Aquifer Protection
Best Management Practices

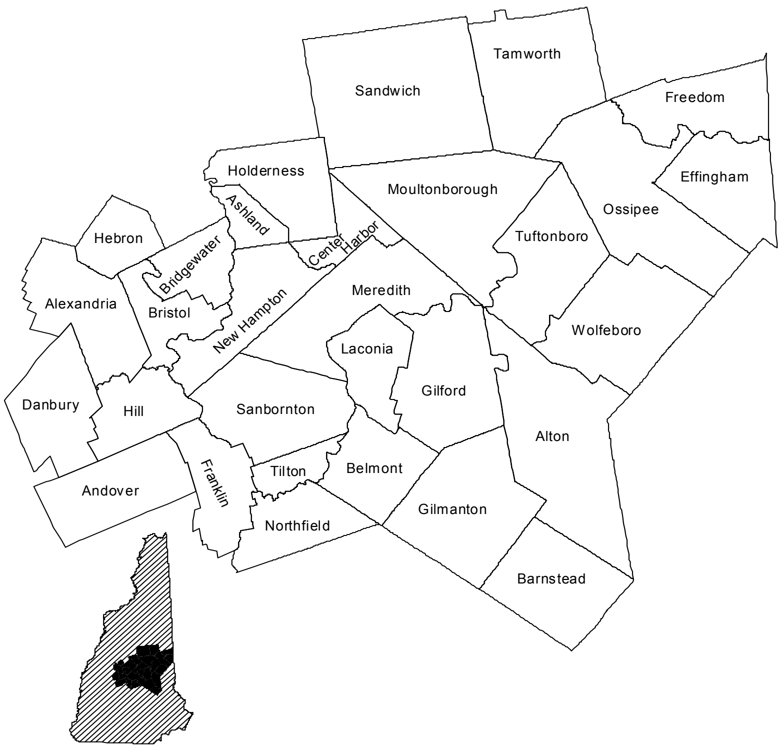
Tri-Town
Aquifer Project

Protecting Shared
Drinking Water Resources

Belmont
Northfield
Tilton

April 2007

THE LAKES REGION PLANNING COMMISSION



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Aquifer Protection
Best Management Practices
Tri-Town Aquifer Project
Belmont • Northfield • Tilton

April 2007

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Funding for this project was provided in part by a Source Water Protection Grant from the NH Department of Environmental Services and by the Lakes Region Planning Commission.

"The primary thrust of this proposal addresses the need for *collaborative* drinking water resource planning among three municipalities."

"Thoughtful planning which works to balance economic growth with ground water protection will assist in maintaining the viability of common drinking water resources into the future."

Quotes from cover letter to Source Water Protection Grant application, November 28, 2001

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Acknowledgments

Members of the Water Resources Committee would like to thank the towns of Belmont, Northfield, and Tilton for supporting this project and for dedicating resources to this drinking water protection effort. Belmont, Northfield, Tilton, and the Lakes Region Planning Commission would like to express appreciation to the Drinking Water Source Protection Program of the New Hampshire Department of Environmental Services for providing funding for this project and extensive staff support along the way. Staff spent considerable time and effort to ensure content is accurate and represents current scientific data. Special thanks to Pierce Rigrod and Paul Susca for their editing and insight. We would also like to thank Garret Graaskamp with the American Ground Water Trust for providing editorial assistance.

Particular recognition should be given to those who participated in the Water Resources Committee from the towns of Belmont, Northfield, and Tilton. Committee members attended project meetings, assisted with fieldwork, and guided all elements of this project. Throughout the past year and a half committee members shared extensive local knowledge with dedication, respect for each others' ideas, and a collaborative spirit.

Common Vision

The towns of Belmont, Northfield, and Tilton are very fortunate that a large stratified drift aquifer serves our existing and potential future drinking water needs. Water is the most basic of resources, and the three towns have a great responsibility to assure that we preserve water quality and conserve water quantity for future generations. Each of our towns recognizes that we share this valuable resource and agree that there is the need for continued collaborative drinking water resource planning. In order for one town's efforts to be effective, they must be complemented by actions in each of the other towns. Thoughtful planning which works to balance economic growth with ground water protection will assist our towns in maintaining the viability of common drinking water resources into the future.

PROJECT SUMMARY

> "We would welcome the opportunity to work with our neighboring towns by initiating plans and doctrine to protect the quality of our shared water resources..."
>
> *-Chairman of the Board of Selectmen, Tilton*

A stratified drift aquifer, totaling approximately 11,108 acres, lies beneath the towns of Belmont, Northfield, and Tilton.[1] The aquifer currently supplies drinking water to a portion of the towns' residents, and has the potential to provide additional sources of drinking water to meet future needs. In the fall of 2001, community interest in the preservation of the quality and quantity of existing and potential future drinking water supplies through aquifer protection measures was expressed to the Drinking Water Source Protection Program (DWSPP) of the New Hampshire Department of Environmental Services (NHDES). The Lakes Region Planning Commission (LRPC) worked with the three towns to develop a proposal for a Source Water Protection Grant to provide planning assistance that would guide the towns in protecting the quality and quantity of this important drinking water resource. The project received funding from NHDES in the spring of 2002, and the project report, *Protecting Shared Drinking Water Resources,* was completed by December 2003. In conjunction with this report, an *Implementation Strategies Workbook* was developed based on priority recommendations identified by the three communities.

> "We appreciate the opportunity for assistance in planning for...present and future water quality in our region."
>
> *-Board of Selectmen, Northfield*

The three towns and LRPC continued their partnership by implementing one of these priority recommendations, and components of additional recommendations, through the development of the Best Management Practice (BMP) Guidebook. The BMP Guidebook is specifically designed to provide guidance to minimize and mitigate the impacts of certain land uses and practices in order to protect the aquifer.

Project Goals and Community Participation

The overarching goal of the project is to assist the towns of Belmont, Northfield, and Tilton in their long-term planning efforts by providing accurate and in-depth information regarding their drinking water resources. This project aims to:

- Provide Belmont, Northfield, and Tilton with a guidebook of best management practices targeted toward community officials, developers, business owners, other professionals, and homeowners to enable further protection of the stratified drift aquifer as a drinking water source for existing and potential future needs;
- Facilitate the exchange of information and ideas across town boundaries; and
- Explore opportunities for collaborative initiatives to protect shared water resources.

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[1] Protecting Shared Drinking Water Resources: A Collaborative initiative of Belmont, Northfield and Tilton. Lakes Region Planning Commission. December 2003.

This planning project is innovative in its collaborative approach to drinking water supply protection. The three towns have been fully committed to the project from the start; they recognize that the stratified drift aquifer does not fit neatly within any one town's boundaries and that there is a need to work together to protect the viability of this shared drinking water resource. The framework, methods, and outcomes of this effort will serve as a model for drinking water protection efforts throughout the region. The quotes in the blue boxes are from the letters of support written by the three communities for the project grant application. These quotes illustrate the towns' strong support for the project and their level of commitment to working collaboratively to protect the shared aquifer resource.

Without the active participation of representatives from the three communities, a great deal of the town-specific concerns, issues, and information would be missing from this report and the project overall. The dedication of the community representatives who served on the Water Resources Committee was apparent from their level of participation in community meetings, fieldwork, and extensive follow-up between meetings via e-mail exchanges and phone calls. The Water Resources Committee included representatives from Boards of Selectmen, Planning Boards, Conservation Commissions, Water Supply Companies, Residents, Town Planners, Town Land Use Staff, and Town Administrators. These community representatives have expressed a commitment to continuing their efforts to protect the stratified drift aquifer by working to implement key project recommendations.

> "The Town of Belmont is very fortunate, in regards to our drinking water needs, to be located on a large aquifer area. However, along with the benefits of this comes great responsibility to assure that we preserve quality and conserve quantity for future generations. We also recognize that we share this valuable resource with adjacent communities and that in order for our efforts to be effective, they must be complemented by actions of both Northfield and Tilton."
>
> *-Vice Chairman of the Board of Selectmen and Chairman of the Planning Board, Belmont*

Implementation

This Guidebook is designed to be a tool to protect the stratified drift aquifer as a drinking water supply. Utilizing and implementing the Guidebook recommendations to decrease threats to the stratified drift aquifer will be a challenging process. Educating the target audience about the economic and environmental benefits of adopting BMPs will be a key component of long-term project success. Implementing the BMP Guidebook will assist the towns protect the quality and quantity of existing and potential water supplies provided by the stratified drift aquifer. It will take the continued dedication of community representatives already committed to the project, as well as extensive education and outreach efforts to the broader public, to continue implementing measures that protect drinking water resources for the benefit of today's residents and the next generations.

Efforts should be made to move beyond the reliance of using only conventional, structural BMPs, to more holistic planning. At their most efficient, performance of conventional structural BMPs can be only partially successful in the removal of pollutants or ground water recharge. Often, only about 50 percent of a particular pollutant is removed with a structural BMP as the result of our best efforts.[2] Utilizing macro-planning principles such as conservation design will optimize protection of water resources in the three communities.

Although all three towns share the aquifer, Belmont, Northfield, and Tilton have different needs and concerns associated with land use. Each town should use this Guidebook to evaluate how to best utilize BMPs to strengthen and improve ordinances and regulations pertaining to aquifer protection.

How Can I Get Involved?

For information about project implementation, please contact the Planning Department, Planning Board, and/or Conservation Commission of Belmont, Northfield, or Tilton for additional information.

For more information about this project or the contents of this Guidebook, please contact:

Lakes Region Planning Commission (LRPC)
103 Main Street, Suite No. 3
Meredith, NH 03253
(603) 279-8171

For information on statewide efforts to protect ground water and drinking water, please contact:

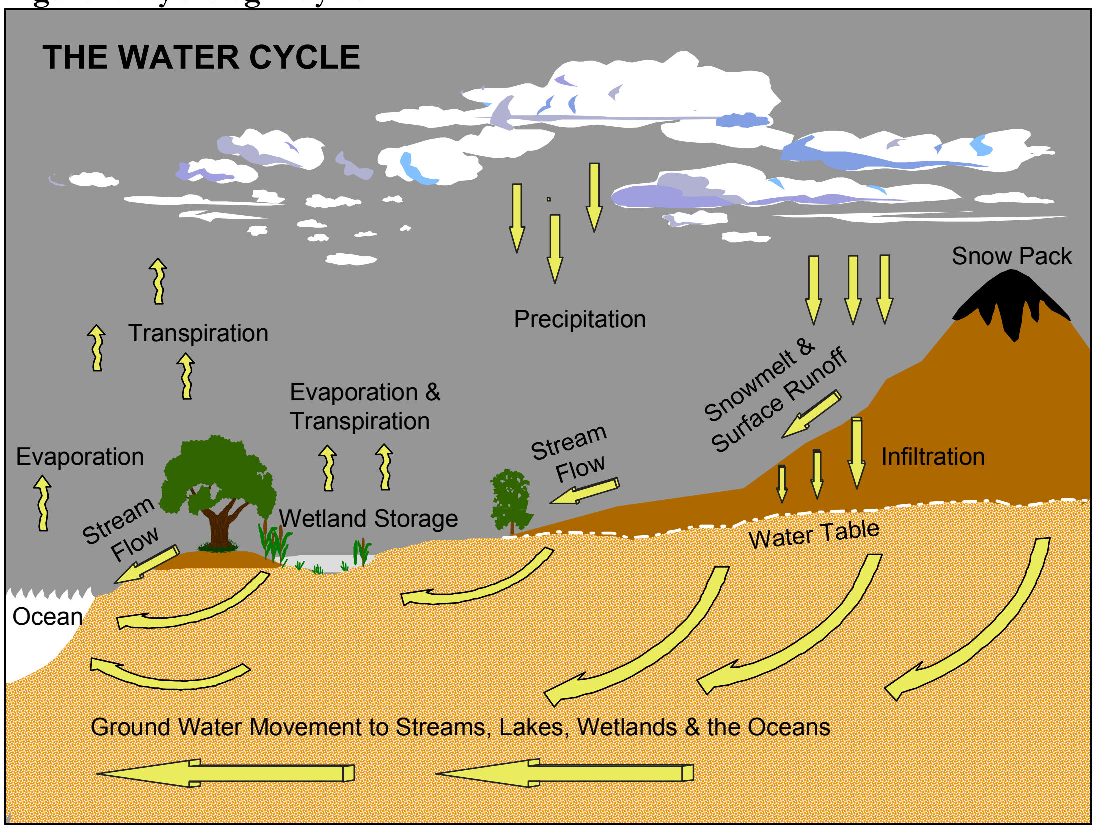
New Hampshire Department of Environmental Services
Drinking Water Source Protection Program (DWSPP)
Paul Susca, Source Water Protection Coordinator
P.O. Box 95, 29 Hazen Drive
Concord, NH 03302
(603) 271-7061

[2] Conservation Design for Stormwater Management. A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use. Delaware DNREC and Brandywine Conservancy. September 1997.

Background Information on Ground Water Resources

This project focuses on the long-term protection of drinking water resources. Since the water is underground, you can not see where the water is, how much there is, or how it moves just by looking around in the same way you can with surface water such as a lake or river. In order to plan for the protection of the quality and quantity of ground water resources, an understanding of what is happening beneath the surface is necessary.

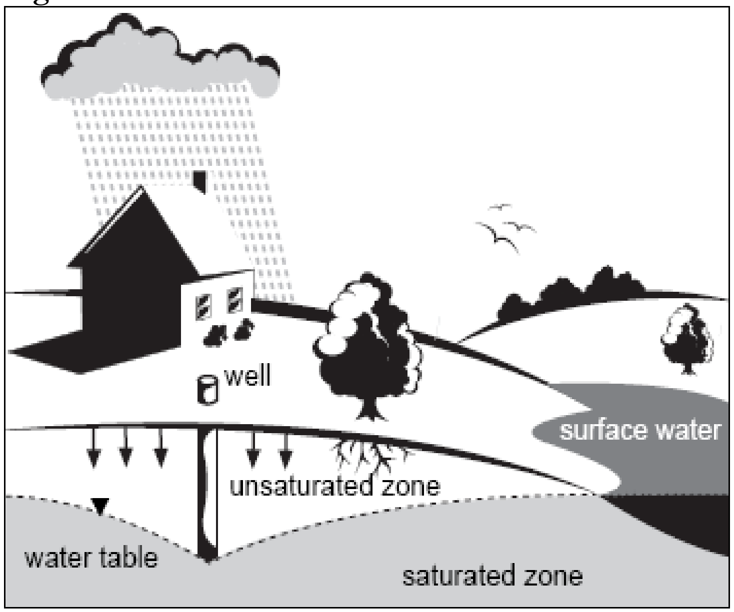
Figure 1. Hydrologic Cycle



Source: Modified from American Ground Water Trust

The movement of water between the atmosphere and the earth, through precipitation and evaporation, as well as overland and subsurface flow, is called the hydrologic cycle. When rain and snow fall, some of the water enters surface water bodies, some evaporates, and some is absorbed by the roots of plants and trees. The rest of the water soaks into the ground, moving down through rocks and soil until it reaches the water table. This phenomenon is called 'recharge.' Beneath the water table is the saturated zone, where all the spaces between rock and soil particles are filled with water. These large, water-filled layers of sand and gravel (called stratified drift) were left behind by the glaciers. These layers comprise a stratified drift aquifer (aquifer).[3]

Figure 2. Saturated Zone



Source: National Small Flows Clearinghouse

When addressing the prevention of contamination of the aquifer, there are a few issues to consider. The aquifer recharge rate, or how quickly water or snowmelt soaks into the ground, depends on the soil composition, as well as land cover and slope. Since this aquifer is composed predominantly of sand and gravel, water can flow relatively quickly into the aquifer.

Additionally, the total land area of the three towns is 46,550 acres, and approximately 24% of this total acreage is located within the direct recharge area of the aquifer, illustrated in Figure 3. The direct recharge area is the land area which lies directly over the stratified drift aquifer. Water has a more direct route to the aquifer in this area due to a higher concentration of porous soil types such as gravel and sand with minimal benefits of filtration or attenuation. This could allow pollutants to more rapidly and severely contaminate the aquifer than if the water was flowing through soils that slowed and trapped some of the contaminants. Land use activities which take place in this direct recharge area have the potential to directly impact ground water quality and quantity (Figure 4).

[3] Presentation Notes, "The Ground Water Protection Connection". Garret Graaskamp, Ground Water Specialist, American Ground Water Trust. Drinking Water Protection Workshop of the Belmont/Northfield/Tilton Initiative to Protect Shared Drinking Water Resources. November 20, 2002

Figure 3. Stratified Drift Aquifer – Direct Recharge Area – Belmont, Northfield, and Tilton

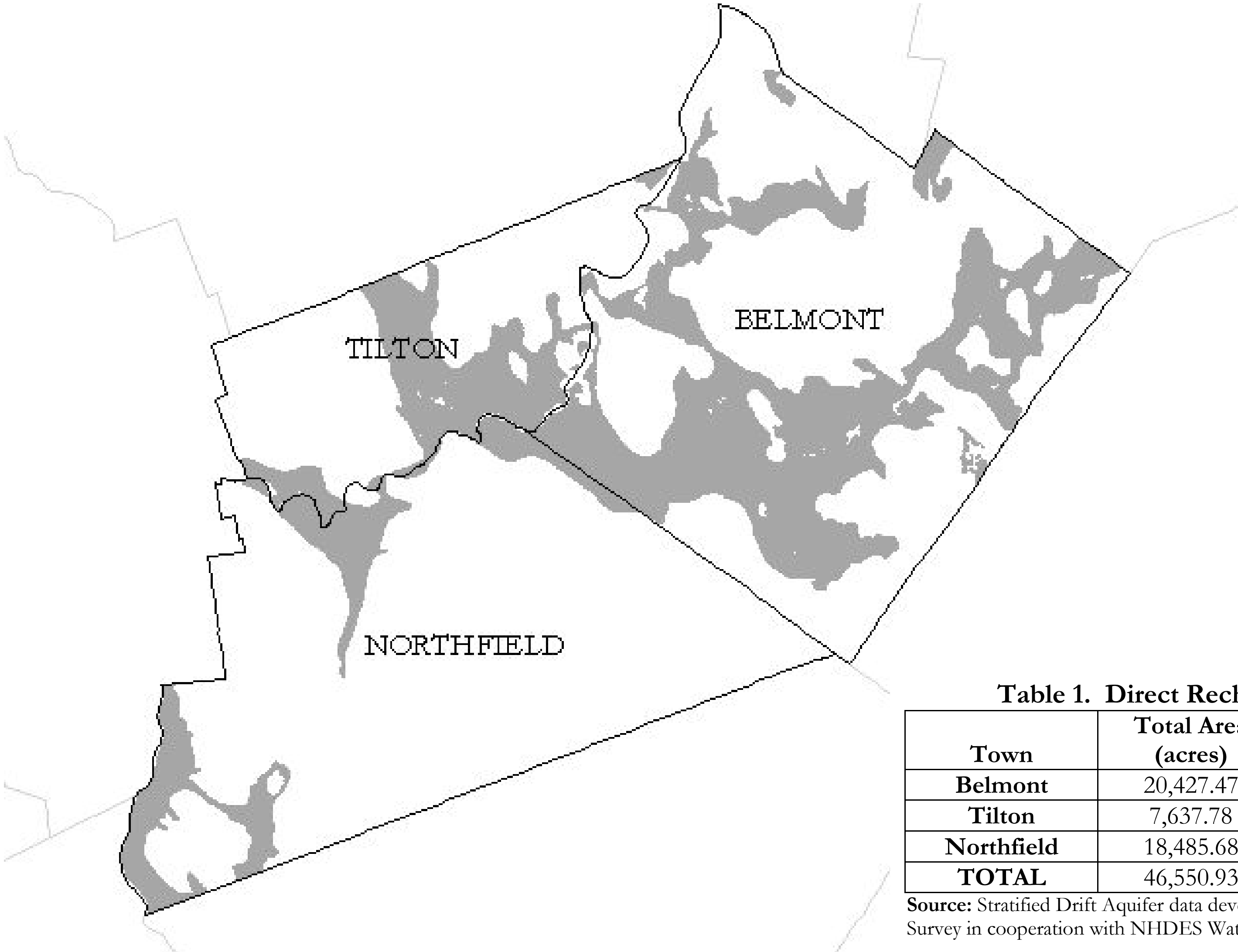


Table 1. Direct Recharge Area

Town	Total Area (acres)	Aquifer Area (acres)
Belmont	20,427.47	7,053.11
Tilton	7,637.78	2,078.35
Northfield	18,485.68	1,976.86
TOTAL	46,550.93	11,108.32

Source: Stratified Drift Aquifer data developed by the US Geological Survey in cooperation with NHDES Water Division, February 2000.

The water within the aquifer is not static; it is always moving from one place to another. Although the movement of ground water is usually much slower than surface water, the rate of flow varies. Other factors being equal, ground water moves faster through coarser materials such as sand and gravel. If pollutants reach the aquifer in the direct recharge area, a large area could become contaminated quickly due to the relatively high hydraulic conductivity of the aquifer materials. Since the aquifer is an important source of drinking water for the three communities, the municipalities are dedicated to protecting this valuable resource.

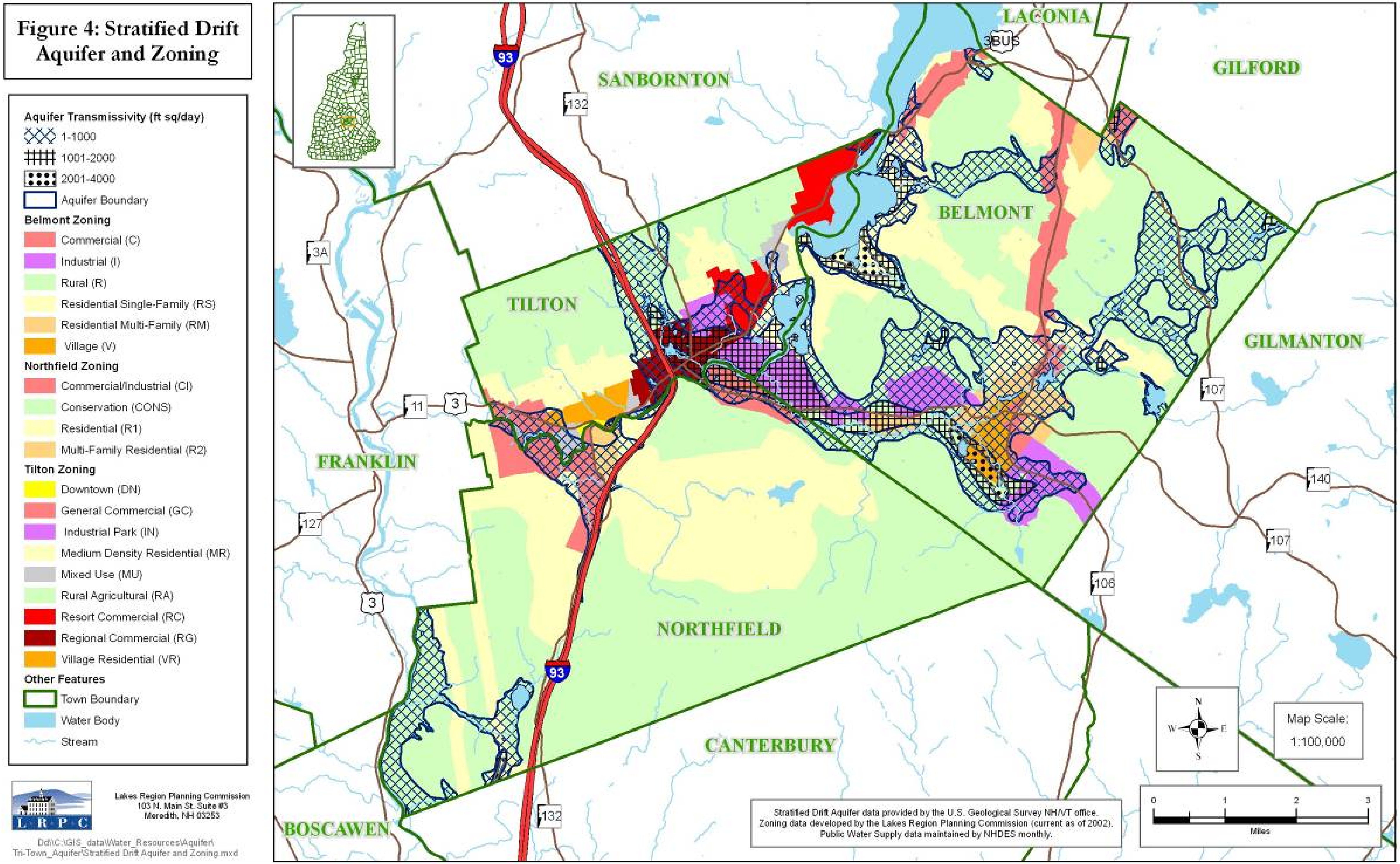
Currently, 33% of the total population of the three towns is served by water drawn from the aquifer. Two water suppliers, the Tilton & Northfield Water District and the Belmont Water Department, supply 3,950 customers (87% of the population served by the aquifer). In addition, there are two other smaller public water supply systems drawing from the aquifer: Lakeland Management Company and Lochmere Village District. The size of the population served by each of the four public water supply systems is depicted in Table 2.

Table 2. Public Water Systems and Population Served

PWS System (gravel wells)	Pop. served
Belmont Water Department	1,450
Lochmere Village District	293
Lakeland Management Co	308
Tilton Northfield Aqueduct Co	2,500
TOTAL	**4,551**

Source: Public Water Supply data developed and maintained by the NHDES-Water Division, Water Supply Engineering Bureau. December 1, 2006.

