reaching nearby waterways. For example, undisturbed forestland in Lake Placid, NY, which receives approximately 40 inches of precipitation each year, yields about four inches of annual runoff on average.

Undisturbed forest cover generates relatively little runoff, typically less than 10% of annual precipitation.

Land development can change all that. Where tree cover and other vegetation are removed, where soils are graded and compacted, and where large areas are paved, the volume and speed of runoff can increase dramatically. This increased runoff, commonly called stormwater when associated with development, can severely degrade local waters in two ways.

Increased Pollutants

As stormwater travels over bare and paved surfaces, it washes a wide range of **pollutants** into local waters and ultimately Lake Champlain. Sediment, bacteria, and nutrients, such as phosphorus, are of particular concern in the Basin for ecological and human health reasons. Stormwater carries other substances such as pesticides, fertilizers, pet waste, and substances deposited by cars (motor oil, gasoline, automotive fluids, metals from brake linings, etc.) into the Lake. Stormwater may also absorb heat as it flows over paved surfaces, warming streams above temperatures favorable for fish and other aquatic life.

Too Much, Too Fast

Sharp increases in runoff **volume** and **speed** cause pervasive problems for streams, rivers, and aquatic habitats. Flooding and erosion following storms becomes more frequent, more intense, and more powerful. Stream banks are undercut, river channels straighten and widen, flows become shallower and warmer between storms, and streambeds become clogged with silt and sediment.

A parking lot generates up to *sixteen times* more runoff than a forested area of equal size.[1]

Stormwater management aims to control such increases in runoff volume and velocity as well as filter pollutants, such that runoff from developed areas mimics natural runoff patterns to the maximum extent possible. Smart growth is fundamental to cost-effective stormwater management for several reasons.

South Burlington, VT. Surging stormwater flows increase erosion, flooding, and sedimentation in rivers and streams.

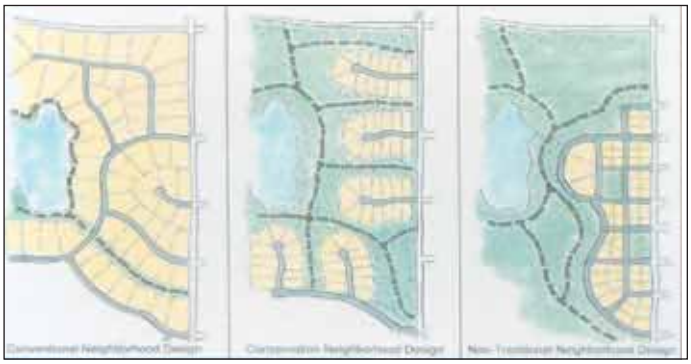
Rutland, VT. Stream health tends to decline with increasing impervious land cover, particularly when total imperviousness reaches a critical threshold. That threshold varies from stream to stream, but averages approximately 10% of a stream s drainage area.

Compact Development Minimizes Water-Impervious Cover

The first principle of stormwater management is to minimize impervious cover—roads, parking lots, roofs etc—that generates stormwater and conserve natural areas that store and infiltrate rain and snowmelt. In short, less impervious cover means less stormwater that needs to be managed. Minimizing impervious surfaces on a given site is helpful, but it is more important to minimize total impervious cover over larger town and regional scales.

Multiple studies of small streams, including streams in the northeastern U.S., show a strong correlation between the total percentage of water-impervious surfaces covering a stream's drainage area (its *watershed*) and the severity of in-stream impacts caused by stormwater.[1] Some streams exhibit significant degradation with less than three percent (3%) of their drainage area covered by hard surfaces. Other streams show comparable effects only at much higher levels of impervious cover. Research results suggest that, on average, indicators of stream health show a marked decline as impervious cover approaches approximately 10% of a stream's drainage area. Specific streams may have higher or lower thresholds, but the 10% figure provides a useful rule-of-thumb.

It might seem that low-density development—where houses or buildings cover a small percentage of a given parcel—would benefit stormwater management. Buildings, however, are not the only impervious surface of concern. Low-density development, requires a significantly larger impervious footprint of roads, driveways, and parking areas compared to compact alternatives.



Scattered, low-density residential development can have an impervious footprint more than three times greater per unit than compact alternatives.

Wallingford, VT. Conversion of natural vegetation to lawns can account for more than 30% of stormwater volume in low-density residential areas.

Fair Haven, VT. Overpaved? Many built areas, even town centers, simply have more paved surfaces than they may need or want.

Pavement and buildings are also not the only source of increased runoff. Lawn areas are often graded and rolled, which compacts soils and removes surface depressions. As a result, lawns often function as *semi-pervious* surfaces and hold much less water than the natural vegetation they replaced. Some lawn areas can be so compacted they generate nearly 90% as much runoff volume as typical pavement.

Substantial conversion of natural forests, fields, and meadows to lawn can add significantly to runoff volume—accounting for up to 30% of total runoff from some low-density residential developments.[2] Fertilizers and pesticides applied to lawns also add to stormwater pollutant loads from many low-density developments.

Thoughtful design at the site scale can also help minimize the total impervious cover required to accommodate a given land use type and density. Many building sites are simply "overpaved" in that they have more impervious surfaces than they need for their desired use. Green spaces and other pavement alternatives can be integrated into even highly compact downtown areas.

Not only does low-density development increase the amount of impervious cover required per building unit, but increased automobile travel induced by low-density sprawl also increases the rate of pollutant build-up on roads and parking lots and the rate at which these pollutants are washed into Lake Champlain.

Rutland, VT. Strip development, low-density land use patterns, and other features of sprawl increases traffic volume and accelerates the build-up of automotive pollutants that wash off roads and parking lots into Lake Champlain.

Redevelopment Minimizes New Stormwater Sources

Annual loads of critical pollutants for Lake Champlain, particularly phosphorus, have been significantly reduced in recent decades with

improvements in wastewater treatment and some improvements in farm runoff control.[3] These phosphorous reductions, however, are being offset by increases in other sources, primarily stormwater from new land development.

Smart growth limits new stormwater sources by emphasizing redevelopment over new "greenfield" development—i.e. building on previously undisturbed land. Even the best-engineered stormwater treatment facilities (ponds, basins, etc.) remove no more than 80% of target pollutants. Consequently, new development, even with state-of-the-art stormwater management practices, can only increase pollutant loading to Lake Champlain and other waterways. Equally important, new development foregoes opportunities to address existing stormwater problems during redevelopment.

Reductions in key pollutants entering Lake Champlain, such as phosphorus, are being offset by new sources, primarily stormwater from new development in the Basin. (Developed land contributes more phosphorus, per acre, on average, than farmland.)

North Elba, NY. New greenfield development increases pollutants to Lake Champlain, even with state-of-the-art stormwater ponds.

Smart Growth Helps "Disconnect" Runoff

All impervious surfaces are not created equal. Stormwater impacts depend greatly on how and where roads, parking lots, and other hardened land cover are located within a watershed.

Under natural conditions, certain parts of a watershed contribute more runoff than others. Runoff is generated where rain or snowmelt adds water faster than vegetation and soil can hold and infiltrate it into the ground. Low-lying areas, especially areas with less permeable and poorly-drained soils, where water frequently collects and saturates soils, are primary source areas for surface runoff. These areas conduct the majority of runoff to stream and rivers and can be described as more "connected" in regards to runoff.

Upland areas with well-drained soils generally contribute little surface runoff under natural forest cover conditions. Runoff from these "disconnected" areas travels a long, slow, trickling path over rough, vegetated surfaces and most often evaporates or soaks into the ground before it ever reaches a stream, river, or lake.

Essex, VT. Sprawl extends roads and drainage channels into areas that were previously disconnected in terms of stormwater. This short-circuiting of natural drainage networks greatly increases the volume, speed, and efficiency of runoff.

Sprawling land use patterns extend roads, driveways, ditches, and other drainage infrastructure into previously disconnected areas. This spreading of infrastructure "short-circuits" the drainage network, allowing runoff to drain more quickly and "efficiently."[4]

Headwater streams are particularly sensitive to this effect. These numerous small streams at the upper reaches of a watershed normally receive the slowest and smallest amounts of surface runoff. Development in these areas can create hydrologic changes that are relatively dramatic and highly destabilizing for these smaller streams.

Compact development and redevelopment limit new extensions of roads and drainage channels by adding impervious cover near areas that are already stormwater-connected. New increases in runoff volume and speed are thereby minimized; and sensitive headwater stream areas are left undisturbed.

Vergennes, VT. Distributed stormwater management practices can reduce the need for more costly centralized practices. This vegetated swale functions to slow, store, and treat stormwater.

Reducing Stormwater Management Costs

In areas that are already developed, thoughtful design can also use green space to disconnect impervious surfaces, such that runoff is allowed to slow, spread, and soak into the ground before it reaches a drainage channel. Combining compact development with green space and design provides a cost-effective opportunity to invest in small, distributed stormwater practices. Such practices can be integrated into even the densest neighborhoods and can reduce or avoid the need for more costly centralized ponds and basins.

Shorter is cheaper. Low-density development typically requires two to five times more linear feet of drainage channels and other stormwater infrastructure than compact alternatives.

