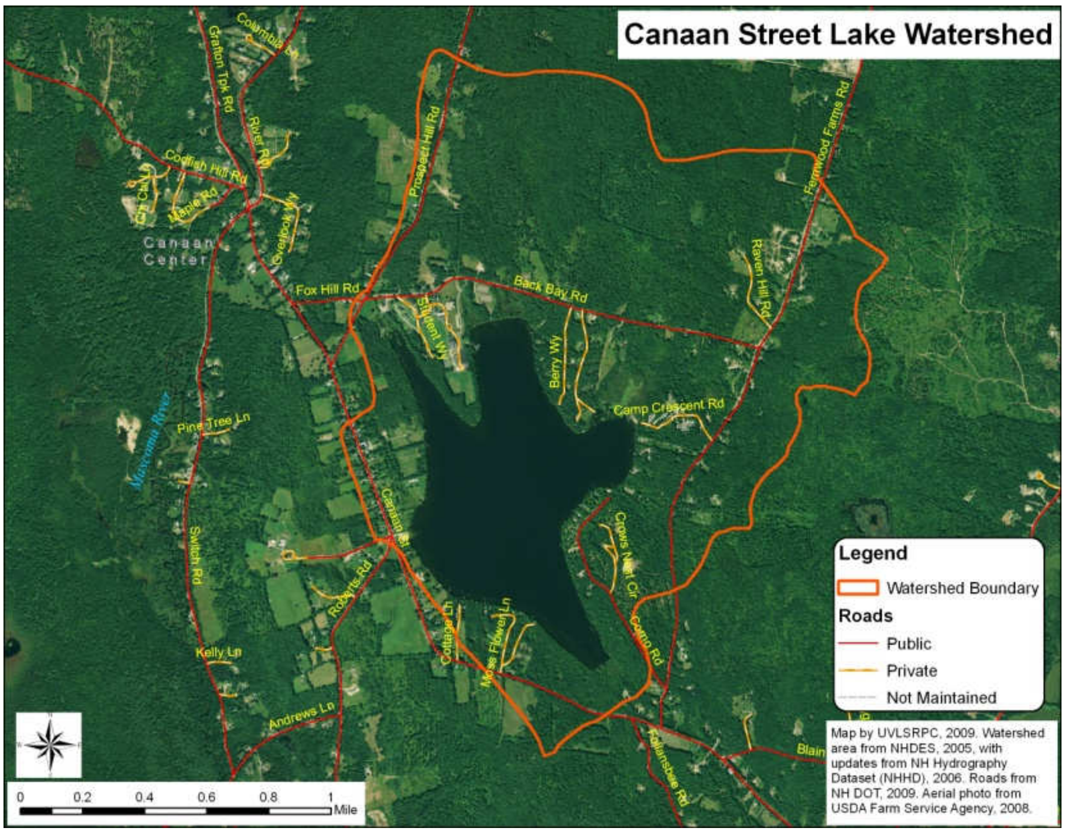
Land Use Recommendations for

Protecting Water Quality in Canaan Street Lake, Canaan, NH

Report by Plymouth State University's Center for the Environment &

Upper Valley Lake Sunapee Regional Planning Commission

December 10, 2009; Revised May 15, 2010 & August 15, 2010*



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Introduction

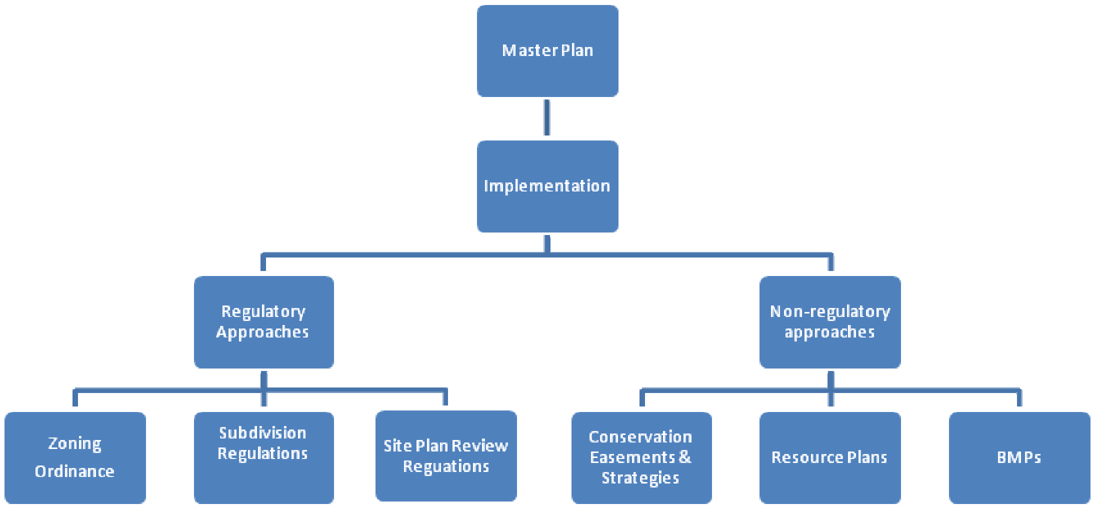
The Center for the Environment at Plymouth State University and the Upper Valley Lake Sunapee Regional Planning Commission (UVLSRPC) were contracted to assist the Town of Canaan, NH with a review of land use regulations and procedures that relate to protecting the water quality in Canaan Street Lake, which is the Town's drinking water. The project involved studying Canaan's Master Plan and land use regulations to evaluate how the community currently addresses water resources in the land use planning process and make recommendations to the Canaan Planning Board about how they can apply land use planning to protect the community's drinking water supply. Work on this project was conducted in the fall of 2009 and was incorporated into a graduate level Land Use Planning Seminar providing several Plymouth State students with an opportunity for applied learning. Funding for this project was provided by a Local Source Water Protection Grant from the NH Department of Environmental Services to the Town of Canaan, NH.

Land Use Planning Overview

Land use planning is an effective method to give towns control of their future and ensure that their desires are realized and values maintained. Land use planning, like all planning, involves preparing for the future in a rational way. It typically includes gathering and analyzing data, examining possible future trends, considering alternatives, choosing preferred paths, and implementing and monitoring the plan. Planning typically results in the development of a Master Plan, which is a document that lays out the desired future or vision for a community and offers direction for development, location of infrastructure, protection of natural resources, and many other factors concerning the area's future.

The Master Plan is the basis for regulatory and non-regulatory approaches to land use in a community. Regulatory approaches include zoning ordinance and subdivision regulations. Non-regulatory approaches include conservation easements, best management practices (BMPs), and natural resource plans. Figure 1 illustrates the relationship between the master plan land use policies.

Figure 1. The relationship between the master plan land use policies.



Regulations and ordinances are the most common and appropriate ways of controlling the use and development of land. Subdivision Regulations address the way in which land is divided into new lots along with the construction of roads and associated features such as drainage systems. Zoning regulates the ways in which land is used and the density of the use. Site Plan Review Regulations address commercial and multi-family developments by controlling site design and aesthetics. New Hampshire law authorizes towns and cities to use innovative land use controls to deal with complex planning and development issues (RSA 674:21) and gives municipalities a great deal of authority and freedom to adopt and administer their own specific land use plans and controls that will foster the type of growth and land use desired by that community.

Summary of Relevant Parts of Land Use Documents and Studies

<u>Canaan Master Plan</u>

The New Hampshire Office of Energy and Planning publication *The Planning Board in New Hampshire: a handbook for local officials* (http://www.nh.gov/oep/resourcelibrary/referencelibrary/p/planningboard/documents/pbhandbook.pdf) describes a master plan as "a planning document that serves to guide the overall character, physical form, growth, and development of a community...It provides guidance to local officials when they are making decisions on budgets, ordinances, capital improvements, zoning and subdivision matters, and other growth related issues." The Master Plan sets the future direction of a community through establishing goals and objectives. It serves as the basis for regulatory measures, such as Subdivision Regulations and Zoning Ordinances, which are used to achieve the goals of the master plan.

Canaan's Master Plan contains a number of goals that address the quality and protection of Canaan Street Lake as well as the town's water supply. Specifically, these include:

- <u>Section VIII. 10</u>. Adopt and enforce regulations such as those proposed by the Source Water Protection Committee that are designed to protect water quality. Develop watershed and Aquifer Protection Zones to prohibit or control any use that would potentially introduce either point or non-point pollutants to Canaan's aquifers and water sources.
- <u>Section VIII. 13</u>. Pass a shorefront ordinance for Canaan Street Lake that will prevent new septic or other potential pollution sources within a shoreline buffer zone of this water body that serves as Canaan's reservoir. Establish a regular and standardized water-testing program for Canaan Street Lake.
- <u>Section VIII. 23</u>. Incorporate a minimum-runoff requirement in the subdivision regulations, requiring new development to design drainage systems that will not discharge additional runoff into existing surface waters in Town.
- <u>Section VIII. 24</u>. Encourage landowners to leave their shorefronts in a natural state...Canaan local government officials should enforce DES wetland, shoreland and reservoir regulations.
- <u>Section X. 14</u>. Establish a 150-foot minimum shore frontage requirement for new lots created fronting on Canaan's lakes and major ponds and the Mascoma and Indian Rivers west of Canaan Village.
- <u>Section X. 15</u>. Adopt and enforce site plan and zoning regulations dealing with water protection, septic systems, and signage.

In addition, Canaan has completed the *Canaan Street Lake Watershed Protection Plan* which has been incorporated as part of the town's Master Plan. This plan outlines the quality of the water in Canaan Street Lake and threats to the water quality, and gives additional objectives for the community to work toward. Of particular significance for this report, the recommendation is made to create a Canaan Street Lake watershed protection area and a shoreland protection district. Another objective is to ensure that subdivision regulations adequately protect water quality from erosion and sedimentation.

<u>Subdivision Regulations</u>

Canaan defines a property subdivision as the division of a lot, tract or parcel of land into two or more lots, plats, sites, or other division of land. The purpose of the divisions can be for the immediate or future sale, rent, lease, condominium conveyance or building development. Any additional dwelling placed upon a lot shall also be deemed a subdivision.

Canaan identifies three categories of subdivisions; Major, Minor and Technical. A Major Subdivision is a subdivision of four or more lots, or one which involves the creation of new streets and/or utilities. A Minor Subdivision divides land into not more than three lots for building development purposes, with no potential for re-subdivision on an existing street and does not involve the creation of new streets and/or utilities. A Technical Subdivision is a subdivision of land into two lots or sites for the purpose of conveying one such lot directly to an abutting landowner.

There are many general requirements for a subdivision of land and these are established in Subdivision Regulations. Canaan's regulations state that in a subdivision the character of the land must not encourage exceptional danger to health or peril from fire, flood, poor drainage, excessive slope or other hazardous conditions. A subdivision will not be allowed if it endangers or injures the health, safety, or prosperity by reason of the lack of water supply, sewage disposal, drainage, transportation, schools, fire protection or other public services. In a subdivision suitable steps should be taken to preserve and protect significant existing features such as trees, scenic points, stone walls, rock outcroppings, water bodies and historic landmarks. Since these general requirements mention water supply and water bodies, it can be inferred that the Subdivision Regulations can be used to protect the water quality of Canaan Street Lake and the public drinking water supply whether it is from surface or ground water.

In Canaan, as in most towns, for a new subdivision it is the subdividers responsibility to provide a state approved individual sewage disposal system or a connection to a public sewer system. For subdivided parcels of land that have existing sewage systems it is the subdividers responsibility to demonstrate that to the planning board that the system is in good working order. If a new well is to be installed it must have a protective radius of 75 feet contained within the subject lot that does not overlap the existing or proposed onsite sewage disposal system, unless the owner demonstrates reasons for the state to waive these requirements. For lots served by public water, approval from the Town Water and Sewer Commission is required. The purpose of these requirements is to protect surface and groundwater water quality for the benefit of public health.

Subdivision regulations typically consist of the establishment of basic requirements of what must be submitted in order to subdivide land as well as minimum design and construction standards for shared facilities and infrastructure. The design and construction standards establish the quality of the proposed development and protection of community resources. These standards are important as they are what the Planning Board will use to base their decision for approval or disapproval of a subdivision. Certain design and construction standards, like erosion and sedimentation control standards and best management practices, can be developed with the intent to protect water quality.

<u>Historic District Regulations</u>

Canaan adopted Historic District Regulations in 1968 and amended them in July 2005. The Historic District lies in the Canaan Street Lake Watershed. These regulations are designed to protect the cultural, social, economic, community, and architectural history of the town while also preserving property values, fostering civic beauty, and strengthening the local economy. The regulations are primarily designed to address aesthetic issues by controlling architectural features and signs in the district. Environmental criteria are also included through a two acre minimum lot size requirement, a 30 foot setback requirement, and conformance with the state's Comprehensive Shoreline Protection Act.

The Historic District Regulations do establish certain permitted uses which include residential (single and multi-family), agricultural, municipal, institutional, and some commercial businesses. All of these permitted uses must be consistent with the architectural and environmental criteria established in the regulations.

Road Policy

A Class VI Highway/Private Road Policy for the Town of Canaan was adopted in 2008 by the Board of Selectmen. This policy addresses accessibility to structures on private roads and Class VI roads for the purpose of safety. The Road Policy relates to the Canaan Subdivision Regulations in terms of the design of new private roads. The Road Policy does not address road maintenance beyond requiring that private roads and Class VI roads with structures be maintained by private parties in such a manner that allows access at all times. Criteria for road maintenance that relate to water quality, such as the application of road salt, storm drainage, and sediment control, are not included in the Road Policy. In March 2010 the town passed a petitioned warrant article which creates a low salt area on the east side of Goose Pond in Canaan. This article also requires removal of accumulated sand at the end of the winter season. Winter maintenance will follow NH DOT recommendations for Type 5 roads with abrasives only. The road in this low salt area runs parallel and very close to the pond for almost the entire length of the pond.

Septic Survey

Septic systems are commonly used in more rural areas to treat sewage. A septic tank and leach field system is an effective method for treating waste and allowing liquids to be purified by percolation through soil. However, these systems must be properly designed and maintained. When they are not functioning properly the result may be contamination of surface and ground water. In 2009, Canaan conducted a septic survey using a questionnaire and interviews to collect data about the septic systems on Canaan Street Lake shoreline properties. This information will help locate older systems and identify potential problem areas. Mapping the data would allow concentrations of septic systems to be seen. Combined with the septic survey has been an effort to educate shoreline property owners about proper septic system use and maintenance. This effort needs to be ongoing.

RSA 485-A:39 requires an assessment of existing septic systems on shorefront properties prior to execution of a purchase and sale agreement. The intent of this assessment is to give buyers of shorefront property information about the condition of existing septic systems.

Env-Ws 386, Rules for Protecting the Purity of Regulated Watersheds

Canaan Street Lake is currently covered by the New Hampshire Code of Administrative Rules Env-Ws 386, Rules for Protecting the Purity of Regulated Watersheds. These rules prohibit certain uses, including land uses, that could contaminate water quality. Env-Ws 386.18(g) (http://des.nh.gov/organization/commissioner/legal/rules/documents/env-ws386.pdf) states that:

1. A person shall not build, continue or maintain a building or structure of any kind in which animals or fowl are kept, within 75 feet of Canaan Street Lake or within 75 feet of any inlet or tributary thereto;
2. A person shall not permit wastes, or waters that have been used for washing or cleansing either materials, persons, or food, to run into said lake, or into any inlet or tributary thereto;
3. A person shall not throw or deposit any dead animal, fish, or parts thereof, or any food or article perishable or decayable, or any dung either human or animal, into said lake, or permit any wastes to remain within 75 feet of any inlet or tributary thereto, or on the ground surface within 75 feet of any inlet tributary thereto;
4. A person shall not throw any sawdust or allow any sawdust to fall into said lake, or into any inlet or tributary thereto;
5. A person shall not trespass, boat, bathe, swim, fish or carry on any activity whatever whether of recreational, occupational or other nature, in the waters or on the ice of Canaan Street Lake, south of a line about 1,200 feet northwest of the lake's southern most part, beginning at a point on the westerly shore at the center line of the road which exists adjacent to the present property line between the properties identified on tax map I-D as lots 38B and 39D, and extending across said lake to the stone jetty on the easterly shore on the property identified on tax map I-D as lot 56-1. The 2 extremities of such a line shall be properly marked by the local water works authority so that they can be readily identified and observed by the general public; and
6. A person shall not throw, deposit or allow to remain upon the ice of the waters of said lake, or upon that of any inlet or stream tributary thereto, any matter, waste, or materials such as are described in (2), (3) and (4) above.

Enforcement of Env-Ws 386.18(g) is the responsibility of Canaan's health officer, Board of Health, and Water Commission.

The land uses that are prohibited by Env-Ws 386.18(g) (listed above) are minimal. NHDES has developed a "Model Rule for the Protection of Water Supply Watersheds" (http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-00-3.pdf) that includes a more extensive list of prohibited uses with a restricted area and a protected area. The restricted area is the land 200 feet from the shore of water supply, and 100 feet from the shore of tributaries to the supply. The protected area is the land 300 feet from the shore of the water supply, and 200 feet from the shore of tributaries to the supply. Within these areas, there are restrictions on the storage of waste and certain materials, the management of stormwater, vegetation removal, types of land uses, and the use of fertilizers.