Figure 4: Stratified Drift Aquifer and Zoning



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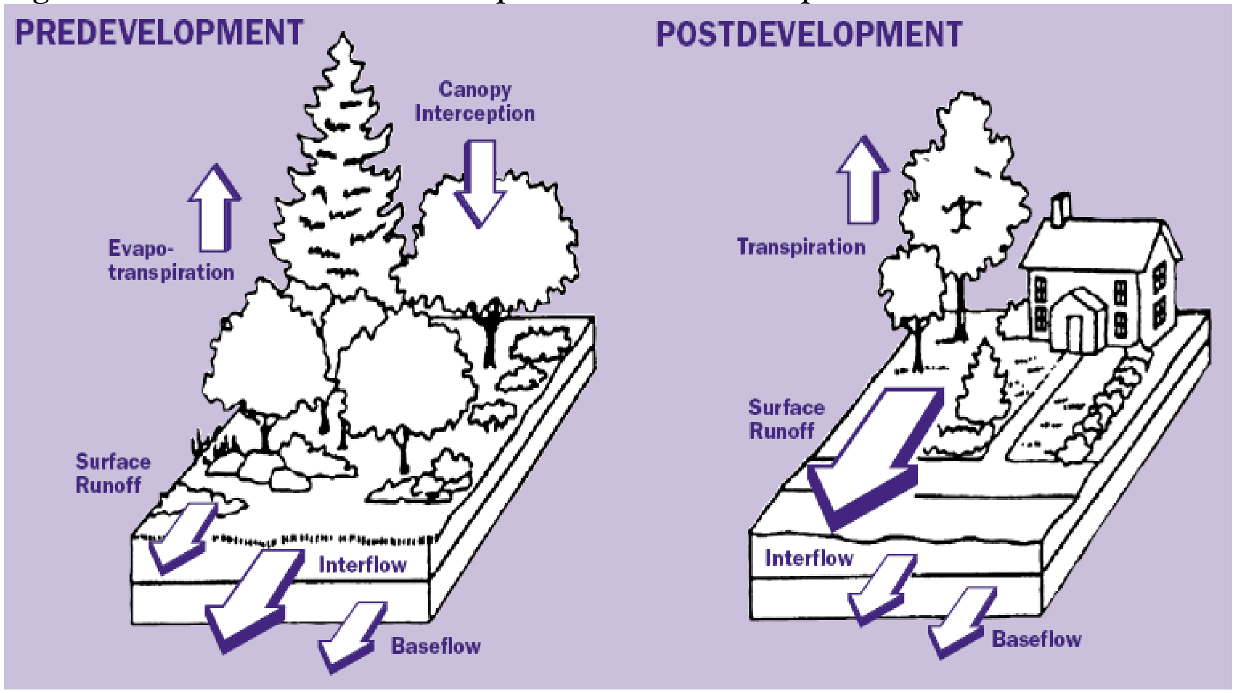
Why Use Best Management Practices to Protect Your Drinking Water?

Naturally vegetated areas are best able to capture and treat rainfall or snowmelt during recharge. Vegetation slows and absorbs surface runoff, allowing water to more effectively infiltrate into the soil horizon (Figure 5). Root structures of vegetated areas hold topsoil that assists in filtering potential pollutants from the water as it recharges the aquifer. Land use pressures and increased development result in fewer naturally vegetated areas to allow percolation and filtration of the rainfall and surface runoff.[4] Topsoil, as well as vegetation, is usually stripped from a site prior to development, thereby compounding the lack of filtration.

Figure 5. Water Balance Pre-Development vs. Post-Development



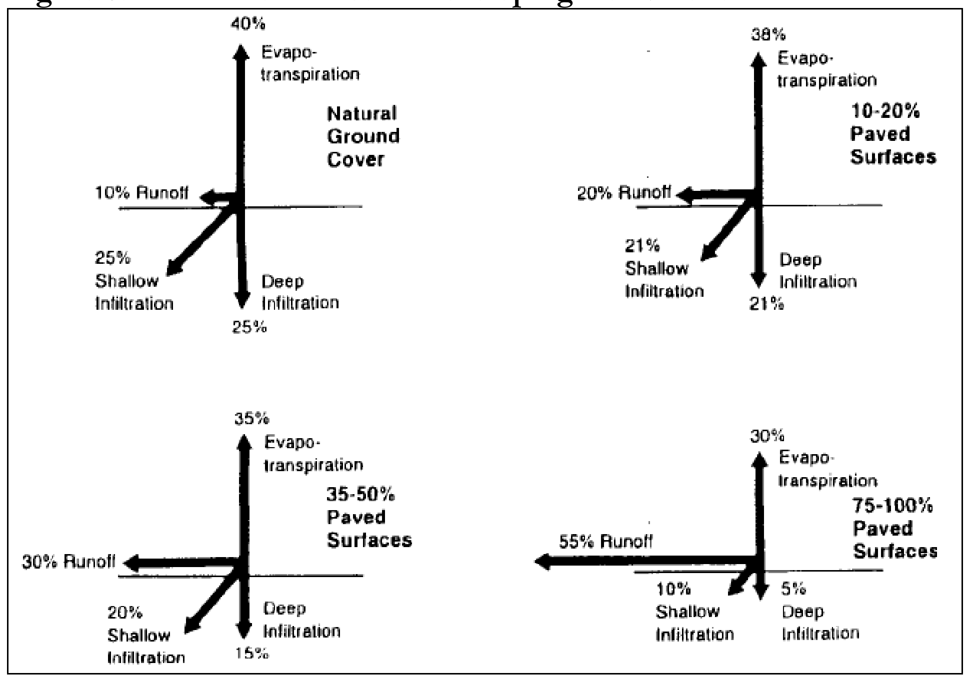
Source: NHDES

[4] Best Management Practices to Reduce Non-Point Source Pollution in the Town of Plainfield, Connecticut. American Ground Water Trust. In cooperation with the Town of Plainfield, CT. December 2000.

Water Quantity
Impacts to ground water quantity are not always easily seen or measured. A way to illustrate potential effects is by looking at a water budget. New or expanded development results in more roads, buildings, lawns, and parking lots. Along with this often comes road widening, commercial buildings, service centers, and infrastructure development. These activities increase the amount of impervious surfaces, resulting in water moving off site quickly and less water soaking into the ground. As Figure 6 shows, an increase in surface runoff translates into a decrease in infiltration. This results in a decrease in recharge to the water table and therefore, the aquifer. It may not seem like much impact to develop a 10 acre site, however, as reductions in infiltration continue acre-by-acre, development-by-development, the cumulative effect grows larger.

A sign of possible problems is when the water table declines or stream flow rates fall. The water table elevation fluctuates seasonally, however, when there is a decline over a period of time that is not attributable to differences in precipitation or ground water withdrawals, or a combination of the two, then changes in land cover may be responsible for the change. In a healthy system, ground water is constantly moving and discharging into wetlands, streams, or other surface waters. When precipitation is diverted (e.g. discharged to surface water body) and not replenishing the aquifer, there is less water to feed wetlands and streams. During dry periods this can be exacerbated during a drought or peak in water use.[5]

Figure 6. Infiltration Rates in Developing Conditions



Source: Conservation Design for Stormwater Management

[5] Conservation Design for Stormwater Management. A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use. DE DNREC and Brandywine Conservancy. 1997.

Impervious surface within the direct aquifer recharge area.

Since most of the aquifer area is zoned industrial or commercial in all three communities, the future impervious surface coverage could be very extensive. In order to estimate the amount of impervious surfaces overlying the aquifer, the impervious surface coefficients, developed by the University of Connecticut Cooperative Extension, were applied to the developed lands data. Different impervious surface coefficients were developed for commercial zones, industrial zones, and residential zones, which provide an estimate of impervious surface coverage by zone. Further information about the use of impervious surface coefficients can be found in *Protecting Shared Drinking Water Resources: A Collaborative initiative of Belmont, Northfield and Tilton,* located in each town office and the LRPC. The type of land use and corresponding impervious surface coefficient is given in Table 3, while the estimated acres of impervious cover are depicted in Table 4. Figures 7 and 8 illustrate the current and potential future impervious surface areas of Belmont, Northfield, and Tilton.[6]

Establishing protection of the aquifer through planning, zoning, and best management practices is crucial to long-term security of the ground water resources. Ultimately, the impacts to ground water quantity from reduced infiltration can have serious and far reaching consequences. Implementation of BMPs to improve infiltration assists in minimizing development impacts to the ground water.

[6] Protecting Shared Drinking Water Resources: A Collaborative initiative of Belmont, Northfield and Tilton. Lakes Region Planning Commission. December 2003.

Table 3: Land Use Types for Impervious Surface Coefficients

Impervious Surface Coefficient	Type of Land Use for Impervious Surface Coefficient
7.0	Residential (Minimum Lot Size = 2-5 acres)
8.0	Residential (Minimum Lot Size = >5 acres)
10.0	Residential (Minimum Lot Size = 1-11/2 acres)
16.0	Residential (Minimum Lot Size = 1/2-3/4 acres)
28.0	Residential (Minimum Lot Size = 1/8-1/4 acres)
53.0	Industrial
53.5	Commercial/Industrial
54.0	Commercial

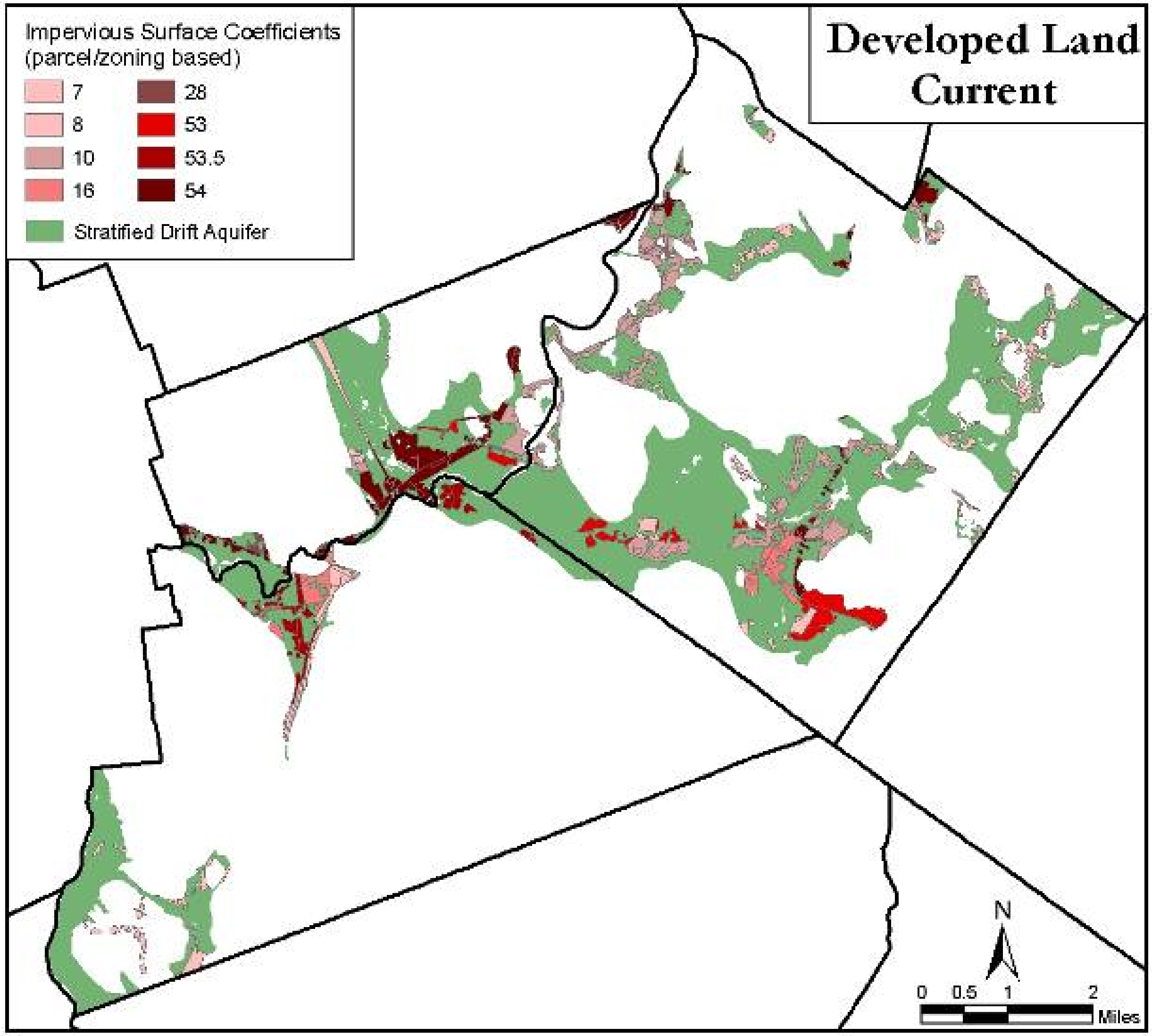
Source: Protecting Shared Drinking Water Resources: A Collaborative initiative of Belmont, Northfield and Tilton.

Table 4: Estimated Acres Impervious

Impervious Surface Coefficient	Belmont Acres of Zone Developed	Estimated Acres Impervious Belmont	Northfield Acres of Zone Developed	Estimated Acres Impervious Northfield	Tilton Acres of Zone Developed	Estimated Acres Impervious Tilton
7.0	393.5	27.6	172.5	12.1	63.4	4.4
8.0	-	-	44.6	3.6	-	-
10.0	753.9	75.4	-	-	97.6	9.8
16.0	136.8	21.9	91.4	14.6	-	-
28.0	-	-	-	-	18.3	5.1
53.0	257.1	136.6	-	-	44.6	23.6
53.8	-	-	180.5	96.6	-	-
54.0	142.2	76.8	-	-	458.7	247.7
TOTAL	**1683.5**	**338**	**489**	**126.9**	**682.6**	**290.6**

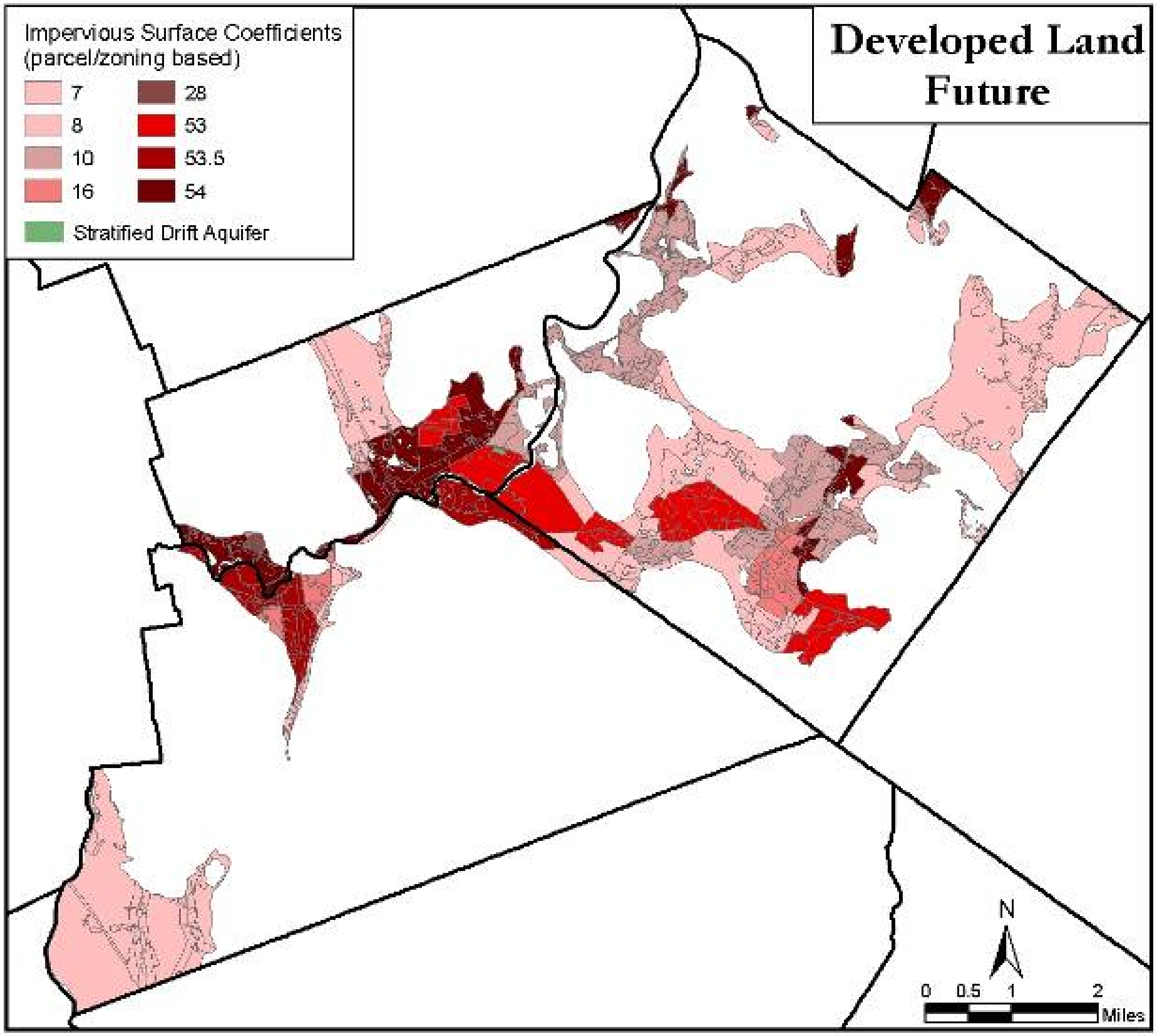
Source: Protecting Shared Drinking Water Resources: A Collaborative initiative of Belmont, Northfield and Tilton.

Figure 7. Impervious Surface Analysis – Current



Source: Protecting Shared Drinking Water Resources

Figure 8. Impervious Surface Analysis – Projected



Source: Protecting Shared Drinking Water Resources

Water Quality

During storms, rainwater flows across impervious surfaces and compacted soils, collecting contaminants, and carrying them to water bodies and into ground water. All of the activities that take place in developed areas have the potential to contribute to the pollutants in storm water runoff. While storm water runoff is often associated with surface water contamination, it can also contribute to ground water/aquifer contamination. Oil, gasoline, and automotive fluids drip from vehicles onto roads and parking lots. Landscaping by homeowners, around businesses, and on public grounds contributes pesticides, fertilizers, and nutrients to the environment. Construction activities disturb protective vegetation and soils thereby creating a more direct avenue for pollutants to infiltrate into the ground and aquifers. They can also contribute various chemicals, automotive fluids, and pollutant-laden sediment to waterways and potentially ground water if construction materials are mishandled. Improperly stored hazardous substances (e.g., household cleaners, pool chemicals, or lawn care products), illicit discharges to storm drains (e.g., used motor oil), and improperly maintained septic systems can also contaminate water supplies.

The US Environmental Protection Agency (EPA) considers nonpoint source (NPS) pollution, including storm water runoff, to be one of the most important sources of contamination of the nation's surface and ground waters. According to a nationwide study, 77 of 127 priority pollutants tested were detected in urban runoff.[7] Principal contaminants found in storm water runoff include heavy metals, toxic chemicals, organic compounds, pesticides and herbicides, pathogens, nutrients, sediments, and salts and other de-icing compounds. Some of these substances are carcinogenic; others lead to reproductive, developmental, or other health problems. Encouraging NPS pollution best management practices (BMPs) for new and existing development will reduce negative environmental impacts on both surface and ground water quality.

Potential Contamination Sources

Potential contamination sources (PCSs) are defined in Section 485-C-7 of the Ground Water Protection Act as "human activities or operations upon the land surface shall be considered potential contamination sources if the activity or operation poses a reasonable risk that regulated contaminants may be introduced into the environment in such quantities as to degrade the natural groundwater quality."[8] Regulated substances, which include regulated contaminants as well as oil or any hazardous substance listed under federal regulation 40 CFR 302, must be managed in accordance with state BMPs as specified under state rule Env-Wq 401, Best Management Practices for Groundwater Protection. The three communities have identified existing potential ground water contamination sources within the aquifer direct recharge area. Figure 9 illustrates the locations of these sources.[9]

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[7] Best Management Practices to Reduce Non-Point Source Pollution in the Town of Plainfield, Connecticut. American Ground Water Trust. In cooperation with the Town of Plainfield, CT. December 2000.

[8] http://www.gencourt.state.nh.us/rsa/html/L/485-C/485-C-7.htm

[9] Protecting Shared Drinking Water Resources: A Collaborative initiative of Belmont, Northfield and Tilton. Lakes Region Planning Commission. December 2003.

Figure 9: Water Resources and Potential Contamination Sources

Potential Contamination Source
2002 Local PCS Inventory
Reported Contamination area

Aquifer Transmissivity (ft sq/day)

1-1000
1001-2000
2001-4000

Wellhead Protection Area

Gravel Well
Bedrock Well

Other Features

Town Boundary
Water Body
Stream

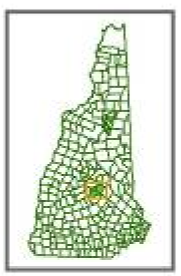
Potential contamination source data maintained by the NH Dept of Environmental Services continually locating sites/facilities, date of data unknown.

Additional local PCS Inventory sites identified by town volunteers, in cooperation with LRPC.

Stratified Drift Aquifer data provided by the U.S. Geological Survey NH/VT office.

N W E S

Map Scale: 1:100,000



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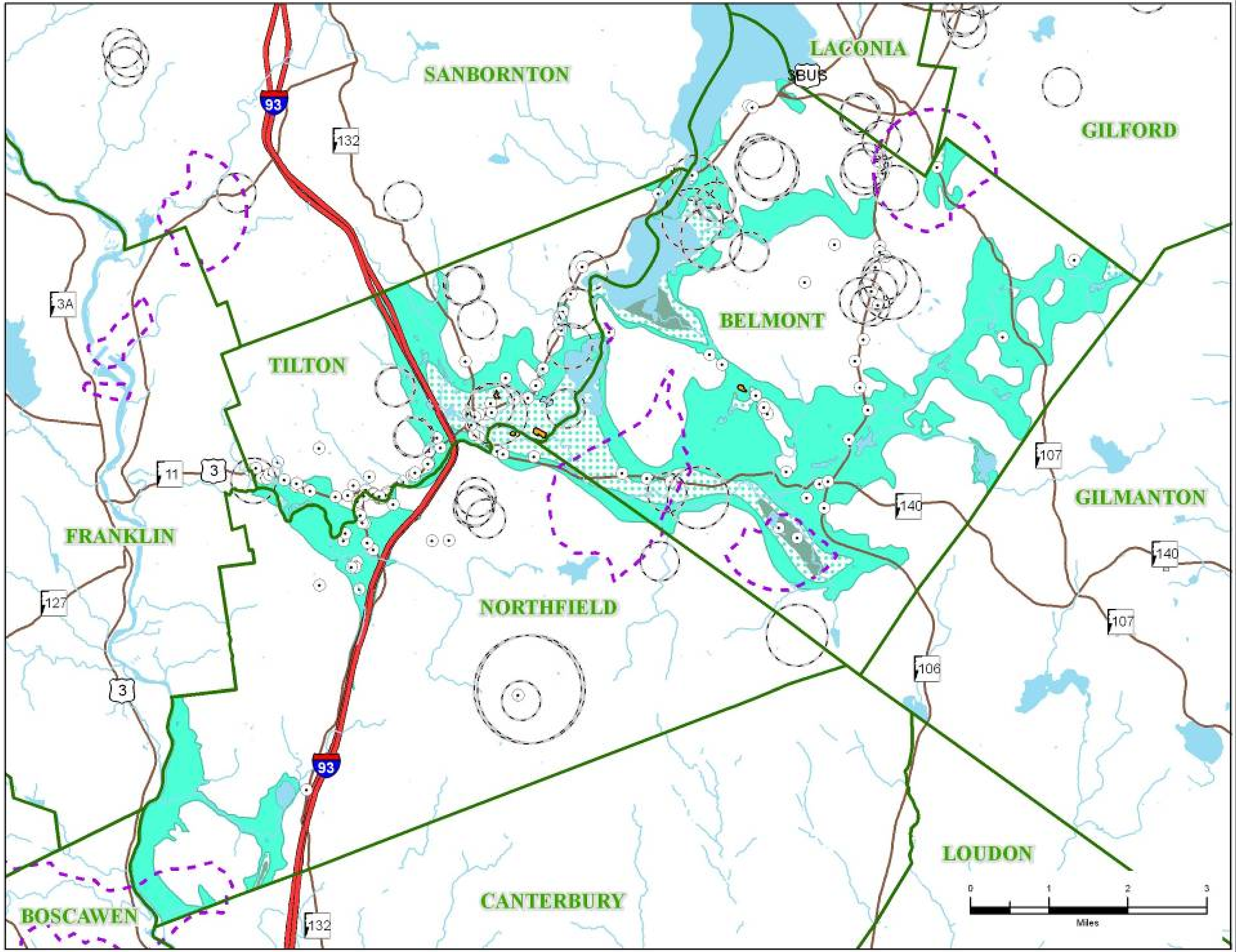

Table 5. Potential Contamination Sources

Potential Contamination Source/Type	Description of Potential Contamination Source	Total # Throughout The Three Towns	Total # Currently Active
Source Water Hazard Inventory Sites	Includes all ground water hazard inventory (sites regulated for ground water concerns), remediation, and initial response spill sites regulated by NHDES to ensure the protection of water resources. *(Updated monthly*)*	127	38
Underground Storage Tank Sites	Sites where there are (or were for inactive sites) underground storage tanks. Tanks with documented releases become classified as a Leaking Underground Storage Tank (LUST) and are listed in the previous row as a Source Water Hazard. *(Updated monthly)*	35	16
Aboveground Storage Tank Sites	Sites where there are (or were for inactive sites) aboveground storage tanks. Tanks with documented releases become classified as a Leaking Aboveground Storage Tank (LAST) and are listed above as a Source Water Hazard. *(Updated monthly)*	14	11
Resource Conservation and Recovery Act (RCRA) Sites	Facilities that generate hazardous waste. Documented releases are listed in the category of Source Water Hazard above. *(Updated monthly)*	101	59
Point/Nonpoint Potential Pollution Sources	Includes local land use inventories carried out by the regional planning commissions in 1995. (March 1995)	29	21
Salvage With 50+ Automobiles	Includes salvage yards registered with NHDES with 50 or more automobiles. (November 1991)	8	8
Local Potential Contamination Sources Inventory Sites (NHDES)	Includes potential contamination sources located within a source water protection area. Sites are located by public water systems applying for a sampling waiver or by windshield surveys by NHDES-WSEB staff. *(Updated monthly)*	40	40
Local Potential Contamination Sources Inventory Sites (LRPC & Town Representatives)	Includes local potential contamination sources identified by LRPC and town representatives during field sessions in each town with GPS equipment as part of this planning project. *(2002)*	91	---

* "Updated monthly" means that the coverage is updated monthly by NHDES to reflect new information that becomes available. The fieldwork upon which the coverage is based is not updated monthly. In the case of the NHDES Local Potential Contamination Sources Inventory, the fieldwork is scheduled to be redone every three years.