Stormwater management also involves substantial linear infrastructure—i.e. swales, ditches, pipes etc. Similar to roads, "shorter is cheaper" when it comes to construction and maintenance of stormwater infrastructure. A typical suburban-style development with large lots and long drives may employ up to five times more linear feet of stormwater channels than an alternative compact site plan. Cost savings of compact development can range into thousands of dollars per unit, though actual cost differences vary with site conditions.

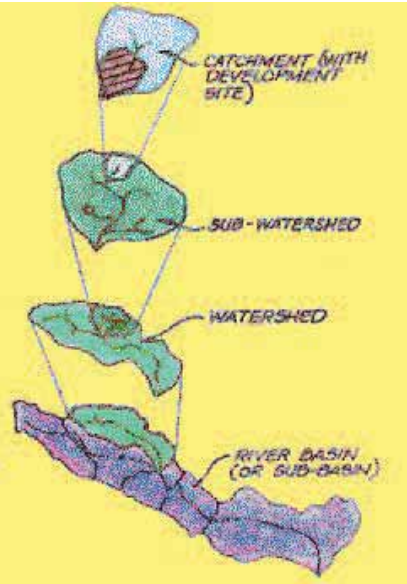
Higher densities also allow infrastructure costs to be divided among a larger population base. While a compact development project may incur higher costs than a low-density plan for the same area, **installation and maintenance costs on a per person or per unit basis are substantially lower.**

PLANNING FOR STORMWATER & SMART GROWTH

The integration of stormwater management and smart growth begins with planning. Stormwater management has been typically regarded as a technical issue to be fixed by technical measures—typically large basins, ponds, and other centralized facilities to collect and treat runoff. There are limits, however, to the effectiveness, costs, land requirements, and desirability of this purely technical approach. A profusion of artificial ponds, for example, can reduce groundwater recharge and create mosquito and safety issues.

Concerns about the effect of smart growth on stormwater management have also focused narrowly on site scale issues—i.e. higher density equals greater site imperviousness. It is equally important, however, to look at the stormwater-smart growth connection at larger neighborhood, town, and regional planning scales.

At the planning scale, Basin towns can be more strategic, comprehensive, and cost-effective about managing stormwater, promoting vibrant communities, and making efficient use of land. Planning is fundamental to advancing goals for compact development, redevelopment, green space, and integrated design. Specifically, planning can:



A sub-watershed is the area draining into a small stream.

1. Promote compact development—in areas where cumulative stormwater impacts can be minimized and managed cost-effectively.
2. Prioritize redevelopment—in areas with greatest opportunities to reduce impervious cover, improve site design, and enhance stormwater management.
3. Reserve green space—within built areas and in outlying areas less suited for intense development.
4. Promote integrated design—of buildings, streets, and green spaces, in order to manage stormwater close to its source and enhance community life.

Defining Sub-Watersheds

Good planning begins with an assessment of existing conditions. To address both smart growth and stormwater management goals, one needs to assess existing land use and water resource conditions. Sub-watersheds are often the most useful planning areas for these purposes.

A sub-watershed is the area draining into a small stream (typically ranging from approximately one to fifteen square miles). Stormwater impacts are readily observable in smaller streams ; and, towns can evaluate and compare sub-watersheds in terms of land use patterns and relative stormwater impacts.[5]

Stormwater impacts—such as channel erosion, pollutant increases, and changes in aquatic life—are strongly correlated with the percentage of impervious cover within a given sub-watershed. The relationship between impervious cover and these stream impacts can vary, however, from one sub-watershed to another, due to natural watershed characteristics or man-made efforts to reduce stormwater impacts.

Why Sub-Watersheds?

Planning at the subwatershed scale is useful because:

1. Influence of impervious cover on stream channels, water quality, and aquatic life is easily observed.
2. Masking effect of other pollutant sources (e.g. wastewater, farm runoff) is minimized.
3. Number of political jurisdictions is limited.

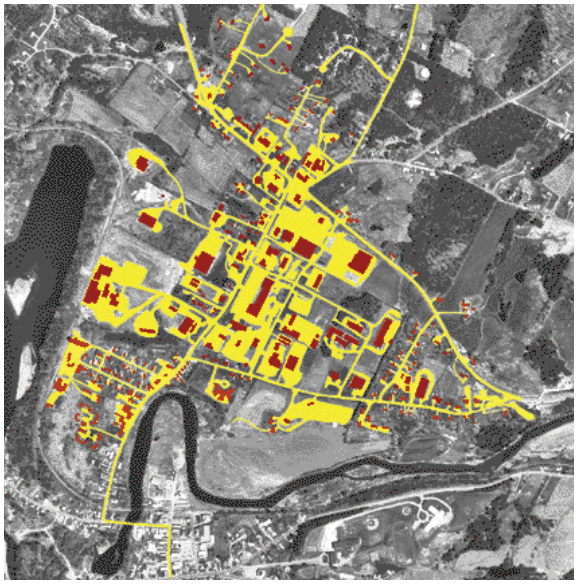


Photo credit: Vermont Forum on Sprawl

Morrisville, VT. Impervious cover can be measured with maps and aerial photos.

Photo credit: Barton Kirk

Williston, VT. Visual observation together with stream monitoring data can be used to assess stormwater impacts to streams.

New Development Areas

Some sub-watersheds may maintain relatively healthy streams despite comparatively high levels of development. Natural factors—such as highly-permeable soils, gentle topography, and protected open space—may moderate the effects of impervious cover on stream health. Man-made factors—such as compact land use patterns, good site design, and engineered stormwater practices—may also combine to ameliorate stormwater impacts. These sub-watersheds demonstrate an effective "capacity" to accommodate development with fewer stormwater impacts. Such areas are the most suitable areas to target new compact development and investments in additional stormwater management capacity.

Redevelopment Areas

Other sub-watersheds may have significant levels of development, but offer fewer advantages for moderating stormwater impacts. Topography and soils may be less favorable, or land use patterns and site conditions may be more characteristic of sprawl—such as strip development with large parking areas or many low-density subdivisions spread across the landscape. Stream conditions in these areas would be expected to be degraded—to or beyond the degree that their level of impervious cover would predict. Some highly-developed sub-watersheds in the Lake Champlain Basin have reached sufficient levels of impervious cover to be designated as water-quality "impaired" by stormwater under state and federal law.

Such sub-watersheds have the greatest relative need for comprehensive stormwater improvements. Redevelopment should be the growth priority in these sub-watersheds. Redevelopment projects are important opportunities to increase density and enhance site design, while reducing excess impervious cover and improving stormwater management.

New greenfield projects, even compact developments, should be discouraged in these degraded watersheds as they will only add to existing stormwater impacts, as discussed in the previous chapter. Towns may create provisions for "offsets" for new developments, where impervious cover is removed elsewhere in order to achieve a net reduction in overall impervious cover.

Hinesburg, VT. Well-designed compact town centers and neighborhoods often present opportunities to add new development with minimum stormwater impacts.

Lake Placid, NY. Many built areas present redevelopment opportunities to reduce impervious surfaces, increase permeable green space, and improve stormwater management.

Restoration Areas

Some sub-watersheds may exhibit significant stormwater impacts despite relatively *low* amounts of total impervious cover. These sub-watersheds may be naturally sensitive to development impacts or have acute site-specific stormwater problems, such as poorly-sited roads or severely eroding drainage ditches. Installing strategic stormwater retrofits to help restore degraded waterways should be the priority for these sub-watersheds. Restoration could include limited redevelopment, but overall, relatively low existing development intensity makes these areas less suitable for major new development.

Moretown, VT. Areas with little development and few stormwater problems merit the highest level of protection from stormwater impacts.

Protection Areas

Other sub-watersheds with little to no development activity generally exhibit high water quality and stable stream channels. Such areas are increasingly rare and generally warrant the highest relative level of protection, regardless of their natural capacity to accommodate development.

Wolcott, VT. Areas with relatively low levels of development may still exhibit significant stormwater impacts that should be addressed without promoting additional development.

Basin towns can assess their own sub-watershed using more detailed information. Each sub-watershed has a unique set of water resource and land use conditions; however, for planning purposes, towns can compare and classify their local sub-watersheds according to their relative levels of impervious cover and stormwater impact. Table 1 shows the basic framework.

TABLE 1. Comparison of sub-watersheds by relative levels of development and stormwater impacts

	HIGH IMPERVIOUS COVER	LOW IMPERVIOUS COVER
HIGH STORMWATER IMPACTS	Priority: **REDEVELOPMENT** Encourage redevelopment that reduces impervious cover and improves stormwater management ¥ Low-density, sprawling land-use patterns ¥ Poor site design ¥ Excessive use of impervious cover ¥ Lack of stormwater controls	Priority: **RESTORATION** Retrofit existing stormwater problems and limit intense development to realize stream restoration potential. ¥ Acute site-specific stormwater problems ¥ Sensitive watershed conditions
LOW STORMWATER IMPACTS	Priority: **NEW DEVELOPMENT** Target specific areas for new compact development. ¥ Favorable topography and soils ¥ Low-impact land-use patterns ¥ Careful site design ¥ Effective stormwater controls	Priority: **PROTECTION** Conserve land and limit intense development to maintain existing water quality ¥ High-quality, stable waterways ¥ Potential sensitivity to stormwater impacts

Growth Planning Goals

Sub-watershed assessments help focus attention on different opportunities to promote smart growth and enhance stormwater management. Towns can develop planning goals for different sub-watersheds that reflect these opportunities, based on relative comparisons of land use and water resource conditions. A general set of planning goals is shown in Table 2; more specific goals may vary depending on other local considerations.