Shoreland Protection

The Comprehensive Shoreland Protection Act (CSPA), RSA 483-B, is a state law that regulates activities within 250 feet, referred to as the protected shoreland, of larger lakes and rivers in New

Hampshire. The law was originally adopted in 1991 and revised in 2008. The current CSPA regulates new construction and expansion of existing uses, clearing of vegetation, removal of stumps, the use of fertilizers, and other activities within the protected shoreland area. The purpose of this regulation is to protect water quality by limiting development activities that might result in excess erosion and pollution along these shorelines.

Detailed and current information about the CSPA is available on the NHDES Web site at http://des.nh.gov/organization/divisions/water/wetlands/cspa/index.htm and since the shoreland around Canaan Street Lake is subject to this state law, it is important for the Town of Canaan to be familiar with it. Compliance assistance is available from the Shoreland Protection Program at DES.

Summary of Issues

Protection of drinking water

In New Hampshire, public drinking water is supplied by both groundwater and surface water sources. In Canaan, approximately 600 individuals in residences, institutions, and businesses are served by a municipal water system and Canaan Street Lake is the source for this system. Other residences in the community use private wells or privately owned community water systems.

Recently, the Town of Canaan pursued adding ground water to the municipal water system in order to dilute the water from Canaan Street Lake and improve the quality of the water in the municipal water system. The Town has drilled one bedrock well located next to the water treatment plant that filters and treats the water from Canaan Street Lake before it enters the distribution system. This well is undergoing testing in 2009 and additional wells are being considered. This first well will cost several hundred thousand dollars when completed. As of the date of this report, approximately $180,000 has been spent on the well.

Surface and groundwater can be contaminated in a variety of ways. Human impact from land development and land uses can cause pollutants and excessive nutrients to enter the surface water body or to travel through the ground and contaminate ground water. The Canaan Street Lake Watershed Protection Plan, which has been adopted as part of the Town's Master Plan, outlines the current water quality concerns and potential contamination sources.

Given the Town's reliance on Canaan Street Lake as a public water supply, and more recently supplemented by groundwater, Canaan needs to consider protecting their investment in the community's water system. The recent addition of a ground water well is a significant cost for a small community and should be considered an investment worth protecting. If contaminated, Canaan Street Lake, the surface water supply, would cause Canaan difficulty and financial hardship to either replace or additionally treat the water before it enters the municipal distribution system.

The Canaan Master Plan, as noted above, supports protecting water quality and the public water supply.

Erosion and Stormwater Management

Erosion is a natural process. It cannot be prevented, only reduced to an acceptable level. In theory, soil erosion on a developed site should be maintained at a rate that either is equal to or is below the natural rate of soil formation. Vegetation is typically the best means for preventing erosion as it intercepts runoff, but land use and development often results in the removal of vegetation or changes to the natural vegetation cover. When vegetation is removed or substantially changed and soils are disturbed erosion can occur at an increased rate. As soils move, or erode, they are eventually deposited in a different location. These sediments from erosion often enter a water body and impact water quality by increasing turbidity or introducing a variety of nutrients or pollutants causing additional water quality problems.

Stormwater is the water from rainfall or snowmelt that runs off across a landscape into surface waters. In a natural forested landscape, common for New Hampshire, about half of rainfall soaks into the ground and forty percent either evaporates or transpires through vegetation back into the atmosphere. This leaves ten percent of the remaining precipitation or snowmelt as stormwater which runs off across the forest floor and into surface waters. All of this changes greatly when the landscape changes, particularly with urban and suburban development. The more developed a landscape becomes the more forests are replaced with homes, buildings, roads, and infrastructure, resulting in an increase in impervious surfaces. Impervious surfaces like roads (paved or gravel), driveways, parking lots, and rooftops are surfaces that do not soak in water and provide a surface for water to runoff across a landscape quickly. Developed landscapes, depending on the percent of impervious surfaces, can have many degrees of reduced groundwater infiltration and increased surface runoff. This landscape change disrupts the natural hydrologic cycle and can adversely affect ecosystem health, which also impacts public health and welfare.

Traditionally, the biggest concerns about stormwater runoff have been erosion and localized flooding. But, as runoff from precipitation and snowmelt travels over the land, wastes and residues are picked up and carried to surface water bodies creating what is commonly known as nonpoint source pollution. The list below from the Environmental Protection Agency (EPA) lists many of the negative effects that can be caused by stormwater runoff:

- ***Sediment*** can cloud the water and make it difficult or impossible for aquatic plants and animals to grow and thrive. Sediment also can destroy aquatic habitats.
- ***Excess nutrients*** can cause algae blooms in surface water bodies. When algae die, they sink to the bottom and decompose in a process that removes oxygen from the water. Fish and other aquatic organisms can't exist in water with low dissolved oxygen levels.
- ***Bacteria and other pathogens*** can wash into swimming areas and create health hazards, often making beach closures necessary.

- ***Debris*** - plastic bags, six-pack rings, bottles, and cigarette butts - washed into waterbodies can choke, suffocate, or disable aquatic life like ducks, fish, turtles, and birds.
- ***Household hazardous wastes*** like insecticides, pesticides, paint, solvents, used motor oil, and other auto fluids can poison aquatic life. Land animals and people can become sick from eating diseased fish and shellfish or ingesting polluted water.
- ***Polluted stormwater*** often affects drinking water sources. This, in turn, can affect human health and increase drinking water treatment costs.

While not included in the specific EPA list shown above, road salt is a major component of stormwater in New Hampshire. The following has been consolidated from the NH Stormwater Manual I, section 7-6, and the reader is directed there for additional information. Although road salt makes for safer travel, it is hard on the environment and can pose a risk to drinking water supplies. Roadside vegetation is visibly impacted from road salt including burned grass and shrubs. High chloride concentrations can be toxic to some aquatic life, including certain types of macroinvertebrates and freshwater fish. Unfortunately, the systems and treatment practices commonly used to treat stormwater runoff do not remove chloride. Practices that do remove chloride are very costly. Because of this, source control (i.e., using less salt in the first place), is the best way to prevent further chloride contamination.

Conventional stormwater management practices focus on mitigating erosion and flooding caused by increases in stormwater volume from impervious surfaces. Historic storm drain networks only collect and route stormwater runoff to the nearest stream, river, lake, or pond, with little to no treatment. This approach to runoff can result in “non-point” sources of contamination degrading the quality of surface and groundwater over time. Land use regulations and ordinances should address not just the volume (quantity) of stormwater, but also the quality of the stormwater by creating requirements that help to minimize nonpoint source pollution. In the case of road salt, regulations and policies which substantially reduce salt application should be pursued.

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Land Use Recommendations for the Protection of Drinking Water Sources

The Town of Canaan has a considerable investment in its public water system that supplies drinking water to a portion of the community and additional measures are needed to protect the drinking water supply. As indicated in the 2006 Canaan Street Lake Watershed Protection Plan, water quality monitoring data from Canaan Street Lake indicate that the quality of this water supply has been deteriorating and actions taken now will help protect the supply in the future. To achieve this goal, the following land use actions are recommended:

<u>Amend the Canaan Subdivision Regulations</u>:

Subdivision Regulations are designed to implement goals established in the Master Plan, which specifically mentions amending these regulations to protect surface water bodies. Subdivision regulations should include design and construction standards for stormwater and erosion control best management practices. A review of Canaan's Subdivision Regulations indicates only a short section on "General Requirements for the Subdivision of Land" (Section III) and some additional standards for roads and driveways in Appendix B. These sections are not very specific and should be amended to establish comprehensive and detailed standards that future subdivisions must meet in order to protect water quality. RSA 674:36 allows these regulations to include provisions which will tend to create conditions favorable to health, safety, convenience, or prosperity. This does allow some level of protection when lots are subdivided.

Controlling the <u>quantity</u> of stormwater runoff from a site is important for mitigating potential flooding and soil erosion. Standards typically call for drainage systems that are designed for a certain magnitude of storm event, such as a 10 or 20 year storm. Stormwater management and erosion control features should be required both during and after construction in order to protect water resources. The Planning Board has a benchmark by which to evaluate applications and to substantially reduce substandard construction practices once construction proceeds. The state and EPA regulate larger construction projects to conform to practices and standards for controlling soil erosion and stormwater runoff from construction sites as part of the Alteration of Terrain (AoT) Program and National Pollution Discharge Elimination System (NPDES), respectively. Establishing similar standards at the municipal level will give Canaan the ability to better control soil erosion and stormwater runoff regardless of the size of the development. These standards can also be more stringent than either AoT or NPDES. Appendix A provides a list of subjects which are covered in more detail in the NH Stormwater manual and these should be examined by Canaan for possible incorporation into the town's regulations and policies. The following section discusses some of the regulatory options.

It is recommended that Canaan amend its Subdivision Regulations to include more specific requirements to address stormwater management practices and erosion controls to protect community water quantity and quality. Specifically, these amendments might require that developments and these are listed in priority order:

1. Use low impact development (LID) techniques to intercept, treat, and infiltrate runoff from developed areas. LID involves using a variety of planning and engineering methods to minimize the impacts of development, preserve natural hydrologic features, and protect water quality. LID attempts to treat stormwater as close to the source as possible. The concept can be simply stated as slow it down, spread it out, and soak it in.
2. Prevent stormwater systems from discharging post treatment and detention runoff within 100 feet of surface water in the Canaan Street Lake Watershed.
3. Encourage open space within subdivisions and ensure that this open space is effective providing buffers and protecting hydrologic features.
4. Require undisturbed buffers to restore, enhance, or protect natural areas such as riparian areas, stream channels, wetlands, and forests. When buffers are used to protect health and safety they may be included in subdivision regulation.
5. Implement Impact Fee ordinance. Canaan has adopted an impact fee ordinance, but has not implemented it. Such an implementation could fund upgrades to stormwater control on existing streets feeding the new development.
6. Control post-development peak rate of runoff so that it does not exceed pre-development runoff for the 2-year, 10-year, and 25-year/24-hour storm events.
7. Maximize the protection of native vegetation.
8. Prevent stormwater from outside the site from entering areas of disturbed soil on site and control water on site.
9. Control sediment transport on site through seeding, mulching, and structural measures, and preventing sediment from leaving the construction site.
10. Minimize the area of disturbed soil and reduce the time that soil is left disturbed by phasing construction.

In addition, Subdivision Regulations can also set quantitative standards that help to maintain the quality of water. For example, the Town of Thornton, NH's Subdivision Regulations (http://www.thorntonnh.org/downloads/SubdivisioinREG081607.pdf) require that all stormwater drainage systems must demonstrate that the stormwater practice(s) provide 80% removal of total solids and 40% removal of phosphorus. The NH DES Stormwater Manual lists stormwater treatment options for achieving certain level of pollution removal for certain contaminants (see Appendix B, BMP Pollutant Removal Efficiency of NH DES Stormwater Manual Volume 2). During the review process, applicants are given options as to how to meet pollution removal goals. Stormwater options may include treatment through standard infiltration, constructed wetlands, detention/retention ponds or other structures or devices designed to remove sediments, phosphorus or other contaminants. Documentation typically from the designer/manufacturer or a technical manual is provided by the applicant to confirm that the device is designed to meet the established goal. Many new stormwater treatment systems are available that can meet these treatment standards. It is the applicant's responsibility to determine the method that best meets an established standard. The Planning Board should familiarize themselves with various alternatives such as bioretention systems, detention ponds, constructed wetlands, and mechanical systems (see

Appendix B of NH DES Stormwater Manual Volume 2). The UNH Stormwater Center provides training and this website provides details http://www.unh.edu/erg/cstev/workshops.htm It is important to note that treatment systems need to be maintained over time to ensure that they function properly, so the Subdivision Regulations should include a provision that approved subdivisions must be built and maintained in accordance with the approved plan. To avoid having the Town incur additional maintenance responsibilities, developers or property owners should be bound by an agreement or easement to regularly clean drainage structures such as drainage swales or catch basins, and mechanical treatment systems. In certain cases, if there is a compelling reason the town may be able to require regular water quality monitoring results as a condition of approval. The amended regulations would need to be carefully worded to enable the Town enforcement procedures and methods for the property owner to correct maintenance deficiencies, or to collect payment for the town to correct deficiencies. In NHDES Stormwater Manual Volume 1, Appendix A, a deed restriction template will be found. This is an important method of insuring that stormwater control continues to be effective in future years. In NHDES Stormwater Manual Volume 2, Chapter 5, Operation, Maintenance, Inspection & Source Control, there is an explanation of stormwater maintenance plans and requirements. Greenfield has a required maintenance procedure included in their regulations which may be viewed here: http://www.greenfield-nh.gov/Public_Documents/GreenfieldNH_BComm/SubdivisionAppendices9-08.pdf
Weare also has a suitable maintenance approach:
http://www.weare.nh.gov/zoningandplanning/SUBDIVISION%20REGULATIONS.pdf

The Canaan Planning Board has procedures for reviewing and approving subdivision proposals, which are located in the Rules of Procedure, and the Subdivision Regulations. The town would benefit from a review of the town of Weare's Subdivision regulations, which provides areas of detail not found in Canaan's regulations.
http://www.weare.nh.gov/zoningandplanning/SUBDIVISION%20REGULATIONS.pdf Assuring compliance with regulations is time consuming and requires detailed review of submitted applications and plans. Site visits can be an important part of the approval process to assure that site details are adequately covered and they should be conducted by the Planning Board. Review of applications by qualified design professionals, such as surveyors and civil engineers, can be conducted at the applicant's expense and Canaan is encouraged to regularly utilize this option to ensure that development plans meet standards set by the Town. During construction, it is important to regularly conduct site visits to ensure that the work is being done in accordance with the plan and that all required erosion control devices are in place and properly maintained. Visits during and after storm events would be a necessary to protect water quality and ensure plans are followed. Consulting engineers can assist the town with these inspections and, if the inspection is made a requirement of the approval, it can be accomplished at the applicant's expense. It is recommended that the Canaan Planning Board amend the town's Subdivision Regulations to allow for review of applications and construction inspection by qualified professionals and the collection of funds from applicants for this purpose.

The NH Stormwater manuals indicate that NHDES requests the development of a Road Salt and Deicing Minimization Plan when a development will create one acre or more of pavement, including parking lots and roadways. Canaan has had a moratorium on accepting news roads for over 20 years. Roads in new developments in this period have been private and gravel, which don't use road salt. Nevertheless Canaan should prepare for the eventual end of this moratorium and consider adopting the above deicing plan.

For existing paved roads town should adopt a road salt control policy. The NH DOT Winter Maintenance Manual provides a very thorough discussion of various treatment options which should be considered.
http://www.nh.gov/dot/org/operations/highwaymaintenance/documents/WinterMaintSnowandIcePolicy.pdf Kyle Foxx, operations manager for the Merrimack DPW, may be contacted to obtain information on their policies to reduce salt application, including "no salt" and "limited salt" routes. The town of Amherst has also reduced salt application and their policy may be viewed at http://www.amherstnh.gov/Regulations/WinterOpProcedures.pdf

All roads, whether new or existing, should be reviewed to insure stormwater is treated at its source, so as to maximize infiltration. This may require regulations for new roads and negotiations with the road agent and selectmen for existing public roads. Canaan has a large number of existing private roads. Stormwater control on those roads may require educating the land owners, and encouraging them to implement stormwater retrofits. Canaan may not have the authority to require alterations on existing private roads.

Road maintenance should conform to NH DOT BMP for routine maintenance.
http://www.nh.gov/dot/org/projectdevelopment/environment/units/technicalservices/documents/BMPManual.pdf Use of this document will improve stormwater control as the techniques in this manual are superior to many of Canaan's road configurations.

Adopt a Zoning Ordinance for the Canaan Street Lake Watershed:

In towns with a town meeting form of government, Zoning Ordinances are usually developed by Planning Boards, but must be voted on by the town. It is recognized that the Canaan Planning Board recently developed a zoning ordinance that was defeated by the town in 2006 and there is reluctance to proposing an ordinance at this time.

While Canaan has traditionally relied on Canaan Street Lake for its water supply, the community has more recently added ground water to its system. The community should now look at both Canaan Street Lake and the aquifer that supplies the new well as part of the water system as an investment to be protected. Land uses can also negatively impact ground water and a land use ordinance is needed to protect ground water and the community's investment.

Zoning Ordinances regulate several functions including the use of land, density of land development, building size, aesthetics, and environmental impacts for the public benefit, health, and welfare. Because there is a correlation between water quality and how land is used and developed, the most effective method to regulate land use in the Canaan Street Watershed is through establishing land use limitations as part of a zoning ordinance. The Planning Board may create a simple ordinance that establishes a limited number of land use districts. This ordinance could be thought of as a "land use ordinance" to benefit the Canaan Street Watershed having the stated purpose of protecting water quality in Canaan Street Lake and ground water in order to protect the town's drinking water supply.