Source: Inventory of Public Water Supply Sources and Potential and Existing Sources of Ground water Contamination in the Towns of Belmont, Northfield, and Tilton. NHDES Water Supply Engineering Bureau. January 21, 2007.

RSA 485-C (Groundwater Protection Act) requires all potential contamination sources to follow BMPs, specifically BMPs that are within DES's BMP rule, Env-Wq 401. The BMP rules apply to any business using regulated substances in regulated containers (> 5 gal). The BMPs are basic operational practices and structural controls concerning the transfer, storage, and disposal of regulated substances. Many BMPs are non-structural and inexpensive to implement such as developing spill response plans, instituting good housekeeping, and recordkeeping. Structural BMPs, such as impervious surfaces or berms, may be more expensive. However, structural BMPs that prevent regulated substances from infiltrating into ground water will reduce the potential liability of significant financial cost for ground water clean up and remediation. Local entities (towns, water suppliers) are indispensable partners with DES to ensure compliance with BMP requirements.

Site planning for new development provides an opportunity to utilize a greater range of BMPs at lower cost to address future potential problems. The goal of this guidebook is to familiarize you with various BMP types and to refer you to materials that will provide specific information needed to make selections for your sites. This guidebook contains examples of BMPs that are suitable for the region. By providing this guidebook to their communities as a resource, the three municipalities are taking a proactive approach to ensure their drinking water supply has the greatest protection available.

How to Use the BMP Guidebook

The guiding principle in selecting a BMP is, will the BMP perform treatment of expected contaminants from proposed uses prior to infiltration. This Guidebook is a resource to raise awareness regarding land use activities and their effect on the aquifer. It describes BMPs that can reduce or prevent pollutants from entering the regional aquifer and impacting ground water. Implementing the BMPs in this Guidebook will help protect the regional public drinking water supply. The Guidebook contains information on BMPs relevant to the land uses and management goals of Belmont, Northfield and Tilton. The Guidebook is designed to serve as a resource for engineers, developers, business owners, town officials, and community members. It is intended as a basic guide for identifying BMPs that may be appropriate for controlling ground water pollution and achieving aquifer protection. Each section includes the following:

- Overview of the BMP category
- Specific information for each BMP
- Laws and regulations in NH pertaining to each category

The BMPs were selected from a variety of published information resources prepared by federal, state, and non-government organization sources listed in the Resources section (pg. 89) of the Guidebook. This list should not be used as a sole source of information for selecting BMPs. As the three communities change and evolve, new approaches may be required to protect the aquifer resources. Furthermore, additional BMPs may become appropriate as new innovations to control pollution and protect ground water are pursued. The Guidebook is not a blueprint on how to design specific BMPs; it is a resource guide to identify BMP options that may be considered during site plan review and activity planning to prevent the pollution of ground water resources.

Choosing appropriate BMPs for a site is based on several factors. Site characteristics such as land use, hydrology, geology, topography, and soil types all effect the selection of BMPs. Further considerations should include development type, aesthetics, maintenance, cost, and ownership. Potential Contamination Sources must comply with Env-Wq 401. Municipalities can also require that specific BMPs be utilized in sensitive ground water recharge areas. Ultimately, where not specifically prescribed by rules, BMP suitability should be based on many factors and is the responsibility of the site engineers and developer to ensure the BMPs meet the site design specifications and protect the aquifer from pollutants.

Reducing pollution from regulated substances is paramount to protecting the aquifer resources. NH DES oversees numerous regulatory programs for substances of concern to aquifer protection. Regulations and information specific to these programs can be found at http://www.des.nh.gov/desadmin.htm.

Past practice has shown that a combination of several complementing BMPs are usually necessary to achieve best water resource protection and sustainable land uses for a particular parcel of land and surrounding area. New innovations to control pollution and runoff are being developed. These evolving approaches to control runoff and protect ground water resources should also be considered. The BMPs contained in the Guidebook were chosen to address the following topics:

- Underground & Aboveground Storage Tank BMPs
- Commercial & Industrial BMPs
- Conservation Design
- Site Design BMPs
- Erosion & Sediment Control BMPs
- Septic System BMPs
- Road Maintenance BMPs
- Gravel & Sand Pit BMPs
- Residential BMPs

Each BMP was chosen to specifically protect the stratified drift aquifer and drinking water supply. There are numerous BMPs appropriate for storm water runoff and surface water protection. However, in order to facilitate the creation of a guidebook to focus on water quantity and quality issues for the aquifer, only those BMPs that address ground water protection have been included. Furthermore, BMPs for high-density, ultra-urban areas are not suitable for the three communities and have not been included.

Appendix A contains checklists highlighting the regulations and suggested BMPs pertinent to each land use category in this Guidebook. The checklists will provide an overview of when a permit is required or when a BMP is recommended. The reader should contact town and state officials for updated and specific permitting and BMP requirements before submitting a site development plan for official consideration.

Appendix B is a comprehensive matrix of the BMPs outlined in the Site Design Section. The matrix rates performance, cost effectiveness, and cold weather effectiveness. Since New Hampshire is in a northern climate, special consideration must be paid to the effects of winter conditions (snow, ice, salt) on the effectiveness of the BMPs, as the next section will explain.

Appendix C contains schematics of each site design, or structural, BMP included in this Guidebook. The schematics provide an example of what the design could look like and should not be used as the only engineering reference.

Cold Climate Considerations

BMPs should always be chosen with site and environmental considerations in mind. Many innovative technologies have been designed and successfully installed in warmer regions of the country; however, many of these BMPs are not suitable for the New Hampshire climate. Prior to adopting BMPs at a site, you first must evaluate the suitability of the BMP to the region.

The UNH Stormwater Center is conducting research on porous pavement and other BMPs and can be contacted for specific information at http://www.unh.edu/erg/cstev/. Caraco and Claytor (1997) is another good source for insight into many of the situations and cold weather BMP modifications that should be addressed for central New Hampshire. Items to be considered when selecting a BMP to be installed in New Hampshire are:[10]

- Frost heaves – potential to damage structural features of BMP such as pipes or concrete infrastructure
- Pipe freezing – when freezing occurs there is a reduction in treatment as well as risk of flooding
- Reduced biological activity – for BMPs that rely on biological mechanisms to reduce nutrients and organic matter. Cold temperatures reduce microbial activity
- Reduced settling velocities – when water cools, its viscosity increases, which reduces particle velocity by up to 50% and makes it more difficult for particles to settle out
- Reduced infiltration – due to freezing of soils and filter media
- Increased runoff volumes during snowmelt – if the ground remains frozen, snowmelt cannot infiltrate the soil and instead will contribute to the amount of runoff present
- Access difficulties in ice and snow – access points frozen shut, difficulty locating BMPs under snow load

There is also a potential for additional maintenance requirements during late fall and winter months due to seasonal occurrences such as leaf fall, road salting and sanding, freezing, and vegetative die-off. The increased vegetation, snow removal aids on the roads, and accumulation of materials in snow piles increase the pollutant loading during these months. Cold climate pollutants include:[10a]

- Sand
- Salt
- PAHs – Polycyclic Aromatic Hydrocarbons emitted from fireplaces and inefficient vehicles in winter
- Cyanide – salt additive to prevent clumping

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[10] Stormwater BMP Design Supplement for Cold Climates. Caraco, Deborah and Richard Claytor. Prepared by the Center for Watershed Protection, Ellicott, Maryland for the U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, EPA Grant #CP 985242-01-0. 1997.

Therefore, BMPs that use filtration, settling, or trapping to remove contaminants require frequent inspection and maintenance. Some highly successful BMPs found in warmer climates, such as porous pavement and surface sand filters are not normally suitable in the New Hampshire region but may be allowable under certain conditions. Regular maintenance of BMPs is recommended just prior to the first snowfall or road sanding, after the last snowfall, and during spring snowmelt to ensure proper treatment of runoff.

New Hampshire Laws and Regulations

The following regulations give communities the authority to implement various actions associated with this Guidebook to protect ground water, such as developing a Master Plan or enacting innovative land use controls. This list is not exhaustive. There are additional federal and state regulations pertinent to ground water protection that are not included here. The New Hampshire legislature enacts new RSAs and the RSA numbers also change. The reader should always check the current regulations to make sure they will be complying with the law. The current laws and regulations can be found at: http://www.gencourt.state.nh.us/rsa/html/indexes/.

Regulations:

- Subdivisions, Nonresidential and Multi-family Residential Site Development (RSA 674:35; 674:43) – Authorizes local planning boards to regulate developing or developed land.

- Innovative Land Use Controls (RSA 674:21) – Defines innovative land use controls and terms for including them in ordinances. Adoption of ground water or aquifer protection regulations as part of a zoning ordinance are also regulated within RSA 674: 21.

- Master Plans (RSA 674:1-4) – Describes requirements for developing a local master plan.

- Zoning Ordinances (RSA 674:17-20) – Authorizes and describes the process for implementing zoning ordinances in municipalities.

- Alteration of Terrain Program Site (RSA 485-A:17) – Regulates excavation and road construction activities greater than 100,000 square feet, or 50,000 square feet within a protected shoreland area. Protected shoreland is any land within 250 feet of the public boundary of public waters, which includes all waterbodies with a surface area of 10 acres or more, all fourth order or higher water courses, estuaries, and coastal waters www.des.nh.gov/rules/env415.pdf.

- NPDES Permit – Phase II Stormwater Regulations – Federal permit for construction sites (including road construction areas if soil is disturbed) that disturb one or more acres. The NHDES is the permitting authority for these regulations. They can be found at www.des.nh.gov/stormwater/construction.htm.

- Septic System Regulations (Env-Ws 1000) – Rules governing subdivision and individual sewage disposal systems. They can be found at www.des.nh.gov/rules/envws1000.pdf.

- Minimum Shoreland Protection Standards (RSA 483-B:9 and CSPA rules Env-Wt 1400) – Prohibits the establishment or expansion of salt storage yards within protected shoreland areas.

- Disposal of Waste to Surface Water (RSA 485-A:13) – prohibits disposal of waste to surface water without a permit. Plowed snow contains waste and needs a permit for such disposal.

- Gravel Excavation Regulations (RSA 155-E & Env-Wq 401) – Authorizes communities to regulate gravel excavations. Operational and reclamation standards are outlined, including setbacks, buffers, drainage, erosion and sediment control, chemical storage, and reclamation.

- Statutory Authority (RSA 125-C:4 & Env-A 600, 700, 800, 900, 2800) – Provide standards for particulate matter emissions.

- Underground Storage Tanks (RSA 146-C and Env-Wm 1401) – New Hampshire regulations specific to underground storage tanks.

- Aboveground Storage Tanks (RSA 146-A:11-c and Env-Wm 1402) – Governs aboveground storage tanks regulations in New Hampshire. Contact the DES Oil Remediation and Compliance Bureau at (603) 271-3644 with questions regarding above or underground tanks.

- Homeowner Grant Program (RSA 146-E) – Homeowners are required to use DES "Best Management Practices for the Installation or Upgrading of On-Premise-Use Heating Oil Tank Facilities." This program authorizes up to $1,000 for owners that demonstrate a financial need to meet these requirements http://www.des.state.nh.us/orcb_hwrb.htm.

- The Hazardous Waste Management Act (RSA 147-A) – Authorizes NH DES to regulate the management, transportation, and disposal of hazardous waste in New Hampshire. Specific regulations governing hazardous waste are found in Env-Wm 100-1000. Questions regarding proper hazardous waste management should be directed to the DES Hazardous Waste Compliance Section at (603) 271-2942. Further information can be found at www.des.state.nh.us/hwrb/hwrules.pdf.

- The Ground Water Protection Act (RSA 485-C) – Authorizes local entities (e.g. municipality, water supplier) to apply to DES to reclassify existing wellhead protection areas (WHPAs) or high value groundwater (aquifers) zones. Reclassification to "GAA" is designed for wellhead protection areas and limits a short list of high-risk land uses within the WHPA. GAA reclassification also provides the authority for a local entity to institute a BMP management program that includes conducting regular BMP surveys (inspections) and distributing education materials to ensure compliance with state rule Env-Wq 401, Best Management Practices for Groundwater Protection. GA1 reclassification applied to high-value groundwater, such as an aquifer, involves establishing a PCS management program and education.

- Collection and disposal fee (RSA 261:153(V) and RSA 149-M:18) – City treasurers and town clerks can assess a fee to pay for collection and disposal fees of motor oil, car batteries, and car tires. A Vehicle Registration Fees fact sheet is available at www.des.nh.gov/sw.htm or call DES at (603) 271-2975.

- The N.H. Pesticides Controls (RSA 430:28-48) – Requires pesticide applicators to obtain permits from or to be licensed by the Division of Pesticides Control prior to application. Pesticides must be registered with the state, and applicators must submit reports of pesticide usage annually. Commercial applicators are also required to pass an exam that covers label protocol, chemical safety, environmental consequences, pest types, and use of application equipment. More information on certification, storage of pesticides, application, and setbacks from water resources can be found in the rules Pes 100-1000 at www.state.nh.us/agric/pecorl.html.

- The Shoreland Protection Act stipulates that no fertilizer, except limestone, shall be used within 25 feet of the high water line of a waterbody www.des.nh.gov/cspa/483B.htm.

Underground & Aboveground Storage Tank BMPs

Underground storage tank in lined excavation

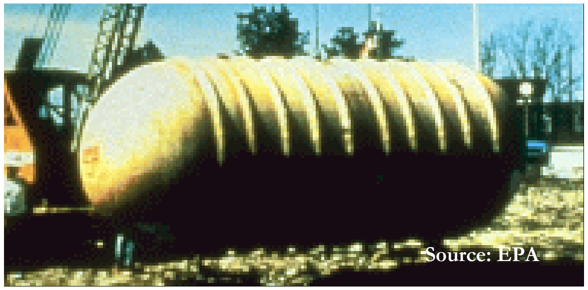
Historically, petroleum products, heating oil, and industrial chemicals and their wastes have been stored in underground tanks. This was originally thought to be the safest place for these hazardous chemicals due to their volatile properties. Some petroleum constituents are carcinogens, some are explosive, and some are toxic if inhaled. Unfortunately, many of these older tanks are now leaking, causing extensive and expensive damage to ground water. For example, one gallon of gasoline can contaminate approximately 730,000 gallons of water.[11] Many industries have started storing these chemicals and fuels in aboveground storage tanks (ASTs) in areas where site conditions prohibit burial of tanks. These conditions could be due to urban land use restrictions, high water table, or location in a source water protection district.

Since 1985, New Hampshire DES has regulated the installation, monitoring, and removal of nonresidential underground storage tanks (USTs) greater than 110 gallons containing hazardous chemicals and motor fuels, and commercial and industrial heating fuel USTs greater than 1,100 gallons. Rules regulating all owners of ASTs 660 gallons or greater, or having a combination of tanks totaling more than 1,320 gallons, were adopted in 1997. The rules established specific requirements for design, installation, maintenance and monitoring of these tanks. NH DES can be contacted for additional information pertaining to these regulations at http://www.des.state.nh.us/orcb_hwrb.htm.

Aboveground storage tank for heating fuel

[11] Best Management Practices to Control Nonpoint Source Pollution – a Guide for Citizens and Town Officials. NHDES. January 2004.

Residential underground heating oil tanks, and aboveground heating oil tanks if a total of less than 1,320 gallons is stored, are not currently regulated by the state and can pose significant risk to ground water contamination. Homeowners are required to use DES *Best Management Practices for the Installation or Upgrading of On-Premise-Use Heating Oil Tank Facilities* http://www.des.state.nh.us/factsheets/rem/rem-16.htm. Following these BMPs enables access to the state cleanup funds in the event of a spill.



UST – Fiberglass Reinforced Plastic Tank

Chemical and Petroleum Handling and Storage

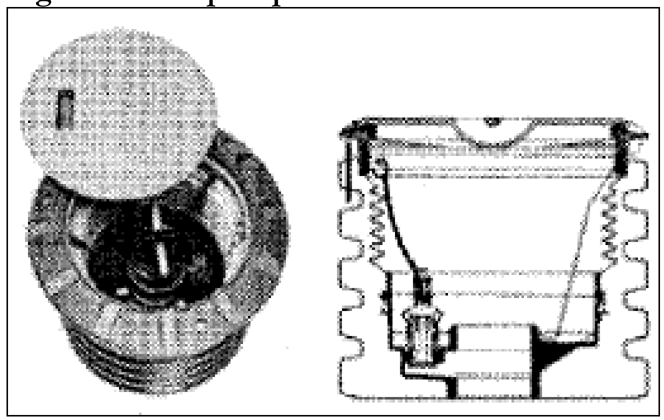
- Local communities can place further restrictions on USTs and ASTs in order to protect their drinking water source. The use of USTs and ASTs within the aquifer direct recharge area could be restricted and additional BMPs could be required. The fact sheet *Preventing Groundwater Contamination at Gas Stations – What Municipalities and Water Suppliers Can Do* - WD-WSEB 22-20, can be adapted for industrial, commercial, residential or agricultural use. http://www.des.state.nh.us/factsheets/ws/ws-22-20.htm
- A site plan should show storage, handling, and use areas for all petroleum products. Include drainage and contour information on the plan. Post the plan in an accessible area so responders can access it in case of a spill.
- A spill prevention, control and countermeasures (SPCC) plan is required by law for all AST facilities capable of 1,320 gallons or more of total petroleum storage capacity. There are many sources available to assist in developing a SPCC plan for any chemical or petroleum product. The US EPA has guidance to assist in developing SPCC plans online http://www.epa.gov/oilspill/.
- Place the UST or AST under cover or away from stormwater drainage areas. This will prevent the flow of runoff from entering the storage area and help prevent leaks or spills from flowing into surface waters or to areas where they could infiltrate into the ground and reach the ground water table.
- Regulated and/or hazardous materials should not be stored in areas with floor drains. All floor drains must be in compliance with underground injection control (UIC) regulations.
- Identify the exact location of tanks, piping, and separators so that inspection, detection, clean-up or other emergency measures can be accomplished in a timely efficient manner.

Ground water monitoring of UST secondary containment

- Use secondary containment for all USTs and ASTs. All tanks and buried pipes should be double-walled, and/or surrounded by an enclosed, impermeable structure capable of containing the contents of the primary tank in the event of a spill or leak. Fiberglass reinforced plastic (FRP) tanks, jacketed steel tanks, and clad steel tanks meet the federal corrosion protection requirements without additional equipment or operation and maintenance as outlined by the EPA http://www.epa.gov/oust/pubs/ommanual.htm. Coated and cathodically protected steel tanks have both a coating and cathodic current protection on the outside wall of the tank. The coating is typically applied to the tank at the factory. The cathodic protection may be either impressed current or galvanic (sacrificial) anodes. Any type of tank should be inspected regularly. The EPA has additional information and guidelines regarding cathodic protection http://www.epa.gov/OUST/ustsystm/cathodic.htm.
- Implement spill protection wherever fuels are refilled. Periodically check to see if your spill protection, such as a spill bucket, will hold liquid. Make sure your spill protection is empty of liquid and debris before and after each delivery. Inspect your primary and secondary containment monthly for signs of wear, cracks, or holes.
- Maintain accurate records of capacity, deliveries, and ground water monitoring and investigate promptly any issues or inconsistencies that come up.
- Install automatic overfill protection and flow valves. Conduct at least monthly inspections and maintenance of the equipment as recommended by the manufacturer.
- Implement ground water monitoring around the perimeter of the site holding the UST or AST.
- Conduct at least monthly inspections for leaks or conditions that could lead to discharges. If any problems are found, report them immediately to the designated spill prevention manager and investigate promptly.
- Conduct transfer operations on impervious surfaces with adequate berms or curbs to control spills. Funnels and drip pans or other appropriate devices should be used to prevent spills.

Additional information about the UST program and these BMPs can be found on the EPA website http://www.epa.gov/oust/. An operating manual including checklists for UST/AST owners, operators, and inspectors can be found online at http://www.epa.gov/oust/pubs/ommanual.htm. NH DES also has guidelines for UST/AST operators on the website http://www.des.state.nh.us/rem.htm.

Figure 10. Sample Spill Bucket & Cross Section



Source: Model Underground Storage Tank Environmental Results Program Workbook

Commercial & Industrial BMPs

Commercial and industrial facilities are often characterized by high levels of impervious surfaces such as parking lots and large structures. Due to this, the ability for recharge to occur on-site is greatly reduced. However, we would not want direct recharge to occur without pre-treatment since the runoff from these commercial sites may contain high hydrocarbon and/or metal loadings significantly above those found in the average urban area.[12] These heightened levels can be attributed to heavy vehicular traffic, imperviousness, and other commercial uses, such as vehicle maintenance, liquids storage, and equipment maintenance. Implementing the following BMPs can decrease the potential for pollutants to reach the ground water table and contaminate the aquifer.

Spill Prevention, Control, and Clean-up Plans

The best way to avoid ground water contamination from spilled materials is to prevent the spill from taking place. Good housekeeping practices are key preventative measures for a business. Some businesses, by the nature of their activities and products, have inherently high environmental risk potentials. For example, photo development shops, dental offices, and veterinary clinics all use hazardous chemicals in film and x-ray processing. Additionally, gas stations, automotive shops, and industrial sites have high potential pollutant loadings from high vehicular traffic and chemical/fuel storage, use, and disposal. Env-Wq 401 stipulates that certain BMPs shall be complied with at facilities using regulated substances in regulated containers (>5 gallons). They are listed at: http://www.des.state.nh.us/rules/env-wq401.pdf. Examples of these BMPs include:

Secondary containment for 55 gallon drums

- Label containers holding regulated substances.
- Store regulated substances in sound, clearly labeled containers.
- Place regulated substances on an impervious surface.
- Cover regulated substances stored outside to protect them from wind and rain.
- Comply with UIC regulations.
- Regulated containers holding regulated substances that are stored outside must have secondary containment that is covered at all times to prevent snow, rain, or ice from collecting within the containment area.
- Schedule regular maintenance and inspection of equipment.

[12] National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

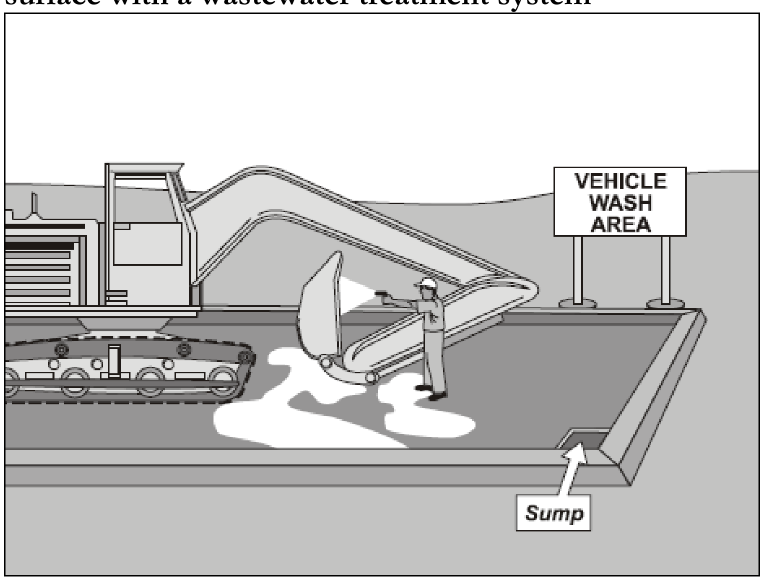
- Prepare a SPCC plan for the business, if applicable, and comply with all applicable RCRA regulations.

Limiting the exposure of materials to rainfall and runoff is one of the most effective and least-expensive ways to reduce or eliminate pollutants in runoff. Facilities should have an inventory of all materials on-site that are exposed to rain and runoff. This inventory provides a starting point for exposure-reduction activities. For example, businesses should be advised to keep dumpsters and other containers securely closed.