TABLE II. Growth planning goals for different sub-watershed designations

DESIGNATION	GROWTH PLANNING GOALS
NEW DEVELOPMENT	¥ Promote compact development and redevelopment ¥ Set appropriate limit for total impervious cover (e.g. <10%) ¥ Expand and enhance green spaces ¥ Invest in additional stormwater management capacity ¥ Designate new town/village centers where necessary
REDEVELOPMENT	¥ Reduce total impervious cover below target threshold (e.g. <10%) ¥ Prioritize redevelopment projects that reduce impervious cover removed and improve stormwater management ¥ Establish higher stormwater standards for greenfield development (including offsets)
RESTORATION	¥ Set total impervious cover limit at level substantially lower than sub-watersheds designated for development (e.g. <5%) ¥ Retrofit existing stormwater problems.
PROTECTION	¥ Set total impervious cover limit at level substantially lower than sub-watersheds designated for development (e.g. <3%) ¥ Apply highest stormwater management standards ¥ Provide additional protections for groundwater recharge and other water-sensitive areas.

Implications for Future Development

Towns may not have areas that fall into every category; but, in general, this framework of sub-watershed designations and associated growth planning goals suggests that:

1. New, compact development should be encouraged in sub-watersheds with the greatest opportunities and "capacity" to manage cumulative stormwater impacts and where additional stormwater management capacity can be most strategically and cost-effectively created.
2. Redevelopment should be prioritized in areas where reduction and reconfiguration of impervious cover is most needed. Sub-watersheds that have exceeded a target threshold of impervious cover and show unacceptable levels of stormwater impacts—impaired streams, in particular—have essentially used up available stormwater management "capacity". Additional capacity should be created before or concurrently with new development activity—through "offsets" or other investments.
3. Sub-watersheds designated for restoration or protection may receive small-scale new development, preferably within or near existing town and village centers, but the overall goal should be to maintain total impervious cover within relatively low limits compared to sub-watersheds designated for development.

Stormwater Considerations in Designating Development Districts

Designating a sub-watershed for new development or redevelopment does not mean all areas within that sub-watershed are equally suitable to accommodate substantial growth. Just as some sub-watersheds are more suitable for development than others, some areas within each sub-watershed are more suitable than others, based on existing land use and watershed conditions.

These areas are where development would, ideally, be located. Existing development centers, however, grew up for other historical reasons and, as discussed earlier, new development is generally best sited within existing town centers, for both smart growth and stormwater management reasons.

Existing development centers, though, are not equally suited for major expansion. Although many land use plans may generally designate existing town centers as target areas for development, the total amount of growth planned for a given district should consider potential cumulative stormwater impacts, existing stormwater capacity, and opportunities to manage stormwater cost-effectively.

For example, town centers that lie low in their watershed and drain to large waterways are typically good candidates for development expansions. Rivers that already carry large volumes of water are better able to accommodate increases in stormwater volume and velocity with fewer impacts compared to smaller streams. Large rivers also dilute pollutants more easily. Such areas offer opportunities to minimize impacts, but cumulative impacts to water quality and increased runoff volume are still a concern, and stormwater should be managed as effectively as possible.

New compact development in and around such town centers also limits extensions of the drainage network into upper reaches of the watershed, and avoid impacts to sensitive headwater streams. Fortunately, because of the Lake Champlain Basin's economic history and often

steep topography, many existing town centers are, in fact, located in the valleys of larger rivers and streams. Developments old and new, however, have also crept up hillsides and higher elevation roads and often contribute stormwater problems disproportionate to their low building density.

Thus, designations of development districts ought to consider their stormwater implications; and distinctions should be made among different levels of planned growth. In Vermont, where the term "growth center" is commonly used, distinctions have been made between regional and local growth centers. In New York, the terms hamlet, village, or downtown districts can help differentiate the intended size of development centers. Stormwater considerations often align with other smart growth goals, but a proper sub-watershed assessment can help identify areas where growth objectives may conflict or be limited by stormwater management constraints.

Montpelier, VT. Town centers along large waterways often offer the most opportunities to accommodate new development with the least cumulative stormwater impacts.

More Green In-Between

In designating development districts, planning for **green space** within such districts is equally important. Open space is often a development afterthought—the space that is leftover after buildings and hard infrastructure have been sited. Deliberate integration of green space into development districts, however, is fundamental to both stormwater management and smart growth goals alike.

A system of "green infrastructure" can include stream corridors, floodplains, wetlands, swales, valleys, and other areas where runoff naturally concentrates. From these primary natural features, the green space system can extend to landscaped features—such as parks, gardens, and lawns—that can be linked and modified, if necessary, to enhance stormwater management.

These same green spaces can be part of efforts to make town centers and neighborhoods more attractive, more walkable, less dominated by cars, and more friendly to people in general. Larger green areas can also be used for recreation, visual buffers, wildlife habitat, and other public uses.

A district plan can show the layout for a functional green space system integrated within a compact town center or neighborhood. It provides the underlying foundation for distribution and design of site-specific green spaces and stormwater practices as discussed in the next chapter.

District plans should show how green spaces will be integrated with development and where stormwater practices will be located.

DESIGNING FOR STORMWATER & SMART GROWTH

Water-smart planning identifies opportunities to promote compact development in places where stormwater impacts can be minimized. Water-smart design endeavors to take advantage of such opportunities. First and foremost, site design can minimize impervious surfaces, even in compactly-built areas. At the same time, water-smart design focuses on creating and enhancing green spaces within compact neighborhoods and town centers, making those green spaces more useful for stormwater management, and providing room to install special stormwater management practices. These green spaces, whether existing or newly-created, can become more than stormwater infrastructure. With thoughtful design, green spaces become enduring site amenities and community assets.

Stormwater management practices include a wide variety of measures and techniques to slow, store, treat, and infiltrate stormwater runoff. Large, structural practices such as stormwater ponds and basins are among the most commonly-known stormwater practices. An alternative approach to stormwater management known as *Low-Impact Development*, however, emphasizes the use of "integrated" or "distributed" practices—multiple, small, decentralized, often low-tech practices that are strategically applied throughout a development site.

Used in combination, distributed practices can significantly reduce the size, cost, and need for centralized stormwater collection systems and large, structural stormwater storage and treatment practices. Low-Impact Development and water-smart site design techniques can be applied to a single site or, better yet, to entire neighborhoods and districts.

Plattsburgh, NY. Water-smart design takes advantage of green spaces within compact town centers and neighborhoods to help manage stormwater.

Rutland, VT. "Low-Impact Development" techniques include maintaining tree cover, minimizing impervious surfaces, and making room for water-permeable green spaces.

Principles

Actual design of green spaces and low-impact stormwater management practices involves site-specific engineering calculations, but the concepts of low-impact site design can be distilled into a few basic principles:

LID Design Principles

Minimize total impervious cover.

Avoid disturbance of natural vegetation.

Maintain and enhance surface depressions.

Flatten grades in developed areas.

Slow and store runoff close to its source.

Disperse and infiltrate runoff.

Lengthen flow paths for concentrated runoff.

Green Spaces

These low-impact development principles can be applied in an infinite variety of ways, but most involve the strategic use and design of green spaces within built areas. There are three basic types of green space features that can be recruited to help manage stormwater. As stormwater flows downhill, depending on the shape of the ground surface, it will either spread out over broad surfaces such as vegetated buffers, concentrate into drainage channels, or collect in surface depressions (whether they be small puddles or large ponds). Most green spaces fall into one of these three basic types of landforms:

Maintaining or restoring open, uncompacted soils and a dense vegetative cover will enhance the capacity of any of these green space features to slow, store, filter, and soak stormwater into the ground. Then, where resources afford or regulations dictate, additional engineered practices can be added to these green spaces to further increase their effectiveness and volume capacity to manage stormwater.

Green Spaces for Managing Stormwater

- Buffers
- Channels
- Depressions

Buffers

Vegetated buffers are flat or convex-shaped areas where runoff is able to spread out, slow down, and eventually infiltrate into the ground. Rooftop runoff, for example, can often be spread over lawn and garden areas instead of being concentrated into a drainage channel. Buffers can be particularly effective for relatively small or narrow impervious areas, such as driveways, sidewalks, and bike paths, but are also useful to break up large paved areas such as parking lots.

A buffer needs to be wide enough for the expected stormwater flow—which, in turn, should be controlled (with a level spreader if necessary) to enter the buffer as low-energy sheet flow. In addition, naturally rough and uneven surfaces within a buffer also help store stormwater until it infiltrates.

Bristol, VT. Vegetated buffers allow stormwater to spread out and infiltrate into the ground.