Since there is opposition to zoning in Canaan, the best zoning approach is to have two zoning districts. Ninety five percent of the town is outside the watershed and that General district would have only the bare minimum of regulations to comply with state zoning requirements. The Canaan Street Lake Watershed district would have only those regulations sufficient to protect the town's drinking water and satisfy state zoning minimums. Another approach is to have a single town district with minimal requirements and an overlay district to protect Canaan's drinking water source. RSA 624:21 gives authority for innovative land use controls, which includes environmental characteristics zoning, to be adopted as part of a zoning ordinance. A third approach is to create a village district (RSA 52:1 I (d)) which is just the Canaan Street Lake watershed. This village district could then adopt zoning, and there would be no requirement to have zoning elsewhere in town. Haverhill is an example of a town which uses zoning in village districts but does not have zoning in most rural parts of town. This may be a cumbersome approach, but it is a possibility. The master plan should be revised to reflect the town's course of action on zoning, as it may take years to accomplish.

Accurately delineating the boundaries of the watershed and the ground water recharge area around the town's well is an important step in establishing the geographic limits for a zoning ordinance with the two zones recommended above. If the Planning Board believes that it is necessary to establish tighter land use controls around the lake and tributaries (and within the greater watershed in Canaan), then the Canaan Street Lake Watershed District could include a non-disturbance buffer that would extend protection beyond the state CSPA. Mapping these buffer areas is also needed. The UVLSRPC can assist with this process.

Zoning ordinances need to be established from goals in the Master Plan and Canaan has adequate goals in their plan to do this. The ordinance for the Canaan Street Lake Watershed should:

- Prohibit uses that have a higher probability of contaminating the surface and ground water within the watershed and ground water well recharge area (such as junkyards, snow dumps, road salt storage areas, gas stations, automobile service facilities, storage of pesticides, underground storage tanks, and businesses that utilize hazardous wastes).
- In other areas in the watershed, allow land uses with a higher probability of contaminating the surface and ground water only if specified management practices are agreed to, including any state requirements.
- Prohibit snow from being plowed or piled within at least 15 feet of a wetland or waterbody.

- Require stormwater management plans with appropriate operation and maintenance plans for new developments. Prevent stormwater systems from discharging within 100 feet of surface water in the Canaan Street Lake Watershed.
- For new developments or changes to existing uses, control post-development peak rate of runoff so that it does not exceed pre-development runoff for the 2-year, 10-year, and 25-year/24-hour storm event.
- Require the use of low impact development techniques to intercept, treat, and infiltrate runoff from developed areas distributed throughout the site (see NH DES Stormwater Manual Volume 1 Chapter 6.1.)
- Establish buffers from development or encourage techniques that restore, enhance, or protect natural areas such as riparian areas, stream channels, wetlands, and forests.
- Require that all drainage systems must demonstrate features that provide 80% removal of total solids and 40% removal of phosphorus.
- Establish limits on the clearing of vegetation and construction within a certain distance of the Canaan Street Lake shoreline and its tributaries. This local regulation should be considered only if the Town believes that more restrictive protections to the CSPA are necessary.

In 2008, NHDES published "Innovative Land Use Planning Techniques: A Handbook for Sustainable Development" (http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm) that includes model ordinances that would be useful to review as part of adopting the above recommendations. Three of these (Model Drinking Water Ordinance, Model Ordinance for Shoreland and Riparian Protection, Permanent Post-Construction Stormwater Management Model Ordinance) would be particularly useful to Canaan and it is recommended that Canaan review these model ordinances and work with the UVLSRPC to modify them to fit the needs of Canaan.

An additional advantage of adopting a zoning ordinance is that it would allow Canaan to develop additional land use regulations for commercial and multi-family developments. These regulations are known as site plan review regulations in New Hampshire and can help address water quality during and after construction for new developments and also substantial changes to existing developments.

As with any town meeting vote, the exact reason that zoning hasn't been adopted is unknown. However it is likely that there are two main reasons for zoning not to have been adopted yet in Canaan. First, there is a substantial group of citizens that believe that regulation of what they can do on their property is detrimental. Many of those people feel that regulation of an abutter's property is not worth the price of regulating their own land. This portion of New Hampshire has a number of voters interested in a small government agenda and very little regulation. The second main reason is lack of understanding the proposed ordinance. This might follow for a variety of reasons: Official Ballot Act (SB-2); lack of a local newspaper or newsletter; general lack of concern for the operation of the town government; busy lifestyles conflicting with the need to be informed;

and low attendance at educational and informative public meetings. Canaan is an SB-2 town with few people attending the deliberative session and many partially informed voters arriving on voting day. Typically about 100 people attend the deliberative session to hear pros and cons of warrant articles debated, while a few weeks later, about 1,000 voters cast ballots on voting day.

<u>Other Alternatives</u>:

Although Canaan Street Lake is currently covered by the New Hampshire Code of Administrative Rules Env-Ws 386, Rules for Protecting the Purity of Regulated Watersheds, the Town can petition NHDES to modify Env-386.18 and add more restrictions on land use around Canaan Street Lake, such as those outlined in the model rule included in the NHDES publication "Model Rule for the Protection of Water Supply Watersheds," (http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-00-3.pdf). The process for requesting the rule change is outlined in this document. However, NHDES would require evidence of why this approach is necessary and preferred to a local zoning ordinance. For more information concerning Env-Ws 386 or the Model Rule, contact DES at 271-7061.

Another alternative approach is to address land use activities in a health ordinance if it can be shown that certain activities and land uses threaten public health due to contamination of the water supply. A zoning ordinance is a preferred method for regulating land uses, and a health ordinance may be used to prohibit and/or regulate situations which are hazardous to the water supply. Both may require Best Management Practices to minimize hazards to the environment and human health.

Recommended Actions

The following actions are listed in priority order, based upon a balance of factors, such as benefit to protecting the water source, ease of implementation, enforcement, and cost. The town will need to compare these and choose the appropriate course of action for the municipality.

- Revise subdivision regulations: LID approaches discussed above should be included in the regulations as the highest priority. As a second priority, maintenance of those LID approaches should be addressed. As a third priority, control of construction phase stormwater needs to be regulated. Model Stormwater Management and Erosion Control Regulation (NH OEP) was created in 1997 http://www.nh.gov/oep/resourcelibrary/referencelibrary/s/stormwater/documents/modelstormwatermanagementanderosioncontrolregulation.doc and provides a good template for creating a Canaan specific regulation, but advances have been made in the treatment of stormwater. Those advances are found in the 2008 NH DES Stormwater manual. Canaan should update the template with current LID methods such as bioretention, constructed wetlands, detention ponds and other current methods. Many of these are similar to 1997 approaches, but much has been learned in the last decade. Changes can be adopted by vote of the planning board following a public hearing.

- Adopt a zoning ordinance: This provides considerable opportunity to protect the watershed primarily through land use regulations, setbacks, and lot density. A vote at town meeting is required for this and other ordinances listed below.

- Adopt a site plan review ordinance: A zoning ordinance must be adopted first. This allows oversight and control of commercial developments.

- Adopt innovative land use controls: A zoning ordinance must be adopted first. Some of these controls allow greater use of open space and buffers. Model Drinking Water Ordinance is the most direct approach, but Model Ordinance for Shoreland and Riparian Protection can provide additional protections.

- Adopt health regulations: Health regulations have been used for controlling hazardous materials. Examples are found at http://www.sutton-nh.gov/public_documents/SuttonNH_Health/Garbage?textPage=1 and http://www.windhamnewhampshire.com/updated/policies/200%20Public%20Safety/Haz-Mat%20Ordinance.pdf. Another health ordinance intended for well head protection, but could be altered for a watershed, is found here http://des.nh.gov/organization/divisions/water/dwgb/dwspp/documents/hodoc4.pdf. They have also been used to add additional requirements beyond what the state requires for septic systems, as in the towns of Bedford and Windham. (http://www.bedfordnh.org/pages/BedfordNH_Health/pub.pdf) (http://www.windhamnewhampshire.com/updated/policies/200%20Public%20Safety/septicord.pdf) A NH model health ordinance is available at http://www.nh.gov/oep/resourcelibrary/referencelibrary/h/healthordinances/documents/modelhealthordinance2.txt Adoption requires approval of the health officer and selectmen. Although not the best solution, rapid adoption is possible.

- Revise -Ws 386, Rules for Protecting the Purity of Regulated Watersheds: While Canaan currently has some restrictions imposed by this rule, those could be expanded to address more threats. However it would be better to have the municipality impose regulations or ordinances rather than the state. As a last resort and after the town has refused to establish suitable controls, the state could be petitioned to implement them.

Conclusion

The Town of Canaan took a proactive step to assess its drinking water supply in 2006 by completing the Canaan Street Lake Watershed Protection Plan and adopting it as part of the Master Plan. However, this plan will only be effective if it is supported by local land use policy decisions. Land use subdivision and site plan regulations and ordinances reflect the policy decisions of a community. They can be difficult to write, adopt, and enforce, but they are the best available means for limiting the potential impact of land use development upon water quality.

In 2009, Canaan appropriated approximately $600,000 to cover the cost of improvements to the town's drinking water system and drilling a ground water well. This well water is to be added to Canaan's drinking water system that has historically relied on Canaan Street Lake as its primary source. While adding an additional water source is a good idea, it is important to remember that the town now has two sources to protect, and that protection of these sources, both in terms of quantity and quality, will be less expensive in the long term than adding additional sources or restoring the current ones if water quality problems occur in the future. In addition, the Canaan Capital Improvement Plan discusses the need for the replacement of water lines at an estimated cost of $750,000. These investments in the town's drinking water system are substantial for a town with a $3.4 million budget and should have basic protections.

The town needs to make a decision about the importance of protecting its drinking water supplies. Amendments should be made to the Canaan Subdivision Regulations and the town should adopt a land use ordinance for the Canaan Street Watershed. It is recognized that a town wide Zoning Ordinance was presented to the town in 2006 and it failed to pass. Despite this, a new effort to address land use issues in the watershed should be made for the purpose of protecting the town's drinking water supply.

References and Resources

NH Department of Environmental Services, http://des.nh.gov/index.htm

Innovative Land Use Planning Techniques: a Handbook for Sustainable Development. (2008) http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm

New Hampshire Water Resources Primer. (2008) http://des.nh.gov/organization/divisions/water/dwgb/wrpp/primer.htm

New Hampshire Stormwater Manual. (2008) http://des.nh.gov/organization/divisions/water/stormwater/manual.htm

Model Rule for the Protection of Water Supply Watersheds. *(2004)* http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-00-3.pdf

NH Office of Energy & Planning, http://www.nh.gov/oep/index.htm

The Planning Board in New Hampshire (2007) http://www.nh.gov/oep/resourcelibrary/referencelibrary/p/planningboard/documents/pbhandbook.pdf

Model Stormwater Management and Erosion Control Regulation (1997)

http://www.nh.gov/oep/resourcelibrary/referencelibrary/s/stormwater/documents/modelstormwatermanagementanderosioncontrolregulation.doc

Town of Thornton, NH's Subdivision Regulations, http://www.thorntonnh.org/downloads/SubdivisioinREG081607.pdf

UNH Stormwater Center, http://www.unh.edu/erg/cstev/

Center for Watershed Protection, http://www.cwp.org/

New England Interstate Water Pollution Control Commission, http://www.neiwpcc.org/

EPA Smart Growth, http://www.epa.gov/smartgrowth/

American Planning Association, http://www.planning.org/

APPENDIX A. List of subjects found in the NH DES Stormwater manual which deserve close examination by Canaan. These may lead to regulatory and policy improvements.

1. Minimize the area of disturbed soil; and
2. Reduce the time that soil is left disturbed by phasing construction; and
3. Maximize the protection of native vegetation; and
4. Prevent stormwater from outside the site from entering areas of disturbed soil on site and control water on site; and
5. Control sediment transport onsite through seeding, mulching, and structural measures, and prevent sediment from leaving the construction site; and
6. Control post-development peak rate runoff so that it does not exceed pre-development runoff for the 2-year, 10-year, and 25 year/24 hour storm events; and
7. Use low-impact development techniques to intercept, treat, and infiltrate runoff from developed areas; and
8. Use development buffers to restore, enhance, or protect natural areas such as riparian areas, stream channels, wetlands, and forests; and
9. Prevent stormwater systems from discharging post-treatment detention runoff within 100 feet of surface water in any Watershed area; and
10. Prohibit snow from being plowed or piled within at least 25 feet of a wetland or waterbody; and
11. All drainage systems must demonstrate features that provide 80% removal of total solids and 40% removal of phosphorus.

Each of the above is explained in the NH Stormwater Manual and DES fact sheet.

http://des.nh.gov/organization/divisions/water/stormwater/manual.htm

http://des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-3.pdf

The following table provides references to relevant volumes, chapters, and pages.

Item Number Above	Stormwater Volume	Chapter	Page
1	1	6.1	44
2	1	7.3	66
3	1	7.2	64
4	1	7.3	66-74
5	1	7.3	66-74
6	2	2.7	22
7	1	6.1	43-53
8	1	7.2	64
9	2	Table 3-3	33
10	N/A	DES Fact Sheet WMB-3	1
11	2	Appendix B	197

WD-08-20A

NEW HAMPSHIRE STORMWATER MANUAL

VOLUME 1
Stormwater and Antidegradation

December 2008
Revision 1.0

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Chapter 6
Non-Structural Site Design Techniques

There are many non-structural site design techniques that can be used to reduce the volume of stormwater runoff generated at a site. Reduced volume means less stormwater requiring treatment before entering a receiving water. These techniques focus on maintaining and mimicking the natural hydrology to the maximum extent practical, minimizing land disturbance, and minimizing the amount of impervious cover.

Some of the techniques mentioned in this chapter may differ from some of the traditional site planning practices upon which local zoning requirements and subdivision standards have been based. As such, application of these techniques will need to be considered in the context of these local requirements. Where allowed by local requirements, the application of the techniques may be feasible with appropriate waivers or exceptions. In some cases, use of the techniques may require changes to zoning provisions or other local requirements.

6-1. Site Design Techniques

Traditionally, runoff management has focused on end-of-pipe methods to detain and treat stormwater. Although end-of-pipe methods have their place in stormwater management, when used alone they are often more costly and maintenance intensive than techniques that minimize stormwater runoff or treat it close to the source. Fortunately, there are many simple, non-structural methods that can be incorporated into the planning process that maintain the natural landscape and preserve the hydrologic functions of a site (U.S. Department of Housing and Urban Development, 2003). Applying such methods minimizes the amount of runoff generated and lessens the treatment volume by controlling stormwater at the source. This approach can also lower overall development costs by reducing the need for, and the sizing requirements of, structural, engineered devices. More information on the cost benefit of these site design

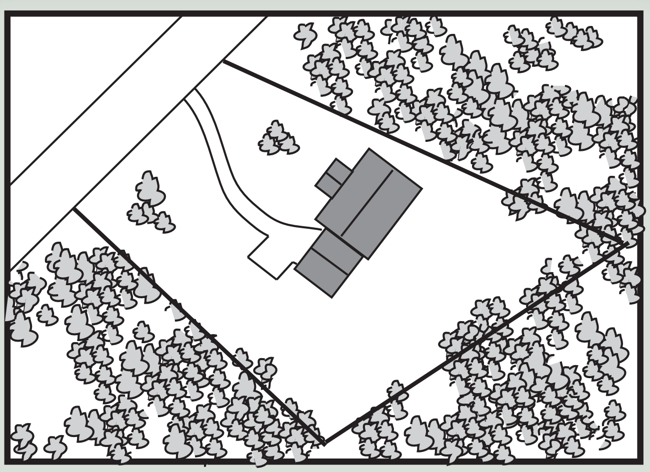

Figure 6-1. Property with maximum disturbance and nearly all of the vegetation removed.

techniques is available from the Low Impact Development Center at: http://www.lid-stormwater.net/background.htm

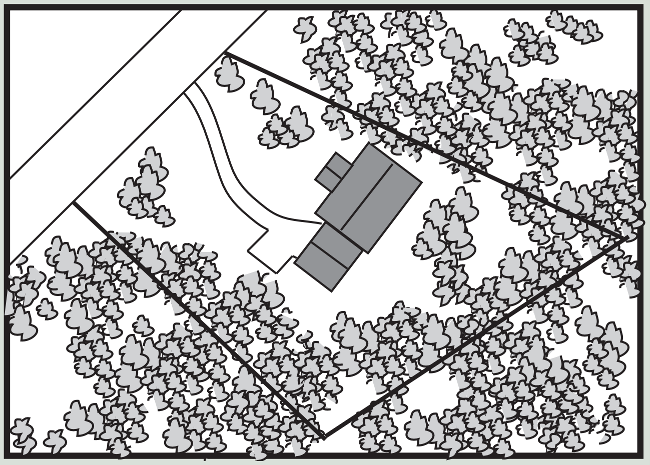

Figure 6-2. Property with vegetation selectively cleared to minimize disturbance.

In order to effectively incorporate these methods, the runoff from a site needs to be managed on a smaller scale. Accomplishing this often requires a shift in thinking. Instead of managing all of a site's runoff through one practice, e.g., collecting the runoff from a subdivision or a commercial development in one large stormwater pond, the runoff is addressed at the individual lot level through many different practices. For example, a site design might incorporate the use of rain barrels or dry wells to collect roof runoff, rain gardens to collect runoff from driveways or parking lots, and smaller stormwater ponds to collect runoff from common, open space areas. This design approach also requires a shift away from altering and grading a site to pipe runoff to a single discharge point, to instead, working with the existing topography and hydrology to maintain flow paths and maximize opportunities for natural flow attenuation and infiltration. This reduces the dependence of the development on downstream carrying and treatment capacity. The following site design concepts assist in reducing the amount of stormwater generated by managing stormwater at the source.