Sometimes spills happen, in spite of our best efforts to prevent them from occurring. For this reason, business managers should develop well-defined procedures for handling spills of any hazardous materials located on-site. These procedures should be incorporated into a SPCC plan kept in an accessible location. Personnel should be adequately trained to understand the plan and how to effectively implement its methods. The plan should address small spills, as well as large spills that require employees to contact emergency personnel. Procedures should emphasize the following:

- Indicate that spills must be cleaned up promptly;
- Locations of drains or inlets to storm sewers that should be plugged during spill remediation to prevent off-site contamination
- Specify how each type of material should be handled;
- Discourage the use of water for clean-up;
- List the type of material to use for cleaning up the spill, e.g. shop rags for non-volatile chemical spills or absorbent "snakes" for large spills;
    - Disposal methods for the contaminated materials; and
    - When to contact emergency management personnel.

Figure 11. Outdoor vehicle wash site on impervious surface with a wastewater treatment system



Source: California Stormwater BMP Handbook – Construction

Businesses storing oil above ground in any size tank containing greater than 1,320 gallons are required to have a spill prevention, control, and countermeasures (SPCC) plan on-site. The EPA has information and guidance for developing a SPCC plan http://www.epa.gov/oilspill/spccguid.htm. Further regulations pertaining to oil storage can be found on the NHDES website http://www.des.state.nh.us/ORCB/doclist/spcc.pdf.

Equipment Washing

It is important when washing and maintaining equipment to adhere to certain pollution prevention measures. Water used to clean industrial equipment typically contains oils, metals, and chemicals from the equipment. In order to prevent this polluted water from leaving the site, certain BMPs should be implemented at wash sites:

- Designate a special cleaning area for greasy equipment or trucks;
- Install structural BMPs, such as oil/water separators [see Site Design BMPs, pg. 49], designed for treating wash water;
- Use the most environmentally safe cleaning agents possible;
- Post signs that prohibit vehicle maintenance at the wash site, such as changing vehicle oil; and
- With proper approvals, install sumps or drain lines to collect wash water for treatment and discharge to the sanitary sewer.

All commercial equipment or vehicle washing that discharges to the ground requires registration with DES's Groundwater Discharge and Permitting Program under Env-Ws 1500. Certain other activities that discharge commercial non-domestic wastewater to the ground may require a DES Groundwater Discharge Permit. The BMPs listed above, particularly those designating cleaning areas, installing equipment, or connections to sanitary sewers may be subject to state or local approvals from state (permitting) official or local officials, such as a pre-treatment coordinator at a wastewater treatment plant. Please refer to the Non-Domestic Wastewater Discharge webpage related to vehicle washing in http://www.des.nh.gov/factsheets/ws/ws-22-10.htm and the program overview in http://www.des.nh.gov/dwspp/gwdisch.htm.

Equipment Maintenance

Vehicle and equipment maintenance should be performed in an indoor garage, not outside. If performing work outdoors, always work on an impervious surface such as a paved parking area. Furthermore, all oil and grease should be captured and precautions taken to prevent them from being carried in runoff, such as with the use of absorbent pads in inlets or grates. Other materials from equipment and vehicle maintenance must also be disposed of properly. Antifreeze, waste oil, and spent solvents can be recycled. Spent batteries should not be discarded with trash, but must either be disposed of as a hazardous waste or returned to the dealer from whom they were purchased.

Training and Education

Employee education at commercial and industrial sites is essential to establishing good pollution prevention practices. Training programs provide information on material handling and spill prevention and response to prepare employees to satisfactorily complete day-to-day operations using BMPs and also to handle possible emergency situations. Employees should also be trained on the purpose, operation, and maintenance of pollution prevention management practices. They should know where spill kits are located and how to use them in the event of a spill. They should also be able to recognize the severity of a spill or incident and when to call for emergency management assistance. Refresher courses and training for new technologies should be part of an employee's regular periodic education. Signage should be posted reminding employees of handling and response practices. Signage can also be used to inform customers of efforts to reduce waste and pollution so they will be less likely to contribute to pollution problems that are ultimately the responsibility of the business. For example, signage at a self-service car wash requesting that patrons not dump oil or chemicals in the storm drains and why can be a step towards protecting the aquifer.

Pollution prevention campaigns can be implemented to target specific commercial activities suspected of contributing to ground water contamination. The first step in a campaign is to complete an assessment of commercial facilities to identify the types of waste produced. Northfield, Tilton, and Belmont have completed an assessment identifying potential contamination sources (Figure 9). The next step is for the municipality (often the building inspector or code enforcement officer) to prepare a list of the types and stored volumes of chemicals located at these facilities. They can then focus on outlining methods to reduce the total amount of waste generated on-site and to properly dispose of potential pollutants. The completed assessment also provides the municipalities with information enabling development of a set of rules and use limitations that can be implemented in commercial covenants, conditions, and restrictions that a commercial tenant must agree to as a condition of occupying a site.

A reduction assessment, or audit, can provide recommendations for modifying the commercial process to generate less waste. Perhaps, the business could use alternative raw materials to generate non-hazardous wastes. The audit then identifies recycling options to reduce the amount of wastes that require disposal. Technical information and assistance about environmental audits can be found at EPA's Office of Pollution Prevention and Toxics website http://www.epa.gov/oppt/pollutionprevention/.

Illicit Connection Detection and Elimination

Illicit connections are defined as "illegal and/or improper connections to storm drainage systems and receiving waters."[13] A commercial or industrial discharge to a storm sewer or waterbody is "illicit" because these discharges are regulated by the EPA and require a permit under the National Point Discharge Elimination System (NPDES). Many building owners and operators are unaware that an illicit connection exists in their facility because many connections pre-date the current management. The level and type of commercial or industrial activities and the surrounding land uses will affect the methods used to identify illicit connections. The Center for Watershed Protection publication *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments* provides information on cost-effective methods to detect and eliminate illicit discharges from municipal storm drains. It is available for download at http://www.cwp.org/PublicationStore/TechResearch.htm.

Enacting an illicit discharge detection and elimination ordinance authorizes a municipality to inspect properties suspected of releasing inappropriate or potentially contaminated discharges into storm drain systems. Enforcement actions should also be established for those properties found to be in noncompliance or that refuse to allow access to their facilities. The EPA, in conjunction with the Center for Watershed Protection, published a model ordinance for illicit discharges on their model ordinances

[13] Rapid Watershed Planning Handbook. Caraco, D., R. Claytor, P. Hinkle, H.Y. Kwon, T. Schueler, C. Swann, S. Vysotsky, and J. Zielinski. Center for Watershed Protection. Ellicott, Maryland. 1998.

website http://www.epa.gov/nps/ordinance/discharges.htm. Municipalities should modify the language to take into consideration enforcement methods that are appropriate for the local area.

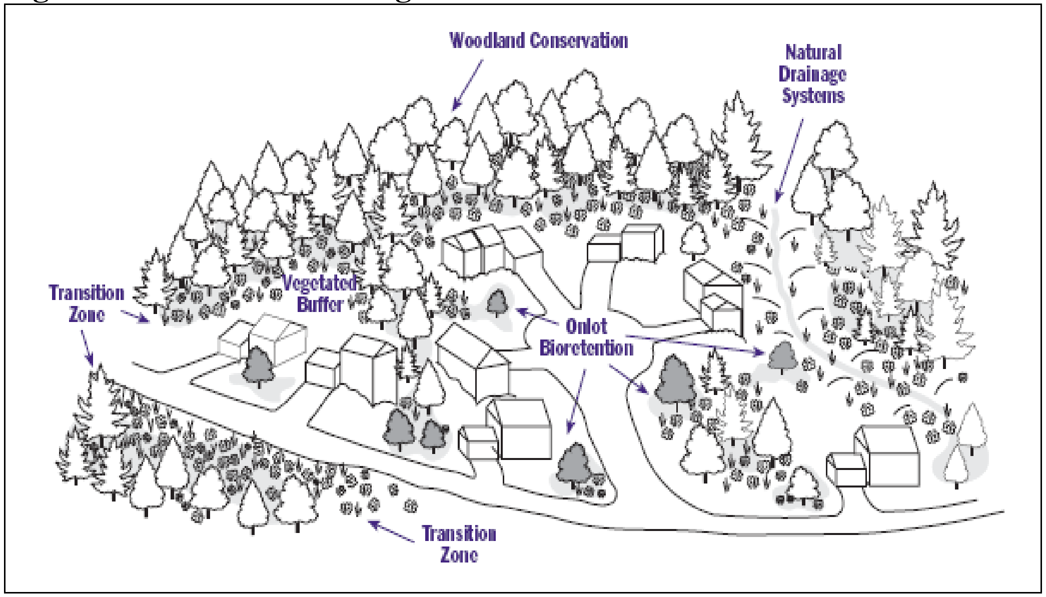
Conservation Design

Municipalities can use a variety of land use controls to protect the aquifer and surface water that will eventually infiltrate to the aquifer. For example, an Aquifer Protection Overlay District (APOD) can include zoning regulations to protect ground water resources. Subdivision controls restricting the percentage of impervious cover help to ensure that expected development will not compromise drinking water quality or ground water recharge. Conservation design incorporates maintaining pre-development hydrology, implementing appropriate effective infiltration technology, and keeping water on-site for treatment and aquifer recharge.[14]

Conservation design:

- minimizes the amount of land disturbed during development;
- maintains significant ecological areas in a natural state;
- reduces the amount of impervious surface created;
- maximizes energy and water efficiency;[11a]
- maintains ground water supplies by increasing infiltration of water into the ground; and
- protects ground water quality by maintaining undisturbed land, especially along wetlands, streams, and other riparian areas.

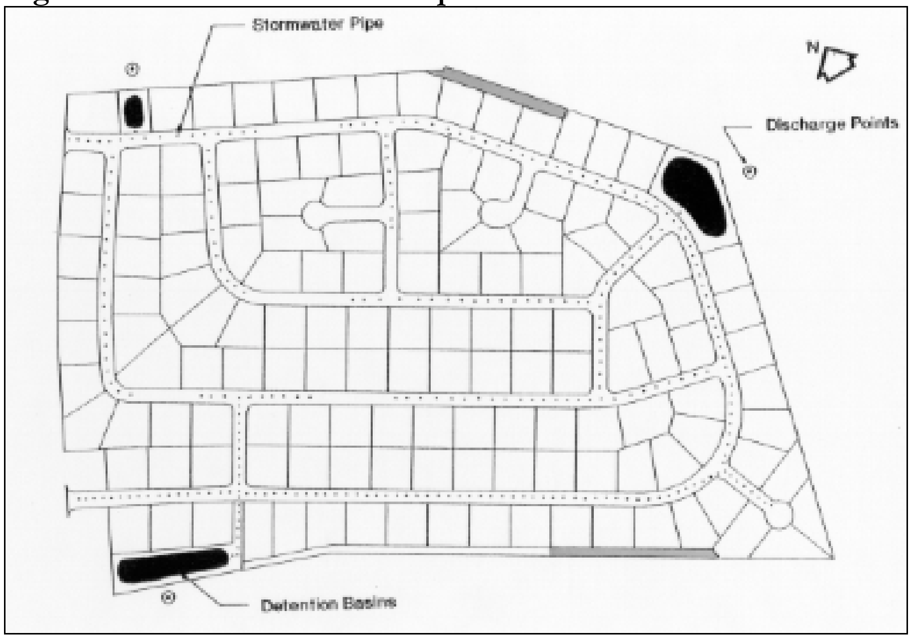
Figure 12. Conservation Design



Source: NHDES

[14] Best Management Practices to Control Nonpoint Source Pollution – A Guide for Citizens and Town Officials. The Watershed Assistance Section. New Hampshire Department of Environmental Services. January 2004.

Figure 13. Conventional Development



Source: Conservation Design for Storm Water Management

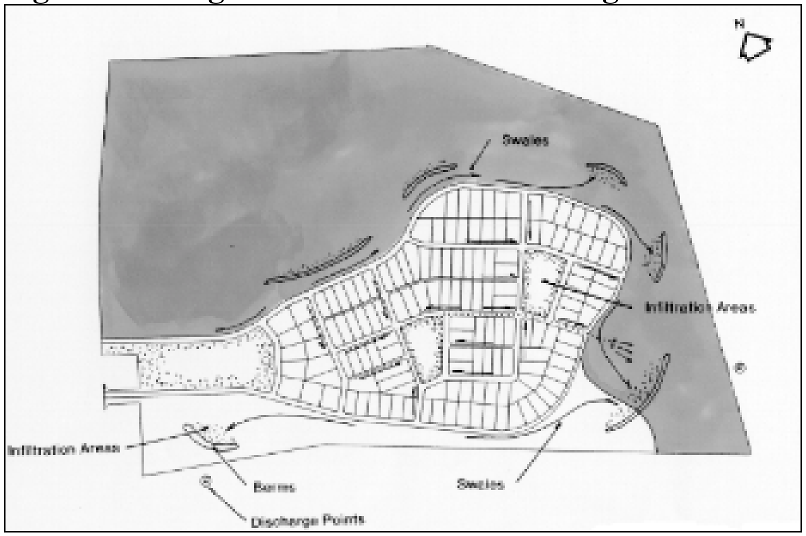
There are several conservation design techniques that can be applied to new developments. Figures 13 – 15 show how these BMPs may look in a conservation design compared to a conventional design. Figure 13 is of a conventional development design and resulting storm water treatment. Storm water treatment designs in this context are often "fit into the lot layout" where site acreage is available with little thought given to hydrology or aesthetics. Compare Figure 13 with Figures 14 and 15, which are conservation designs that work with existing topography and hydrology and integrate storm water treatment features into the landscape.[15] The following are typical standards for conservation design that will result in greater protection of the surface and ground water. See *Conservation Design for Subdivisions – A Practical Guide to Creating Open Space Networks* or *Conservation Design for Storm water Management* in the References section (pg. 111) for additional information.

Aspects of Conservation Design:

- Locate new developments away from sensitive surface waters and the aquifer recharge area.
- Cluster development together in order to preserve open space and natural features such as streams, ponds, and woodlands.
- Allow for smaller lots and narrower setbacks and frontages to reduce the amount of land "disturbed" by development and to maximize the amount of land retained in open space
- Disconnect impervious surfaces (e.g., slope drive-ways towards lawns or vegetated areas rather than the street).

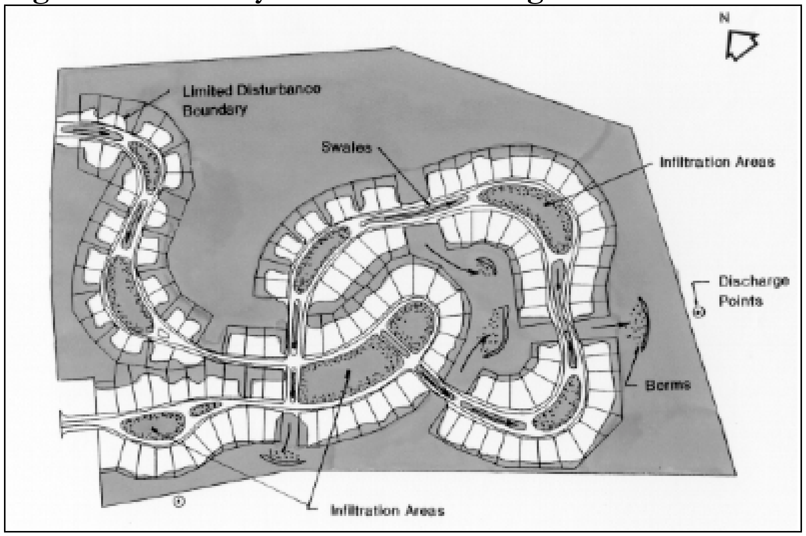
[15] Conservation Design for Storm water Management. A Design Approach to Reduce Storm water Impacts from Land Development and Achieve Multiple Objectives Related to Land Use. DE DNREC and Brandywine Conservancy. September 1997.

Figure 14. Village Cluster Conservation Design



Source: Conservation Design for Storm Water Management

Figure 15. Parkway Conservation Design



Source: Conservation Design for Storm Water Management

- Reduce the size of parking areas and use permeable surfaces such as hardy grass or crushed stone for overflow parking areas.
- Maintain vegetated buffers and filter strips extensively and allow ground water recharge of only treated runoff. (Buffers are not intended to serve as primary treatment or to receive channelized flow.)
- Use the topography at the site to guide the development instead of clearing and grading the site prior to construction.
- Integrate smaller-scale BMPs and landscape features throughout the site to manage storm water.
- Conduct routine septic system inspections when a development is not served by sewer. (Poorly functioning waste water disposal systems with leach fields may concentrate nitrates to the point that ground water is impacted, i.e. influent flows are too high to be diluted)

Economic Benefits of Conservation Design

There are many economic benefits of implementing conservation design techniques. Conservation design often reduces the infrastructure engineering, construction, and maintenance costs of a development. Narrower and/or shorter streets and driveways are less costly for the developer to build and for the town or homeowner to maintain. Vegetated grassed swales reduce the amount of storm water run-off from streets and parking lots and therefore, the size and number of additional treatment facilities. Establishing environmentally sensitive areas within the development as open space will reduce the number of costly or contentious wetland crossings or fillings and also provide an amenity at the site. Implementing several complementary BMPs in one design will result in greater aquifer protection while reducing costs associated with storm water treatment.

Table 6. Conventional vs. Cluster Site Development Costs ($)

	Conventional		Cluster	
Site Improvement	**Total Costs**	**Costs /Lot**	**Total Costs**	**Costs /Lot**
Street Pavement	862,165	1,827	540,569	1,145
Curbs and Gutters	433,872	919	N/A	N/A
Street trees	412,496	874	374,640	794
Driveways	743,400	1,575	527,715	1,213
Storm drainage	696,464	1,476	278,295	590
Water distribution	746,044	1,581	492,792	1,044
Sanitary sewer	1,142,647	2,421	1,009,601	2,139
Grading	332,044	703	220,755	468
Clearing/grubbing	156,915	332	109,785	233
Sidewalks	209,250	443	197,775	419
Subtotal	5,735,297	12,151	3,751,927	8,045
Engineering fees	332,647	705	217,612	467
Total	**6,067,945**	**12,856**	**3,969,539**	**8,512**
Cost difference on a per lot basis		**4,344**		
Percent of conventional lot cost		100%		66%

Source: Adapted from *Conservation Design for Stormwater Management*

Property values are often higher for sites incorporating conservation design techniques. Realtors and developers may market the properties as "environmentally friendly" and highlight the benefits of living and/or working in a community where wetlands, forests and shorelines have been protected and preserved. Likewise, conservation design properties also appreciate faster in value than those in conventional developments. Trails and parks for passive and organized activities created in the open space areas can be highlighted and illustrated in marketing tools. For example, if a development has set aside 50-60% of the total area as open space, a potential buyer is not only buying a specific parcel, but access to the open space acreage as well. Consumers have demonstrated a clear preference for buying homes and properties with views onto farmland or open space instead of their neighbor's yards or houses.[16]

Performance

Benefits achieved from conservation design strategies can be innumerable. Maximum benefits can be realized from pollutant capture and recharge compared to strictly structural BMPs because they are often implemented on a more holistic basis with site-specific design criteria.

[16] Conservation Design for Subdivisions – A Practical Guide to Creating Open Space Networks. Arendt, R.G. Natural Lands Trust, American Planning Association, and American Society of Landscape Architects. 1996.

Benefits from good conservation designs and implementation include:

- Reduction in imperviousness leads to greater on-site infiltration and treatment
- Reduction in pollutant loads
- Preservation of hydrological and sensitive features such as wetlands, streams, and habitat areas
- Preservation of undisturbed ground water recharge area
- Passive recreation and open space areas
- Aesthetics
- Reduction in development and maintenance costs
- Increased property values and appreciation

Site Design BMPs

This section contains site design (also called structural) BMPs that should be considered during the planning and site design stage of development. Proper selection and design of structural BMPs is critical to ground water protection. For example, if a commercial site installs an infiltration basin with inadequate pre-treatment for sediment removal, the basin will become a pond of stagnant water as the bottom becomes clogged. Similarly, if the volume of runoff at a site exceeds the capacity of an oil/water separator, untreated, contaminated water could enter the aquifer and adversely impact ground water.

An additional design concern is placement. Incorporating BMPs into the development design in the proper location will often decrease long-term operation and maintenance requirements. See the Resources section (pg. 89) for sources with more information on selection and placement of specific structural BMPs.

Section 1: Infiltration BMPs

Infiltration structures capture and temporarily store runoff allowing it to permeate through the soil down to the ground water table and aquifer. In order for the infiltration structures to work properly, sediments and potential pollutants should be captured before the runoff enters the structure. Vegetated filter strips, swales, or water/oil separators should be used in conjunction with the infiltration structures to prevent premature clogging and ground water contamination. Infiltration structures should not be used adjacent to areas where there is heightened risk of contamination such as at gas stations or automotive shops. Additionally, in cold climates such as New Hampshire infiltration structures have the added challenge of dealing with salt and sand in runoff, as well as frozen ground. Salt is difficult to capture and will not be collected significantly in any of the BMPs listed in this Guidebook. If properly designed, sand can be captured in one of the pre-treatment BMPs mentioned in the following sections. Frozen ground conditions may inhibit the infiltration capacity of the ground. This should be taken into consideration when designing the infiltration structure.

Infiltration basin for large parking area with check dam at inflow

Section 1.1: Infiltration Basin

Infiltration basins are temporary detention basins created by excavation or creation of berms or small dams. They are typically flat-bottomed with no outlet. This allows runoff to recharge the ground water table through the floor and sides of the basin. Ideally the basin should recharge (drain) completely within 72 hours to maintain aerobic conditions and ensure readiness for the next storm event. The key to success for infiltration basins is to keep the sides and floor of the basin unclogged. Schueler (1992) reported failure rates in infiltration basins due to sediment clogging ranging from 60-100 percent in the Mid-Atlantic region.[17] Sediment clogging results when sediment traps such as berms or swales are not used and maintained as pre-treatment allowing fine particles of clay and silt to enter the basin. Grasses or other vegetation should be planted on the basin floor and sides. If the basin becomes clogged, the bottom should be roughened or dredged to restore percolation rates. Proper placement, installation, and maintenance of the pre-treatment BMPs are also necessary to keep the failure rates low.

Infiltration basin clogged due to sediments

Section 1.2: Infiltration Trench

Infiltration trenches are similar to basins in that they allow runoff to gradually recharge the ground water. Trenches are typically shallow (2- to 10-feet deep), excavated ditches that have been backfilled with stone to form an underground reservoir. An infiltration trench can be designed to fit different site sizes and styles, but are most commonly used for drainage areas of less than 5 to 10 acres. The surface can be covered with a grating or consist of stone, gabion, sand, or a grass-covered area with a surface inlet. They can be used on small, individual sites or for multi-site runoff treatment. As is the case with basins, trenches should not be used until construction is complete. The "upstream" sediment control BMPs must be fully functional before infiltration BMPs are brought on-line so the risk of clogging with high quantities of sediment is decreased. Vegetated filter strips, swales, or similar sediment control BMPs must be incorporated into the design.

Infiltration trench next to parking lot with vegetated swale as pretreatment

[17] National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

Section 1.3: Pervious or Porous Surfaces

Current research at the University of New Hampshire Stormwater Center has shown that pervious pavements can be suitable for northern climates. Seasonal parking or driveways can be grass, crushed rock, pavers, or other permeable surfacing. In this way the ground water is still able to recharge but the additional capacity is available if needed. For additional information on the types of pavement they are researching, visit their website http://www.unh.edu/erg/cstev/. As in the case with infiltration basins and trenches, pervious surfaces should not be used in potential contaminant source areas with high probabilities for significant contaminant releases.


Source: E Anderson

Permeable pavers for overflow parking

Section 2: Open Channel System BMPs

Open channel systems function as both runoff conveyance and infiltration devices. The open channels are lined with grass or other erosion-resistant plant species to slow flow velocity and allow infiltration to ground water. They also filter sediments, a process that can be enhanced if sediment check dams are added to the design. This would necessitate regular maintenance to clean out the captured sediment behind the check dam. Open channel systems can be an aesthetic benefit of a development and are successfully used adjacent to roadways, in parking lots, medians, and residential areas. They can also be combined with other BMPs to improve their success rates. Open channel systems have reduced effectiveness in the winter due to dormant vegetation and frozen ground. However, they have been shown to be valuable for snow storage as they can capture sediments prior to meltwater infiltration.

Vegetated swale and check dam used as pretreatment for the infiltration trench

Section 2.1: Grass Swale

Grass swales have a wide bottom, gentle slopes, and are designed to detain flows for 10-20 minutes some sediment filtration can occur. They are well suited for frequent, small storm events. Construction and maintenance costs are relatively low. Although longer grass is preferred to improve infiltration and sediment trapping, regular mowing is recommended to decrease leaf litter and tall grasses. Fertilizers and pesticides should not be applied on the swale.

Grass swale used for a road and parking lot

Section 2.2: Dry Swale

Dry swales function like grass swales in that the surface vegetation filters the sediments. However, they are designed to move the runoff quickly through 30" of underlying soil bed to an underdrain collection system. Dry swales are designed to drain within 24 hours of a storm event, or are discharged to a receiving waterbody or another structural control. Dry swales should not be used where flow rates exceed 1.4 feet per second without using additional erosion control measures.[18]

Wet swale adjacent to a commercial parking lot

Section 2.3: Wet Swale

Wet swales have gently sloping sides and a wide base designed to have standing water and saturated soils. The soil bed is composed of a pea gravel layer and function best with diverse wetland plants as the filtering vegetation. Wet swales are designed to store water for 24 hours while it infiltrates into the ground. This BMP is a good choice if the ground water table is high.