In addition to buffers, other permeable surfaces can sometimes be substituted for conventional hard surfaces. Grass pavers, open-design brick and concrete pavers, and other types of permeable pavement can, like buffers, allow stormwater to infiltrate into the ground. Rooftop gardens and other "green" roofs also help reduce runoff from buildings. Rooftop runoff, which is relatively clean, can also be collected in cisterns or other storage devices (and used for landscaping and other water needs).

In addition to buffers, other water-permeable surfaces, such as these porous pavers, can help infiltrate stormwater.

Channels

Channels include broad, vegetated swales and other drainage pathways that act to slow and detain stormwater as it travels. Open channels are much preferable to pipes or narrow, bare soil ditches which convey water rapidly with little opportunity for infiltration or treatment, and may even contribute sediment and other pollutants through their own erosion. Curb and gutter systems, a feature of many traditional neighborhoods, also function as high-velocity channels. Curbs can remain a part of water-smart street design, however, by installing breaks and turnouts where stormwater can flow through adjacent green spaces and stormwater practices.

Rutland, VT. Grassed swales and other vegetated drainage channels help slow and infiltrate stormwater as it travels downhill.

Depressions

Depressions are one of the most important landscape features for stormwater management. Under natural conditions, undulations of topography and rough, uneven surfaces create a variety of depressions—large and small—that store and infiltrate runoff. In a developed landscape, rough surfaces are often graded and smoothed over or depressions are drained or isolated, such that they no longer collect water. Rough surfaces and depressions in lawns and other landscaped areas, however, can be re-created and enhanced as natural, temporary storage for runoff.

Castleton, VT. Landscape depressions can help store and treat stormwater.

Stormwater Management Practices

In addition to their natural hydrologic functions, green spaces provide opportunities to distribute engineered stormwater practices throughout built areas to further increase stormwater management effectiveness and volume capacity. Note, this design approach addresses the green space system and ways to reduce stormwater volume and velocity first. This emphasis differs from conventional approaches where large stormwater practices are applied at the bottom of the drainage network.

The goals of stormwater management practices—large, small, or in combination—however, are the same: to slow, store, infiltrate, and filter stormwater, and both centralized and distributed practices can play important roles in make Basin communities more water-smart.

Both the New York and Vermont stormwater manuals provide detailed descriptions and specifications of different types of practices. These practices generally fall into five basic types: **infiltration** practices, **filtering** practices, **channel detention** practices, **ponds,** and **wetlands**—many site-specific practices may involve more than one type. The key issue for planning and site design, though, is to understand how these practices can fit into existing or newly created green spaces.

Small depressions, for example, can be specifically designed with vegetation, soil amendments, and accessory drain pipes to increase their capacity to filter stormwater. These "rain gardens" can be particularly effective in treating the "first flush" of a rainstorm (the initial 1/2 inch) which often carries the majority of pollutants.

Ponds and wetlands, on the other hand, are basically large depressions with varying levels of standing water. They may occur naturally in low-lying areas, while artificial ponds, basins, and wetlands have been used widely in the Lake Champlain Basin to control and treat stormwater. Their effectiveness, however, can vary. Many existing stormwater basins only reduce peak flows, but are not designed to control for water quality or total stormwater volume.

Rain gardens and other stormwater practices can enhance the effectiveness and capacity of green spaces to manage stormwater.

All stormwater practices require periodic maintenance to function properly. An uncounted number of stormwater facilities in the Lake Champlain Basin have not been regularly maintained or monitored, however, and may not be functioning at their intended level of effectiveness.

Williston, VT. Large stormwater management facilities, such as this artificial wetland, can also blend into neighborhood design.

Opportunities & Applications

Perhaps the most important step in water-smart design is to identify *opportunities* to enhance existing green spaces, restore new green spaces, and add new stormwater practices. First, existing green spaces can be inventoried and assessed for their potential function as buffers, open channels, or depressions. Many green spaces are already provide such stormwater management functions; but many vegetated and landscaped areas are prevented from receiving stormwater by grading, curbing, or other design factors. Recruiting these areas for stormwater management and stormwater practices typically involves regrading and rerouting stormwater drainage paths, while also ensuring good soil and vegetation conditions.

Other opportunities can be found where excess pavement or other hard surfaces can be restored to green space (or replaced with alternative surfaces) without reducing other design functions such as automobile, bicycle, and pedestrian traffic, parking, etc. Opportunities commonly exist in many, if not all, Basin towns, particularly in town centers and compact neighborhoods. Some of these common opportunities to create new or enhance existing green areas are described below.

Parks

Parks are fundamental green space features for enhancing the vitality and livability of compactly-settled areas. Parks can also provide abundant space to receive stormwater runoff from adjacent built areas and accommodate a variety of stormwater practices. Rain gardens, vegetated swales, ponds and wetlands have all been installed in public parks. Planting trees, installing landscaping, and restoring natural groundcover in strategic drainage areas can also help reduce and slow runoff. In other ordinary lawn areas, soils and grades can be enhanced to lengthen drainage paths and increase depression storage and infiltration capacity.

Plattsburgh, VT. Stormwater is often prevented from draining to green space by curbing or other site grading features.

Wallingford, VT. The relative presence or absence of storm drains is one indication of how well green space is being used to manage stormwater.

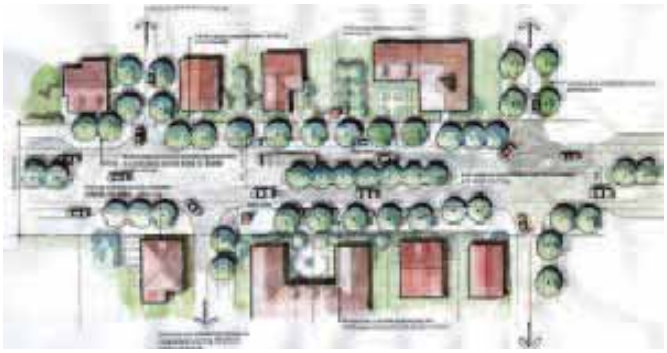
Streets & Public Rights of Way

Public roads and streets often contribute the largest share of collected stormwater; yet, they also provide some of the best opportunities to integrate green space and low-impact stormwater manage-

ment practices into built areas. The trend for many roads is to become steadily wider over time. Advocates for safer, more walkable, and more livable communities, however, often recommend limiting or reducing road widths and installing other traffic-calming features to improve traffic flow, reduce car speeds, and enhance pedestrian and bicycle use.

Road-narrowing may provide enough space to add an open, vegetated swale to convey and treat stormwater from roads and other impervious surfaces. In other cases, road-narrowing may provide room to plant trees and increase the green buffer between roadways and sidewalks. Green space can also be added as a central median to create boulevard-style streets, which can accommodate trees, swales, and other practices, as well as pedestrian paths. Such green medians, where they exist, are often the most prized feature of neighborhood streets.

Other techniques can help narrow roads and reduce overall imperviousness. Queuing lanes—where one travel lane is used for traffic in two directions and side lanes are used for parking or to wait for on-coming traffic to pass—can be used in low-traffic neighborhood streets. All these measures can help reduce distances that pedestrians must cross at one time and make town streets safer and more walkable. Road narrowing also tends to reduce automobile speeds which can increase safety for children who bike or play on neighborhood streets.



Streetscape improvements can simultaneously increase safety, enhance pedestrian use, and provide space for stormwater practices.

Plattsburgh, NY. New and existing parkland can provide prime opportunities to manage stormwater and improve neighborhoods.

Private Yards & Gardens

Public rights-of-way are sometimes not wide enough to accommodate new green space or stormwater practices. In some cases, yards and gardens of adjacent lots may be recruited to provide the necessary green space. Lots fronting on streets may have existing drainage easements and may already conduct runoff from adjoining parcels, although it may be in a fast-flowing ditch or pipe. These areas provide prime opportunities for rain gardens or other spot practices to detain and slow runoff from both roadways and other hard surfaces.

Parking Lots

Parking lots can be sources of major stormwater problems. Parking designs often create large, uninterrupted areas of hard surfaces which allow stormwater to accelerate and concentrate. Parking lots also accumulate high pollutant loads as cars

Vergennes, VT. Private yards may play an important role in managing stormwater from public roads and

Lake George, NY. The design of this parking lot ignored the opportunity to drain stormwater to adjacent green space.

drip fluids and deposit other substances over an extended time period.

The large size and configuration of many parking lots, however, present an opportunity to manage stormwater and soften their visual impact. Existing or added landscape islands within parking lots as well as perimeter landscaping are excellent opportunities to install stormwater practices such as rain gardens, swales, and buffers.

Permeable paving, grassed paving, or just plain grassed lawn can also be used for seasonal, overflow, and other low-traffic parking areas. Permeable alternatives to asphalt include open-design ceramic or brick pavers that can also be attractive for pedestrian and other uses when not occupied by cars. Underground or decked parking, where land use densities can support the cost, can also greatly reduce the total impervious footprint devoted to parking.

Walkways & Bicycle Paths

Sidewalks and other walkways need to be designed as carefully as any other impervious surface, especially given their linear form that may provide long distances over which stormwater may accelerate. But because they are typically narrow (relative to roads), walkways and bicycle paths often present simpler stormwater management challenges. Runoff from these features can often be managed with a well-vegetated shoulder and properly-designed buffer, provided there is sufficient space.