Minimize Disturbed Areas

Any change in the landscape from the existing condition is considered a disturbance. Disturbed areas include all impervious areas such as roads, sidewalks, and rooftops as well as pervious areas such as graded lawns and open drainage systems. The most effective way to minimize the amount of disturbed area and to reduce the stormwater impacts of a site is to use hydrology-based site design.

The primary function of hydrology-based site design is to work within the boundaries of the existing landscape. The first step is to identify existing natural features on the site to restrict and define site disturbance (Prince George's County, Maryland, 1999). For example, are there any steep slopes? Are there wetlands or streams? What are the soil conditions? Asking these questions and determining the most appropriate locations for disturbance and for preservation on the site is often referred to as "site fingerprinting".

Designers are encouraged to avoid disturbing sensitive areas, such as wetlands and streams and their buffer areas, flood plains, and steep slopes. It is also important to try to target disturbance to areas that already have a low capacity for infiltration, such as soils classified as hydrologic soil group C and D or other existing impervious areas. Once these areas have been identified it should be clearer where to locate the areas of disturbance on the site. Regulated resource areas such as wetlands should be clearly marked in the field for survey. All of these areas should be clearly identified on the base plans that the designer will use to develop the site plans for the project.

The following methods are examples of measures that can minimize the disturbed area on a site:

- Define the development envelope and clearly mark it on the plans and in the field.
- Use existing drainage divides by maintaining existing site topography.
- Avoid the removal of trees.
- Limit clearing and grading to the smallest amount required; disturbance should be limited to the building footprint, construction access and safety setbacks.
- Cluster vegetated areas and connect them with vegetated corridors.
- Cluster developed impervious areas and **disconnect** them (see explanation of "Disconnect Impervious Areas" below).
- Establish buffers to wetlands and streams.
- Conserve as much of the site in natural or existing vegetated condition as possible, or in re-development activities, reduce the amount of effective impervious cover by removing or replacing existing impervious cover and disconnecting it.

Maintain Natural Buffers

Maintaining natural buffers goes hand in hand with minimizing disturbed areas. Natural buffers around streams, wetlands, and other sensitive areas intercept runoff from pervious and impervious areas and treat it through natural filtration, infiltration, and vegetative uptake. The following criteria, adapted from the Center for Watershed Protection's "Site Design Credits", should be followed for a natural buffer to effectively treat stormwater.

- The minimum stream buffer width (i.e., perpendicular to the stream flow path) should be 50 feet as measured from the top of bank elevation of a stream or the boundary of a wetland;
- The stream buffer should meet the maintenance and design requirements of a local buffer ordinance, if applicable;

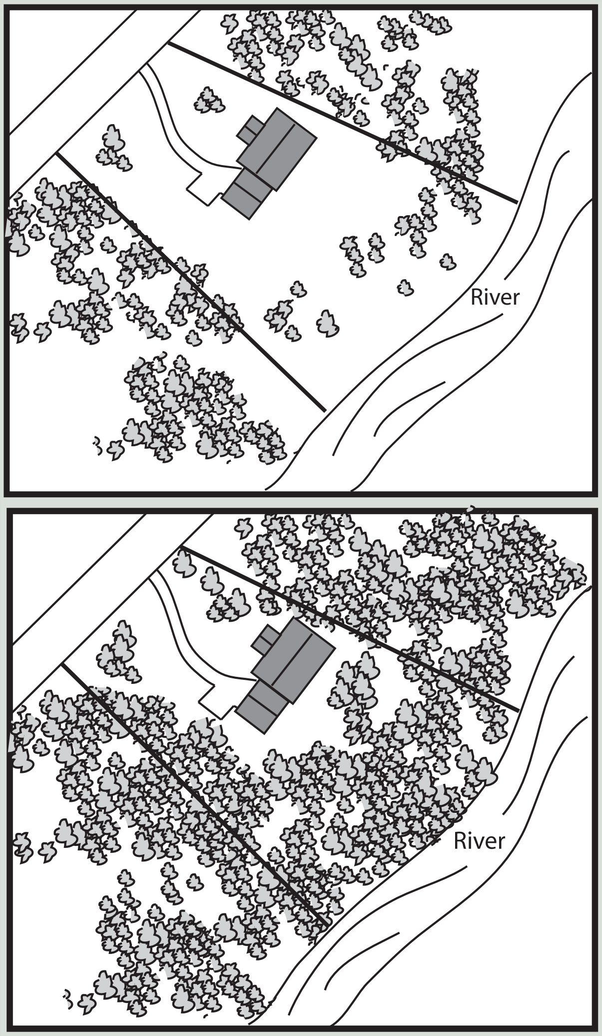

Figure 6-3. Comparison of a lot with very little natural buffer to one with a significant natural buffer intact.

- The maximum contributing flow path should be 150 feet for pervious surfaces and 75 feet for impervious surfaces;
- The average contributing overland slope to and across the stream buffer should be less than or equal to 5.0%;
- Runoff should enter the stream buffer as sheet flow. A stone level spreading device should be used where local site conditions prevent sheet flow from being maintained;
- The stream buffers should remain preserved by a conservation easement or similar protective mechanism. The ground surface must remain ungraded and uncompacted, and the over-story and under-story vegetation maintained in a natural condition.

Minimize Impervious Cover

Impervious cover includes areas such as sidewalks, driveways, roadways, parking areas and rooftops. In some cases, even lawn areas can be essentially impervious depending on construction practices and the extent to which the soils are compacted (USEPA, 2005).

Frequently, the highest percentage of impervious cover from a development site consists of the roadway. This is particularly the case in many residential subdivisions, and some commercial and industrial park areas.

Methods to minimize the impervious area associated with roadways include:

- Consider alternative roadway layouts.
- Employ narrower road widths.
- Use rural road design ("country drainage") instead of curb, gutter, and piped roadway drainage ("closed drainage").

- Limit sidewalks to only one side of the road, or consider pervious trails instead of sidewalks.
- Reduce the amount and type of on-street parking – only on one side, or parallel instead of diagonal.
- Incorporate porous or permeable pavement.

In commercial and industrial developments, as well as residential sites, rooftops, driveways, and parking areas also contribute to the total impervious cover. The following is a sample of methods that can be used to reduce impervious cover from these areas:

- Use a green roof .
- Build two story structures instead of single story structures, to maintain the square footage but reduce the building footprint.
- Use narrow driveway widths.
- Shorten driveway lengths, where grade allows.
- Use shared driveways.
- Use porous pavers or other pervious type of pavement for driveways, parking lots, and overflow parking areas.
- Reduce pavement within parking areas through careful design of efficient aisles and parking bays (e.g., parking on both sides versus one side of an aisle), coupled with the use of vegetated parking lot islands (instead of paved or gravel islands) with depressed planting beds to infiltrate runoff.

Disconnect Impervious Cover

Although the amount of impervious cover on a site can be minimized, it is unrealistic to think it can be eliminated completely. Despite this, impervious areas do not necessarily have to contribute to the runoff leaving the site. For example, by disconnecting the impervious areas and directing the flow to infiltration basins or designated buffer areas, a portion of additional runoff that would contribute to stormwater runoff is instead infiltrated close to the source. The runoff that would potentially carry pollutants from the site to a surface water instead gets treated and helps recharge groundwater. Disconnection methods and criteria are explained in Section 6-2 below.

Minimize Soil Compaction

As noted above, even lawns and gravel-surfaced areas can be essentially impervious. We typically think that the infiltration capacity of a lawn should be similar to that of a naturally vegetated area. This is not the case and is most often due to soil compaction during construction.

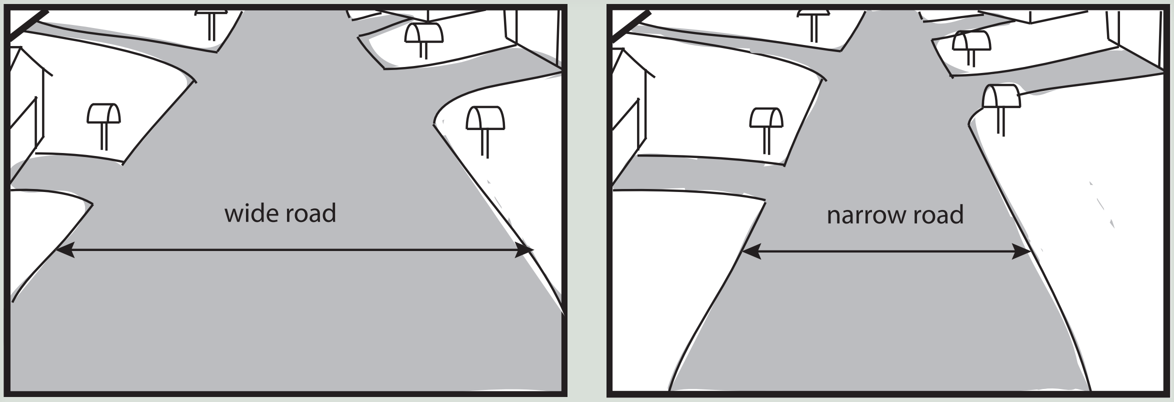

Figure 6-4. Reducing roadway widths can decrease impervious cover.

To reduce the potential for compacted soils, similar to minimizing impervious cover, the following methods can be used:

- Use site "fingerprinting" (discussed above) to determine the areas most appropriate for locating impervious cover.
- Limit development to soils with existing low infiltration capacity such as hydrologic soils group C and D soils (note, however, that some areas classified as D soils may be wetland resource areas or may have water tables at or near the surface and may not be suitable for development).
- Store machinery and equipment within the construction envelope to avoid unnecessarily disturbing areas that could remain vegetated.
- Store construction material and soil stockpiles within the construction envelope.
- Clearly mark on the plans and in the field the boundaries of disturbed areas.
- To the extent feasible, avoid repeated trafficking with construction equipment over areas that will be landscaped, and where construction traffic cannot be diverted, prior to final landscaping deeply scarify impacted soils to restore their infiltration capacity.
- If areas are proposed for use for infiltration of stormwater, then particular efforts will be required to avoid compaction of these areas by construction equipment or traffic, discharge of sediment laden waters to these areas during construction, and premature use of these areas for stormwater management prior to stabilization of these facilities and the contributing drainage areas.

Use Alternative Pavement

The largest portion of impervious cover in most developed areas is created by parking lots and roadways. It may not be feasible, at this stage in the development of alternative pavements, to use them on highways and heavily traveled secondary roadways. However, parking areas, including commercial parking lots and residential driveways, present an ideal opportunity for alternative pavements to reduce impervious cover. Alternative pavements can also be used on sidewalks, low-traffic alleys or side streets, and walking paths. They may also be used in overflow parking areas, rest areas, and park-and-ride lots. The most common alternative pavement materials are separated into two types: modular pavers and porous pavement.

Modular pavers consist of a solid, structural component such as brick, block, concrete, stone, or interlocking grid pavers separated by a pervious material such as sand, gravel, or sod. They are typically set on a sand or gravel base and are load bearing sufficiently to support vehicles. Porous pavements are either porous asphalt or porous concrete. Porous asphalt is similar to traditional asphalt with the exception that there are no fine aggregate materials. Instead only coarse aggregate is used, which creates voids in the material for water and air to easily pass. Similarly, porous concrete is a discontinuous mixture of Portland cement, coarse aggregate, admixtures, and water that result in voids where water and air can pass. Both porous asphalt and concrete are typically underlain by a reservoir comprised of coarse aggregate (such as uniformly graded stone). Further information on the design of these systems can be found in the New Hampshire Stormwater Manual Volume 2: Post-Construction Best Management Practices Selection and Design.

Using these alternatives to traditional asphalt pavement reduces the overall impervious cover of a site and can also act as a mechanism to disconnect other impervious areas. It can reduce the need for conventional stormwater management facilities as more water is infiltrated and the volume of water to be treated through detention or retention is reduced. Research conducted by the University of New Hampshire's Stormwater Center has also found that porous pavement can reduce the amount of salt needed for deicing road and parking area surfaces, and reduces the formation of black ice due to less pooling of water on the pavement surface.

There may be a number of barriers to using alternative pavement. The most common barrier seems to be the misconceptions in regard to maintenance, long term effectiveness, and use in cold climates. These misconceptions are summarized in Table 6-1. An additional barrier may be that a municipality's zoning ordinance or subdivision regulations do not allow for alternative pavement. Overcoming these barriers can be accomplished through education, observation of example projects in other locations, and local demonstration projects, as well as revisions to local land use regulations. More information on porous pavement can be found at the University of New Hampshire's Stormwater Center website at: http://www.unh.edu/erg/cstev/

Table 6-1. Misconceptions & Truths about Porous Pavement Compared to Traditional Pavement

Misconception	Truth
Freezes faster	Has demonstrated increased speed in thawing due to flow through by meltwater
Higher maintenance and cost	Overall costs are comparable
Slippery	Developed to have higher friction than traditional asphalt
Cannot plow, salt, or de-ice	Can be plowed and de-iced, however salt brine solutions are recommended over road salt application
Heaving and shifting	Reduced compared to traditional asphalt due to vadose zone disconnect
Lower life span	Actually increased life span due to reduced freeze thaw

Source: University of New Hampshire Stormwater Center.

6-2. Impervious Surface Disconnection Methods

The amount of runoff and associated pollutants from a project can be reduced by disconnecting impervious surfaces. These disconnection methods are non-structural stormwater management practices focused on infiltrating stormwater. They are based on the "Site Design Credits" developed by the Center for Watershed Protection. By implementing the disconnection methods according to the criteria described here, a project can more easily meet the effective impervious cover targets described in Section 5-2. In addition, well-conceived use of disconnection methods can reduce overall project costs by reducing or eliminating the need for more expensive structural practices.

Disconnection methods should be incorporated at the planning and design level. However, the designer and reviewer should note that these methods must be used in concert with the design of other stormwater conveyance and treatment practices. The use of these disconnection methods does not relieve the designer or reviewer from following the standard engineering practices associated with safe conveyance of stormwater runoff and good drainage design. The nonstructural disconnection methods are presented in this manual under two categories:

- Disconnection of Rooftop Runoff
- Disconnection of Non-Rooftop Runoff

The minimum criteria that must be met in order to be considered sufficiently disconnected and eligible to omit the disconnected impervious areas from the Effective Impervious Cover (EIC) of the site (see discussion in Chapter 5) are described below.

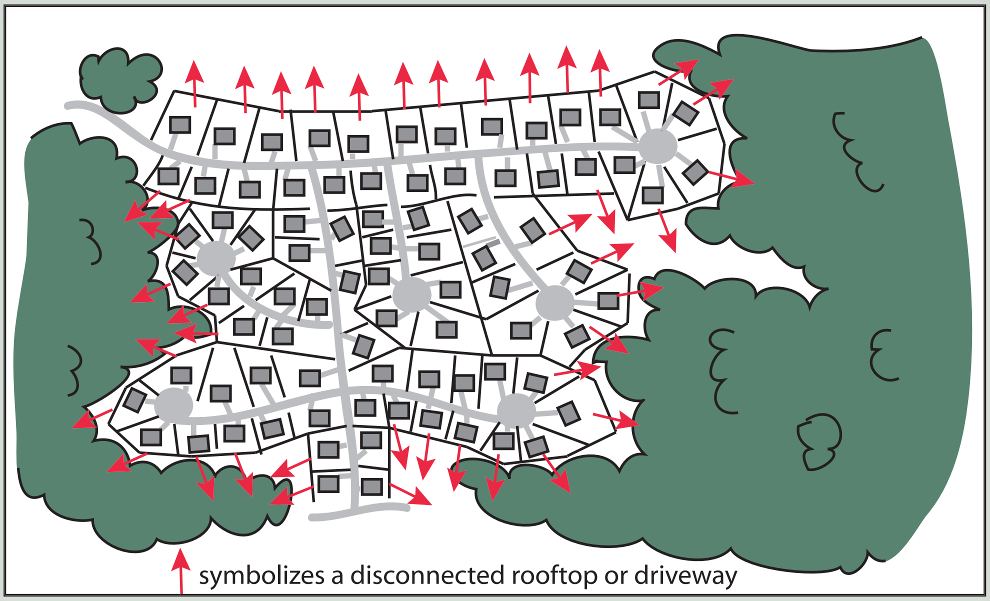

Figure 6-5. The amount of runoff and associated pollutants from a project can be reduced by disconnecting impervious surfaces through the disconnection methods described in Section 6-2.

Disconnection of Rooftop Runoff

The impervious area associated with a rooftop can be omitted from the impervious cover of a site when the rooftop runoff is "disconnected" and then directed to an area where it can infiltrate the soil or flow over a pervious area such as a lawn or a swale with sufficient time and velocity to allow for filtering. This is typically accomplished by grading an area of the site, if natural slopes are not suitable, to promote overland flow through a vegetated buffer, or by directing the flow to an infiltration practice.