A vegetated filter strip is ideally suited for a residential development

Section 2.4: Vegetated Filter Strip

Vegetated filter strips provide a natural area for sediments in runoff to accumulate while infiltration occurs. They can be incorporated into many designs and are often utilized as aesthetic landscaping features. Vegetated filter strips are composed of a stone trench, grass strip, and wooded strip. The grass strip can function as pretreatment for the wooded strip and allows sheet flow. The filter strip can provide treatment for a 0.5-1 inch rainfall event with significant quantity and quality benefits for these small rainfalls. Native plants and trees should be used in the wooded strip to improve survival rates and negate the need for fertilizers and pesticides.

Section 3: Filtering System BMPs

Filtering systems are impoundments that treat runoff received from filtering media such as sand or gravel. After going through the filtering system, runoff can either be routed back to the conveyance system, or allowed to infiltrate into the ground. They are designed to filter pollutants from runoff, not to reduce flows in storm events since typical detention time is only four to six hours.

[18] National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

Filtering systems are most effective on small drainage systems of five acres or less and work better when sediment-trapping structures are used to prevent premature clogging of the filter medium. There are many types of filtering systems being used successfully across the nation. However, many of these have either not been tested in cold climates or are ineffective.[19] The BMPs discussed below have proven effective when adapted to cold climates.

Section 3.1: Underground Sand Filter

Sand filters usually consist of two-chambers: the first is a settling chamber and the second is a filter bed filled with sand, gravel, or other medium. The first chamber allows large particles to settle out. The second filter removes finer particles and other pollutants (design and filter media dependent) as runoff flows through the filtering medium. There are several modifications of the basic sand filter design. The underground sand filter was adapted to fit into confined urban spaces and is designed to receive only flows from small rainstorms. The construction and maintenance costs of an underground sand filter are high; however, it has been proven successful in cold climates when placed below the frost line. They can be located in the basements of buildings, such as in parking garages, for easier access for maintenance and monitoring. This will also protect the filter from frost heaves and freezing.

Underground sand filter during construction

[19] Storm water BMP Design Supplement for Cold Climates. Caraco, Deborah and Richard Claytor. Prepared by the Center for Watershed Protection, Ellicott, Maryland for the U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, EPA Grant #CP 985242-01-0. 1997.

Section 3.2: Oil/Grit Separator

Oil/grit separators are a type of water quality inlet device that is designed to remove particulate solids through underground retention systems. Water quality inlet designs in their simplest form are single-chambered catch basins to provide 2 to 4 feet of additional space between the outlet pipe and the structure bottom for collection of sediment. Oil/grit separators consist of three chambers. The first chamber removes coarse material and debris; the second chamber provides separation of oil, grease, and gasoline; and the third chamber provides safety relief if blockage occurs.[20]

Underground oil/water separator

Because it is an underground system, minimal land area is required to effectively use an oil/grit separator. They can also be successfully retrofitted into existing small urban environments. Separators could provide particular benefit in areas of high pollutant runoff such as automotive and car wash facilities. However, they do <u>not</u> treat dissolved contaminants. Frequent maintenance and disposal of trapped residuals and hydrocarbons are necessary for these devices to continuously and effectively remove pollutants. Single systems are not suitable for large land areas as they do not have the capacity to handle large storm events. Another limitation is the relatively high cost of installation and maintenance compared to most above-ground systems.

Section 3.3: Bioretention

Bioretention systems are modifications of the traditional parking lot island. They can be easily integrated into the landscaping features of a development while providing treatment for runoff. They are also commonly paired with other BMPs to provide the necessary level of treatment depending on runoff volume and pollutant loading.

Curb cuts allow runoff to flow from the parking lot into the bioretention area

Retrofits to these parking lot islands can create successful bioretention areas

Runoff can be directed to the bioretention areas with proper sloping and no curbs, or frequent curb cuts. The soil bed traps sediments and pollutants while the filtered runoff is collected in an underdrain system for discharge or allowed to exfiltrate to the subsurface. The plants used in

[20] National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

these systems are not only for aesthetics, they also trap additional pollutants (plant species and design dependent). Salt tolerant species should be planted where deicing salts are used.

The shape of this pond is aesthetically pleasing and enhances pollutant removal

Bioretention systems are very flexible and economical for a wide variety of commercial, industrial or residential sites. For example, a developer in Prince Georges County, Maryland, incorporated bioretention areas into each lot of a suburban development to control runoff quantity and quality. The bioretention areas eliminated the need for a wet pond, allowed the development of six extra lots, and resulted in a cost savings of more than $4,000 per lot.[21] Where conventional storm water facilities can often be eyesores and attract insects, safety issues and mosquitoes have not been a problem at this site since it is a comprehensive biological system complete with insect predators. In fact, the residents are actively maintaining their bioretention areas.

Bioretention areas have been successfully installed as retrofits. An existing parking facility was retrofitted with a bioretention area in order to compare the costs and benefits of retrofitting and study the pollutant removal capability of the BMP.[22] The study showed the bioretention area lowered runoff temperature 12 degrees Celsius, lead levels were lowered 79 percent, zinc levels were lowered 78 percent, and numerous other pollutant levels were also considerably reduced. The retrofit cost $4,500 to construct, while conventional BMPs would have cost $15,000 to $20,000, involved fewer environmental benefits, and higher maintenance costs. They also noted that a drought occurred after the installation, and although many of the other plants in the parking lot died or experienced severe drought stress, those in the bioretention facility survived because of the retained water supply.

Dry ED pond for large runoff capacity – lack of woody vegetation on embankments protects structural stability

Section 4: Pond and Wetland BMPs

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[21] National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

[22] Bioretention Applications. USEPA. EPA-841-B00-005A. October 2000.

Ponds and wetlands are the most common types of BMPs currently used in developments and, with filter strips and swales, are the most highly recommended BMPs in cold regions for storm water runoff.[23] The goal of using ponds and wetlands is primarily to regulate the post-development discharge rate so that it equals the pre-development rate. Depending on design, ponds and wetlands may also remove pollutants other than sediment. This can either be through temporary detention or retention (permanent pool). In this way, runoff is treated prior to its release to surface water or infiltration area for ground water recharge. Success rates vary dramatically depending on many factors, such as hydrology, soils, topography, design, and vegetation. Slight modifications can improve the effectiveness and aesthetic of the conventional rock-lined detention pond. Pond and wetland adaptations specific to cold climates can also be found in Caraco and Claytor (1997).

Source: LRPC

Design modifications could create habitat, aesthetics, and greater pollutant removal for this conventional wet pond more aesthetic

Section 4.1: Dry Extended Detention Pond

Dry extended detention (ED) ponds temporarily detain a portion of runoff for up to 24 hours after a storm. This allows pollutants and sediments to settle out before being conveyed through a fixed outflow device to a receiving location. Dry ED ponds are designed to be dry between storm events and not contain any permanent standing water. There are many variations on the basic design for dry ED ponds that should be matched to the environment and development. Construction and maintenance costs can be high depending on the type of design used and the site specifications. Additional maintenance requirements may be necessary during the winter months to deal with ice and snow. Dry ED ponds can also be used to store snow – a practice that is not possible for the other pond and wetland systems due to the permanent pool features. (Note: Storing ice-treated snow in these ED ponds will concentrate salt to potentially adverse levels beneath and down gradient of the BMP.)

Source: Center for Watershed Protection

This multiple cell wet pond provides additional treatment pathways while being aesthetically pleasing

[23] Storm water BMP Design Supplement for Cold Climates. Caraco, Deborah and Richard Claytor. Prepared by the Center for Watershed Protection, Ellicott, Maryland for the U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, EPA Grant #CP 985242-01-0. 1997.

Section 4.2: Wet Pond

Wet ponds are designed to maintain a permanent pool of water in addition to the temporary storage of runoff. Vegetation is often used to increase pollutant uptake, habitat, and aesthetic value of the facility. Like dry ED ponds, there are many design variations for wet ponds. Additional BMPs can be used to enhance the effectiveness of the overall runoff treatment. For example, a settling forebay can be used at the inflow to maximize pollutant and sediment trapping.

In areas with a high water table, wet pond designs should also account for the infiltration of ground water. Depending on the soil type or land use, a liner may be needed to maximize treatment prior to infiltration. The liner, if needed, should be of natural material (clay, silt, sand) so that any required future maintenance dredging will not have to include a complex procedure to separate a synthetic-liner material from the dredge spoils prior to reuse.

The cost of construction and maintenance for wet ponds can be high. Costs and benefits should be weighed to determine whether a site would benefit most from a localized treatment facility or a regional one. Regional facilities can incorporate more advanced treatment technologies than on-site facilities and may be easier to maintain. They can also be an asset to the community by providing aesthetic, recreation, and wildlife benefits. Surveys have found that wet ponds and wetlands can increase property values and increase people's willingness to pay a premium for adjacent lots.[24]

The fountain in this constructed wetland aerates water while treating parking lot runoff

This wetland incorporates a safety bench and aquatic bench

Section 4.3: Constructed Wetland

Constructed wetlands are designed to treat storm water runoff in much the same way as ponds, except they are generally shallow and incorporate wetland vegetation. As runoff flows through the wetland system, contact with vegetation is maximized to slow runoff velocity and improve settling

[24] Storm water Detention Basins and Residential Locational Decisions. Emmerling-DiNovo, C. Water Resources Bulletin 31(3):515-520. 1995.

rates of sediments and plant uptake of dissolved pollutants, while decreasing the incidence of erosion and turbidity at the outfall. Contact with the wetland vegetation also enhances additional trapping of pollutants.

There are many variations of constructed wetlands that enable them to be utilized under a variety of conditions and constraints. They are feasible at most sites where there is enough rainfall and/or snowmelt to maintain a permanent pool. Constructed wetlands should be located contiguous to existing wetlands when possible, unless there is a high potential for contamination. When sited over a direct aquifer recharge area, a liner should be used so infiltration does not occur prior to treatment. The liner should be constructed of natural material (clay, silt, sand) so that any required future maintenance dredging will not have to include a complex procedure to separate a synthetic-liner material from the dredge spoils prior to reuse.

Multiple benches, or stepped plateaus, should be part of the constructed wetland design. These allow for deeper water in the center of the wetland while providing shallow areas for vegetation. Proper bench design also decreases the potential safety concerns of having a wetland in high traffic recreation areas. Regardless of the wetland design, most should be designed to receive periodic maintenance to ensure they function properly. Additional modifications are also needed to ensure the vegetation survives during the winter months.

Erosion & Sediment Control BMPs

Newly seeded parking lot site – note the silt fence in the background

There are many erosion and sediment control (ESC) BMP guides available today. The Resources section (pg. 89) includes a number of these as references. Although all runoff is ultimately connected to both surface and ground water in the hydrologic cycle, this section will focus mainly on ESC measures used specifically for ground water protection, in order to focus the scope of this guidebook.

Erosion and Sediment Control Plan

Erosion and sediment control plans are often the first step to protect water resources. ESC plans describe pre-existing site conditions, as well as how a developer will contain and treat runoff that is carrying pollutant-laden sediments during site development and construction. Plans should include descriptions and locations of soil stabilization practices, perimeter controls, and runoff treatment facilities that will be installed and maintained before and during construction activities. Land use, soil types, and hydrology are particularly important when evaluating protection for ground water quality. The full ESC plan review should include:

- Pre-development site conditions (e.g. soil characteristics and water quality)
- Topographic and vicinity maps
- Site development plan
- Construction schedule
- Erosion and sedimentation control plan drawings
- Detailed drawings and specifications for practices
- Inspection schedule
- Maintenance procedures and criteria during site development activities
- Design calculations
- Vegetation plan

Same parking lot site after seed is established – note silt fence still up to minimize sediment runoff until complete

measures – sites like this can cause many problems off-site as well as on-site!

ESC plans do very little if they are not followed. Maintenance and inspections of ESC measures and repair of controls where needed will maintain these controls and maximize their benefit. Developers should prepare field documents for the construction crew and the planning board, with clear instructions and dimensions for erosion control measures. Regular reporting to the municipalities on the status of construction, condition of the stormwater controls, and

notification of any issue is essential. Guidelines for developing an ESC plan, reporting, and steps involved can be found on the New Hampshire DES pollution prevention program website:
http://www.des.state.nh.us/Stormwater/construction.htm.

Erosion and Sediment Control Measures
There are several pollutants of concern associated with construction activities: sediment; pesticides; fertilizers for vegetative stabilization; petrochemicals (oils, gasoline, and asphalt degreasers); construction chemicals such as concrete products, sealers, and paints; wash water associated with these products; paper; wood; garbage; and sanitary waste.[25] Solid wastes and hazardous wastes may also be handled on site. ESC measures for ground water protection are intended to reduce the transport of these pollutants off-site while controlling their infiltration in the direct recharge zone of the aquifer. Many structural BMPs discussed in the previous chapters are also used for ESC measures to protect ground water.
Additional measures include:[26]

- Minimize the amount of bare soil exposed by scheduling phases of construction and stabilization.
- Retain natural vegetation where possible, especially near waterbodies, wetlands, and steep slopes.

- Locate chemical/supply storage away from sensitive areas and on an impervious surface. Use secondary containment for all chemical/supply storage areas.
- Develop and implement a spill prevention, control, and containment (SPCC) plan.
- Monitor practices and adjust, maintain, and repair them periodically and after every storm.
- Line stormwater controls that may receive regulated substances (oil, gas, solvents) in the direct aquifer recharge area to minimize infiltration of pollutant-laden water.
- Remove temporary measures only after construction is completed. Remove sediment accumulated during construction from permanent BMPs once construction activities are completed.
- Design roads to minimize the amount of impervious surface created and maximize opportunities for on-site treatment and infiltration of stormwater.

A timeline for development may be finite, but water quality impacts from construction are not. Construction can have long-term impacts to water quality. Changes in the hydrology and topography of an area can cause water table elevation changes, flooding, and road wash-outs. Site excavation and development removes soil and consequently reduces the filtering capability both in volume

[25] Stormwater Management Manual for the Puget Sound Basin. Washington State Department of Ecology, Olympia, Washington. 1991.
[26] Best Management Practices to Control Nonpoint Source Pollution – A Guide for Citizens and Town Officials. The Watershed Assistance Section. New Hampshire Department of Environmental Services. January 2004.

and infiltration travel time of the unsaturated soils above the water table. Towns and/or developers could face financial and legal burdens from these impacts. It is in everyone's best interest to utilize BMPs to avoid costly, long-term problems.

Chemical and Other Construction Material Control Measures

Accidental spills and poor housekeeping practices can contribute to runoff contamination at construction sites. Proper management of erodible or potentially hazardous materials will help minimize these risks. All potentially hazardous materials should be stored in a secure, dry location that has an impermeable floor. The contractor should have an inventory of all materials and corresponding threats they pose to soil, surface, or ground water contamination. Every site should also have, at a minimum, a spill prevention, control and clean-up plan (the Commercial section has additional information, pg. 37), equipment suitable to contain and clean up spills, and personnel trained in proper spill response. However unlikely an accidental spill may seem, they do occur and proper prevention is key to minimize the risk of runoff contamination. Table 7 identifies materials common to construction sites that could be potentially hazardous to ground water and the recommended BMPs.

Concrete wash-out station

Table 7. BMPs for Potentially Hazardous Construction Materials

Material	BMP
Pesticides	▪ Store pesticides in a secure, dry, covered area that has an impermeable floor. ▪ Provide curbs or dikes around the storage area to prevent spills and leaks from reaching unprotected areas. ▪ Provide site personnel with the proper pesticide spill response training and have adequate measures on-site to contain and clean up pesticide spills. ▪ Strictly follow recommended application rates and application methods. ▪ Handle pesticide wastes appropriately. Many pesticides are considered hazardous wastes when they are disposed of. Pesticide wastes should be managed as required by all applicable waste regulations.
Petroleum Products	▪ Store petroleum products in designated areas that are covered, have impermeable floors, and are surrounded with dikes, berms, or absorbent pads to contain any spills. ▪ Provide site personnel with the proper spill response training and have adequate measures on-site to contain and clean up petroleum spills. Store spill cleanup equipment in fuel storage areas or on board maintenance and fueling vehicles. ▪ Conduct periodic preventive maintenance of on-site equipment and vehicles to prevent leaks.
Fertilizers and Detergents	▪ Minimize the use of fertilizers and detergents. Determine the smallest amounts needed for the tasks at hand and avoid using unnecessary amounts. Apply fertilizers and use detergents only in the recommended manner and never in amounts greater than those recommended. ▪ Apply fertilizers more frequently but at lower application rates. ▪ Implement appropriate erosion and sediment control practices that will control and limit the amount of nutrients leaving the

	site due to attachment to soil particles. ▪ Conduct washing/cleaning operations in designated areas that are equipped to contain wash water and prevent it from being discharged to the site runoff collection and conveyance system. ▪ Do not mix surplus products together unless following specific instructions from the manufacturer.
Hazardous Products	▪ Determine what hazardous materials are being used on-site and which hazardous waste streams, if any, are generated as a result of construction activities. Once all of the hazardous materials used and hazardous wastes generated are identified, it is possible to implement an appropriate waste management and disposal strategy. ▪ Know the applicable hazardous waste regulations and the associated requirements for storing, marking, and disposing of wastes. Someone on-site should be trained to properly manage hazardous wastes. If waste disposal obligations are not clearly understood, contact the correct regulatory agency to find out what specific requirements must be followed. ▪ Use as much of a product as possible before disposing of containers. Containers that are not empty but have been stored for disposal can be sources of drips, leaks, or spills, and they can contaminate landfills or other disposal areas. ▪ Do not remove the original product label from the container. It contains important use, safety, and disposal information about the product.

Source: National Management Measures to Control Nonpoint Source Pollution from Urban Areas

Implementing proper disposal procedures for all wastes at construction sites can significantly reduce the potential for contamination of runoff and infiltration to the ground water table. Wastes such as paint, cleaning fluid, oil, contaminated soil, and metal grit can accumulate and become a significant threat to ground water if allowed to infiltrate into the ground. Table 8 lists BMPs and disposal procedures for some wastes common to construction sites.

Table 8. Disposal Procedures for Construction Materials

Material	**Disposal Procedures/BMPs**
Construction Waste ▪ Trees and shrubs removed during clearing and grubbing ▪ Packaging materials such as wood, paper, plastic, and polystyrene ▪ Scrap or surplus building materials such as scrap metal, rubber, plastic, glass, and masonry ▪ Paints and paint thinners ▪ Demolition debris such as concrete rubble, asphalt, and brick	▪ Select a designated on-site waste collection area. ▪ All regulated or hazardous wastes should be stored and handled according to procedures approved by the proper regulatory agency. ▪ Provide an adequate number of containers with lids or covers that can be placed over the containers prior to rainfall. ▪ Locate containers in a covered area when possible. ▪ Arrange for waste collection before containers overflow. ▪ Explore recycling options for specific wastes generated at the site. Wastes such as used oil, used solvents, and construction debris can often be reclaimed or recycled, thereby reducing the amount of waste actually requiring permanent disposal. Numerous companies can provide recycling services, including the provision and maintenance of on-site recycling containers. ▪ Implement appropriate response procedures immediately when a spill does occur. ▪ Plan for additional containers and more frequent pickups during the demolition phase of construction activities. ▪ Ensure that all waste types are disposed of using method(s) approved by the proper regulatory agency and/or at facilities authorized to receive such wastes.
Hazardous products	▪ Follow manufacturer's recommended disposal method on product label – the materials have different

	properties and requirements for disposal.
Contaminated soils	▪ Clean on-site or excavate and remove to a designated location approved by the proper regulatory agency
Concrete truck waste	▪ Prevent residual wash-out from entering runoff ▪ Construct dikes around wash-out area to allow concrete to harden before disposing as solid waste
Sandblasting grits	▪ Residue may be a hazardous waste depending on metal content ▪ Do not direct residue to ground or storm sewer ▪ Dispose of it as a hazardous waste or solid waste depending on metals content
Sanitary waste	▪ Contract waste hauler to dispose of sanitary waste and maintain the facilities ▪ Do not discharge any waste to sanitary sewer system or septic system

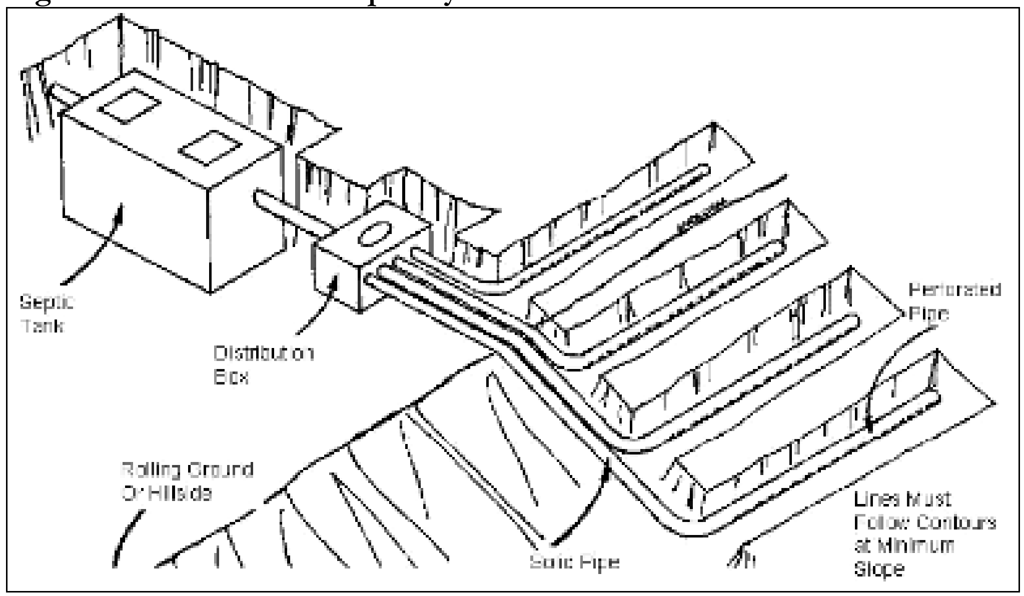
Source: National Management Measures to Control Nonpoint Source Pollution from Urban Areas

Septic System BMPs

On-site wastewater treatment systems, or septic systems, can effectively remove or treat sanitary domestic-type contaminants such as pathogens and nutrients in human sewage when properly designed, installed, and maintained. Septic systems are not capable of effectively protecting ground water from significant quantities of commercial and industrial chemicals. Even in household situations septic systems should never be used for disposal of waste oils, fuels, solvents, metals, or other synthetic chemicals.

Many systems eventually fail due to age, faulty design or installation, or inadequate maintenance. Estimated septic system failure rates range from 5 to 25 percent or higher.[27] Impacts to ground water can be severe and drinking water contamination could result if these failing systems are sited within direct aquifer recharge areas or wellhead protection zones. According to the *Septic System Failure Summary* prepared for USEPA, states have identified septic systems as the third most common contributor to ground water pollution and a significant threat to drinking water sources.[28] In order to protect ground water and prevent contamination of sensitive drinking water resources, programs are in place to monitor design, installation, and maintenance of septic systems. Figure 14 is an example of a conventional septic system design.

Figure 16. Conventional Septic System



Source: National Management Measures to Control NPS Pollution from Urban Areas

Permitting and Planning

DES regulates Underground Injection Control (UIC) systems for commercial, non-domestic wastewater discharges, including dry-cleaning facilities. As these facilities are highly regulated, this Guidebook will only address domestic septic systems.

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27 Estimate of National Gap for On-Site Wastewater Treatment Systems – Draft. USEPA, Office of Wetlands, Oceans, and Watersheds, Washington DC. 2001

28 Septic System Failure Summary. Parsons Engineering Science, prepared for USEPA. 2000

Permitting is often the first opportunity municipalities have to comment on septic system proposals. Permitting and planning that protect ground water resources are necessary to decrease or eliminate risks to human health. Planning approaches can require that the treatment capabilities of on-site technologies match the conditions and sensitivity of the receiving environment.

The integration of planning with regulatory programs can provide a basis for ensuring the performance of existing systems and permitting future installations. In order to better protect aquifer resources, planning should consider regional environmental characteristics and identify areas where:[29]

- Installation of conventional systems can be allowed at specified densities;
- Alternative systems could be required;
- Septic systems could be permitted only under strict design and performance; and
- The locations and types of facilities could be part of an overall wastewater management plan.

Planning and zoning can provide one of the best vehicles for ensuring that wastewater management issues are considered under future growth and development scenarios. Planning and zoning for septic systems enable communities to:

- Establish performance requirements for individual or clustered systems within the direct recharge area;
- Limit, manage, or prevent development in designated critical areas (e.g., in wellhead protection zones or aquifer protection overlay districts);
- Encourage infill development within areas serviced by adequate sewer systems.

Once a septic system design has been approved by DES, on-going field inspections by state and sometimes local inspectors verify that systems are constructed and installed as designed. Implementing municipal inspection and enforcement will help ensure the system performs as intended and contamination of ground water is minimized.

Alternative/Innovative Septic Systems
A conventional septic system consists of a septic tank and a subsurface wastewater infiltration system. These systems are designed to receive and pre-treat domestic wastewater with anaerobic digestion processes. The effluent is then discharged into a drain field where aerobic treatment processes continue before it ultimately infiltrates to the ground water.