Grading and buffer design, however, is particularly important for such linear features. Stormwater should generally flow perpendicular to the direction of pathway into the buffer. Where runoff is allowed to flow parallel to the paved travelway, it can accelerate, concentrate, and erode new unplanned drainage channels and compromise the effectiveness of buffer.

Driveways

Driveways are also often unnecessarily wide or excessively paved. Driveways can often be narrowed

Plattsburgh, NY. Stormwater from walkways and bicycle paths often can be managed simply with a well-designed buffer.

and, because of their low-traffic, are excellent candidates for permeable pavements. Limiting pavement to surfaces that vehicle tires are actually rolling on and planting the remainder in grass or other groundcover is an even simpler way to reduce impervious cover and increase permeability.

Stormwater from driveways is also frequently channelized and directed toward the street and its drainage network. Diverting stormwater flows into adjacent buffers, or into side or rear yards where possible, is an effective way to disconnect driveway runoff from and reduce collected stormwater volumes. Where driveways are also relatively short, stormwater can often be easily managed by small practices, such as buffers and rain gardens.

New Subdivisions & Site Plans

The opportunities described above apply to existing as well as new developments. Opportunities for low-impact design in new developments, however, are even greater and more flexible. The arrangement of lots, siting of houses and buildings, and layout of roads, driveways, and parking areas can all help reduce imperviousness and manage stormwater, while, at the same time, enhancing neighborhood character.

In residential and commercial developments, houses and buildings can be clustered and sited close to the street, reducing the length of connecting roads and driveways. Clustering also creates more contiguous green space, where stormwater may be diverted and infiltrated on-site. Multistory buildings further reduce the size of their impervious footprint and expand green spaces in compact areas. They can also, when carefully sited, help create a sense of proportion and enclosure that enhances the human scale of neighborhood streets.

Driveways and parking are often best located toward the side and rear of residential and commercial buildings where there is often more room for green space and stormwater practices. Separating houses and buildings from streets and sidewalks with vast areas of cars and parking has become an all too-common practice in newer developments, making local streets less inviting for walking and other activities that add to community vitality.

Front yards may also provide functional green space and room for stormwater practices and should be recruited for such purposes where possible. In compactly-designed neighborhoods and business districts, however, space between buildings and their street frontages is typically more limited; and stormwater from driveways, parking areas, or other impervious surfaces is more likely to be directed toward the overtaxed street drainage system. This is another good reason to locate parking and other impervious toward the side and rear of buildings as much as possible.

Rutland and Burlington, VT. Driveways can be designed with minimum impervious surfaces

EXISTING POLICIES FOR STORMWATER & SMART GROWTH

Stormwater and smart growth have become significant policy issues on both the Vermont and New York sides of the Lake Champlain Basin (less so in the predominantly aqricultural Quebec portion). However, stormwater and land use policies in each state have evolved within different political, social, and economic contexts. An understanding of these policies is useful before moving on to consider local strategies that Basin towns might develop to integrate stormwater management and smart growth efforts. A brief overview of these policies is provided below.

VERMONT

Vermont State Stormwater Program

Stormwater management policies in Vermont have gone through several iterations in recent years. Prior to the 1990's, state regulations were limited to requirements to control peak stormwater discharges in order to address flooding problems. Such controls were required primarily of new, large developments. Advances in stormwater research, however, triggered efforts in Vermont to also reduce water quality, channel erosion, and stream habitat impacts caused by stormwater. In 2002, the Agency of Natural Resources (ANR) released the first Vermont Stormwater Design Manual, which contained guidance for the installation of stormwater practices to be installed under a state stormwater permit program.

Stormwater became a particularly controversial policy issue in Vermont when an ANR stormwater permit for a large retail development in South Burlington was appealed. The case raised concerns that stormwater regulations may create an unwieldy hindrance to development activity, particularly where it involved waterways on the state "impaired waters" list.

The fact that the site of the contested permit was located within an area designated for growth in the town plan raised further questions whether stormwater policies might, in fact, discourage smart growth. It is worth noting that land use in this area would be aptly described as strip commercial development (along a busy state highway route) versus a compact, walkable business district; and the proposed project was not touted as a smart growth project. Yet, questions and debate continued.

In response, the Vermont legislature passed three successive bills between 1998 and 2003 in the hope of creating an effective and legally-acceptable stormwater permit program. The latest resulting program, however, remains

to be tested, while legal cases are still pending to decide whether developers are also required to obtain federal stormwater discharge permits.

While waiting for resolution of the state program, Vermont cities and towns have continued to wrestle with other growth and development concerns. Many towns are pursuing the tenets of smart growth in various ways under Vermont's banner of "growth centers". The growth center concept is well-established in many Vermont state, regional, and local policies and many Vermont towns in the Basin have identified growth centers in their local plans—whether they be village centers or urban downtowns.

Local Land Use Authority

Vermont towns have considerable latitude under the Vermont Municipal and Regional Planning and Development Act (Title 24 VSA, Chapter 117), to address land use growth and development issues. This same authority also extends to planning and project review efforts aimed to manage stormwater in the interest of public health, safety, and welfare.

More specifically, stormwater management directly relates to local discretion to locate and maintain public facilities. The public facility in this case is a network of stormwater management infrastructure, including "green" infrastructure which may help store, convey, and treat stormwater.

Despite such authority, Vermont towns have typically deferred to the state in the regulation of stormwater discharges. Stormwater management, however, is inextricably linked with land use, a predominantly local issue. A truly comprehensive and cost-effective stormwater management approach requires efforts at the local level that are connected to land use and growth decisions. Federal and state-mandated stormwater regulations are also likely to influence land use decisions. Local officials that fail to address stormwater as a local planning issue risk losing significant control over the future course of development within their towns.

NEW YORK

New York Stormwater Design Manual

New York's approach to stormwater management has evolved differently than Vermont's partly due its large geographic area, its many large cities, and its unique home-rule form of government.

At the state level, New York's stormwater program is an extension of federal stormwater rules that require a permit for developments that disturb more than one acre of land. New Phase II federal stormwater rules will also extend to 16 larger metropolitan areas across the state. Larger cities such as Rochester, Buffalo, and New York City, have also operated under Phase I rules for more than a decade.

The threshold of these state and federal requirements, however, has not applied to the relatively small projects and small communities found in the New York portion of the Lake Champlain Basin. Even Plattsburgh, New York's most urbanized area within the Basin is exempt from Phase II rules. Hence, local strategies for managing stormwater are arguably even more important on the New York side of the Basin.

Local and county officials, however, may use and refer to the same state-authorized stormwater management manual that state regulators use to review large projects for state permits. The same entity that developed the Vermont stormwater design manual, the Center for Watershed Protection, also produced New York's manual, and the two references are similar in content. The New York manual, however, is not tied to a general statewide stormwater permit program as is the case in Vermont.

Local Land Use and the Adirondack Park Agency

Land use is regulated by New York towns under their "home-rule" authority, such that powers not

specifically reserved by the State of New York are assumed by municipal and county entities. Hence, the authority of municipalities to address land use and related growth and stormwater issues as a public concern is, in general, a matter of local discretion.

Much of the New York portion of the Basin, however, also lies within the Adirondack Park, and towns must also comply with regulations administered by the Adirondack Park Agency (APA). APA regulations for development projects contain general requirements that include stormwater runoff as a project review consideration. The APA allows towns to adopt stormwater regulations and policies, subject to APA review, but many towns currently defer to project reviews by APA staff. An important exception is the Lake George Park, where the Lake George Park Commission has developed specific stormwater performance requirements that towns must comply with or adopt their own local equivalent.

Thus, both Vermont and New York towns in the Basin currently have considerable powers but few specific obligations to address smart growth and stormwater—individually or in an integrated manner. The incentives and benefits to do so, however, are substantial. Basin towns already expend tens of thousands of dollars each year to maintain and repair stormwater infrastructure along public roads and municipal facilities. This infrastructure also typically receives a large volumes of stormwater from private developments.

The predominant hill and mountain topography of the Lake Champlain Basin exacerbates stormwater problems and raises the costs of inadequate stormwater management. Washed-out roads, failed culverts, and flood damages are reported from different corners of the Basin almost every year. Many of these problems and damages are a function of how a town has grown up over time and where it has built its houses, roads, and businesses. Towns do not have the luxury of starting over, but they can address the problems they have and act to avoid new problems in the future.

LOCAL STRATEGIES FOR STORMWATER & SMART GROWTH

The planning and design concepts presented here can be advanced by Basin towns through a variety of measures. Towns should start by developing or revising their stormwater management and growth goals and comparing those goals against current policies and procedures. Such reviews help identify the need for policy changes or additional measures.

Some Basin towns already have substantial policies to address stormwater; some towns have none. Most Basin towns, however, fall under some form of land use regulation—town plan, zoning ordinance, public works specifications, subdivision review, etc. These regulations may directly or indirectly shape growth patterns and runoff changes, and deserve a critical review of their potential cumulative impacts on community character and stormwater management.