If a rooftop is adequately disconnected, the disconnected impervious area can be deducted from the total site impervious cover. Disconnections of rooftop runoff must meet the following criteria:

Criteria:
The disconnection must be designed to ensure no basement seepage or connection to foundation drains;

- The contributing rooftop length should be 75 feet or less;
- The rooftop contributing area to any one discharge location cannot exceed 1,000 square feet;
- The length of the "disconnection" flow path over the pervious area should be equal to or greater than the contributing rooftop length;

- Credit for disconnections will only be given for lot sizes greater than 6,000 square feet unless management practices include dry wells, infiltration trenches or basins, or equivalent infiltration practices;

Example Disconnection of Rooftop Runoff Calculation

Scenario

Site Data: 54 Single Family Residential Lots
(~ ½ acre lots)
Site Area: 27 acres
Total Impervious Cover (TIC): 6 acres
Number of disconnected rooftops: 20
Average house area: 2,500 ft^2
Conversion factor (ft2 to acres): 43,560 ft^2/acre

Calculation

Disconnected Area (AD)
= (# Disconnected rooftops) * (Average house area)
= (20) * (2,500 ft^2)
= 50,000 ft^2
= 1.15 acres

Effective Impervious Cover (EIC)
= TIC - AD
= (6 acres) – (1.15 acres) = **4.85 acres**

- The disconnection flow path length should be only that which drains continuously through a vegetated channel, swale, or through a filter strip to the property line or a stormwater treatment practice;
- The entire vegetative "disconnection" should be on a slope less than or equal to 5.0%;
- Downspouts must be at least 10 feet away from the nearest impervious surface to discourage re-connection to the drainage network;
- Disconnections are encouraged on relatively permeable soils (USDA Hydrologic Soil Groups A and B);
- For rooftop disconnection in a designated high load land use, the rooftop must not commingle with runoff from any paved surfaces.

Disconnection of Non-Rooftop Runoff

Non-rooftop impervious surfaces associated with site development, such as driveways or parking areas, can be omitted from the impervious cover of a site, when the impervious surfaces are directed to an area where runoff can infiltrate into the soil or is allowed to flow over a pervious area such as a lawn or swale that provides sufficient time and slows the flow of water enough to allow for filtering or infiltration.

If impervious areas are adequately disconnected, the disconnected areas can be deducted from the total site impervious cover. Disconnections of non-rooftop runoff must meet the following criteria:

Criteria:

- The maximum contributing impervious flow path length should be 75 feet;
- Runoff cannot come from a designated hotspot land use;

- The disconnection must drain continuously through a vegetated channel, swale, or filter strip to the property line or a stormwater treatment practice;
- The length of the "disconnection" flow path over pervious surface must be equal to or greater than the contributing length;
- The entire vegetative "disconnection" should be on a slope less than or equal to 5.0%;
- The area of impervious surface contributing to any one discharge location cannot exceed 1,000 ft2;
- Disconnections are encouraged on relatively permeable soils (HSGs A and B).

Example Disconnection of Non-Rooftop Runoff Calculation

Scenario

Site Data: 54 Single Family Residential Lots
(~½ acre lots)
Site Area: 27 acres
Total Impervious Cover (TIC): 6 acres
Number of disconnected driveways: 32
(avg. length 100 ft)
Driveway width: ~10 ft
Total disconnected driveway length: 3,200 ft
Conversion factor ft2 to acres: 43,560 ft^2/acre

Calculation

Disconnected Area (AD)
= (driveway width) (total disconnected driveway length)
= (10ft) (3,200 ft)
= 32,000 ft^2
= 0.73 acres

Effective Impervious Cover (EIC) = TIC - AD
= (6 acres) – (0.73 acres) = 5.27 acres

Chapter 6 References

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Chapter 7
Introduction to
Best Management Practices

This chapter provides an overview of structural Best Management Practices for managing and treating stormwater runoff. It includes a brief description of post-construction pretreatment and treatment practices for long-term management of stormwater, as well as an introduction to temporary (construction phase) practices. This chapter also discusses the screening and selection of structural best management practices and their operation and maintenance needs.

Structural BMPs should be considered only after non-structural site design techniques, discussed in Chapter 6, have been implemented to reduce the volume of stormwater runoff. While the goal is to minimize the generation of runoff requiring treatment, it is anticipated that many projects will still require structural BMPs to treat the stormwater from the remaining connected impervious surfaces. Structural BMPs are designed to remove pollutants from stormwater runoff as well as provide for groundwater recharge, peak runoff attenuation, and stream channel protection.

Note that Volume 2 of the New Hampshire Stormwater Manual addresses the selection and design of BMPs in greater detail, along with additional information on operation and maintenance. Volume 3 of the Manual provides additional detailed discussion of construction phase practices.

7-1. Pre-Treatment Practices

Pre-treatment practices are used to treat runoff prior to a permanent best management practice to settle out coarse sediments, slow runoff velocities, and in some cases, provide additional treatment (such as removal of floating debris and oil). This increases overall pollutant removal and reduces the maintenance requirements on permanent treatment practices.

Pretreatment Practices include the following measures:

Sediment Forebays

A sediment forebay is an impoundment, basin, or other storage structure designed to dissipate the energy of incoming runoff and allow for initial settling of coarse sediments. Forebays are used for pretreatment of runoff prior to discharge into the primary water quality treatment BMP. In some cases, forebays may be constructed as separate structures but often, they are integrated into the design of larger stormwater management structures.

Vegetated Filter Strips

Filter strips (grassed filter strips, vegetated filter strips, grass filters) are vegetated surfaces designed to treat stormwater sheet flow. Filter strips are designed to slow stormwater velocity, filter out sediment and associated pollutants, and provide minimal infiltration of runoff. Filter strips are most appropriate for receiving sheet flow runoff before it enters another treatment practice or leaves a site. They function best at removing sediment. They also provide wildlife habitat and travel corridors.

A level spreader may be necessary to convert runoff to sheet flow as it enters the filter strip. Vegetation may consist of meadow, forest, or a combination. Vegetated Filter Strips may have substantially shorter lengths of flow path than "Vegetated Buffers," and would not be anticipated to provide the level of treatment afforded by buffers sized in accordance with the Alteration of Terrain regulations (Env-Wq 1500). Therefore, Filter Strips are not considered "Treatment Practices" but may be used as pretreatment practices.

Pre-treatment Swales

Pre-treatment swales are shallow, linear, vegetated, earthen channels designed to convey flows, while capturing a limited amount of sediment and associated pollutants. A pre-treatment swale differs from a Treatment Swale in that the pre-treatment swale is not designed for a specified hydraulic residence time, but only for a minimum length. Therefore, pre-treatment swales do not necessarily provide sufficient time for the removal of pollutants other than those associated with larger sediment particles, and may only be used for pretreatment.

Flow Through Devices

Flow-through devices can provide pre-treatment of stormwater runoff before entering a treatment practice. These devices include:

Water Quality Inlet
A water quality inlet is an underground storage structure with multiple chambers, designed to capture coarse sediments, floating debris, and some hydrocarbons from stormwater runoff. Such inlet devices are typically used for pretreatment of runoff prior to discharge to another treatment practice.

The devices use baffles with weirs or orifices to control flow and help capture sediment, and inverted baffles or hooded outlets to help capture floating materials. Depending on the design of the unit and the magnitude of peak flow events, the captured sediments may be subject to re-suspension and flushing from the device. Floating hydrocarbons captured in the unit can be removed for disposal during maintenance operations by skimming or by use of sorbent materials. To limit potential for re-suspension of captured materials, the device is usually designed as an "off-line" unit sized for the Water Quality Flow. Larger storm events would then bypass the unit.

Proprietary Flow Through Devices

Proprietary flow through devices may be used for pretreatment of stormwater. Several manufacturers offer a number of proprietary flow-through stormwater treatment devices. These devices are variously referred to as "oil/particle separators," "oil/grit separators," or "hydrodynamic separators." Some of these devices use multiple chambers arranged horizontally or vertically to help trap and retain sediments and floating substances. Some use internal components to promote a swirling flow path to help enhance removal and retention of sediment.

These flow-through devices are normally sited close to the source of runoff, often receiving stormwater from relatively small areas that are mostly, if not entirely, impervious surface. They may only be used as pretreatment of stormwater prior to discharge to other treatment BMPs added.

Deep Sump Catch Basins

A deep sump catch basin consists of a manhole-type structure with an inlet grate, an outlet pipe connected to the piped drainage system, and a sump with a depth several times the diameter of the outlet pipe. The inlet grate is located at the surface, and is sometimes combined with a vertical inlet integrated with a street or parking area curb. The sump's purpose is to capture coarse sediments and debris from the runoff intercepted by the structure. The outlet pipe can be fitted with a "hood" consisting of a cast metal or formed plastic fitting, designed to prevent floating materials from exiting the structure.

Deep sump catch basins used as pretreatment are most effective when they only receive flow from the inlet grate (i.e. no piped inflow from adjacent catch basins) since flow-through basins are more susceptible to sediment re-suspension. The outlet hood provides benefits for trapping floating trash, as well as for short-term spill containment.

7-2. Treatment Best Management Practices

NHDES recognizes the following categories of primary BMPs to treat stormwater runoff. These BMPs provide water quality treatment and are permanent practices for post-construction stormwater management.

Stormwater Ponds

Stormwater ponds are impoundments designed to collect, detain and release stormwater runoff at a controlled rate. They provide treatment through the use of a permanent pool, which helps settle solids and associated pollutants. Extended detention features can be incorporated into stormwater ponds by combining permanent micropools or other permanent pool storage with an extended drawdown time of the water quality volume.

In addition to water quality benefits, by providing additional storage capacity and a multi-stage outlet structure, stormwater ponds can also be designed to provide flood control.

The following are examples of Stormwater Ponds:

Micropool Extended Detention Pond

An extended detention pond with a micropool temporarily stores and releases the Water Quality Volume over an extended drawdown time. The micropool is typically provided near the outlet, to enhance pollutant removal and to help prevent resuspension of captured sediments. Except for the micropool, the basin is designed to be dry between storms, once the WQV has been discharged. The basin provides pollutant removal by settling of sediments and associated pollutants.

Wet Pond

Wet ponds are designed to maintain a permanent pool of water throughout the year. The pool, located below the outlet invert, allows for pollutant removal through settling and biological uptake or decomposition.

Wet ponds, if properly sized and maintained, can achieve high rates of removal for a number of urban pollutants, including sediment and its associated pollutants: trace metals, hydrocarbons, BOD, nutrients and pesticides. They also provide some treatment of dissolved nutrients through biological processes within the pond.

Wet Extended Detention Pond

Wet extended detention ponds combine the features of wet ponds and extended detention ponds. The combined permanent pool and extended detention volume can be used to treat the Water Quality Volume and meet Channel Protection requirements .

Multiple Pond System

The multiple pond system is similar to the wet pond, except that the total treatment volume is distributed over two or more pond "cells," rather than a single pond. This type of design can be useful for adapting the component ponds to fit a particular site layout, provide for a more aesthetic design, or address changes in elevation on a sloping site.

Pocket Pond

The pocket pond is a wet pond or wet extended detention pond designed to serve a small contributing area. While similar to other wet ponds and wet extended detention ponds in design, the water budget for this pond will likely depend on the presence of groundwater, because the smaller contributing watershed would not sustain a permanent pool. Note that NHDES considers a "wet swale" type of water quality swale to be a "pocket pond."

Stormwater Wetlands

Stormwater wetlands are similar to stormwater ponds in that the design includes a permanent pool of water. However, the retained pool is designed with varying depths to support a wetland plant community. In addition to the settling processes that occur in the permanent pool, stormwater wetlands provide pollutant removal/uptake by vegetation and by other biological activity supported within the wetland environment. In some stormwater wetlands, such as "gravel wetlands," the systems provide filtration, as well.

Stormwater wetlands are constructed depressions or impoundments designed to function similar to natural wetlands. However, unlike natural wetlands, stormwater wetlands are designed specifically to treat stormwater. It is important to stress the distinction between using constructed wetlands to treat stormwater versus directing untreated runoff to a natural wetland. The direct discharge of stormwater runoff to natural wetlands is typically not allowed in NH. It alters the critical wetland hydrology and increases the potential to degrade wetland habitat. It can also cause stress to plants and animals and contribute to die-off of these species. Natural wetlands should be protected and should not be used to treat stormwater runoff.

The following are examples of Stormwater Wetlands:

Shallow Wetlands

Shallow wetlands for stormwater treatment consist of pools ranging from 6 to 18 inches in depth under normal conditions, with some areas of deepwater pools. They may be configured with a variety of low marsh and high marsh "cells" with sinuous channels to distribute flows to maximize retention time and contact area. Shallow wetland systems are designed with wetland vegetation suitable for these varying depths. The entire Water Quality Volume is provided within the deepwater, low marsh, and high marsh zones.

Extended Detention Wetlands

Extended detention stormwater wetlands typically require less space than shallow wetlands systems, because part of the Water Quality Volume is stored above the level of the permanent pool. Deepwater areas tend to be less extensive and semi-wet areas more extensive than those provided for shallow wetlands. Wetland plants that tolerate both intermittent flooding and dry periods must be selected for the area above the permanent marsh.

Pond/Wetland System

The wetlands/pond system for stormwater treatment consists of a series of cells using at least one wet pond in combination with shallow marsh wetlands. The first cell typically comprises the wet pond, which provides initial treatment primarily by settling of particulates. The wet pond can also reduce the velocity of runoff entering the system. The shallow marsh provides subsequent additional treatment of the runoff, particularly for soluble pollutants through vegetative uptake and the biological activity associated with the wetland vegetation community. With the deeper pool of the wet pond, these systems can typically require less space than the shallow marsh system.

Gravel Wetlands

The gravel wetland system consists of one or more flow-through constructed wetland cells, preceded by a forebay. The cells are filled with a gravel media, supporting an organic substrate that is planted with wetland vegetation. During low-flow storm events, the system is designed to promote subsurface horizontal flow through the gravel media, allowing contact with the root zone of the wetland vegetation. The gravel and planting media support a community of soil microorganisms. Water quality treatment occurs through microbial, chemical, and physical processes within this media. Treatment may also be enhanced by vegetative uptake.

The system can be designed to integrate some stormwater storage, and also to provide infiltration. With these features, the practice would not only remove pollutants, but also contribute to the attenuation of peak rates through temporary storage and reduction in runoff volume through infiltration and evapotranspiration.

Infiltration Practices

Infiltration practices are designed to capture and temporarily store the water quality volume of stormwater while it infiltrates into the soil. Infiltration practices help to recharge groundwater, but must be designed and maintained to avoid clogging and system failure. Pollutants are removed through adsorption of pollutants onto soil particles, and biological and chemical conversion in the soil.

Infiltration practices differ from filtering practices in that stormwater is infiltrated through native soil and allowed to recharge groundwater, while filtration practices typically employ non-native soil materials or other media, and may use underdrains to convey the filtered water to discharge.

Examples of Infiltration Practice are provided below. Note that “permeable pavements,” discussed under “Filtering Practices,” may also be designed to provide for infiltration.

Infiltration Trench (Including Drip Edge)

An infiltration trench is a stone-filled excavation used to temporarily store runoff and allow it to infiltrate into surrounding, natural soil. Typically, runoff enters the trench as overland flow after pretreatment through a filter strip or vegetated buffer. An infiltration trench is suitable for treating runoff from small drainage areas (less than 10 acres). Installations around the perimeter of parking lots, between residential lots, and along roads are most common. Infiltration trenches can also be incorporated along the center of a vegetated swale to increase its infiltration ability.

An infiltration drip edge is constructed similar to an infiltration trench, except that a drip edge intercepts only roof runoff, and does not require pretreatment.

In-Ground (Surface) Infiltration Basin

In-ground infiltration basins are impoundments designed to temporarily store runoff, allowing all or a portion of the water to infiltrate into the ground. An infiltration basin is designed to completely drain between storm events. An infiltration basin is specifically designed to retain and infiltrate the entire Water Quality Volume. Some infiltration basins may infiltrate additional volumes during larger storm events, but many will be designed to release stormwater exceeding the water quality volume from the larger storms. In a properly sited and designed infiltration basin, water quality treatment is provided by runoff pollutants binding to soil particles beneath the basin as water percolates into the subsurface. Biological and chemical processes occurring in the soil also contribute to the breakdown of pollutants. Infiltrated water is used by plants to support growth or it is recharged to the underlying groundwater.

Underground (Subsurface) Infiltration Basin

Infiltration basins are structures designed to temporarily store runoff, allowing all or a portion of the water to infiltrate into the ground. The structure is designed to completely drain between storm events. An underground infiltration basin is specifically designed to retain and infiltrate the entire Water Quality Volume. Some infiltration basins may infiltrate additional volumes during larger storm events, but many will be designed to release stormwater exceeding the water quality volume from the larger storms. In a properly sited and designed infiltration basin, water quality treatment is provided by runoff pollutants binding to soil particles beneath the basin as water percolates into the subsurface. Biological and chemical processes occurring in the soil also contribute to the breakdown of pollutants. Infiltrated water is recharged to the underlying groundwater.

Subsurface infiltration basins may comprise a subsurface manifold system with associated crushed stone storage bed, or specially-designed chambers (with or without perforations) bedded in or above crushed stone.