[29] National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

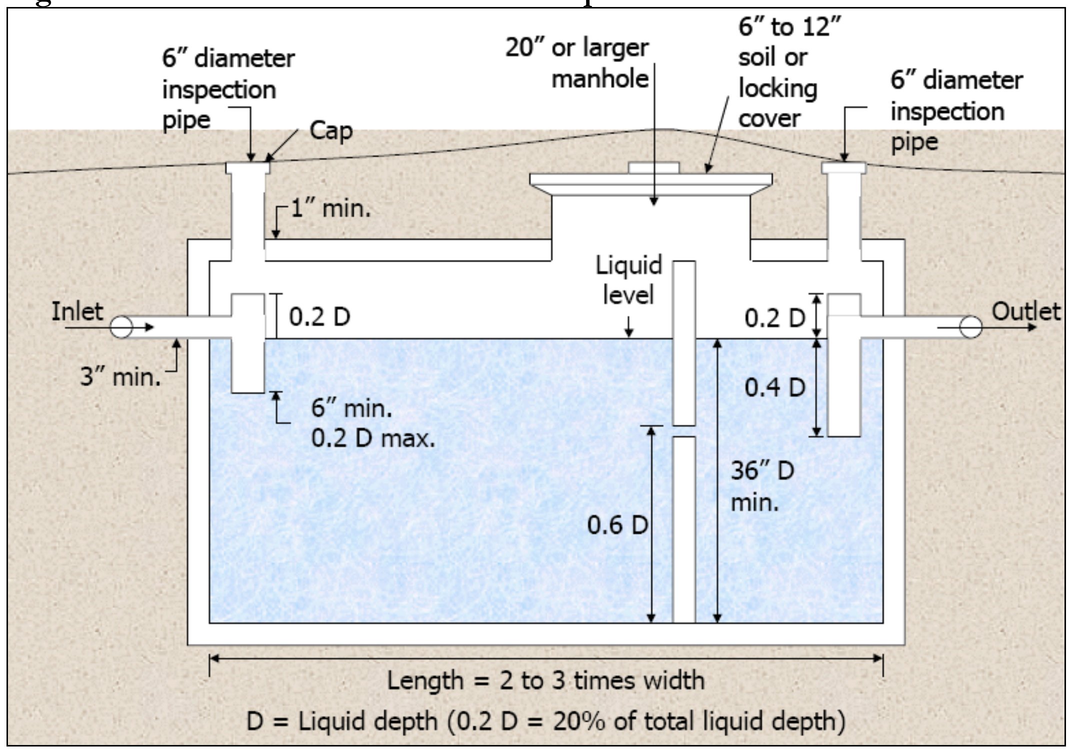
Alternative, or innovative, systems are gaining popularity in areas that may not be suitable for conventional systems. The DES *Approved Technologies for Septic Systems* fact sheet provides an overview of innovative systems that have been approved in the past http://www.des.state.nh.us/factsheets/ssb/ssb-12.htm. The innovative systems feature components and methods designed to promote degradation and/or treatment of wastes through biological processes, oxidation/reduction reactions, filtration, evapotranspiration, and other processes. Examples of innovative systems include mound systems, fixed-film contact units, wetlands, aerobic treatment units "package plants", low-pressure drip applications, and cluster systems. There are many resources available to provide site and design considerations for these systems and this Guidebook does not go into details on each of these. However, the Resources section lists several sites for additional information. Additionally, all innovative septic system proposals must meet with DES approval prior to installation. Contact the DES Subsurface Systems Bureau for more information http://www.des.state.nh.us/SSB/.

Regardless of the type of septic system being used, either conventional, innovative, or a combination, all systems require appropriate design, installation, and maintenance to function properly. The type of maintenance needed depends on the type of system being used and should be matched to those standards. Design, operation, and maintenance information for septic systems can be found in the *Design Manual: Onsite Wastewater Treatment and Disposal Systems* (USEPA, 1980), the *Onsite Wastewater Treatment System Manual* (USEPA, 2002a) and the *Draft Onsite Wastewater System Management Handbook* (USEPA, 2002b).

Septic Tank BMPs

Septic tanks are designed to be watertight and have a detention time between 24 to 48 hours. They are the first phase in treating wastewater on-site. In order to ensure the entire system functions properly, the following septic tank BMPs should be followed:

Figure 17. Illustration of a Conventional Septic Tank



Source: National Management Measures to Control Nonpoint Source Pollution from Urban Areas

- Septic tanks should be inspected annually and serviced/pumped every 3-5 years for the average household. Business septic tanks should be serviced more frequently depending on the capacity of the tank and frequency of use.
- Know the location of your septic tank and effluent disposal.
- Do not operate heavy equipment over the tank to prevent settling or cracking unless designed to accommodate the vehicular wheel loading.
- Keep toxic materials such as paint thinner, pesticides, or chlorine out of your system. These chemicals may kill the necessary bacteria in the tank.
- Do not use septic tank additives. They may cause harm by killing essential bacteria.
- Avoid putting food waste and grease into the system or using a garbage disposal. Food waste will not only fill your septic tank rapidly and require more frequent pumping, but could also float and could eventually clog the tank and effluent disposal system.
- Minimize the use of detergents and bleaches; use alternative cleaning products such as baking soda, borax, or non-chlorine scouring powders. Many cleaning products such as toilet bowl cleaners contain chlorine and strong acids that will kill the necessary bacteria in the septic system. (Normal household use of chlorine bleach in laundries is allowable.)
- Schedule "high volume" water use evenly through the week to minimize peak flow discharges and optimize (extend) the periods of low flow and particle settlement.

Septic Field BMPs

A tank alone is not adequate for treating wastewater. The tank, which settles waste solids, needs to be tied into additional treatment components of a leach field that can vary in type. Design of a leach field should incorporate site features such as soil type, depth to water table, and slope. Additional regulations and design standards can be found by contacting the DES Subsurface Systems Bureau. The following BMPs will help protect the entire system from failing:

Raw sewage in a septic field from a failing system

- Do not operate heavy equipment over the area used for soil absorption to prevent compaction of the soil structure and system clogging. Heavy equipment may also crush the pipes or conveyance system in the leach field.
- Vegetation should be restricted to grasses or flowers. Trees or shrubbery should be immediately removed from effluent disposal systems.
- Keep bulky items such as disposable diapers, sanitary pads, cigarettes, or paper towels out of the system. These will clog the leaching system.
- Repair leaking fixtures promptly; use water-reducing fixtures wherever possible to reduce the amount of water the system must treat. Refer to DES for information on water conservation http://www.des.state.nh.us/h2o_conservation.htm.

Road Maintenance BMPs

New Hampshire seasons require a diversity of road maintenance techniques. During the summer months, vegetation along the roadsides will be mown and road improvements will be underway. Fall brings leaf litter and challenges to keep the stormwater systems clear to prevent flooding and wash-outs. The winter months necessitate snow and ice removal to ensure safe vehicle passage. This section lists BMPs that minimize potential impacts of infrastructure upkeep and maintenance throughout the seasons. The following BMPs highlight specific focus areas to decrease the potential for chemical contamination in ground water:

- Landscape with natural vegetation
- Reduce chemical applications
- Define restricted application areas
- If chemical applications are necessary, develop seasonal maintenance schedules to minimize their use
- Provide proper training to the Department of Public Works (DPW) staff about chemical application procedures
- Follow the packaging guidelines for proper storage and application of all chemicals

Pesticides and Herbicides

Following recommended timing and volume application instructions protects our water resources. Chemicals applied too soon before a rain storm may remobilize or leach and consequently adversely impact ground or surface water. Over-application of pesticides and herbicides may cause the excess chemicals to infiltrate and mix with ground waters or flow into surface waters. New Hampshire requires licensing for all commercial pesticide applicators. Specific information about the licensing and Pesticide Safety Education Program can be found at http://extension.unh.edu/Agric/AGPMP/PATLandC.htm. Integrated pest management (IPM) techniques should be utilized to decrease the use of pesticides and herbicides throughout the communities but especially within the direct aquifer recharge area. See the Lawn and Landscaping section in the Residential chapter (pg. 81) for more information on IPM.

Fertilizers

Improper application of fertilizers along roadsides can result in the excess nutrients being transported to surface waters or mixing with ground water. Use of native vegetation should be maximized to improve survival rates and negate the need for fertilizer once it is established.

Road De-icing

Application of salt (sodium chloride) on roads, parking lots, driveways, and sidewalks has become an expected way of life during a New Hampshire winter. Subsequently, plowing and stockpiling snow from the salted roads and parking lots gathers and accumulates pollutants trapped in the snow such as salt, oil, gas, metals, and particulates. Runoff generated from the melting of snow or ice that has been treated with salts or other chemicals can be very damaging, especially from snow stockpile areas. For example, the buildup of salts along roadsides over the course of a winter can damage and reduce the effectiveness of structural infiltration controls such as vegetative filter strips and grass-lined channels. Salt in surface or ground water can adversely affect water quality and damage wetlands (e.g. I-93 Widening Study by EPA and NHDOT). The trade-off for passable, safe roadways is the runoff and infiltration of accumulated pollutants from treated roads and parking lots. In order to minimize these impacts, the following BMPs have been used to provide environmental as well as economic benefits.

Alternate de-icing materials

Over the years, many states have investigated alternatives to conventional de-icing materials. Some of these alternative chemicals include liquid calcium magnesium acetate (CMA), liquid calcium chloride, liquid magnesium chloride, and liquid potassium acetate. Research has found that there are advantages and disadvantages with these chemicals compared to salt, as shown in Table 9. In general, costs tend to be much higher for alternative de-icing materials. However, use of calcium magnesium acetate or sand in sensitive areas will decrease the potential for chloride contamination. On the other hand, acetates have pollution potential as well. Further research needs to be done before widespread use of these alternatives is feasible. In order to make the best cost/benefit choice of material to use, sensitive areas such as wetlands, surface waters, direct aquifer recharge areas and public water supply protection areas should be identified, mapped, and made known to personnel in public works.

Table 9. Advantages and Disadvantages of Road Salt and Alternative De-icing Chemicals

Type	Advantages	Disadvantages
Road Salt	▪ Low cost ($30-40/ton) ▪ Readily available	▪ Negative impact on the environment ▪ Corrosiveness
Alternative deicing chemicals	▪ Reduced corrosivity ▪ Reduced impact on the environment ▪ CaCl2 can be used in very low temperatures (-20ºF)	▪ Higher cost (from several hundred dollars per ton to several thousand per ton) ▪ CMA starts to act at a slower rate than salt

Source: National Management Measures to Control Nonpoint Source Pollution from Urban Areas

De-icing techniques

Technology has enabled public works departments and plow crews to have more control of salting and sanding application methods and timing than ever before. Many trucks are equipped with ground-speed controllers and sensors to help applicators determine precise road conditions. The applicators can then regulate location, amount, and timing to maximize the effectiveness of salt application. If this technology isn't available, applicators often use prior experience and their knowledge of the roads to determine when and where to salt and plow. Providing maps of levels of service for all the roadways in a service area to public works and the applicators can assist them with making road ice control decisions. For example, on lesser traveled, two-lane roads, salt can be applied in a 4 to 8 foot wide strip along the centerline. This minimizes salt waste as well as runoff potential.

Watch the cars traveling the road to look for signs that the amount of salt used is adequate. Salt should be given a chance to work before plowing. When slush fans out behind cars like water, the salt is still working. Plow after the slush has started to stiffen, at which point the salt is no longer effective. At the end of the season, salt and sand should be swept and removed from the roadways and parking lots to minimize additional pollutant-laden runoff.

Road plowing and de-icing

With the advent of new technology, anti-icing operations are growing in popularity and feasibility. Anti-icing operations are performed before a storm starts to prevent snow or ice from accumulating on road surfaces. Successful anti-icing strategies reduce the amount of chemicals and abrasives needed to keep roads clear. This is an important point in that reduced chemicals lead to reduced environmental impacts and therefore, greater protection for the aquifer. Anti-icing operations typically use the same chemicals used for de-icing, but in different forms and amounts. For example, using a brine solution by pre-wetting de-icing salt is effective and results in fewer handling problems. Timing and up-to-date road conditions are critical for anti-icing operations. Many states have adopted the use of Roadway Weather Information Systems (RWIS), which report road conditions through pavement sensors that monitor pavement temperatures and the amount of anti-icing materials present on the pavement. For states with a high incidence of storms, the RWIS has shown to be cost effective when compared to the cost of labor and materials for conventional de-icing and snow removal.

Snow plowing and stockpiling

Snow plowing and storage areas should take into consideration the runoff design of the property, protection of existing water treatment BMPs, and landscaping to minimize damage and runoff. Snow should be stored on relatively flat, pervious surfaces. Infiltration BMPs that contain forms of pre-treatment or diversions, such as open channel systems, are ideal for snow storage when chlorides aren't a concern, such as in low-density residential areas. In order to decrease the potential for chlorides to reach the ground water, snow from parking lots or roads should not be stockpiled in infiltration BMPs in a direct aquifer recharge area. Additional maintenance may be required to clear interstitial spaces and improve infiltration capacity if infiltration BMPs are used to stockpile snow with de-icing sand and debris.

Snow storage must not be within a sanitary radius (typically between 75 and 400 ft from the well) of a community water supply well or within 100 feet of surface waters or wetlands.[30] Do not store treated snow on a frozen pond surface because the subsequent snowmelt will enter the water body and create a density stratification, which can prevent re-oxygenation in addition to chloride problems. Snow storage is also prohibited within wellhead protection areas if reclassified to a GAA ground water class under RSA 485-C. Silt fence or equivalent barriers should also be installed between snow storage areas and waterbodies to minimize adverse impacts from particulates trapped in the snow and released during melting. The NH DES has recommendations for snow storage on their website http://www.des.nh.gov/factsheets/wmb/wmb-3.htm. The NH Department of Transportation (DOT) has further guidance for winter road maintenance policies on their website http://www.nh.gov/dot/bureaus/highwaymaintenance/documents/WinterMaintSnowandIcePolicy.pdf.

Storage of Salt and Sand

One teaspoon of salt can contaminate five gallons of drinking water. In order to protect the aquifer from salt storage facilities that house many tons of salt, several BMPs are necessary. De-icing compounds should be stored in buildings such as enclosed concrete pads or salt domes. Placing de-icing chemicals in storage buildings minimizes the likelihood of polluting surface and ground waters with contaminated runoff and eliminates the economic loss from chemicals that are dissolved and washed away by precipitation. Where this is not possible, salt piles and chemical containers should be stored on impermeable bituminous pads and covered with a tarp or other waterproof cover. Outdoor salt storage is not allowed within wellhead protection areas (WHPAs) that have been reclassified to GAA through DES under RSA 485-C. There is no inexpensive way to remove sodium chloride from water. Prevention is by far the best way for a municipality to control and minimize water resource pollution from salt contamination. Any internal drainage should be directed to a collection system and treated prior to being routed to a stormwater system. Both salt and sand should be stored at least 100 feet from surface waters or wetlands. Curbing or sediment control devices should be used to keep sand from contributing to sedimentation in runoff. The Seacoast Storm Water Coalition has additional information and guidelines for salt and sand storage at http://www.des.state.nh.us/StormWater/NH_IDDE_SOP.pdf.

Storage facility for salt and sand

[30] Best Management Practices to Control Nonpoint Source Pollution – A Guide for Citizens and Town Officials. The Watershed Assistance Section. New Hampshire Department of Environmental Services. January 2004

Gravel & Sand Pit BMPs

Economically, gravel and sand excavation is an important industry in New Hampshire. The increase in new development throughout New England has placed a high demand on gravel excavation in our region. Additionally, the onset of winter requires sand stockpiles for road maintenance. Since stratified drift aquifer soil types are typically composed of sand and gravel in the direct recharge area, many excavation pits are located in this permeable, sensitive area. Therefore, the potential impacts to ground water could be significant. Contamination from improper chemical storage, truck washes, and petroleum products could directly affect ground water quality in the direct recharge area. Implementation of BMPs would decrease the potential for ground water contamination at excavation sites.

Excavation BMPs

During site excavation, BMPs should be followed to better protect ground water resources. Under RSA 155-E, New Hampshire has authorized local communities to establish regulations for gravel pits. Many BMPs can be tied to these regulations for more comprehensive protection. The following BMPs can be implemented to provide additional protection for ground water resources:

- Maintain an adequate thickness of unexcavated material above the seasonal high water table to act as a filter.
- Maintain buffer strips of natural vegetation between the pit and surface water, wetlands, and depressions in the pit.
- Construct diversions at tops of slopes to divert runoff water away from the slope banks to a stable outlet.
- Install ground water monitoring wells to assess the impact of the excavation on nearby drinking water wells, especially if ground water or surface water is to be withdrawn near the pit area.
- Salting, oiling roads, and fueling activities should be prohibited within excavated areas.

Chemical Storage

Each site should have a spill prevention, control, and clean-up plan available in an accessible location. Personnel should be familiar with the plan and trained in control and containment for all chemicals on-site. Having personnel who are knowledgeable about prevention and control of spill methods minimizes the risks of potentially significant impacts to drinking water contamination. Additional BMPs to protect ground water include:

- Store and handle petroleum products outside the active pit area on a covered, impervious surface. Surround the area with berms, curbs or some other form of effective secondary containment.
- Make a spill kit available for every chemical used on-site and ensure personnel are trained in how to use them.
- Provide storage and handling area for all chemicals used on-site at quantities at or above regulated amounts that can fully contain any spill. Spill control devices such as absorbent snakes and mats should be immediately available at the storage site to limit, control, and clean up any spills.

- Maintain and wash equipment outside the active pit area. Divert and pre-treat or otherwise dispose of properly according to regulation all runoff from the maintenance/washing area prior to allowing it to infiltrate the ground water.
- Identify the location of floor drains, drain outlets, separators, holding tanks, piping systems and underground storage structures. This information should be documented in a SPCC plan and will enable personnel to effectively contain a spill within the smallest possible area.

Contaminated Soil and Water

Hazardous materials and wastes should be properly managed to prevent ground water contamination. If there is spill of hazardous material at a gravel pit there are specific procedures that must be followed to minimize negative effects on the aquifer. Excavation, transport, and disposal of contaminated soil and water, as well as hazardous waste, must be in accordance with the rules and regulations of EPA, the U.S. Department of Transportation, the Department of Toxic Substances Control, and state and local regulatory agencies. NH DES requirements for disposal of contaminated substances can be found in Env-Wm 2603 and Env-Ws 412 and online at www.des.nh.gov/rules/swrules.pdf and www.des.nh.gov/orcb/412.htm.

Reclaimed excavation site after seeded with native grasses – no topsoil was used here

Reclamation BMPs

Reclamation of excavation pits is an important step to re-establish vegetation that provides water quality treatment and enhances infiltration. Spread a minimum depth of 4 inches of stockpiled topsoil over the site in order to re-vegetate the site. Slopes should not exceed 3:1 to facilitate seeding efforts. Further guidance for reclamation can be found by contacting the NH DES Waste Management Division.

Residential BMPs

The daily activities of citizens have the potential to unintentionally pollute the aquifer. The average residential household contains numerous cleaners, solvents, and chemicals that can pose a threat to ground water quality. The risk for an individual household to suffer a spill that significantly and adversely impacts ground water quality is low. However, the cumulative impact of multiple households spilling "small amounts" as a "routine" over an extended period of time can be significant. Educating citizens on the proper use, storage and disposal of these materials is essential to decrease the occurrence of pollutant loading in residential areas. Potential household contributions to ground water pollution include:

- Bacteria, chemical, and nutrient discharges from septic systems [see Septic System BMPs on pg. 67].
- Chemical use, storage, and disposal for various activities (e.g. hobbies, automotive, pools, etc.).
- Chemicals from lawn and garden activities.
- Home maintenance-related chemicals.

Household chemicals collected at the Household Hazardous Waste Collection Day

Household Chemicals

Hazardous products common to households include paints, bleach, cleaners, paint thinner, spot remover, oven cleaner, drain cleaner, furniture polish, and silver polish. Storage, use, and disposal directions on the containers should be closely followed to decrease the incidence of spills and improper disposal. The following are BMPs for handling household chemicals:

- Use biodegradable cleaners and non-toxic chemicals when available.
- Follow the label directions carefully to use or dispose of products.
- Buy only the quantity that you need and use only the recommended amount.
- Properly label wastes and store them safely.
- Dispose of materials at a local household hazardous waste collection [contact DES at 603-271-2047 for dates and locations].
- Hazardous chemicals should NOT be poured on the ground or down the drain, discarded in the trash, buried, or burned.
- Do NOT pour unwanted household chemicals down household drains, storm drains, onto lawns, or driveways. Septic systems cannot properly treat these substances.
- Cars should be washed at commercial car wash facilities when possible.

Recycled batteries and oil at the Household Hazardous Waste Collection Day

Recycling is another viable solution for certain household chemicals, especially used oil and batteries. Automotive service stations often provide used oil and antifreeze recycling facilities for residents to encourage environmentally sound chemical management.

Old or corroded storage tanks or drums containing chemicals such as household heating fuel, hydraulic oil, or diesel are another venue for potential pollution problems. Residential tanks of 1,100 gallons or smaller are not currently regulated by the state but can pose a significant risk to contaminate ground water. Homeowners are required to use DES guidance found in *Best Management Practices for the Installation or Upgrading of On-Premise-Use Heating Oil Tank Facilities* http://www.des.state.nh.us/factsheets/rem/rem-16.htm. Following these BMPs enable access to the state cleanup funds in the event of a spill.

Funding also exists to assist homeowners and farm operators to replace old, rusty tanks and drums with new ones http://www.des.state.nh.us/factsheets/rem/rem-17.htm. NH DES also provides guidance for the closure of underground home heating oil tanks http://www.des.state.nh.us/factsheets/rem/rem-22.htm. These replacement programs enable greater protection of the aquifer from residential chemical spills.

Home heating fuel tanks are unregulated by DES but should be replaced when they become rusty and corroded like the one shown in this picture

Non-Hazardous Substitutes for Common Household Chemicals

Instead of this:	*Use this:*
Ammonia-based cleaner	Vinegar, salt & water mixtures for surface cleaning
Toilet/bathroom cleaner	Baking soda and water
Abrasive cleaners	Rub with half a lemon dipped in borax, rinse
Furniture polish	1 part lemon juice, 2 parts olive/vegetable oil
Silver polish	Soak in boiling water with baking soda, salt, piece of aluminum foil
Disinfectants	½ cup borax in 1 gallon water
Drain cleaner	Plunger, flush with boiling water, ¼ cup baking soda, ¼ cup vinegar
Enamel/oil-based paints	Latex or water-based paints
House plant insecticide	Old dishwater or bar soap mixed with water (spray leaves and rinse)
Flea collars and spray	Gradually add brewer's yeast to pet's diet
Roach killer	Powdered baking soda,
Ant killer	Chili powder at doorsteps hinders entrance
Powdered detergents	Liquid laundry detergents (do not have phosphates)
Chlorine bleach	Borax

Source: The Homeowner's Conservation Guide. 2nd Edition. Ohio-Kentucky-Indiana Regional Council of Governments and the Regional Conservation Council. July 1998.

Lawn & Landscaping

Chemical application on lawns and landscaping can contribute to ground water pollution, particularly in the aquifer direct recharge area. The U.S. Geological Survey (USGS) conducted a nationwide study in 1999 and found a high incidence of insecticides and herbicides in urban streams. Insecticides commonly used in homes, gardens, and commercial areas were found more frequently and in higher concentrations in urban streams than in agricultural streams.[31] Furthermore, research on diazinon indicates that even proper use, according to the label instructions, can result in harmful levels of diazinon in urban streams.[32] These findings suggest modifications to conventional landscaping practices are necessary to protect the aquifer from runoff and recharge in residential and commercial areas.

If fertilizers or pesticides are used at all, the label instructions should be followed at all times. When possible, alternatives such as compost, native plants, and mulch should be employed. Using these non-chemical xerographic alternatives will ultimately decrease

[31] National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

[32] Diazinon Sources in Runoff from the San Francisco Bay Region. Schueler, T., and C. Swann. Watershed Protection Techniques 3(1): 613:616. 2000.

the need for fertilizers, pesticides, or irrigation. The following BMPs can decrease the incidence of pollutant loading from yard practices:

Fertilizing should be done sparingly and only if necessary

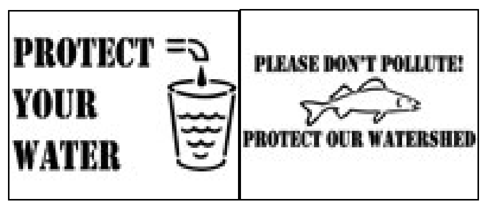
- Conduct soil tests to determine soil nutrient-balance and pH prior to fertilizing [UNH Cooperative Extension 1-877-EXT-GROW].
- Use slow-release fertilizer and follow the recommendations on the container when fertilizing is necessary.
- Maintain a 25 foot fertilizer-free buffer around wetlands and surface water (as per the Shoreland Protection Act).
- Plant natural, native plant species – they generally require less herbicides, fertilizers, or maintenance.
- Increase recharge by planting low-maintenance ground-covers, trees, flowers, and shrubs.
- Maintain a 100 foot vegetated buffer between the lawn and surface water.
- Do NOT use pesticides or herbicides within 25 feet of surface water.
- Read pesticide and herbicide labels carefully and follow all instructions for storage, use, and disposal.

If the yard or landscape has a pest problem, one alternative to conventional pesticides is the Integrated Pest Management (IPM) program. IPM is defined as "a pest control strategy that uses an array of complementary methods: natural predators and parasites, pest-resistant varieties, cultural practices, biological controls, various physical techniques, and pesticides as a last resort."[33] For example, pest-resistant plant varieties, regular monitoring for pests, pesticides, natural predators, and good management practices may be used singularly or in combination to control or prevent particular pests. The Northeastern Regional USDA Pest Management Center website http://neipmc.org/index.cfm contains details about the program and low impact strategies you can use. The Cooperative Extension Service has additional information about IPM programs suitable in New Hampshire http://extension.unh.edu/Agric/AGPMP/PMPIPM.htm.