No single measure is likely to effectively resolve stormwater and smart growth issues by itself. Achieving stormwater and smart growth goals, rather, relies on a comprehensive and varied suite of strategies. Strategies should also be developed to fit the community and its stakeholders. Local officials want tools and policies they can easily administer. Developers regularly express a desire for clearly written regulations, and often a preference for incentives over regulations. Landowners' are wary of how policies may affect their property rights. Concerned citizens appreciate transparency, simplicity, and accountability in policies intended to protect the public's interest.

Stakeholders from around the Basin provided input on potential local strategies to address stormwater and growth issues. The suggested measures below were developed to respond to and respect the interests and needs of these stakeholders. Potential measures coalesced into four major types:

- **Modified land use regulations**
- **Incentives for landowners and developers**
- **Direct public investment**
- **Technical assistance**

At the planning level, local measures should encourage compact development and redevelopment within appropriately designated development districts. They should discourage—or at least not encourage—growth and conserve land in areas designated for protection and restoration.

At the site design scale, measures should encourage more creative and comprehensive use of low impact development practices, and promote the

creation, enhancement, and integration of green spaces into town centers and neighborhoods.

Strategies were developed to be simple and flexible, yet useful to achieve goals for compact development, redevelopment, green space, and integrated design. Measures described below are intended to build upon each other and they are presented roughly in order of fundamental importance. Towns may nonetheless draw on whatever strategies are most practical and feasible for their local situation.

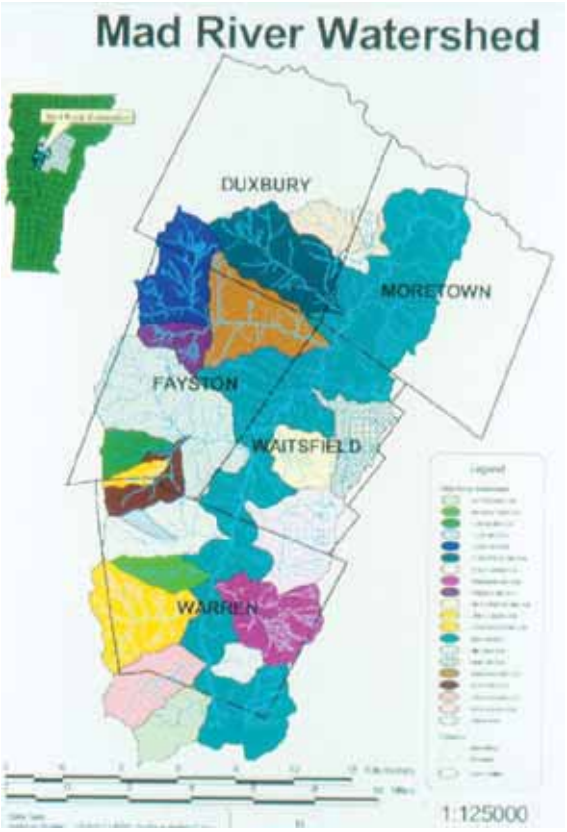
Land Use Regulations

Local land use regulations are sometimes at odds with stormwater management and smart growth goals. They may, for example, dictate uniformly large lot sizes and widely-separated buildings and land uses. Regulations can often be made more effective simply by removing barriers to compact development and innovative site design.

Land use regulations should focus directly on the amount and distribution of impervious cover and green space at both the site and watershed scale.

Many local regulations address factors that only *indirectly* influence the amount and distribution of impervious cover and green space—such as unit density, lot size, setbacks, and lot coverage requirements. To effect stormwater management goals, land use regulations need to directly address imperviousness and its converse, green space, at both the site and district level.

The arrangement of buildings, impervious surfaces and green space are also the primary shapers of a neighborhood's character and attractiveness.



Municipal plans should designate sub-watersheds where development is most suitable.

By directly addressing impervious cover and green space, land use regulations can also help integrate stormwater management with smart growth goals.

Town Plans

Towns can begin by delineating planning areas and development districts—based on sub-watershed boundaries—in their comprehensive plans. Towns should explicitly define stormwater and smart growth development goals tailored to each sub-watershed. The labels *new development, redevelopment, restoration,* and *protection* used in this booklet are broad enough to integrate other planning issues and factors in addition to smart growth and stormwater considerations. Towns, however, may choose to use other terms.

Development District Plans

Many towns try to document all their development goals in a town plan. The scale of town plans, however, does not lend itself to meaningful guidance at the district and neighborhood scale. Towns will benefit in the long run from more detailed district plans for areas designated for development or redevelopment.

A key element of a district plan is the layout of **green space** for stormwater management and other community purposes. In particular, the district plan should show the major drainage pathways for stormwater. A combination of public lands, rights-of-way, landscaping, and easements on private land can be designated in a district plan to create the foundation of a functional stormwater-green space network.

South Burlington, VT. District plans should identify the location of major drainage pathways and other potential green spaces to be used for stormwater management.

Smart Growth Stormwater Overlay Zone

Towns can also carry the idea of special development districts forward by defining them in local zoning ordinances. A simple way to do this is with a zoning overlay—where special conditions apply to an overlay area without changing the underlying zoning (i.e. both overlay and original zoning provisions apply).

Zoning ordinances typically prescribe parameters such allowable land use types and site dimensions. A smart growth-stormwater overlay zone—or more generally, a designated development district zone—can add guidelines and requirement for functional green space, impervious coverage, and mass and height of buildings. Zoning overlays can also add flexibility to existing regulations, such as allowing shifts of density or impervious coverage within a given development district (see below).

Drainage Easements

Existing public land and rights-of-way may be insufficient to create an adequate network of functional green spaces and stormwater practices. Private land often needs to be part of an effective community stormwater strategy. Towns can require new developments to set aside areas for stormwater management purposes—by designating such areas on an official town map or by reserving drainage easements on private lands. For existing developments, towns can offer landowners options to donate or sell such easements, where the town has the right and responsibility to maintain proper drainage and stormwater management practices on private land.

Keeseville, NY. Fast, paved ditches can be replaced with slow, vegetated swales, using drainage easements on private land if necessary.

Green Space and Landscape Requirements

While many towns have requirements for setbacks, lot coverage, and other parameters related to the location of buildings, the condition and function of remaining "unbuilt" areas is often neglected. Such areas can either add to or help control stormwater runoff. Towns can enhance their landscape requirements to ensure that grading, vegetation, and soils of unbuilt or unpaved areas promote retention and infiltration of stormwater. Within compact developments, no area should be regarded as "leftover" space in terms of stormwater; most green areas can be enhanced to infiltrate and reduce stormwater runoff to some degree.

Fair Haven, VT. The ability of trees to catch and store rain in built areas is often underappreciated. Planting trees also greatly adds to neighborhood character.

In addition, trees and other plants can intercept substantial volumes of precipitation. Tree ordinances to protect existing trees and minimize disturbance of natural vegetation by development activity can be a huge aid to stormwater management. Protecting and replanting trees along roads can be particularly effective by intercepting rain and snow that otherwise becomes road runoff.

Impervious Cover Limits

While making green spaces more functional for stormwater management is important; it is equally important to minimize impervious surfaces. A fundamental element of an integrated stormwater-smart growth strategy is to set an impervious cover target for different sub-watersheds and development districts. Such limits can be used as a planning goal—to guide efforts to minimize and reduce impervious cover—or as a regulatory limit—where total impervious cover is maintained below a certain level, requiring new development to remove and restore existing impervious surfaces if necessary.

An impervious cover limit can also be incorporated into criteria for individual project review. Development projects can be evaluated in terms of how much imperviousness they add or remove relative to an established limit. Many Basin towns already have lot coverage limits, however, capping impervious coverage for individual lots will not necessarily limit total imperviousness at the district or sub-watershed level. In addition, areas such as unpaved parking lots and compacted lawns may not count toward lot coverage, but still contribute stormwater.

Impervious Cover Zoning

Many zoning ordinances typically regulate land use type, dwelling unit density, and lot size in order to, among other purposes, control the character and development intensity of different areas. Parameters, such as units per acre and minimum lot dimensions, however, are often only indirect

indicators of the character that towns are trying to create or maintain.

Other design factors such as building mass, impervious cover, and green space, arguably have a more direct influence on the character of a district or neighborhood, as well as its stormwater impacts. Towns can reduce or waive density and minimum lot size requirements in designated development districts, and substitute guidelines for impervious cover, green space, and building mass to achieve a desired result.

Minimum lot sizes and uniform density requirements also tend to spread density uniformly across a zoning district. Alternative impervious cover guidelines would allow developers more flexibility to appropriately vary density and lot size, while minimizing imperviousness within a zoning district without seeking a variance.

Coverage Trading and Mitigation Banking

Impervious zoning ordinances could also allow trading or transfers of coverage within a zoning district to allow flexibility to increase coverage in some areas and restore functional green space in others, while maintaining total impervious cover below a target threshold. Such provisions would help promote compact development within both high and low density districts, while maintaining the intended average density for a given zoning district.

In areas where it is necessary or desirable to substantially reduce overall imperviousness, coverage trading provisions may not be sufficient. Towns may need a banking mechanism to charge or credit landowners and developers for the removal and restoration of existing impervious cover. Landowners may perform the restoration themselves or a municipally-designated entity can also implement such restorations and bank coverage credits for use by future projects.