Dry Well & Leaching Basin

Dry wells are essentially small subsurface leaching basins. The dry well consists of a small pit filled with stone, or a small structure surrounded by stone, used to temporarily store and infiltrate runoff from a very limited contributing area. Runoff enters the structure through an inflow pipe, inlet grate, or through surface infiltration. The runoff is stored in the structure and/or void spaces in the stone fill. Properly sited and designed dry wells provide treatment of runoff as pollutants become bound to the soils under and adjacent to the well, as the water percolates into the ground. The infiltrated stormwater contributes to recharge of the groundwater table.

Dry wells are well-suited to receive roof runoff via building gutter and downspout systems. With the small size and manageable cost of these BMPs, they are particularly suited for use in subdivisions and for single-family homes. When used for roof drainage, pretreatment of runoff is not typically required.

Leaching basins are dry wells used in well drained soils for the discharge of roadway or parking area runoff. In this case, pretreatment is required prior to discharge to the leaching basin. A typical arrangement is to use a deep sump, hooded catch basin in combination with a leaching basin.

Filtering Practices

Filtering practices treat stormwater runoff by capturing and passing the water quality volume through a bed of sand, other soil material, or other acceptable treatment media to remove pollutants from the water. Sediments and other pollutants are removed by physical straining and adsorption. Filters can be constructed using common materials, or proprietary systems using various filter media can be employed. Filtration BMPs have shown to be very effective at removing a wide range of pollutants from stormwater runoff, particularly when organic soil filter media have been used.

Filtering practices differ from infiltration practices in that the stormwater filters through an engineered filter media, rather than native soil. However, filtering practices can be constructed in combination with infiltration practices, where the filtered water is discharged into the ground beneath the BMP.

Alternatively, filters can be designed with an underdrain to collect the treated water and convey it to discharge. Underdrained filters can be lined to isolate the filters from the adjacent soil material or underlying groundwater.

The following are examples of filtering practices:

Surface Sand Filter
The surface sand filter is typically designed as an off-line device, so that storms exceeding the water quality volume are diverted from the BMP. Thus, the system usually includes a flow splitter, used to divert the first flush of runoff into a pretreatment device, such as a sedimentation chamber (wet or dry) where coarse sediments settle out of the water. Pretreated runoff then enters the sand filter, saturating the filter bed and filling temporary storage volume provided above the bed. As the water filters down through the sand bed, pollutants are strained from the water or adsorbed to the filter media. The top surface of the sand filter is exposed to the elements, but is kept free of vegetation.

If the filter is designed for infiltration, the treated water is allowed to percolate into the underlying native soil. Alternatively, the filter can be designed with a perforated underdrain system to collect treated water at the bottom of the sand filter and direct it to a suitable outlet. If necessary, the underdrained sand filter can be designed with a liner to isolate it from adjacent soil material and prevent discharge of treated water to the groundwater table.

Underground Sand Filter

The underground sand filter operates in a similar fashion to the surface sand filter, except that the system is enclosed in a below-grade structure. The structure may consist of a multi-chambered vault that accommodates pretreatment, as well as the filtration component of the system. The structure is made accessible through manholes or grate openings. Typical subsurface filter systems are fully enclosed in structures. However, some systems may be designed with an open bottom in contact with native soils, allowing for infiltration to occur.

Bioretention System

A bioretention system (sometimes referred to as a "rain garden") is a type of filtration BMP designed to collect and filter moderate amounts of stormwater runoff using conditioned planting soil beds, gravel beds and vegetation within shallow depressions. The bioretention system may be designed with an underdrain, to collect treated water and convey it to discharge, or it may be designed to infiltrate the treated water directly to the subsoil. Bioretention cells are capable of reducing sediment, nutrients, oil and grease, and trace metals. Bioretention systems should be sited in close proximity to the origin of the stormwater runoff to be treated.

The major difference between bioretention systems and other filtration systems is the use of vegetation. A typical surface sand filter is designed to be maintained with no vegetation, whereas a bioretention cell is planted with a variety of shrubs and perennials whose roots assist with pollutant uptake. The use of vegetation allows these systems to blend in with other landscaping features.

Tree Box Filter

The Tree Box Filter consists of an open bottom or closed bottom concrete box or barrel filled with a porous soil media. An underdrain system, consisting of a perforated pipe bedded in crushed gravel, is provided beneath the soil media. A tree is planted in the soil media. Stormwater is directed from surrounding impervious surfaces through the top of the soil media.

If the device has an open bottom, the stormwater percolates through the media into the underlying ground. If the filtered stormwater exceeds the infiltration capacity of the underlying natural soil, the excess will be intercepted by the underdrain, where it may be directed to a storm drain, other device, or surface water discharge.

Where a closed bottom box filter is used, such as where necessary to protect groundwater resources, the filter is isolated from the underlying soil. In this case, all of the stormwater that passes through the soil media filter will be intercepted by the underdrain and conveyed to a suitable outlet.

Permeable Pavement

Permeable pavement consists of a porous surface, base, and sub-base materials which allow penetration of runoff through the surface into underlying soils. The surface materials for permeable pavement can consist of paving blocks or grids, pervious asphalt, or pervious concrete. These materials are installed on a base which serves as a filter course between the pavement surface and the underlying sub-base material. The sub-base material typically comprises a layer of crushed stone that not only supports the overlying pavement structure, but also serves as a reservoir to store runoff that penetrates the pavement surface until it can percolate into the ground.

Although traffic loading capacities vary, permeable pavement alternatives are generally appropriate for low traffic areas (e.g. sidewalks, parking lots, overflow parking, residential roads). Careful maintenance is essential for long term use and effectiveness.

Frequently, permeable pavements filter only the runoff generated on the pavement surface itself. However, runoff from other areas can be directed to permeable pavement if properly designed. Runoff generated from adjacent areas of the site may require pretreatment prior to discharge to the pavement surface, to prevent clogging of the pavement structure and (where the pavement is used to infiltrate as well as filter the runoff) the underlying soils.

Treatment Swales

Treatment swales are designed to promote sedimentation by providing a minimum hydraulic residence time within the channel under design flow conditions (Water Quality Flow). This BMP may also provide some infiltration, vegetative filtration, and vegetative uptake. Conventional grass channels and ditches are primarily designed for conveyance. Treatment swales, in contrast, are designed for hydraulic residence time and shallow depths under water quality flow conditions. As a result, treatment swales provide higher pollutant removal efficiencies. Pollutants are removed through sedimentation, adsorption, biological uptake, and microbial breakdown.

Treatment swales also differ from practices such as underdrained swales (for example, "dry swales" and "bioretention swales"), which are essentially filtration practices, and "wet swales," which are similar in function to pocket ponds.

Vegetated Buffers

Vegetated buffers are areas of natural or established vegetation allowed to grow with minimal to no maintenance. Buffers reduce the velocity of runoff as it flows through the vegetation. Buffers also provide a permeable area where runoff can infiltrate the soil. They promote groundwater recharge, filter out sediments, and create shade to maintain water temperatures. They can also provide wildlife habitat and connect habitat corridors.

Buffers are often provided along the shoreline of waterbodies and wetlands, and may be controlled at the municipal level through buffer requirements and development setbacks. Although municipal buffer requirements are recommended, it may not be appropriate to arbitrarily set a standard buffer width. Instead, a municipality can establish buffer guidelines to determine buffer widths that are dependent on site conditions and goals for individual sites.

Vegetated buffers include, but are not limited to:

Residential or Small Pervious Area Buffer
This type of vegetated buffer is for individual residential lots or for developments with limited areas of impervious surface, where runoff enters the buffer as sheet flow without the aid of a level spreader. This type of buffer can be sited adjacent to single family or duplex residential structures, or impervious surfaces where flow length over the surfaces is limited. This design is not appropriate for treating large impervious areas where there is the likelihood for runoff flows to concentrate and create channels through the buffer instead of discharging as dispersed sheet flow.

Developed Area Buffer
Developed Area Buffers serve areas that exceed the thresholds for "residential or small pervious area buffers." They may also be used for small areas where the runoff is discharged as concentrated flow, rather than sheet flow. Developed area buffers require the use of stone-berm level spreaders to discharge runoff into the buffers as sheet flow. Runoff is directed to the channel upstream of the stone berm, which is located along the contour of the slope at the upper margin of the buffer area. This stone berm spreads the runoff so that it uniformly seeps through the berm and evenly distributes across the top of the buffer as sheet flow.

Roadway Buffers
A buffer adjacent to the down-hill side of a road should be sited directly adjacent to the roadway. In addition, the road must be parallel to the contour of the slope. Runoff must sheet immediately into the buffer, and must not include runoff from areas other than the adjacent road surface and shoulder. The buffer may consist of man-made buffer, natural buffer, or a combination.

Ditch Turn-out Buffer
A ditch turn-out buffer diverts runoff collected in a roadside ditch into a buffer. A combination of check dams and bermed level lip spreaders convert the concentrated ditch flows into sheet flow. The sheet flow distributes across the top of the buffer.

7-3. Construction-Phase Management Practices

Temporary management practices are intended to protect disturbed soils and stabilize areas during construction until vegetation or other permanent management measures are installed. Temporary measures are expected on all construction sites and are not factored into pollutant load reduction calculations. Temporary measures typically include both erosion control practices and sediment control practices.

Erosion Control Practices

Erosion controls are employed to prevent the displacement of soils by wind, rainfall, and runoff. These measures depend on limiting areas of disturbance of soils, limiting times of duration of soil disturbance, careful land grading practices, and the implementation of measures to maintain undisturbed surfaces and stabilize disturbed surfaces. Typical erosion control and stabilization practices include:

Construction Phasing
Land alteration is an essential component of site development and building construction, and is often required for redevelopment as well. Land grading consists of shaping the existing land surface in accordance with a plan determined by engineering survey and layout. This activity must be performed in a manner to minimize exposure of slopes to runoff and potential erosion, provide for stable permanent slopes, and facilitate the establishment of vegetation.

During construction, land grading practices intended to minimize impacts of surface runoff and erosion include:

- Planning earth disturbance and grading activities so as to minimize the area of soil exposed at one time, as well as the length of time between initial soil exposure and final grading. On large projects this is accomplished by phasing the operation.
- Protecting existing vegetation and natural forest cover.
- Preserving and maintaining buffer strips of undisturbed vegetation.
- Diverting clean water away from the immediate construction area.
- Dispersing clean stormwater to undisturbed, vegetated, flat or moderate-sloped, surfaces wherever possible, rather than concentrating it into channels.
- Upgrading and refining the implementation of fall and winter erosion control measures to protect the site from spring runoff and snowmelt.

Dust Control

Dust control consists of applying various measures to prevent blowing and movement of dust from exposed soil surfaces. This practice is applicable to areas subject to dust blowing and soil movement where on-site and off-site damage is likely to occur if preventive measures are not taken. Typical dust control measures include traffic control, construction phasing, and maintenance of existing vegetation to limit exposure of soils and prevent conditions that result in dry soils and dust; application of water, calcium chloride, and temporary stabilization practices to control mobilization of dust by equipment operation or wind; and pavement sweeping to prevent accumulation of dust-producing sediment.

Surface Roughening

Surface roughening is a technique for creating furrows in a bare soil surface, by tracking the slope with construction equipment. The purpose of surface roughening is to aid the establishment of vegetative cover from seed, to reduce runoff velocity and increase infiltration, and to reduce erosion and provide for sediment trapping. This practice applies to all construction slopes to facilitate long-term stabilization with vegetation, and particularly slopes steeper than 3:1.

Soil Stockpile Practices

Soil stockpile practices include measures to locate, manage, and protect stockpiled earth materials to reduce or eliminate wind and water erosion, and prevent resulting air and water pollution from displaced sediment. Stockpile practices apply to topsoil, excavated materials, borrow materials imported to the site, and construction aggregates and paving materials that are stockpiled on the site prior to use in the construction work.

Temporary & Permanent Mulching

Temporary mulching consists of the application of plant residues or other suitable materials to the soil surface. Mulching prevents erosion by protecting the exposed soil surface from direct impact by rainfall. It also aids in the growth of vegetation by conserving available moisture, controlling weeds, and providing protection against extreme heat and cold. Mulches can also protect the infiltration rate of the soil, prevent soil compaction, and provide a suitable microclimate for seed germination. This is the quickest and most cost effective method of preventing erosion on disturbed soils and its value should not be underestimated.

Permanent mulch consists of the application of long-term surface cover such as bark, wood chips, or erosion control mix. Permanent mulch can be used as a permanent ground cover, as an overwinter stabilization mulch, or left to naturalize. It is not designed to support grass vegetation, but legumes or woody vegetation may be established for additional stability.

Temporary and permanent mulches may consist of hay or straw, wood chips or bark, or erosion control mix (a mixture of fibrous organic materials such as from shredded bark, stump grindings, composted bark, or equivalent manufactured products). Please note that hay mulch can contain a variety of seeds some of which may be invasive plants such as reed canary grass and purple loosestrife. It is suggested that hay mulches not be used near important resources such as wetland streams and lakes to prevent the spread of invasive plants .

Temporary Vegetation

Temporary vegetation consists of the establishment of a grass and legume cover on exposed soils for periods of up to 12 months. The purpose is to reduce erosion and sedimentation by stabilizing disturbed areas that will not be brought to final grade for a year or less and to reduce problems associated with mud and dust production from exposed soil surfaces during construction. Temporary seeding is also essential to preserve the integrity of earthen structures used to control sediment, such as diversions and the embankments of sediment basins.

Runoff and sheet erosion caused by splash erosion (rain drop impact on bare soil) is the source of most fine particles in sediment. To reduce the sediment load in runoff, the soil surface itself should be protected. The most effective and economical means of controlling sheet and rill erosion is to establish a vegetative cover. Annual plants that sprout rapidly and survive for only one growing season are suitable temporary vegetative cover.

Permanent Vegetation

Permanent vegetative cover should be established on disturbed areas where permanent, long lived vegetative cover is needed to stabilize the soil, to reduce damages from sediment and runoff, and to enhance the environment. The most effective and economical means of controlling sheet and rill erosion is to establish a permanent vegetative cover.

Temporary Erosion Control Blanket

Erosion control blankets or mats consist of protective manufactured mulch blankets, installed on prepared soil surfaces to provide erosion protection and surface stability on steep slopes, vegetated channels, or shorelines during vegetation establishment. Erosion control blankets temporarily stabilize and protect disturbed soil from raindrop impact and surface erosion. Like other types of mulch, the blankets help increase infiltration, decrease compaction and soil crusting, and conserve soil moisture. Erosion control blankets increase the germination rates for grasses and legumes and promote vegetation establishment. Erosion control blankets also protect seeds from predators and reduce desiccation and evaporation by insulating the soil and seed environment.

Erosion control blankets generally consist of machine-made mats made of organic, biodegradable mulch such as straw, curled wood fiber (excelsior), coconut fiber or a combination thereof, evenly distributed on or between manufactured netting. Netting is typically composed of photodegradable polypropylene or biodegradable natural fiber.

Erosion control blankets can be applied to steep slopes, vegetated waterways, and other areas sensitive to erosion, to supplement vegetation during initial establishment and help provide for safe conveyance of runoff over the protected surface.

Diversion

A diversion is a temporary channel constructed across the slope to intercept runoff and direct it to a stable outlet or to sediment trapping facilities. The channel may be formed by excavation, placement of a berm (or dike), are a combination of these measures. This temporary measure is used immediately above a new cut or soil fill slope or around the perimeter of a disturbed area. Diversion practices themselves should be stabilized.

Diversions can be used to direct storm runoff from upslope drainage areas away from unprotected disturbed areas and slopes to a stabilized outlet. In this case the diversion is placed upslope of the construction area. They can also be used to divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or sediment basin. In this case, the diversion is placed below the disturbed area, to assure that sediment-laden runoff will not leave the site without treatment.

Diversions are intended to facilitate management of the site during construction, and should not be substituted for terracing, vegetated waterways, permanent land grading practices, or other permanent measures for providing long-term erosion control.

Slope Drain

A slope drain comprises a pipe, flexible tubing, or other conduit extending from the top to the bottom of a cut or fill slope. During construction, cut and fill slopes are exposed to erosion between the time they are graded and permanently stabilized. During this period, the slopes are very vulnerable to erosion, and temporary slope drains together with temporary diversions can provide valuable protection. The temporary conduit safely conveys runoff down the disturbed face of an embankment without causing erosion. The practice is maintained until the slope has been sufficiently stabilized to enable it to convey runoff by sheet flow, or until another practice has been installed to convey concentrated runoff from the top of slope to a safe outlet. The outlet from the slope drain should be stabilized.

Sediment Control Practices

Sediment controls interrupt the sediment conveyance process. Once erosion occurs, soil particles are conveyed by runoff away from the source of sediment, and deposited in downslope land areas or in downstream receiving waters. To capture sediment generated during construction, practices are implemented to intercept sediment before it leaves the site; some examples of sediment controls include:

Silt Fence

Silt fence is a temporary sediment barrier consisting of filter fabric attached to supporting posts and entrenched into the soil. This barrier is installed across or at the toe of a slope, to intercept and retain small amounts of sediment from disturbed or unprotected areas.

Silt fences have a useful life of one season. They function primarily to slow and pond the water and allow soil particles to settle. Silt fences are not designed to withstand high heads of water, and therefore should be located where only shallow pools can form. Their use is limited to areas where overland sheet flows are expected.

Silt fence is a sediment control practice, not an erosion control practice. It is intended to be used in conjunction with other practices that do prevent or control erosion. Improperly applied or installed silt fence will increase erosion.