[33] Wikipedia [http://en.wikipedia.org/wiki/Integrated_Pest_Management]

Education & Outreach
Education programs are essential to inform citizens about the potential dangers of household pollutants to the aquifer. Brochures and hand-outs mailed with water bills are often used as a way to reach residents. Incorporating ground water explanations, use examples, and protection methods in school lessons is another successful way to educate the community. Often the most successful education practice with household chemical use is to focus on point-of-sale outreach. Municipalities can provide literature about environmentally sensitive alternatives to businesses that sell paints, fertilizers, pesticides, and other chemicals.

Whatever type of household chemical that is used, citizens should be encouraged to follow the manufacturer's recommendations for use and disposal of the chemicals. Dates of the 'Household Hazardous Waste' collection days should be posted at trash collection sites and Town Halls. Additional information can include the location and hours of operation of disposal facilities, as well as a list of waste products that are accepted. Belmont, Northfield, and Tilton all collect used oil for incineration at the public works or highway departments.



Stencils that can be painted on curbs near storm drains

Operation and Maintenance

The continued protection of ground water resources is reliant on the success of regulatory controls and implemented BMPs. Proper operation and maintenance of BMPs is essential to ensure each management practice or set of practices continues to function as designed. Maintenance requirements are often overlooked after a BMP is installed. One way to ensure that inspections and maintenance occur is through the development of an operation and maintenance (O&M) plan for each BMP or set of BMPs used. The following elements should be incorporated into the O&M plan:

> A Maryland study evaluated the maintenance of 250 stormwater practices a few years after installation. The researchers found that approximately one-third of the practices were not functioning as designed and most required maintenance. Approximately one-half of the facilities were undergoing sedimentation and many had problems with clogging due to poor maintenance.
>
> **Source:** National Management Measures to Control Nonpoint Source Pollution from Urban Areas

- Clearly and unmistakably identify the responsible party for implementing the O&M plan in the site development plan and any operational permits or approvals;
- Scheduled inspections (based on climate, precipitation, and management practice);
- Scheduled maintenance activities (e.g. removal of sediments, vegetation management);
- Cold climate considerations (e.g. leaf debris, ice build-up, mud season);
- Use of maintenance checklists to systematize and document the inspection process;
- Initial and follow-up monitoring of management practices to establish performance baselines and trends to guide maintenance activities; and
- Establish a bond as part of site plan approval to at least partially insure the cost to fund the O&M plan.

Incorporating maintenance considerations in the BMP design process will often reduce subsequent maintenance costs and repairs and help to avoid failures. For example, the removal of material from sediment traps can be facilitated by designs that allow easy access to accumulated sediments without specialized equipment.

Resources for BMPs

Site Design BMPs

Center for Watershed Protection. "The Benefits of Better Site Design in Residential Subdivisions," article #46 in *The Practice of Watershed Protection*, 2000, editors Thomas R. Schueler and Heather K. Holland, Ellicott City, MD. Available online at www.stormwatercenter.net/Library/Practice/46.pd f or from the Center for Watershed Protection, 8391 Main Street, Ellicott City, MD 21043, (410) 461-8323.

Center for Watershed Protection. *Better Site Design: A Handbook for Changing Development Rules in Your Community*. August 1998. Online at www.cwp.org/index.html. Handbook discusses 22 design principles to address NPS pollution and conserve natural areas. It provides detailed information on the current practice, preferred approach, and current perceptions regarding residential streets and parking areas, residential developments, conservation of natural areas, and open space.

Center for Watershed Protection. *Stormwater BMP Design Supplement for Cold Climates*. 1997. Available from the Center for Watershed Protection, 8391 Main Street, Ellicott City, MD 21043, (410) 461-8323 or online at www.cwp.org/cold-climates.htm.

Center for Watershed Protection. *The Practice of Watershed Protection*, 2000, editors Thomas R. Schueler and Heather K. Holland, Ellicott City, MD. Available online at www.stormwatercenter.net/Library/Practice/46.pdf or from the Center for Watershed Protection, 8391 Main Street, Ellicott City, MD 21043, (410) 461-8323.

Center for Watershed Protection. Stormwater Manager's Resource Center at www.stormwatercenter.net is a website designed for stormwater practitioners, local government officials, and others that need technical assistance on stormwater management issues.

Center for Watershed Protection – The Stormwater Manager's Resource Center has sample O&M checklists available for download from its Web site: http://www.stormwatercenter.net On the homepage, click "Manual Builder" and choose "Construction and Maintenance Checklists" from the pull-down list. There are checklists for the following practices: ponds, infiltration trenches, infiltration basins, bioretention facilities, sand filters, and open channel practices.

Containment Solutions, Inc. Website showing various oil water separators, underground storage tanks, aboveground storage tanks, etc. http://www.containmentsolutions.com/products/oilwater_seps/system.html

DES Drinking Water Source Protection Program. Managing Stormwater as a Valuable Resource: A Message for New Hampshire *Municipalities and Water Suppliers*. DES-R-WD-01-13, September 2001. Online at www.des.nh.gov/dwspp/stormwater.pdf

DES Phase II Website: www.des.nh.gov/stormwater/

DES Fact Sheets:

*Federal Stormwater Permits.*WD-WEB-8, 2002. Available online at: www.des.nh.gov/factsheets/wwt/web-8.htm

*Impacts of Development Upon Stormwater Runoff.*WD-WQE-7, 1996. Available online at: www.des.nh.gov/factsheets/wqe/wqe-7.htm

DES. *Comprehensive Shoreland Protection Act*. Available at: www.des.nh.gov/cspa/

DES. *Best Management Practices for Urban Stormwater Runoff.* R-WSPCD-95-3, January 1996. Copies ($5 each) can be ordered from DES by calling (603) 271-2975.

DES. Drinking Water Source Protection Program. *Managing Stormwater as a Valuable Resource: A Message for New Hampshire Municipalities and Water Suppliers*. DES-R-WD-01-13, September 2001. Online at www.des.nh.gov/dwspp/stormwater.pdf

DES Wetlands Bureau. *Guidebook for Wetlands Permit*. www.des.nh.gov/wetlands/guidebook/

DES Watershed Management Bureau. *Innovative Stormwater Treatment Technologies: Best Management Practices Manual*. DES-WD-02-2, May 2002. Online at: www.des.nh.gov/wmb/was/manual

Maryland Department of Environmental Resources, Prince Georges County. *Low-Impact Development Design Strategies: An Integrated Design Approach*. Programs and Planning Division, June 1999. Available online at www.epa.gov/owow/nps/lidnatl.pdf

Metropolitan Council Environmental Services. *Minnesota Urban Small Sites BMP Manual: Stormwater Best Management Practices for Cold Climates*. Prepared by Barr Engineering Company, 2001. Metropolitan Council Environmental Services, Mears Park Center, 230 E. 5th St., St. Paul, MN 55101.Available at www.metrocouncil.org/environment/Watershed/ BMP/manual.htm

Rockingham County Conservation District and DES. *Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire*. August 1992. Copies ($25 each) can be ordered from DES by calling (603) 271-2975.

South Carolina Department of Health and Environmental Control. *A Citizen's Guide to Stormwater Pond Maintenance in South Carolina*. 2000. Available for download in PDF format at http://www.scdhec.net/eqc/admin/html/eqcpubs.html. The booklet is intended as a guide for homeowners' associations and others responsible for the proper maintenance of storm water ponds. Photos and descriptions of nuisance aquatic plant species are presented in the guide to aid in identifying these species and removing them from ponds.

Terrene Institute. *Nonpoint Source News-Notes*. Online at www.epa.gov/owow/info/NewsNotes

USDA Natural Resources Conservation Service, NH office. *Municipal Guide for Nonpoint Source Pollution*. Fact sheet available by calling (603) 868-7581.

USEPA Office of Water. *Low Impact Development (LID): A Literature Review. Washington DC*. EPA 841-B-00-005, October 2000. Online at: www.epa.gov/owow/nps/lid.pdf

USEPA. Fact sheets on each of the minimum measures and other aspects of the Phase II rule are available on the EPA's website: http://cfpub.epa.gov/npdes/stormwater/swfinal.cfm 16

USEPA. Stormwater Program online at http://cfpub.epa.gov/npdes/home.cfm?program_id=6

Erosion & Sediment Control BMPs

The DES Phase II website address for construction requirements is: www.des.nh.gov/stormwater/construction.htm

DES Fact Sheets:

Fees for Alteration of Terrain Permits. WD-WQE-2, 1997. Available online at www.des.nh.gov/factsheets/wqe/wqe-2.htm

Alteration of Terrain Permits, When Are They Required? WD-WQE-3, 1997. Available online at www.des.nh.gov/factsheets/wqe/wqe-3.htm

Soil Erosion and Sediment Control on Construction Sites. WD-WQE-6, 1996. Available online at www.des.nh.gov/factsheets/wqe/wqe-6.htm

Impacts of Development on Stormwater Runoff. WD-WQE-7, 1996. Available online at www.des.nh.gov/factsheets/wqe/wqe-7.htm

Federal Stormwater Permits. WD-WEB-8, 2002. Available online at www.des.nh.gov/factsheets/wwt/web-8.htm

DES. *Best Management Practices for Urban Stormwater Runoff*.R-WSPCD-95-3, January 1996. Copies ($5.00 each) can be ordered from DES by calling (603) 271-2975.

DES. *Best Management Practices for Construction Site Chemical Control*. 2000. NH Office of State Planning, DES, and NH Department of Agriculture, Markets, and Food. Available at DES.

DES and Rockingham County Conservation District. *Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire*. August 1992.

DES and USDA Soil Conservation Service. *Soil Manual for Site Evaluations in New Hampshire*. 2d Edition, December 1991. Available through DES.

NHDOT Bureau of the Environment. B*est Management Practices for Routine Roadway Maintenance Activities in New Hampshire*. August 2001. Order copies from NHDOT Bureau of the Environment, 7 Hazen Drive, Concord NH 03301 (603) 271-3226.Available online at http://webster.state.nh.us/dot/environment/pdf/BMPManual.pdf

NHDOT Bureau of Construction. *Guidelines for Erosion and Sediment Control and Stormwater Management*. Order from NHDOT Bureau of Construction, 7 Hazen Drive, Concord NH 03301.Available online at http://webster.state.nh.us/dot/business.htm

The Staff Transportation Board of the National Research Council. *Environmental Impact of Construction and Repair Materials on Surface and Ground Waters*. 2000. Non-technical language bulletin explaining how test methods and supporting computer software

can provide answers to questions about the environmental impact of new construction or the repair or rehabilitation of existing highways. Published reports from NCHRP are available from http://www.trb.org.

The Transportation Research Board (TRB) published several studies that investigate the environmental impacts of activities related to transportation infrastructure available at: http://www4.trb.org/trb/onlinepubs.nsf

Best Management Practices for Environmental Issues Related to Highway and Street Maintenance, available in hard copy from the Transportation Research Board's bookstore http://trb.org/bookstore/ for $30.

Highway Deicing: Comparing Salt and Calcium Magnesium Acetate (available electronically at http://trb.org/publications/sr/sr235.html or for $22 from the online bookstore)

Assessing the Impacts of Bridge Deck Runoff Contaminants in Receiving Waters—Volume 1: Final Report, available electronically at http://gulliver.trb.org/publications/nchrp/nchrp_rpt_474v1.pdf

Assessing the Impacts of Bridge Deck Runoff Contaminants in Receiving Waters—Volume 2: Practitioner's Handbook, available at: http://gulliver.trb.org/publications/nchrp/nchrp_rpt_474v2.pdf

Guidelines for the Selection of Snow and Ice Control Materials To Mitigate Environmental Impacts (Draft). Available at http://www.trb.org

Winter Highway Operations (Draft). Available at http://www.trb.org

UNH Technology Transfer Center. *Series of Quick Guides for New Hampshire Towns. A set of pamphlets distributed as a set.* The topics are 1) Culvert Installation and Maintenance, 2) Ditch/Channel Construction and Maintenance,3) Vegetative Erosion & Sediment Control,4) Non-Vegetative Erosion & Sediment Control,5) Cut and Fill Slopes, 6) Beaver Pipe: Construction and Maintenance, 7) Stormwater Inlets and Catch Basins, 8) Mowing and Brush Control, 9) Snow and Ice Control, and 10) Obtaining Permits. Ordering information at www.t2.unh.edu/video_pub/publist.html

USEPA Office of Water. *Stormwater Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices.* EPA 832-R-92-005, September 1992. Online at www.epa.gov/npdes/pubs/owm0307.pdf

USEPA. Information on erosion, sediment, and runoff control from roads, highways and unpaved roads available from the EPA online at www.epa.gov/owow/nps/roadshwys.html

Septic Systems

Architerra Enterprises, Inc. *The Natural Home Building Source.* Alternative residential wastewater treatment systems found at: http://www.thenaturalhome.com/septic.html

DES Fact Sheets:

There are 12 DES fact sheets related to septic systems. They are available on the web at www.des.nh.gov/sub.htm and www.des.nh.gov/factsheets/bb/bb-11.htm or call (603) 271-2975.

DES. *You and Your Septic, a brochure*. Available if you call (603) 271-2975.

National Small Flows Clearinghouse Environmental Technology Initiative. Provides support for localities in wastewater treatment systems. Information on alternative technologies is available at: http://www.nesc.wvu.edu/nsfc/nsfc_ETI.htm and at http://www.epa.gov/owm/decent/treat.htm. An extensive list of links to public and private sector OWTS resources can be found at http://centreforwaterresourcesstudies.dal.ca/cwrs/onsite/info.htm. For information on loading rates, design, and performance capabilities for conventional and alternative treatment systems, refer to the Onsite Wastewater Treatment System Manual (USEPA, 2002a). Table 6.9 provides a summary of capital and maintenance cost data for selected OWTS technologies.

Road Maintenance BMPs

Center for Watershed Protection. *Influence of Snowmelt Dynamics on Stormwater Runoff Quality*. Gary L. Oberts, Metropolitan Council, St. Paul, MN. Article #3 in *The Practice of Watershed Protection*, 2000, Thomas R. Shueler and Heather K. Holland, eds. Ellicott City, MD. Available online at www.stormwatercenter.net under "Publications" or from the Center for Watershed Protection, 8391 Main Street, Ellicott City, MD 21043, (410) 461-8323.

DES Fact Sheets:

Snow Disposal Guidelines.WMB-3, 1992. Available online at www.des.nh.gov/factsheets/wmb/wmb-3.htm

Road Salt and Water Quality.WMB-4, 1996. Available online at www.des.nh.gov/factsheets/wmb/wmb-4.htm

Environment Canada. *Assessment Report – Road Salts*. www.ec.gc.ca/substances/ese/eng/psap/final/roadsalts.cfm

Federal Highway Administration. *Manual of Practice for an Effective Anti-Icing Program: A Guide For Highway Winter Maintenance Personnel*. 1996. A guide for maintenance personnel in developing a systematic and efficient practice for maintaining roads in the best condition possible during a winter storm. It describes the factors that should be understood and addresses the specific needs of the site or region. It focuses on weather information and materials and methods that will best address site conditions such as level of service, highway agency resources, climatological conditions, and traffic. The manual can be downloaded in HTML format from: http://www.fhwa.dot.gov/reports/mopeap/mop0296a.htm.

Michigan Department of Transportation (1993) conducted a detailed study on the environmental effects and costs of using several deicing products, including salt, calcium magnesium acetate, an agricultural byproduct, a magnesium chloride product, calcium chloride, a type of concrete pavement, and sand. The study can be accessed at: http://www.michigan.gov/documents/toc-deice_51451_7.pdf More information on alternative deicers can be found at http://www.betterroads.com/articles/prod801.htm, http://www.forester.net/sw_0106_deicing.html, and http://www.wsdot.wa.gov/partners/pns/htm/resources.htm.

UNH Technology Transfer Center. *Pros and Cons of Sand on Ice and Snowpack*. Fall 2001 newsletter, online at www.t2.unh.edu/fall01/pg6-7.html

UNH. The following publications are available from UNH Technology Transfer Center, 33 College Road, Durham NH 03824. (603) 862-2826.They are listed at www.t2.unh.edu/video_pub/publist.html

Calcium Chloride Package. A package of articles and pamphlets explaining the benefits of deicing with calcium chloride.

Deicing, Anti-Icing, and Chemical Alternatives. Informative sheet discusses the benefits of anti-icing, deicing, prewetting, and liquid chemical alternatives.

Road Salt and Water Quality. Environmental fact sheet discusses road salt management, alternatives to road salt, and the DOT Reduced Salt Pilot Program.

The Salt Storage Handbook. A practical guide for handling deicing salt. Published by the Salt Institute.

Series of Quick Guides for New Hampshire Towns. A set of pamphlets developed by the UNH Technology Transfer Center and distributed as a set. Topic #9 is Snow and Ice Control.

The Snowfighter's Handbook. A practical guide for snow and ice control before, during, and after a storm. Published by the Salt Institute.

Winter Operations Snow Removal and Ice Control Policy. From NHDOT, describes general policies, maintenance techniques, and equipment for snow and ice management.

USEPA. *Minimizing Effects from Highway Deicing*. Storm Water Management Fact Sheet, EPA 832-F-99-016, September 1999. Available online at www.epa.gov/owmitnet/mtb/ice.pdf

Washington State Department of Transportation. (2002) The Pacific Northwest Snowfighter's Association Web site: http://www.wsdot.wa.gov/partners/pns/ provides resources pertaining to deicing and anti-icing products and practices, such as a list of approved products, deicing specifications, a fact sheet on magnesium chloride, and testing methods and protocols for deicing products.

Sand & Gravel Pit BMPs

DES Fact Sheets:

State Alteration of Terrain Permit Requirements for Sand & Gravel Pits. WD-WQE-1, 1997. Available online at www.des.nh.gov/factsheets/wqe/wqe-1.htm

Alteration of Terrain Permits (Site Specific) When Are They Required? WD-WQE-3, 1997. Available online at www.des.nh.gov/factsheets/wqe/wqe-3.htm

NH Office of State Planning, DES, and NH Department of Agriculture, Markets, and Food. *Best Management Practices for Construction Site Chemical Control.* 2000. Available at DES.

NH Office of State Planning. *RSA 155-E: Earth Excavations.*1998. A 20-minute video on gravel pit regulation. This video provides a basic understanding of RSA 155-E, the law governing earth excavations and covers the operational and reclamation standards and common questions and answers. Available for $12 from the Municipal and Regional Planning Assistance section of OSP. For more information see www.state.nh.us/osp/publications/start.html or contact OSP, 57 Regional Drive, Concord, NH 03301 (603) 271-2155.

Southwest Regional Planning Commission. *The Law Governing Earth Excavations.* A manual about state statutes governing gravel pits and local regulatory options, including recommended procedures for addressing gravel pits locally, a model ordinance, application checklist, and sample application form. Contact the Southwest Regional Planning Commission at 20 Central Square, 2nd Floor, Keene, NH 03431, (603) 357-0557, www.swrpc.org/library/index.html

USDA NRCS NH Office. *Vegetating New Hampshire Sand and Gravel Pits.* Technical Note PM-NH-21, April 1991; Revised April 2000. Provides recommendations for controlling erosion at sand and gravel pits. Online at www.nh.nrcs.usda.gov/news/publications.html listed under "Conservation Planning and Practices."

USDA NRCS NH Office. *Gravel Pit and Other Sandy and Droughty Site Renovation Trials and Experiences in New Hampshire.* Technical Note PM-NH-26, May 1991, Revised April 2000. Available online at www.nh.nrcs.usda.gov/news/publications.html listed as "Gravel Pit Renovation."

Underground & Aboveground Storage Tank BMPs

DES Fact Sheets:

Fact sheets related to hazardous wastes can be found at www.des.nh.gov/hw.htm

Fact sheets related to oil can be found at www.des.nh.gov/oil.htm

Consumer Tips for the Safe Management of Gasoline. CO-10, 1998. Available online at www.des.nh.gov/factsheets/co/co-10.htm

MtBE in Drinking Water.WD-WSEB-3-19, 2000. Available online at www.des.nh.gov/factsheets/ws/ws-3-19.htm

DES Storage Tank Facilities and Contaminated Sites Databases: www.des.nh.gov/asp/onestop/des_menu.asp

DES publications available from the DES Public Information Center by calling (603) 271-2975 or writing pip@des.nh.gov

List of Underground Storage Tanks (USTs) - CD-ROM. $30, No Code #.

List of Leaking Underground Storage Tank (LUST) Sites. $25, No Code #.

List of All Contaminated Groundwater Sites. $25, No Code #.

Case Studies and Evaluations of Remedial Technologies at Leaking Underground Storage Tank Sites in NH, R-WSPCD-95-5.

Summary Requirements for Management of Used Oil Being Recycled (as provided in New Hampshire's Hazardous Waste Rules Env-Ws 100-1000). Available online at www.des.nh.gov/hwcs/requirements.pdf

NH Office of State Planning, DES, and NH Department of Agriculture, Markets, and Food. *Best Management Practices for Construction Site Chemical Control*. 2000. Available at DES; call (603) 271-2975.

USEPA. *Catalog of EPA Materials on Underground Storage Tanks*. EPA-510-B-00-001, January 2000.This updated, revised booklet provides an annotated list of UST materials and includes ordering information. Many of the informational leaflets, booklets, videos, and software items listed are designed to provide UST owners and operators with information to help them comply with the federal UST requirements. Available online at www.epa.gov/swerust1/pubs/index.htm.

USEPA. *Model Underground Storage Tank Environmental Results Program Workbook*. EPA 510-R-04-003. 2004.

Commercial & Industrial BMPs

US Department of the Interior, National Park Service. *Understanding Spill Prevention Control and Countermeasure (SPCC) Plans.* Concession Environmental Management Program, Denver, CO. February 2003. http://www.planning.nps.gov/concessions/document/CoEMPGuidanceSPCC.pdf

Household BMPs

Center for Watershed Protection. "Toward a Low Input Lawn," article #130 in *The Practice of Watershed Protection*, 2000, editors Thomas R. Schueler and Heather K. Holland, Ellicott City, MD. Available online at www.stormwatercenter.net under "Publications" or from the Center for Watershed Protection, 8391 Main Street, Ellicott City, MD 21043, (410) 461-8323

Connecticut River Joint Commissions. *A Homeowner's Guide to Non-point Source Water Pollution in the Connecticut River Valley*. 1994. Available online at www.crjc.org/pdffiles/homeguide.pdf or at PO Box 1182, Charlestown, NH 03603 (603) 826-4800. This booklet offers useful hints for homeowners on managing runoff, caring for septic systems, conserving water, and dealing with yard waste, bugs, and chemicals. It also offers alternatives for toxic household products and a directory of sources of help.

DES Household Hazardous Waste Section. *Hazardous Materials in Your Home*. Online at www.des.nh.gov/pdf/hmiyhome.pdf or call (603) 271-2047

DES Clean Cars Program and Energy Star Program. Online at www.des.nh.gov/ard/clean_cars.htm For more information contact the Air Resources Division at (603) 271-6284.

DES. The schedule for household hazardous waste collection days in New Hampshire is posted on the DES website at www.des.nh.gov/hhw/hhwevent.htm

DES Fact Sheets:

Proper Lawn Care in the Protected Shoreland, the Comprehensive Shoreland Protection Act. SP-2 (1997). www.des.nh.gov/factsheets/sp/sp-2.htm

Municipal Composting of Yard Waste. DES Fact Sheet WMD-SW-3, 1998 www.des.nh.gov/factsheets/sw/sw-3.htm

DES. "Native and Naturalized Shoreland Plantings for New Hampshire." An appendix in *Best Management Practices for New Hampshire Marinas: Guidelines for Environmentally Proactive Marinas*. (1995, revised in 2001) www.des.nh.gov/nhppp/marinas2.pdf

Hillsborough County Conservation District and the USDA Natural Resources Conservation Service Greenscaping *(Reducing Pollution in Your Backyard)*. Chappell Professional Center, 468 Route 13 South, Milford, NH 03055 or call (603) 673-2409.

The Hubbard Brook Research Foundation. *Acid Rain Revisited: Advances in Scientific Understanding Since the Passage of the 1970 Clean Air Act Amendments*. Online at www.hbrook.sr.unh.edu/hbfound/hbfound.htm or contact the Foundation at 6 Sargent Place, Hanover, NH 03755, (603) 653-0390.

Massachusetts Department of Food and Agriculture. *A Homeowner's Guide to Environmentally Sound Lawncare: Maintaining A Healthy Lawn the IPM Way*. July 1997. Online at www.state.ma.us/dfa/pesticides/publications

Massachusetts Department of Food and Agriculture. *Pesticide Storage and Handling Practices for Homes.* July 1997. Online at www.state.ma.us/dfa/pesticides/publications

University of Wisconsin Cooperative Extension. *Pet Waste and Water Quality* fact sheet, GWQ006, DNR WT-534-99, R-11-99-10M-20-S. Online at http://clean-water.uwex.edu/pubs/sheets/index.html Also available from Extension Publications, 630 W. Mifflin St., Madison, WI 53703 (608) 262-3346.