Trading and banking of impervious coverage can be used in conjunction with other flexible stormwater mitigation provisions—such as allowing developers to pay for stormwater improvements on other parcels. Off-site measures can provide mitigation for individual projects or provide clustered mitigation for several projects. Developers can pay for mitigation projects directly or purchase mitigation credits from a municipally-designated entity.

Coverage trading and banking can be restricted within a single sub-watershed to help implement sub-watershed development plans. Or, transfers can also be allowed between sub-watersheds to minimize imperviousness in areas designated for protection and concentrate impervious cover in areas designated for development. Such provisions are analogous to transfers of development rights; however, transfers of coverage would allow unit development rights to remain, but reduce impervious coverage rights that are more relevant and critical to managing stormwater.

Reduction of existing impervious cover is an important stormwater mitigation measure.

Tiered Stormwater Management Requirements

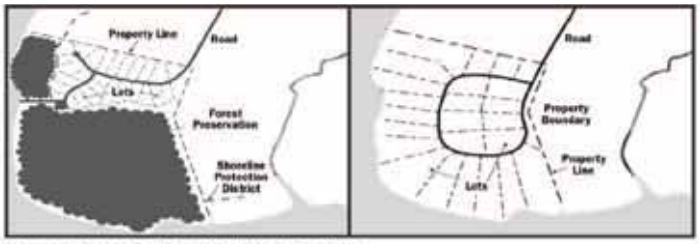
Many local and state policies provide the least stringent stormwater requirements for the most sensitive and highest-quality watersheds, despite vulnerability and unsuitability of these areas for intense development. Adopting more stringent stormwater requirements for these areas would be an appropriate and rational signal for large-scale development to locate in already-impacted areas. Such provisions are consistent with anti-degradation provisions already embodied in state and federal law, but rarely implemented and enforced at the local level.

Subdivision Regulations

Subdivision regulations often prescribe uniform and rigid requirements for minimum building setbacks and frontage requirements. Allowing the flexibility to vary these parameters within an appropriate range for different neighborhoods can help ensure adequate space for stormwater management practices as site conditions vary. Establishing maximum setbacks can also reduce driveway length and impervious cover while keeping buildings generally close to the street to provide for compact development and pedestrian-friendly neighborhood design.

Towns can also established a planned unit development (PUD) provision that allows setbacks and subdivision requirements to be negotiated with the town or waived entirely when alternative design criteria are met.

Castleton, VT. Road specifications should promote narrow roads in low-traffic neighborhoods.



Source: Center for Watershed Protection, 1998

Towns can provide flexible options for neighborhood design.

In some cases, allowing **alternative lot** shapes can reduce impervious cover. Lots can be angled to facilitate alternating side and front garages (Z-lots). Lots can have minimal rear setback with angled back yards that are almost shared between lots (zipper lots). Flag-shaped lots allow access to buildings located behind street front houses using shared driveways. Such lot shapes can help increase density and are particularly useful for infill situations.

Road Specifications

Many towns often apply relatively fixed and uniform specifications to new or reconstructed roads. Towns can instead develop a hierarchy for sizing roads according to the character of the neighborhood and the volume of traffic they will carry. Towns can provide guidelines for specific roads or prescribe a range for street widths and design requirements for different types of roads.

Parking lanes, turnouts, and emergency shoulders that receive less traffic can also be engineered with permeable pavements and provide a change of surface that can both add to the character and reduce speeds on neighborhood streets.

Parking Requirements

Parking areas, especially large continuous parking areas, are a major source of stormwater problems, while parking requirements for commercial and multi-unit housing projects can present significant obstacles to smart growth projects. Towns can help avoid overbuilt parking by eliminating fixed formulas for required parking and allow requirements to be based on a parking assessment. Project applicants can also be given the option to enhance on-street and public parking areas instead of fulfilling parking requirements entirely on each individual site.

Towns can effectively remove parking from the development equation—while pro-actively addressing stormwater impacts—by forming public-private partnerships to build community parking facilities. Instead of requiring on-site parking on every project, landowners and businesses can contribute funds toward shared parking facilities. Such measures may reduce the total number of spaces needed to meet actual parking needs.

Community and shared parking strategies can make installation of permeable pavement and other measures more cost-effective and affordable.

Incentives

Towns can complement and reinforce changes in zoning ordinances and other local regulations by providing additional incentives to locate and design low-impact development in designated areas.

Incentives can offer enhanced predictability, speedier reviews, or financial benefits to project applicants.

Expedited Project Review

Time savings usually translate into cost savings in most development projects. Hence, expedited project reviews are often the strongest incentive that towns can offer project applicants. Towns can offer expedited review to projects that: 1) conform with a specific district development plan (also an incentive for towns to complete such plans); 2) achieve a qualifying score on a project evaluation point system; or 3) earn a smart growth endorsement (see below). In this way, towns can link planning to permitting and project developers can better respond to water-smart planning and design guidelines that towns provide.

Conversely, towns can also require more detailed project review requirements for projects outside designated growth centers, such as independent studies, performance bonds, and monitoring, while waiving these requirements for projects demonstrating conformance with established plans for designated development districts.

Permit Review Point System

A point system can help towns evaluate projects more consistently and encourage applicants to go beyond minimum requirements. Points are accrued by a project for meeting certain specified criteria, which can be weighted to award more points for satisfying more important criteria. Points can be weighted for locating projects in designated growth sub-watersheds and districts. Points can also be awarded for incorporating green space, low-impact stormwater practices, and other water-smart design features (the Vermont Stormwater Manual provides examples of information on good site practices may be credited).

Points could also be awarded based on an independent "design opportunity assessment" that highlights the opportunities that a given site offers to achieve water-smart development. The assessment itself (location, site conditions, existing

impacts etc.) can be used to establish a base suitability score and points can be added or subtracted from the base score for each opportunity that is seized or ignored. Towns can set a minimum score for project approval, while projects exceeding a high score can qualify for expedited review.

Smart Growth Endorsement Program

Towns can institute a smart growth endorsement program through which projects that meet certain criteria receive a smart growth "seal of approval." Projects earning such a designation can qualify for expedited review or other incentives. Towns can administer such a program themselves or designate a separate entity to develop the criteria and perform the evaluations for the endorsement program.

Density Bonuses

One of the most common and basic incentives that towns can provide developers is to increase the allowable number of units which can make a project more profitable. Density bonuses can be used as an incentive for projects that minimize impervious cover through site design or redevelopment. Bonuses can also be conditioned on meeting other design and stormwater management criteria. A point system could also be used for this purpose—additional units could be awarded for reaching an outstanding point total or superior use of low-impact stormwater practices.

Variable Impact Fees

Impact fees are common provisions that towns use to compensate for the public costs incurred by a project. Projects located in less developed and more sensitive outlying areas often have higher cumulative and site costs for stormwater management, especially if stormwater management costs associated with roads are considered. Factoring stormwater management cost differences into impact fee calculations, in addition to costs for other services such as road maintenance, can justify higher impact fees in relatively undeveloped areas.

Variable Service Fees

Towns may decide to assess fees to landowners in order to fund collective efforts to manage stormwater (this may involve the creation of a separate utility to administer use of these funds). Such stormwater management fees can be calculated in various ways, but the most useful methods account for impervious cover in some form.

Towns may include treat all parcels as a single service area, but it may also divide service areas into development districts and outlying areas. Designated districts would have lower fees per person where costs are spread among a denser population. Outlying areas would have higher costs per person or per unit, again particularly if public roads are included in calculations. A grandfather exception may be used for existing development.

Stormwater Cost-Share Fund

Establishing a fund to share costs of meeting stormwater requirements in designated districts can attract development and encourage private stormwater investments. A cost-share fund can also help address the financial hardship often raised in response to new stormwater requirements. Where resources are not available to directly pay for stormwater infrastructure, paying for a stormwater master plan for designated districts can still offer an incentive to developers by providing a clear blueprint for proposed stormwater infrastructure and associated green spaces.

Direct Public Investment

In addition to regulations and incentives, towns can use their capital budgets to prioritize infrastructure investments that support their growth and stormwater management goals.

Public works projects can either attract and catalyze water-smart development...or they can help fuel sprawl.

Stormwater Service Areas

Towns can create stormwater service areas—coinciding with designated development districts—that can be prioritized for stormwater management improvements. Within these service areas, stormwater requirements would essentially be coordinated and fulfilled by the town or, if necessary, a special utility created by the town. In outlying areas, landowners and developers would still have stormwater management responsibilities and requirements, only the costs and coordination of implementing stormwater measures and improvements would be born by individual landowners.

This cost and administrative difference would encourage development within the service area. Where stormwater requirements are also more stringent for outlying areas, difference in costs may be greater still. Again, grandfather exceptions may be applied to existing development sites.

Towns can also prioritize development districts for stormwater infrastructure investments that would be financed and installed in advance of development projects. Future projects could "hook up" to the stormwater management system—as they do for water and sewer service—for a fee rather than debate town officials over what stormwater infrastructure they need to provide.

Fix-It First Road Policies

Road improvement projects are key opportunities to improve stormwater management in developed areas, especially as collected stormwater from private developments often flows into public road drainage systems. Many of these measures can be relatively low-cost where stormwater issues are considered early in the project design process.