Silt fences should not be used across streams, channels, ditches or other drainage ways. Silt fences are not capable of effectively filtering the high rates and volumes of water associated with channelized flow.

Straw or Hay Bale Barrier

Straw and hay bale barriers are a type of temporary sediment barrier installed across or at the toe of a slope, to intercept and retain small amounts of sediment from disturbed or unprotected areas.

Straw or hay bale barriers have a useful life of less than six months. They function primarily to slow and pond the water and allow soil particles to settle. They are not designed to withstand high heads of water, and therefore should be located where only shallow pools can form. Their use is limited to areas that only contribute sheet flow to the device.

Straw or hay bale barriers constitute a sediment control practice, not an erosion control practice. The must be used in conjunction with other practices that do prevent or control erosion. Improperly applied or installed sediment barriers will increase erosion.

Straw or hay bale barriers should not generally be used across streams, channels, ditches or other drainage ways or areas with concentrated flows. Such barriers are not capable of effectively filtering the high rates and volumes of water associated with channelized flow. However, they may be used for check dams in applications where installation access or other conditions prevent the use of preferred materials such as stone; in such cases, installation must provide proper embedment of the straw or hay bale barrier, limit contributing drainage area to less than an acre, and provide for frequent monitoring of the barrier. Straw or hay bale barriers installed across a concentrated flow path are subject to undercutting, end cutting, and overtopping. Please note that hay bales can contain a variety of seeds some of which may be invasive plants such as reed canary grass and purple loosestrife. It is suggested that hay bales not be used near important resources such as wetland streams and lakes to prevent the spread of invasive plants .

Erosion Control Mix Berms

An erosion control mix berm is a trapezoidal berm that intercepts sheet flow and ponds runoff, allowing sediment to settle, and filtering sediment as well. They are an environmentally-sensitive and cost-effective alternative to silt fence. An alternative to a simple erosion control mix berm is a "continuous contained berm", consisting of erosion control mix compost encapsulated in a mesh fabric (or "filter sock"). This barrier is installed across or at the toe of a slope, to intercept and retain small amounts of sediment from disturbed or unprotected areas.

Erosion control mix berms and socks sometimes offer a better solution than silt fence and other sediment control methods, because the organic material does not require any special trenching, construction, or removal, unlike straw bales, silt fence or coir rolls. This makes the technique very cost-effective.

The erosion control mix is organic, biodegradable, renewable, and can be left onsite. This is particularly important below embankments near streams, as re-entry to remove or maintain a synthetic barrier can cause additional disturbance. Silt fence has to be disposed of as a solid waste, and is often left abandoned on jobsites. Erosion control mix berms can be easily and quickly fixed, if they are disturbed in the course of construction activity.

Temporary Check Dams

Temporary check dams are small temporary dams constructed across a swale or drainage ditch. Check dams are used to reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch. Check dams may also trap small amounts of sediment generated in the ditch itself. However, the check dam is not a sediment trapping practice and should not be used as such. The practice is limited to use in small open channels that drain one acre or less. It should not be used in either perennially flowing streams or intermittent stream channels.

Check dams can be constructed of stone. In locations where stone is not available, timber check dams may be considered. Typical applications include:

- Temporary ditches or swales which, because of their short length of service, cannot receive a non-erodible lining, but still need some protection to reduce erosion.
- Permanent ditches or swales which for some reason cannot receive a permanent non-erodible lining for an extended period of time.

- Either temporary or permanent ditches or swales, which need protection during the establishment of grass linings.

Hay or straw bales should not generally be used as check dams, or in any location where there is concentrated flow.

Temporary Storm Drain Inlet Protection

A storm drain inlet protection is a sediment barrier installed around a storm drain drop inlet or curb inlet to reduce sediment discharge. The sediment barrier may be constructed of straw or hay bales, gravel and wire mesh, or concrete blocks and gravel. Sediment removal is accomplished by shallow ponding adjacent to the barrier and resulting settling of the sediment particles.

The purpose of storm drain inlet protection is to prevent sediment from entering a storm drainage system prior to permanent stabilization of the contributing disturbed area. Storm drains made operational before their drainage areas are stabilized can convey large amounts of sediment to storm sewer systems or natural drainage ways. In some cases, the storm drain itself may accumulate sufficient sediment to significantly reduce or eliminate its conveyance capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Temporary Construction Exit

A stabilized construction exit consists of a pad of stone aggregate placed on a geotextile filter fabric, located at any point where traffic will be leaving a construction site to an existing access road way or other paved surface. Its purpose is to reduce or eliminate the tracking of sediment onto public roads by construction vehicles. This helps protect receiving waters from sediment carried by stormwater runoff from public roads.

Temporary Sediment Trap

A sediment trap is a small, temporary ponding area to intercept sediment-laden runoff from small disturbed areas. Intercepted runoff is retained long enough to allow for settling of the coarser sediment particles. A sediment trap is usually installed in a drainage swale or channel, at a storm drain or culvert inlet, or other points of discharge from a disturbed area.

Temporary Sediment Basin

A sediment basin is a water impoundment constructed to capture and store sediment and/or debris. Sediment is removed by temporarily storing sediment-laden runoff, allowing time for the sediment particles to settle. In some instances, settling may be enhanced by the introduction of flocculants. Sediment basins may be made by constructing a dam or embankment or by excavating a depression.

Sediment basins differ from sediment traps, in that basins are engineered impoundment structures, and may serve larger areas than sediment traps.

The sediment basin is designed to:

- Detain stormwater volume and slowly release it to the downstream waterways;
- Trap sediment originating from construction site and prevent subsequent deposition in downstream drainage waterways;
- Provide storage of the trapped sediment and debris.

Construction Dewatering

Construction dewatering must be conducted in a way to prevent sedimentation associated with the management of water removed during construction from excavations, cofferdams, and other work areas that trap stormwater and groundwater. Construction dewatering discharges to surface waters must obtain coverage under either the NPDES Construction General Permit (CGP) (the State Permit Conditions Section details requirements for construction dewatering) or for sites disturbing less than one acre, the NPDES Construction Dewatering General Permit . These permits contain, among other requirements, numeric limits for total suspended solids (TSS).

Construction sites in New Hampshire typically require construction dewatering operations. Excavations that do not "daylight" to existing grade trap either rainwater or groundwater, and cofferdams collect rain, ground or seepage water within the work area. This water needs to be removed before certain operations can be performed or to keep work conditions safe. Contractors typically use ditch pumps to dewater these enclosed areas. If care is not taken to select the point of discharge and provide adequate treatment, the pumped water may discharge to down-gradient natural resources such as lakes, wetlands, or streams, with subsequent sedimentation of those waterbodies.

Construction dewatering activities must be conducted to prevent the discharged water from eroding soil on the site, remove sediment from the collected water, and preserve downgradient natural resources and property.

Flocculants

Flocculants (or coagulants) are natural materials or chemicals that cause colloidal particles (clay) to coagulate. The coagulated particles group together to form flocs, which settle out of detained stormwater.

Flocculants can be used in conjunction with sediment basins and sediment traps to remove suspended clay and fine silt particles from stormwater runoff prior to discharge. Use of flocculants improves the ability of these settling facilities to remove finer particles than would be removed otherwise and can increase the percentage of fines removed during the detention period.

Flocculants should only be used upon prior approval by NH DES.

Winter Weather Stabilization and Construction Practices

A project involving construction activity extending beyond one construction season will require measures to stabilize the site for the over-winter period. If a construction site is not stabilized with pavement, a road gravel base, 85 % mature vegetation cover, or riprap by October 15, then the site must be protected with over-winter stabilization. The winter construction period is from October 15 through May 15.

Winter excavation and earthwork activities need to be limited in extent and duration, to minimize potential erosion and sedimentation impacts. Various erosion and sediment control practices need to be applied, as discussed in Volume 3 of the New Hampshire Stormwater Manual, to stabilize a project site during the winter period.

7-4. Selection Criteria for Best Management Practices

There is no single stormwater best management practice that is appropriate for every development site. Soils, topography, slope, and many other factors make each site unique and require individual assessments to determine the most suitable stormwater BMPs. Depending on the needs of a site, BMPs can be implemented to meet one or more of the following management objectives:

- Recharge groundwater and reduce total runoff volumes
- Protect stream channels
- Control peak rates for flood control
- Reduce pollutant loads

Often, a site has a combination of management objectives and requires BMPs that achieve multiple objectives. The selection of BMPs requires careful consideration of these objectives, as well as a variety of constraints that may influence the effective application of particular types of BMPS. In some situations, two or more BMPs in a series may be necessary to achieve sufficient treatment to reduce pollutant loads.

This section provides an overview of the screening criteria that should be considered when selecting BMPs. These criteria are intended to provide only general guidance in the selection of BMPs and should not be used in the place of best professional judgment. Volume 2 of the New Hampshire Stormwater Manual provides a detailed discussion of the criteria in order to select measures that are appropriate for meeting management objectives while taking into consideration unique site constraints.

Land Use Criteria

Selecting a stormwater BMP requires consideration of, among other factors, space availability, fitting with the neighborhood character, housing density, and future growth and development. Some practices require very little space and some are land intensive. Some practices blend in with the landscape and others are less compatible. As discussed in Volume 2 of the New Hampshire Stormwater Manual, selection of BMPs may be dependent on which of the following land-use settings apply:

- Rural
- Residential
- Roads and Highways
- Commercial Development
- High Load Areas

Of particular note are high-load areas, which include areas where activities involve storage of regulated substances that may be exposed to rainfall or runoff. These areas typically generate higher concentrations of hydrocarbons, metals, or suspended solids than found in typical stormwater runoff and may include industrial facilities, petroleum storage or dispensing facilities, vehicle fueling or maintenance stations, fleet storage areas, public works storage areas, road salt facilities, commercial nurseries, non-residential facilities with uncoated metal roofs, or facilities with outdoor storage, loading, or unloading of hazardous substances. These areas have particular requirements for the management of stormwater, including the prohibition of infiltration of stormwater runoff, in order to protect groundwater supplies.

Site Physical Feasibility Factors

Physical site constraints such as the infiltration capacity of the soil, depth to bedrock or water table, size of the drainage area, and slope can limit the selection of stormwater BMPs. Depending on the physical site constraints, certain BMPs may be too costly to install or may be ineffective. NHDES has established requirements for physical feasibility factors. These requirements are described in the Alteration of Terrain Program Administrative Rules (Env-Wq 1500) and are summarized in Volume 2 of the New Hampshire Stormwater Manual. Physical feasibility criteria include:

- Soil infiltration capacity
- Water table
- Drainage area
- Slopes

Watershed Resource Factors

Chapter 3 discussed how the impacts of development activities can be far reaching. Because of this, it is important to look not only at the impacts the development will have at a site, but also how downstream resources may be impacted by development activities. The following downstream resources should be considered when selecting stormwater BMPs:

- Sensitive receiving waters such as impaired waters, outstanding resources waters, and prime wetlands , located downstream of a development site;
- Water supplies: aquifers and surface waters
- Lakes and ponds
- Estuary and Coastal Areas

BMP Capability Factors

Pollutant removal efficiencies are dependent on many variables including proper selection and installation of the BMP, proper placement of the BMP on a site, and proper maintenance. Various field and laboratory tests have determined average expected pollutant removal efficiencies for various management practices. These values, expressed as a percentage of the total load, can be seen in Chapter 8. As more studies are conducted and the amount of pollutant removal efficiency data grows, these estimates may change to more accurately reflect the level of stormwater treatment provided through these practices.

Maintenance Factors

Regular inspection and maintenance is essential for long-term effectiveness of stormwater BMPs. Sediment, trash, and other debris can accumulate in BMPs and needs to be removed periodically. Pre-treatment devices, such as sediment forebays, can reduce the amount of sediment accumulation in the primary treatment device; however, pre-treatment practices also require maintenance. If not properly maintained, the BMP will not operate as designed and will not provide effective treatment of stormwater runoff. This jeopardizes water quality and may violate permit conditions. All stormwater BMPs require maintenance; however, the frequency and difficulty of maintenance activities and the equipment needed to carry them out varies. Maintenance criteria need to be considered when selecting a stormwater BMP.

Community and Environmental Factors

It is important to think about how a stormwater BMP will fit into the community. Some BMPs may be aesthetically attractive and will blend into the local landscape and may actually become a landscape feature. Others may pose a safety risk, such as deep standing water, that may be unsuitable for a residential area with small children or increase mosquito habitat and the potential for human exposure to mosquito-borne illnesses. Some BMPs are more expensive to construct and maintain than others. It is important that the municipality, home association, or homeowner will be able to afford and maintain the practice. In addition, some practices may have other environmental benefits; for example, some BMPS can provide wildlife and wetland habitat.

7-5. Stormwater System Operation and Maintenance Plan

It is essential for all stormwater management systems to be carefully planned and to undergo routine inspection and maintenance in order to operate at the designed efficiency. To more easily track the operation and maintenance activities, including the activity schedule, the person(s) responsible, and the maintenance activity records, it is recommended (and sometimes required) that a stormwater management plan is developed and implemented. If a plan is being developed under a specific permit, check with the permit program to see if additional plan elements are required. At a minimum, the Stormwater System Operation and Maintenance Plan should include the following elements:

- The names of the responsible parties who will implement the Plan,
- The frequency of inspections,
- And inspection checklist to be used during each inspection,
- And inspection and maintenance log to document each activity,
- A plan showing the locations of all the stormwater practices described in the plan.

7-6. Road Salt and Deicing Minimization Plan

New Hampshire's cold winter climate and snowfall require plowing and de-icing of roadways and other impervious surfaces to allow for safer travel. The most commonly used de-icing salt is sodium chloride (NaCl). In general, road salt is used to reduce the adherence of snow to the pavement, keep the snow in a "mealy" condition to allow for easier plowing, and to prevent the formation of ice or snow ice (hard pack).

Although road salt makes for safer travel, it is hard on the environment and can pose a risk to drinking water supplies. Roadside vegetation is visibly impacted from road salt including burned grass and shrubs. High chloride concentrations can be toxic to some aquatic life, including certain types of macroinvertebrates and freshwater fish. New Hampshire has several surface waters that are listed as impaired in the Section 305(b) and 303(d) Surface Water Quality Report. The majority of these waterbodies are in heavily urbanized areas. Chloride impairments in surface waters along the Interstate 93 corridor in southern New Hampshire have lead to the development of several chloride TMDLs for these waters. In addition to the habitat and water quality impacts, private wells can become contaminated by chloride.

Unfortunately, the systems and treatment practices commonly used to treat stormwater runoff do not remove chloride. Practices that do remove chloride, such as reverse osmosis, are very costly. Because of this, source control (i.e., using less salt in the first place), is the best way to prevent further chloride contamination.

To address the concerns associated with the application of chlorides and other deicing materials, NHDES requests the development of a Road Salt and Deicing Minimization Plan when a development will create one acre or more of pavement, including parking lots and roadways. The plan should address the policies that the development will keep in place to minimize salt and other deicer use after the project has been completed. A component of the plan should include tracking the use of salt and other deicers for each storm event and compiling salt use data annually.

New Hampshire does not yet have salt reduction guidance, but recommends following the guidelines available in the *Minnesota Winter Parking Lot and Sidewalk Maintenance Manual* (www.pca.state.mn.us/publications/parkinglotmanual.pdf) and the *Minnesota Snow and Ice Control* handbook, (www.mnltap.umn.edu/pdf/snowicecontrolhandbook.pdf). Deicing application rate guidelines and a form for tracking salt and other deicer usage are included in Appendix C.

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NEW HAMPSHIRE STORMWATER MANUAL

VOLUME 2
Post-Construction Best Management Practices: Selection and Design

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24-hour pre-development peak flow rate or to the 1-year, 24-hour pre-development peak flow rate.

Rationale

One of the earliest and most common methods developed to protect stream channels involved the control of post-development peak flows associated with the 2-year, 24-hour storm event to pre-development levels. More recent research indicates that this method does not adequately protect stream channels from erosion and may actually contribute to erosion, since banks are exposed to more frequent and longer duration of erosive bankfull events (MacRae, 1993 and 1996, McCuen and Moglen, 1988).

This is illustrated in Figure 2-3, which compares typical hydrographs for an undeveloped site, the same site developed with no control of peak rates, and the developed site with facilities to attenuate peak rates. As expected, the uncontrolled post-development hydrograph shows a higher peak runoff rate and greater volume of runoff than the pre-development hydrograph. To control peak rates, attenuation facilities are designed to store runoff and release it over an extended period, in order to control the release rate to pre-development levels. While this controls the rate, the period of time during which the receiving water experiences the flow is extended. The extended duration is significant, because flows approaching and larger than the 2-year storm comprise the erosive, channel-forming events. The net result is that receiving channels experience greater erosion due to the increased frequency and duration of bankfull events. The Channel Protection criterion addresses this condition.

2-7. Peak Runoff Control

Criteria

The purpose of peak runoff controls is to address increases in the magnitude of flooding caused by development. The following criteria should be met to control peak discharge rates and improve the overall effectiveness of the stormwater treatment systems:

1. The 10-year, 24-hour post-development peak flow rate should not exceed the 10-year, 24-hour pre-development peak flow rate for all flows leaving the site;
2. The 50-year, 24-hour post-development peak flow rate should not exceed the 50-year, 24-hour pre-development peak flow rate for all flows leaving the site;
3. The project should provide supporting information showing that there is no impact to properties as a result of developing within the100-year floodplain;

4. The design must ensure that the conveyance system and land grading direct runoff to the peak control structure for all pertinent storm events. On some sites, detention facilities are designed for one storm event, while pipes are designed for a different event. For example, the control structure may be designed for the 25-year storm, while the drainage system may only be sized to handle a ten-year storm, with larger storms flooding the distribution system and traveling overland. In this case, the design should ensure that this overflow will be directed into the peak control structure;

5. On some sites, stormwater enters the site from adjacent property. If this stormwater must be handled by the project's drainage system, then the system design and supporting calculations should account for this condition for each design storm, in both pre- and post-development conditions;

6. The design should provide for an emergency spillway for any peak rate control structure that requires an embankment (dam). The emergency spillway's purpose is to protect against embankment failure, in the event the primary outlet cannot handle flows discharging form the impoundment (see description of Detention Basin in Chapter 4).

7. Use NRCS (formerly SCS) methods (TR-20 or TR-55) to develop hydrographs and peak flow rates for the proposed development site. The hydrograph time interval (dT) in TR-20 should be no greater than 0.1 hours. All areas should be accounted for in the pre/post

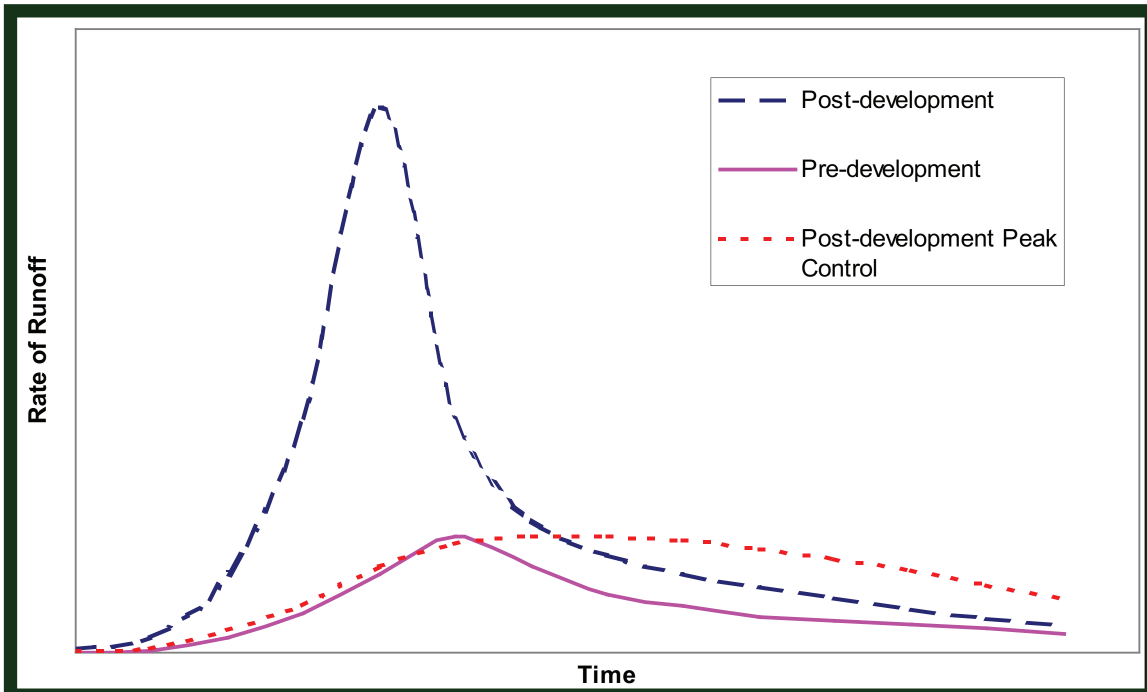

Figure 2-3. Pre- and Post-Development Hydrographs

runoff calculations. The total tributary area that contributes flow to the proposed site, including runoff entering the site through piped drainage or surface runoff from off-site sources, should be included even if a portion does not contribute flow to the site BMPs. The objective is for the development's storm drain design to account for total runoff leaving the site;

8. Any site that was wooded within the last ten years should be considered undisturbed woods for all pre-construction runoff conditions, regardless of clearing or cutting activities that may have occurred on the site during that pre-application period;

9. For all areas that are not modeled in "good" condition, photo documentation should be obtained.

10. Off-site areas should be modeled as present land use condition for all design storm events for both pre and post development calculations; and

11. The length of overland sheet flow used in time of concentration (tc) calculations should be limited to no more than 100 feet for pre- and post-development conditions.

In general, peak runoff controls as described in 1) and 2) above may not be necessary if the project area abuts and discharges to a large receiving waterbody. This typically can be shown through off-site drainage calculations for the 10-year and 50-year, 24-hour storm, showing that at a point immediately downstream from the project site, the post-development peak flow rate from the site and the off-site contributing area does not exceed the pre-development peak flow rate at that point.

Rationale

This criterion is generally consistent with storm drainage system design in New Hampshire, with some added provisions to help guide the design of peak attenuation structures.

The provision to consider any site that was wooded within the last ten years as undisturbed woods for all pre-construction runoff conditions is incorporated to address properties that are cleared with an intent to develop, before the development application process is triggered. Without this provision, the pre-development peak discharge rate may be overestimated, since cleared land produces more runoff than forested land, resulting in a lesser degree of control when the development actually occurs.

- Vehicle fueling facilities;
- Vehicle service, maintenance and equipment cleaning facilities;
- Fleet storage areas;
- Public works storage areas;
- Road salt facilities;
- Commercial nurseries;
- Non-residential facilities with uncoated metal roofs with a slope flatter than 20%;
- Facilities with outdoor storage, loading, or unloading of hazardous substances, regardless of the primary use of the facility; and
- Facilities subject to chemical inventory under Section 312 of the Superfund Amendments and Reauthorization Act of 1986 (SARA).

Water Supply Areas

Water supply areas include water supply wells, groundwater protection areas and water supply intake protection areas, which are defined below. The locations of water supply wells and groundwater protection areas are available from the NHDES OneStop GIS website.

Water Supply Well – as defined under RSA 482-B:2, a water supply well used as a source of water for human consumption and is not a public water supply.

Groundwater Protection Areas – wellhead protection areas (WHPAs) for community and non-transient, non-community public water supply wells; and areas of groundwater reclassified as GA1 or classified as GA2 pursuant to RSA 485-C and Env-Wq 401 or successor rules, Env-Dw 901.

Water Supply Intake Protection Areas – areas within 250 feet from the normal high water mark of a surface water source or its tributaries within ¼ mile radius of an intake point, excluding areas outside the watershed of the surface water.

Tables 3-3 and 3-4 summarize setback distances and other restrictions on BMPs installed in the vicinity of water supply resources.

Table 3-3. Water Supply Well Set-Backs		
Well Type	**Well Production Volume (gallons per day)**	**Setback from Well (feet)**
Private Water Supply Well	Any Volume	75
Non-Community Public Water Supply Well	0 to 750	75
	751 to 1,440	100
	1,441 to 4,320	125
	4,321 to 14,400	150
Community Public Water Supply Well	0 to 14,400	150
Non-Community and Community Public Water Supply Well	14,401 to 28,800	175
	28,801 to 57,600	200
	57,601 to 86,400	250
	86,401 to 115,200	300
	115,201 to 144,000	350
	Greater than 144,000	400

3-2. Physical Feasibility Factors

Physical site constraints such as the infiltration capacity of the soil, depth to bedrock or water table, size of the drainage area, and slope can limit the selection of stormwater BMPs. Depending on the physical site constraints, certain BMPs may be too costly to install or may be ineffective. Physical feasibility factors are described below with their applicability to BMP selection summarized in Table 3-2.

Soil Infiltration Capacity

Soil infiltration capacity affects the design of stormwater management systems in several ways:

- In designing a site to minimize the generation of runoff, it is easier to maintain or mimic the natural hydrology of a site if impervious surfaces are located over areas that naturally have low infiltration capacity. This in turn helps minimize the loss of natural infiltration and/or preserves higher-capacity soils for the siting of BMPs designed to promote infiltration;
- Soils infiltration capacity must be evaluated to determine whether infiltration practices can be used to remove pollutants from stormwater runoff or recharge stormwater runoff. If soil infiltration rates do not fall within accepted ranges (see Table 3-5), then the top three feet, or more of soil must be amended to fall within these ranges or other BMPs will be required to provide water quality treatment.

<table>
<tr><th colspan="3">Table 3-4. Summary of BMP Restrictions Associated with High-Load and Protected Resources</th></tr>
<tr><th>Protected Resources</th><th>Stormwater from High-load Areas</th><th>Stormwater From Non High-load Areas</th></tr>
<tr><td rowspan="2">All Areas</td><td>• No filtering or infiltration practices allowed from gasoline dispensing areas under regulated RSA 146-A or RSA 146-C
• Use of unlined detention ponds or unlined swales prohibited
• Source control plan required[1]</td><td>• Pretreatment is required prior to all filtering or infiltration practices
• Infiltration practices must have 3’ of separation from the bottom of the practice to the SHWT
• Filtering practices must have an impermeable liner or 1’ of separation from the bottom of the filter course to the SHWT</td></tr>
<tr><td colspan="2">• No infiltration or unlined filtering practices within areas identified by NHDES with contaminated soils or groundwater, as defined under Env-Or 600.</td></tr>
<tr><td rowspan="2">Water Supply Wells</td><td colspan="2">• Minimum setbacks between stormwater discharge and water supply wells (see Table 3-3)</td></tr>
<tr><td>• No Exemption to minimum setbacks</td><td>• Exemption to minimum setbacks – if the stormwater management system receives runoff from less than 0.5 ac.</td></tr>
<tr><td>Groundwater Protection Areas</td><td>• Infiltration practices prohibited
• Unlined filtering practices prohibited</td><td>• Infiltration practices must have 4’ of separation from the SHWT
• Filtering practice should have:
• impermeable liner, or
• 1’ of separation from the bottom of the practice to the SHWT, or
• 1’ of separation from the bottom of the filter course material and twice the depth of the filter course material recommended</td></tr>
<tr><td rowspan="2">Water Supply Intake Protection Areas</td><td colspan="2">• Infiltration practices must have 4’ of separation from SHWT
• Filtering practice should have:
  • Impermeable liner, or
  • 1’ of separation from the bottom of the practice to the SHWT, or
  • 1’ of separation from the bottom of the filter course material and twice the depth of the filter course material recommended
• Minimum 100’ setback between stormwater discharge and the WSIPA</td></tr>
<tr><td>• Shut-off mechanism required where bulk oil or hazardous material is transferred</td><td>• Exemption to 100’ setback – if the stormwater management system receives runoff from less than 0.5 ac.</td></tr>
</table>

[1] “Source control plans” are designed to minimize the volume of stormwater coming into contact with regulated substances. Chapter 5 provides further discussion of the preparation of the Source Control Plan to specify necessary structural controls and/or operational practices to minimize contact between stormwater and regulated substances.

- Soils infiltration capacity is ultimately used in the sizing of infiltration practices when they are applicable, with soils with low infiltration capacity requiring more surface area than those with high infiltration capacity to treat the same volume of water.

Appendix B.
BMP Pollutant Removal Efficiency

Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis

Best Management Practice (BMP) removal efficiencies for pollutant loading analysis for total suspended solids (TSS), total nitrogen (TN), and total phosphorus (TP) are presented in the table below. These removal efficiencies were developed by reviewing various literature sources and using best professional judgment based on literature values and general expectation of how values for different BMPS should relate to one another. The intent is to update this information and add BMPs and removal efficiencies for other parameters as more information/data becomes available in the future.

NHDES will consider other BMP removal efficiencies if sufficient documentation is provided.

Please note that all BMPs must be designed in accordance with the specifications in the Alteration of Terrain (AoT) Program Administrative Rules (Env-Wq 1500). If BMPs are not designed in accordance with the AoT Rules, NHDES may require lower removal efficiencies to be used in the analysis.

<u>BMP in Series</u>: When BMPs are placed in series, the BMP with the highest removal efficiency shall be the efficiency used in the model for computing annual loadings. Adding efficiencies together is generally not allowed because removals typically decrease rapidly with decreasing influent concentration and, in the case of primary BMPs (i.e., stormwater ponds, infiltration and filtering practices), pre-treatment is usually part of the design and is therefore, most likely already accounted for in the efficiencies cited for these BMPs.

Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis				Values Accepted for Loading Analyses		
BMP Type	**BMP**	**Notes**	**Lit. Ref.**	**TSS**	**TN**	**TP**
Stormwater Ponds	Wet Pond		B, F	70%	35%	45%
	Wet Extended Detention Pond		A, B	80%	55%	68%
	Micropool Extended Detention Pond	TBA				
	Multiple Pond System	TBA				
	Pocket Pond	TBA				
Stormwater Wetlands	Shallow Wetland		A, B, F, I	80%	55%	45%
	Extended Detention Wetland		A, B, F, I	80%	55%	45%
	Pond/Wetland System	TBA				
	Gravel Wetland		H	95%	85%	64%
Infiltration Practices	Infiltration Trench (≥75 ft from surface water)		B, D, I	90%	55%	60%
	Infiltration Trench (<75 ft from surface water)		B, D, I	90%	10%	60%
	Infiltration Basin (≥75 ft from surface water)		A, F, B, D, I	90%	60%	65%
	Infiltration Basin (<75 ft from surface water)		A, F, B, D, I	90%	10%	65%
	Dry Wells			90%	55%	60%
	Drip Edges			90%	55%	60%
Filtering Practices	Aboveground or Underground Sand Filter that infiltrates WQV (≥75 ft from surface water)		A, F, B, D, I	90%	60%	65%
	Aboveground or Underground Sand Filter that infiltrates WQV (<75 ft from surface water)		A, F, B, D, I	90%	10%	65%
	Aboveground or Underground Sand Filter with underdrain		A, I, F, G, H	85%	10%	45%
	Tree Box Filter	TBA				
	Bioretention System		I, G, H	90%	65%	65%
	Permeable Pavement that infiltrates WQV (≥75 ft from surface water)		A, F, B, D, I	90%	60%	65%
	Permeable Pavement that infiltrates WQV (<75 ft from surface water)		A, F, B, D, I	90%	10%	65%
	Permeable Pavement with underdrain		Use TN and TP values for sand filter w/ underdrain and outlet pipe	90%	10%	45%

Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis				Values Accepted for Loading Analyses		
BMP Type	**BMP**	**Notes**	**Lit. Ref.**	**TSS**	**TN**	**TP**
Treatment Swales	Flow Through Treatment Swale	TBA				
Vegetated Buffers	Vegetated Buffers		A, B, I	73%	40%	45%
Pre-Treatment Practices	Sediment Forebay	TBA				
	Vegetated Filter Strip		A, B, I	73%	40%	45%
	Vegetated Swale		A, B, C, F, H, I	65%	20%	25%
	Flow-Through Device - Hydrodynamic Separator		A, B, G, H	35%	10%	5%
	Flow-Through Device - ADS Underground Multichamber Water Quality Unit (WQU)		G, H	72%	10%	9%
	Other Flow-Through Devices	TBA				
	Off-line Deep Sump Catch Basin		J, K, L, M	15%	5%	5%

ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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WMB-3 2007

Snow Disposal Guidelines

Introduction

During each snowfall season from November to April, the Department of Environmental Services receives many complaints related to snow disposal into and/or near surface water. There are several different concerns regarding disposal of snow cleared from streets and parking lots. These can be initially categorized as aesthetic concerns, such as minimizing the visibility of debris and huge snow piles, and environmental concerns, such as protection of groundwater quality, surface water quality, and aquatic life.

The environmental effects of disposed snow result from high levels of sodium chloride, sand, debris and contaminants from automobile exhaust. It is the debris contained in plowed snow that makes it illegal to dump snow directly in water bodies. RSA 485-A:13,I(a) prohibits discharging wastes to surface waters without a permit. Groundwater is sensitive to snow dumping due to the high levels of sodium chloride in plowed snow. RSA 485-C:12 prohibits the siting or operation of snow dumps within classified wellhead protection areas.

Refer to the following guidelines for siting legal snow dumps and protecting the environment.

Recommended Guidelines for Snow Disposal

By following these guidelines you will find a safe place to dump plowed snow. Please note that snow dumps are kept out of water bodies due to litter and debris. Litter and debris do not belong on the land surface either; after the snow melts, all litter and debris must be collected and disposed of properly.

- Disposed snow should be stored near flowing surface waters, but at least 25 feet from the high water mark of the surface water.
- A silt fence or equivalent barrier should be securely placed between the snow storage area and the high water mark.
- The snow storage area should be at least 75 feet from any private water supply wells, at least 200 feet from any community water supply wells, and at least 400 feet from any municipal wells. (Note: Snow storage areas are prohibited in wellhead protection areas [class GAA groundwater].)
- All debris in the snow storage area should be cleared from the site prior to snow storage.
- All debris in the snow storage area should be cleared from the site and properly disposed of no later than May 15 of each year the area is used for snow storage.

For more information about snow storage contact DES Watershed Management Bureau at (603) 271-2457.