A fix-it-first policy—where transportation funds are prioritized to maintain and improve existing transportation infrastructure—can be critical to improving the stormwater and smart growth benefits of roads. Stormwater management improvements can be included in overall efforts to enhance existing roads—or "complete the streets" with facilities for pedestrians, bicycles, traffic-calming, etc.—before new road projects are undertaken.

As a complement to a local fix-it-first policy, towns can also establish criteria under which they will accept dedications of new roads. Towns can require that all new proposed roads fit the town's plan for a road network—as most private development roads become public roads—or define limited conditions under which they will accept new roads outside designated development districts.

Street intersection and crosswalk improvements are great opportunities to add green space and enhance stormwater management.

Landscape Restoration Program

Planting street trees, providing assistance for landowners to plant trees and shrubs, and rehabilitating soils and vegetation on public lands are all direct ways to reduce stormwater volumes (through increased interception and infiltration of

rain and snow). Towns can also assist and coordinate with landowners to improve landscaping or install practices such as rain gardens on their property. Such municipal investments can add aesthetic and other community benefits.

Technical Assistance

Alternative development approaches can be difficult to communicate, let alone dictate, in land use policies. Efforts to educate and directly assist towns and developers to apply and integrate *Low-Impact Development* and smart growth practices can complement changes in local regulations and procedures.

Training and Consultation with Designated Professionals

Even when local officials have established worthy stormwater and smart growth goals, they may lack the confidence and capacity to implement them. Training and assistance from landscape architects, planners, engineers or other professionals experienced in innovative site design can help towns convey and discuss design alternatives with project applicants. Training can also be provided directly to project applicants and their consultants. In addition, towns can require or provide incentives for applicants to consult with a designated professional that has developed an understanding of the town's development goals.

Sketch Plan Review

Most towns welcome early project consultation, but explicit measures to encourage it are less common. Towns can require applicants to complete a "sketch plan" review as part of the application process under subdivision and planned unit development regulations. A consultation with a town-designated professional can also be part of this review requirement.

In addition to private development projects, public works projects can also be required to consult with alternative design professionals at the conceptual design stage. Such discussions can often integrate stormwater features into street improvements and other public works at little to no additional cost.

Education and communication with design professionals can assist towns to implement their development goals.

Design Guidelines

In addition to written regulations, towns can provide graphic design guidelines and visual examples of appropriate development. These guidelines can be referenced in land use regulations, but graphic guidelines and examples can also be used as educational tools to aid early conversations between towns, developers, and the interested public. Involving a non-municipal entity to promote these guidelines can also help separate them from the legality of the formal project review process.

Development Review Board

Many towns have consolidated their project review functions in a single development or design review board (DRB)—allowing the planning commission to focus on planning. Creating a specialized board can also facilitate training for and early consultations with local officials. DRB members are often professionals with experience in site design issues or quickly become educated in such matters.

FUNDING & RESOURCES FOR STORMWATER & SMART GROWTH

Integrated stormwater and smart growth strategies can save money for towns, landowners, and developers in the long run. Transitions to new policies and practices, however, may require supplemental funding and additional resources. The information below may help guide Basin towns to find additional information and support.

FUNDING

Funding is always a sensitive issue, but where plans have been developed and priorities identified, funding efforts are more likely to be successful. Several funding sources, in fact, require consistency with an established plan. Planning is a good place to start, but planning efforts themselves often require supplemental funding.

Municipal Planning Grants

Both New York and Vermont make grants available to towns for local planning projects and several Basin towns have received funds to develop stormwater management plans. These grants have been used for data gathering, analysis, and public information-sharing and typically range from ten to fifty thousand dollars.

Community Block Grants

Community Block Grants (CBG) are federal funds made available to states for flexibly-defined public and community development purposes. CBG funds have been used for both planning and construction of downtown projects such as park enhancements, streetscape improvements, and infrastructure development. The multiple community benefits of integrated stormwater and smart growth strategies would generally score well under CBG criteria. CBG grants can be small, but some Basin projects have secured CBG funds over one million dollars.

Transportation Enhancements

The Transportation Enhancement (TE) program makes funds available—on a grant application basis—to initiate transportation-related projects (excluding normal road and bridge projects). Improvements for stormwater, streetscapes, pedestrian and bicycle paths, and wildlife habitat are expressly listed criteria and projects that satisfy more than one of the eleven major criteria are reviewed particularly favorably.

Transportation and Community and System Preservation Program

There are also several other state and federal transportation funds that can be used for stormwater management and other design improvements involving public roads. Many of these programs are allocated through administrative discretion, not an application process. The most opportune pool of funds for stormwater and smart growth related projects is the Transportation and Community and System Preservation (TCSP) program. These funds are targeted for land use planning and community development purposes. This program allocates several millions of dollars in New York and Vermont each year.

Clean Water State Revolving Fund

Both New York and Vermont have established a Clean Water State Revolving Fund (SRF) as provided for by the federal Clean Water Act. This fund may be used to pay for point and non-point source pollution reduction projects. In the past, SRF has funded wetland protection, stormwater improvements, as well as traditional wastewater collection and treatment projects. Use of these funds related to stormwater has trended toward projects requiring a federal stormwater permits, but towns can solicit these funds for non-regulated improvements for which they are eligible.

Other State and Federal Funding

Other funding sources may be applicable to particular local projects where they involve economic development, environmental protection, or social welfare benefits. Major projects may also be eligible for special funding within federal appropriation bills. Your congressional representatives' office can assist you in identifying other opportunities for federal funds.

Demonstration projects are often of particular interest to federal programs created to address water resource issues. Funding for innovative and integrated stormwater management may be available through the Lake Champlain Basin Program, the Environmental Protection Agency, state-administered Clean Water Act non-point source program (Section 319 grants), the Federal Emergency Management Agency, or other programs.

Local Funding

Towns may consider diversion of local funds, especially where such funds can help reduce maintenance and repair costs for public roads and other infrastructure. Other social, economic, and recreational benefits, together with stormwater management improvements can easily justify the merit of such local expenditures. Funding options involving impact fees, utility service fees , or other assessments are described in the *Local Strategies* section. Other options include:

Special Improvement and Service Districts

Special areas that have been organized to share improvements or services (downtown retail districts, for example) may opt to finance and implement landscape or streetscape enhancements. Such enhancements can include stormwater management improvements, especially where such measures can satisfy stormwater regulations that would otherwise apply to individual landowners.

Open Space Funding

Many towns have developed open space funds to help purchase different types of open space. While typically intended for large parcels outside town centers, protection of parcels that are strategically located to provide both open space and water resource benefits should also be considered

For more information on local finance options, the Center for Urban Policy and the Environment at Indiana University-Purdue University Indianapolis has developed a website http://storm-water-finance.urbancenter.iupui.edu/home.htm designed to help communities find ways to pay for stormwater management projects.

RESOURCES

The **Vermont Forum on Sprawl** offers a wealth of resources on smart growth including an on-line community assessment tool and multiple publications targeted to local officials. In particular, *Community Rules: a New England Guide to Smart Growth Strategies* offers specific strategies, case studies, and mechanisms for implementing innovative planning tools. Many other smart growth resources are available on-line at: *http://-www.vtsprawl.org.*

Quality Communities Initiative is New York State's answer to issues related to smart growth. The program, coordinated by the offices of the Lieutenant Governor and the Secretary of State., maintains an easy-to-use information clearinghouse at http://www.qualitycommunities.org and includes well-organized information regarding options for funding and technical assistance.

The **Center for Watershed Protection** (CWP) and the **Low-Impact Development Center** are the two leading authorities for research, technical guidance, and policy development regarding stormwater management. CWP maintains an excellent website, www.cwp.org. and has also developed a special stormwater website for the U.S. Environmental Protection Agency— www.stormwatercenter.net . The CWP publication, *The Practice of Watershed Protection,* contains a series of easy-to-read articles on a full range of stormwater topics.

The **Low Impact Development Center,** www.lid-stormwater.net, has published a guide for developers who wish to incorporate Low Impact Development (LID) principles. The guide is also useful for municipal officials. Low Impact Development was pioneered by the Prince George's County (Maryland) Department of Environmental Resources Programs and Planning Division who can also provide information on LID (see http://www.lowimpactdevelopment.org/publications.htm).

The **U.S. Environmental Protection Agency** has produced a new guide to integrating smart growth principles and water quality protection. The report presents 75 innovative policies and practices, many of which relate stormwater. A copy of the report in PDF format can be downloaded at http://www.epa.gov/smartgrowth. A free copy can also be ordered by phone, 1-800-490-9198, request EPA publication 231-R-04-002. Other useful EPA information related to stormwater management can be found at http://www.epa.gov/watertrain/protection/r3.html.

The **State of Washington** also has an excellent, easy-to-follow website dedicated to Low Impact Development with lots of graphic examples. The site includes links to LID projects, an LID development brochure, and examples of LID ordinances and regulations: http://www.psat.wa.gov/Programs/LID.htm.

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Notes

[1]Center for Watershed Protection, (Schueler, T et al) . The Importance of Imperviousness, 1992.

[2]Natural Resource Conservation Service, Technical Release 55 (TR-55), 1986, (based on five-acre lot zoning and 1-acre lawn area).

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