USDA Natural Resource Conservation Service. "Lawn and Garden Care" website. Information includes proper fertilizer use and alternatives to pesticides and chemicals by insect pests www.nrcs.usda.gov/feature/highlights/homegarden/lawn.html

USEPA Office of Water. *Pointer No. 10: Managing Nonpoint Source Pollution from Households.* EPA841-F-96-004J. Online at www.epa.gov/OWOW/NPS/facts/point10.htm

USEPA. *Do's & Don'ts Around the Home.* This EPA article has text on household chemicals, landscaping and gardening, septic systems, water conservation, other areas where you can make a difference (e.g., cleaning up pet waste), and community action. Online at www.epa.gov/OWOW/NPS/dosdont.html

USEPA. *Healthy Lawn Healthy Environment: Caring for Your Lawn in an Environmentally Friendly Way.* Available through the NH Department of Agriculture, Markets & Food Division of Pesticide Control, call (603) 271-3550

USEPA. Pet waste poster at EPA's website: www.epa.gov/region01/eco/lis/posters/pet.html

Vitousek, Peter M., Chair, John Aber, Robert W. Howarth, Gene E. Likens, Pamela A. Matson, David W. Schindler, William H. Schlesinger, and G. David Tilman. *Issues in Ecology – Human Alteration of the Global Nitrogen Cycle: Causes and Consequences.* Full report published in Ecological Applications, Volume 7, August 1997. Summary available online at http://esa.sdsc.edu/tilman.htm

Glossary

The following are commonly used technical terms related to aquifer protection and Best Management Practices. The glossary is not intended as a source for precise scientific definitions or for specific legal interpretations.

AESTHETICS: Pleasing in appearance or effect. A subjective determination based on an individual's preference.

ALLUVIAL: Pertaining to material that is transported and deposited by running water.

AQUIFER: A geologic formation or structure that transmits water in sufficient quantity to supply the needs for water development.

ASSOCIATION: A legal entity operating under recorded land agreements or contracts through which each unit owner in a conservation development is a member and each dwelling unit is subject to charges for a proportionate share of the expenses of the organization's activities.

BACKGROUND LEVEL: Naturally occurring concentration of a substance or chemical element dissolved in surface or ground water.

BACKGROUND LOAD: Naturally occurring levels or concentrations of pollutants and non-pollutants in a stream prior to watershed development.

BANKFULL DISCHARGE: A flow condition where streamflow completely fills the stream channel up to the top of the bank. In an undisturbed watershed, the discharge condition occurs on average every 1.5 to 2 years and controls the shape and form of natural channels.

BASEFLOW: The portion of stream flow that is not due to storm runoff, and is supported by ground water seepage into a channel.

BEDROCK: The solid rock underlying unconsolidated surface material (as soil). NH bedrock types include granitic and metamorphic rock.

BEST MANAGEMENT PRACTICES (BMPs): Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the risk of contamination of ground water.

BUFFER: Preservation of natural areas adjacent to channels, wetlands, or lakes for purpose of stabilizing banks and reducing contaminants in stormwater that flows to such areas.

CATCH BASIN: A conventional structure for the capture of stormwater in streets and parking areas. It typically includes an inlet, sump, and outlet and provides minimal removal of suspended solids. In most cases a hood also is included to separate oil and grease from the stormwater.

CONSERVATION DEVELOPMENT: A contiguous area of land to be planned and developed as a single entity, in which buildings are accommodated under more flexible standards, such as building arrangements and setbacks, than those that would normally apply under conventional regulations, allowing for the flexible grouping of structures in order to conserve open space and existing natural resources.

CONSERVATION EASEMENT: A legal interest in land which restricts development and other uses of the property in perpetuity for the public purpose of preserving the rural, open, natural or agricultural qualities of the property.

CONTAMINANTS: Substances that become entrained in stormwater and degrade water quality. Sources include process waste, raw materials, toxic pollutants, hazardous substances, or oil and grease.

CONTOUR: 1) An imaginary line on the surface of the earth connecting points of the same elevation. 2) A line drawn on a map connecting point of the same elevation.

CUT AND FILL: Process of earth moving by excavating part of an area and using the excavating material for adjacent embankments or fill areas.

DETENTION TIME: The amount of time a parcel of water actually is present in an impoundment. Theoretical detention time for a runoff event is the average time parcels of water reside in the basin over the period of release from the BMP.

DISCHARGE: Water or effluent released to a receiving waterbody.

DRAINAGE AREA: Land area from which water flows into a stream or lake (see also watershed).

DRIFT: Sediments deposited by glaciers that repeatedly advanced and retreated across the North American landscape until about 10,000 years ago.

EFFLUENT: Solid, liquid, or gaseous wastes that enter the environment as a byproduct of man-oriented processes.

ERODIBLE: Susceptible to erosion with reference to soil.

EROSION: Weathering of soil by running water, wind, or ice.

EROSION AND SEDIMENT CONTROL PLAN: A plan for the control of erosion and sediment resulting from a land-disturbing activity.

EVAPORATION: The process by which a liquid is changed to a vapor or gas.

EXFILTRATION: The downward movement of runoff through the bottom of an infiltration BMP into the soil layer.

FERTILIZER: Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply elements essential to plant growth.

FINISHED GRADE: The final grade or elevation of the ground surface forming the proposed design.

FIRST FLUSH: The run-off at the very beginning of a storm event carrying pollutants, including suspended sediments, at concentrations typically higher than at the middle or end of a storm.

FLOATABLES: Materials in stormwater or sanitary flows that float to the surface.

FOREBAY: An extra storage area provided near an inlet of a BMP to trap incoming sediments before they accumulate in a water impoundment BMP.

GPM (GALLONS PER MINUTE): The unit of measure for discharge determining how many gallons of a liquid are released through a pipe in one minute.

GROUND WATER: Subsurface water occupying the zone of saturation. In a strict sense, the term is applied only to water below the water table.

HABITAT: The environment in which the life needs of a plant or animal organism, population, or community are supplied.

HEAVY METALS: Any element with an atomic weight of greater than twenty (20), such as copper, cadmium, lead, selenium, arsenic, mercury, and chromium. Heavy metals are typically found in minimal quantities in stormwater, but can be toxic at trace amounts.

HERBICIDE: A chemical substance designed to kill or inhibit the growth of plants, especially weeds.

HYDRAULIC GRADIENT: A measurement used in ground water science to calculate directions and rates of ground water flow. In a stratified drift aquifer (unconfined), the hydraulic gradient is the slope of the water table between any two points. The hydraulic gradient is a ratio of the difference in vertical elevation between two places on the water table and their horizontal difference apart.

INFILTRATION: The gradual movement of water (from precipitation, irrigation, or runoff) into the soil.

IMPERVIOUS: The property of a material that does not allow the infiltration of water into and through the pores of the soil, such as pavement or rooftops.

IMPOUNDMENT: The collection and confinement of water as in an artificial reservoir or dam.

INLET: An entrance into a ditch, storm sewer, or other waterway.

INTEGRATED PEST MANAGEMENT (IPM): A pest control strategy that uses an array of complementary methods: natural predators and parasites, pest-resistant varieties, cultural practices, biological controls, various physical techniques, and pesticides as a last resort.

LEACHATE: Liquids that have percolated through a soil and that contain a substance(s) in solution or suspension.

LEACHING: The removal or dissolving of a compound from a soil, waste, or other material into the surrounding fluid (water).

NONPOINT SOURCE (NPS) POLLUTION: Pollution of surface or ground water supplies originating from land use activities and/or the atmosphere, having no well-defined point of entry.

NUTRIENTS: Elements, or compounds, essential as raw materials for organism growth and development, such as carbon, nitrogen, phosphorus.

OIL AND GREASE: This includes hydrocarbons, fatty acids, soaps, fats, waxes, and oils.

OIL/WATER SEPARATOR: A device installed, usually at the entrance to a drain, which removes oil and grease from water flows entering the drain.

OPEN SPACE: An area that is intended to provide light and air. Open space may include, but is not limited to, meadows, wooded areas, and waterbodies.

PEAK DISCHARGE: The maximum instantaneous flow from a given storm condition at a specific location.

PERCOLATION: The downward movement of water through soil, especially the downward flow of water in saturated or nearly saturated soil.

PERMEABILITY: The quality of a soil horizon that enables water or air to move through it. The permeability of a soil may be limited by the presence of one nearly impermeable horizon even though the others are permeable.

PERVIOUS SURFACE: A porous surface, which allows for the infiltration of water. This typically implies unaltered, natural surfaces without pavement or development.

PESTICIDE: Any chemical agent or compound used for control of plant or animal pests. Pesticides include insecticides, herbicides, fungicides, nematocides, and rodenticides.

POLLUTANT: Anything introduced into the environment (soil, water, or air) that degrades the usefulness of a resource.

POROSITY: The volume of open spaces in rock or soil; if pores are large and abundant more water can be stored.

PRECIPITATION: Water that falls to the earth in the form of rain, snow, hail, or sleet.

PRETREATMENT: Techniques employed in stormwater BMPs to provide removal (storage, filtration, etc.) and help trap coarse materials before they enter the system.

RECHARGE: Addition of water the saturated zone of an aquifer.

REGULATED CONTAMINANT: Any physical, chemical, biological, radiological substance or other matter, other than naturally occurring substances at naturally occurring (background) levels, in water which adversely affects human health or the environment.

RETENTION: The holding of runoff in a basin without release except by means of evaporation, infiltration, or emergency bypass.

RETROFIT: The installation of a new BMP or improvement of an existing BMP in an already developed area.

RIPARIAN: A relatively narrow strip of land that borders a stream or river, and often coincides with the maximum water surface elevation of the 100 year storm.

RISER: The inlet portions of a drop inlet spillway that extend vertically up from the pipe conduit barrel to the water surface.

RUNOFF: Precipitation, snowmelt, or irrigation that flows over the land, eventually making its way to surface water (such as a stream, river, pond).

SATURATED ZONE: The subsurface locations where all the available pores and spaces are filled with water.

SEDIMENT: Eroded soil and rock material and plant debris transported and deposited by runoff.

SETBACK: The required distance between a building and a lot line, street right-of-way, pavement, stream or riverbank, wetland or other delineated site feature.

SHEET FLOW: Water, usually storm runoff, flowing in a thin layer over the ground surface; also called overland flow.

SITE PLANNING: In terms of stormwater management, a preliminary component of a development plan, where the appropriate BMP structures are properly selected and installed.

SLOPE: The degree of deviation of a surface from horizontal, measured in a numerical ratio, percent, or degrees. Expressed as a ratio or percentage, the first number is the vertical distance (rise) and the second is the horizontal distance (run), as 2:1 or 200 percent. Expressed in degrees, it is the angle of the slope from the horizontal plane with a 90-degree slope being vertical (maximum) and 45 degree being a 1:1 slope.

STABILIZATION: The process of establishing an enduring soil cover of vegetation and/or mulch or other ground cover in combination with installing temporary or permanent structures for the purpose of reducing to a minimum the transport of sediment by wind, water, ice or gravity.

STORM DRAIN: An inlet for the capture of stormwater.

STORMWATER: Runoff from a storm event, snowmelt runoff, and surface runoff and drainage.

STRATIFIED DRIFT AQUIFER: A geologic formation of predominantly well-sorted sediment deposited by or in bodies of glacial meltwater, including gravel, sand, silt, or clay, which contains sufficient saturated permeable material to yield significant quantities of water to wells.

STREAMFLOW: Water flowing in a natural channel, above ground.

STRUCTURAL PRACTICES: Soil and water conservation measures, other than vegetation, utilizing the mechanical properties of matter for the purpose of changing the surface of the land or storing, regulating, or disposing of runoff to prevent excessive sediment loss. Including, but not limited to, riprap, sediment basins, dikes, level spreaders, waterways or outlets, diversion, structures, sediment traps, etc.

SUBSTRATE: The natural soil base underlying a BMP.

SURFACE WATER: Inland waters, except ground water, which are on the land surface, such as reservoirs, lakes, rivers, transitional waters, coastal waters and, under some circumstances, territorial waters.

SWALE: A natural depression or wide shallow ditch used to temporarily store, route or filter runoff.

TARGET POLLUTANTS/CONTAMINANTS: The pollutants or contaminants at a specific site that will be removed upon implementation of a BMP.

TOPSOIL: Earthy material used as top-dressing for house lots, ground for large buildings, gardens, road cuts, or similar areas. It has favorable characteristics for production of desired types of vegetation or can be made favorable.

TOTAL SUSPENDED SOLIDS (TSS): Matter suspended in water or stormwater.

TRANSMISSIVITY: The rate at which water is transmitted through a unit width of a water-bearing formation under a unit hydraulic gradient. It is equal to the hydraulic conductivity times the thickness of the formation, and is given in units of distance squared per unit time.

TURBIDITY: Reduced clarity in a body of water caused by suspended matter such as clay, silt, algae, and other material, which causes light to be scattered and absorbed, not transmitted in straight lines through the water.

ULTRA-URBAN: Densely developed urban areas in which little pervious surface exists.

UNDERDRAIN: Plastic pipes with holes drilled through the top, installed on the bottom of an infiltration BMP, or sand filter, which are used to collect and remove excess runoff.

UNSATURATED ZONE: The area just below the ground surface and above the seasonal-high ground water table, which is filled with air.

VACTORING: The act of using a vacuum to remove accumulated sediment and other contaminants from containment areas of stormwater treatment devices.

VEGETATION PRACTICES: Stabilization of erosive or sediment-producing areas by grading and covering the soil with: (a) Permanent seeding; producing long-term vegetation cover or (b) Short-term seeding; producing temporary vegetative cover or (c) Sodding; producing areas covered with a turf of perennial sod-forming grass.

WATERSHED: A geographic area in which all surface water drains into a given stream, lake, wetland, estuary, or ocean.

WATER TABLE: The upper surface or top of the saturated portion of the soil or bedrock layer indicating the uppermost extent of ground water.

WATERWAY: A natural course or constructed channel for the flow of water.

WELL RECHARGE AREA: That portion of an aquifer from which ground water can be diverted to a well (sometimes referred to as area of contribution), and upgradient areas from which water flows naturally into the drawdown area of a well.

WELLHEAD PROTECTION AREA: The surface and subsurface area surrounding a water well or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield.

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Appendix A. Regulatory Checklist

Regulatory Checklist

Regulated Activity	Requirements	Definition
Construction on ≥1 acre site http://www.des.nh.gov/Stormwater/construction.htm	Construction General Permit (CGP)	Construction activity that disturbs one or more acre of land, including that conducted by a municipality.
Ground Water Discharge http://www.des.state.nh.us/dwspp/gwdisch.htm	Ground Water Release Detection Permit	The proposed facility or activity includes a hazardous waste disposal facility, lined solid waste landfill, lined wastewater lagoon, or a facility for processing soil contaminated with petroleum products; or the facility or activity (such as a new solid waste composting operation or an existing outdoor storage facility for deicing chemicals, junk/salvage yard, or snow dump) will be located in a Class GAA wellhead protection area.
	Underground Injection Control Registration for Floor Drains	Non-domestic, non-hazardous wastewater free of "regulated contaminants" and human sanitary wastes, that has been or will be generated as a result of commercial or industrial operations discharged through a floor drain to the ground or surface.
	Temporary Ground Water Discharge Permit	Nonrenewable permit issued for the temporary discharge to the ground or ground water of non-domestic wastewater that has received treatment by best available technology (typically, granular activated carbon) including, but not limited to, the discharge generated from the rehabilitation or redevelopment of a public water supply well or the discharge generated from the dewatering of tank excavations
	Holding Tank Registration	Commercial or industrial non-domestic, non-hazardous wastewaters generated and discharged through a floor drain, work sink, or other similar release point, located in an area that "regulated contaminants" are used or stored.

Regulated Activity	Requirements	Definition
On-site Septic System Installation http://www.des.state.nh.us/factsheets/ssb/ssb-12.htm	Approval for Septic System Construction/Operation	Two separate approvals are needed for septic systems: an Approval to Construct and an Approval to Operate. The first approval is required prior to construction of a septic system or for any building from which wastewater will discharge; the second is required for actual use of the septic system. This rule applies to alternative technologies as well.
Excavation and Road Construction http://www.des.state.nh.us/factsheets/wqe/wqe-1.htm	Alteration of Terrain Permit	Sand and gravel pits which will disturb more than 100,000 square feet of contiguous area or 50,000 square feet within the area protected by NH RSA 483-B, The Comprehensive Shoreland Protection Act.
Regulated Underground or Aboveground Storage Tanks http://www.des.state.nh.us/rem.htm	Registration of New and Substantially Modified Aboveground Petroleum Storage Tank (AST) Systems	At least 45 days prior to commencing the construction or installation of a new or replacement AST system having a capacity of more than 660 gallons, or a new or replacement underground or over-water piping system, a completed application along with a complete set of plans that have been prepared and stamped by a New Hampshire licensed professional engineer will be submitted to DES.
	Registration of Aboveground Petroleum Storage Tank (AST) Systems	The owner of a regulated AST facility will register all ASTs with DES. A regulated AST facility is one that has a single petroleum AST with a capacity of more than 660-gallons, or two or more petroleum ASTs having a combined storage capacity of more than 1,320-gallons. If a facility stores less than 1,320-gallons of virgin heating oil used only for on-premise use heating of structures, then that virgin heating oil storage is not included in calculating the combined regulated storage capacity.
	Registration of New and Substantially Modified Underground Petroleum Storage Tank (UST) Systems	At least 45 days prior to commencing the construction or installation of a new or replacement UST system having a capacity of more than 1,100 gallons, or a new or replacement underground or over-water piping system, a completed application along with a complete set of plans that have been prepared and stamped by a New Hampshire licensed professional engineer will be submitted to DES.

Regulated Activity	Requirements	Definition
	Registration of Underground Petroleum Storage Tank (UST) Systems	The owner of a regulated UST facility will register all USTs with DES. A regulated UST facility has at least one petroleum UST with a capacity of more than 1,100-gallons, or at least one UST containing hazardous chemicals and motor fuels with a capacity greater than 110 gallons.

Source: NH DES

Appendix B. Matrix of Site Design (Structural) BMPs

Matrix of Site Design (Structural) BMPs

Practice & Specifications	Advantages	Disadvantages	Cold Climate Restrictions
Infiltration BMPs			
Infiltration Basin *Size of drainage area:* Moderate to large *Site requirements:* Deep, permeable soils *Maintenance burdens:* High *Longevity:* Low *Comparative Cost:* Construction moderate but rehabilitation cost high	▪ Provides ground water recharge ▪ Can serve large developments ▪ High removal capability for particulate pollutants and moderate removal for soluble pollutants ▪ When basin works, it can replicate pre-development hydrology more closely than other BMP options ▪ Basins provide more habitat value than other infiltration systems	▪ Possible risk of contaminating ground water if used at high-risk sites ▪ Only feasible where soil is permeable and there is sufficient depth to bedrock and water table ▪ Fairly high failure rate ▪ If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors ▪ Regular maintenance activities cannot prevent rapid clogging of infiltration basin	▪ Avoid areas with permafrost ▪ Monitor ground water for chlorides ▪ Do not infiltrate road/parking lot snowmelt if chlorides are a concern ▪ Increase percolation requirements ▪ Use 20' minimum setback between road subgrade and BMP
Infiltration trench *Size of drainage area:* Moderate *Site requirements:* Deep, permeable soils *Maintenance burdens:* High *Longevity:* Low *Comparative Cost:* Cost effective on smaller sites, rehabilitation costs can be considerable	▪ Provides ground water recharge ▪ Can serve small drainage areas ▪ Can fit into medians, perimeters and other unused areas of a development site ▪ Helps replicate predevelopment hydrology, increases dry weather baseflow and reduces bankfull flooding frequency	▪ Possible risk of contaminating ground water ▪ Helps replicate predevelopment hydrology, increases dry weather baseflow, and reduces bankfull flooding frequency ▪ Possible risk of contaminating ground water if used at high-risk sites ▪ Only feasible where soil is permeable and there is sufficient depth to bedrock and water table ▪ Since not as visible as other BMPs, less likely to be maintained by residents ▪ Requires significant maintenance	▪ Avoid areas with permafrost ▪ Monitor ground water for chlorides ▪ Do not infiltrate road/parking lot snowmelt if chlorides are a concern ▪ Increase percolation requirements ▪ Use 20' minimum setback between road subgrade and BMP

Practice & Specifications	Advantages	Disadvantages	Cold Climate Restrictions
Pervious or Porous Surfaces *Size of drainage area:* Small *Site requirements:* Deep, permeable soils, low slopes, and restricted traffic *Maintenance burdens:* Moderate to high *Longevity:* Low *Comparative Cost:* low to high - based on type of surfacing or pavers	▪ Can provide peak flow control ▪ Provides ground water recharge ▪ Provides water quality control without additional consumption of land	▪ Requires regular maintenance ▪ Not suitable for areas with high traffic volume ▪ Possible risk of contaminating ground water if used at high-risk sites ▪ Only feasible where soil is permeable, there is sufficient depth to bedrock and water table, and there are gentle slopes	▪ Only use on non-sanded surfaces ▪ Pavement may be damaged by snow plows ▪ Maintenance is essential
Open Channel System BMPs			
Grassed Swale *Size of drainage area:* Small *Site requirements:* Low-density areas with <15% slope *Maintenance burdens:* Low *Longevity:* High if maintained *Comparative Cost:* Low	▪ Requires minimal land area ▪ Can be used as part of the runoff conveyance system to provide pretreatment ▪ Can provide sufficient runoff control to replace curb and gutter in single-family residential subdivisions and on highway medians ▪ Economical	▪ Low pollutant removal rates ▪ Leaching from culverts and fertilized lawns may actually increase the presence of trace metals and nutrients	▪ Avoid areas with permafrost ▪ Use cold- and salt tolerant vegetation ▪ Plowed snow can be stored in the swale ▪ Increase underdrain pipe diameter and size of gravel bed ▪ Provide ice-free culverts ▪ Ensure soil bed is highly permeable
Dry Swale *Size of drainage area:* Small *Site requirements:* Low-density areas with <15% slope *Maintenance burdens:* Low *Longevity:* High if maintained *Comparative Cost:* Low to moderate	▪ Requires minimal land area ▪ Can be used as part of the runoff conveyance system to provide pretreatment ▪ Can provide sufficient runoff control to replace curb and gutter in single-family residential subdivisions and on highway medians ▪ Can be used with additional pretreatment BMPs to provide peak flow control	▪ Low pollutant removal rates ▪ Leaching from culverts and fertilized lawns may actually increase the presence of trace metals and nutrients	▪ Avoid areas with permafrost ▪ Use cold- and salt tolerant vegetation ▪ Plowed snow can be stored in the swale ▪ Increase underdrain pipe diameter and size of gravel bed ▪ Provide ice-free culverts ▪ Ensure soil bed is highly permeable

Practice & Specifications	Advantages	Disadvantages	Cold Climate Restrictions
Wet Swale *Size of drainage area:* Small *Site requirements:* Low-density areas with <15% slope *Maintenance burdens:* Low *Longevity:* High if maintained *Comparative Cost:* Low	▪ Requires minimal land area ▪ Can be used as part of the runoff conveyance system to provide pretreatment ▪ Can provide sufficient runoff control to replace curb and gutter in single-family residential subdivisions and on highway medians ▪ Can be used where ground water table is high	▪ Possible risk of contaminating ground water if used at high-risk sites ▪ Leaching from culverts and fertilized lawns may actually increase the presence of trace metals and nutrients	▪ Avoid areas with permafrost ▪ Use cold- and salt tolerant vegetation ▪ Plowed snow can be stored in the swale ▪ Increase underdrain pipe diameter and size of gravel bed ▪ Provide ice-free culverts ▪ Ensure soil bed is highly permeable
Vegetated Filter Strip *Size of drainage area:* Small *Site requirements:* Low-density areas with low slopes *Maintenance burdens:* Low *Longevity:* Low if poorly maintained *Comparative Cost:* Low	▪ Low maintenance requirements ▪ Can be used as part of the runoff conveyance system to provide pretreatment ▪ Can effectively reduce particulate pollutant levels in areas where runoff velocity is low to moderate ▪ Provides excellent urban wildlife habitat ▪ Economical	▪ Often concentrates water, which significantly reduces effectiveness ▪ Ability to remove soluble pollutants highly variable ▪ Limited feasibility in highly urbanized areas where runoff velocities are high and flow is concentrated ▪ Requires periodic repair, re-grading and sediment removal to prevent channelization	▪ Small setback may be required between filter strips and roads when frost heave is a concern ▪ Avoid areas with permafrost ▪ Use cold- and salt-tolerant vegetation ▪ Plowed snow can be stored in-practice
Filtering System BMPs			
Underground Sand Filter *Size of drainage area:* Small *Site requirements:* Widely applicable *Maintenance burdens:* High *Longevity:* Low to Moderate *Comparative Cost:* High	▪ Provide high removal efficiencies of particulates ▪ Require minimal land area ▪ Flexibility to retrofit existing small drainage areas ▪ Higher removal of nutrient as compared to catch basins and oil/grit separator	▪ Not feasible for drainage areas greater than 5 acres ▪ Only feasible for areas that are stabilized and highly impervious ▪ Not effective as water quality control for intense storms	▪ Only effective if placed below the frost line
Oil/Grit Separator *Size of drainage area:* Small *Site requirements:* Widely applicable *Maintenance burdens:* High *Longevity:* Low to Moderate *Comparative Cost:* High	▪ Captures coarse-grained sediments and some hydrocarbons ▪ Requires minimal land area ▪ Flexibility to retrofit existing small drainage areas and applicable to most urban areas ▪ Shows some capacity to trap trash, debris, and other floatables ▪ Can be adapted to cold climates	▪ Not feasible for drainage area greater than one acre ▪ Minimal nutrient and organic matter removal ▪ Not effective as water quality control for intense storms ▪ Concern exists for the pollutant toxicity of trapped residuals ▪ Require high maintenance	▪ Most effective if placed below the frost line

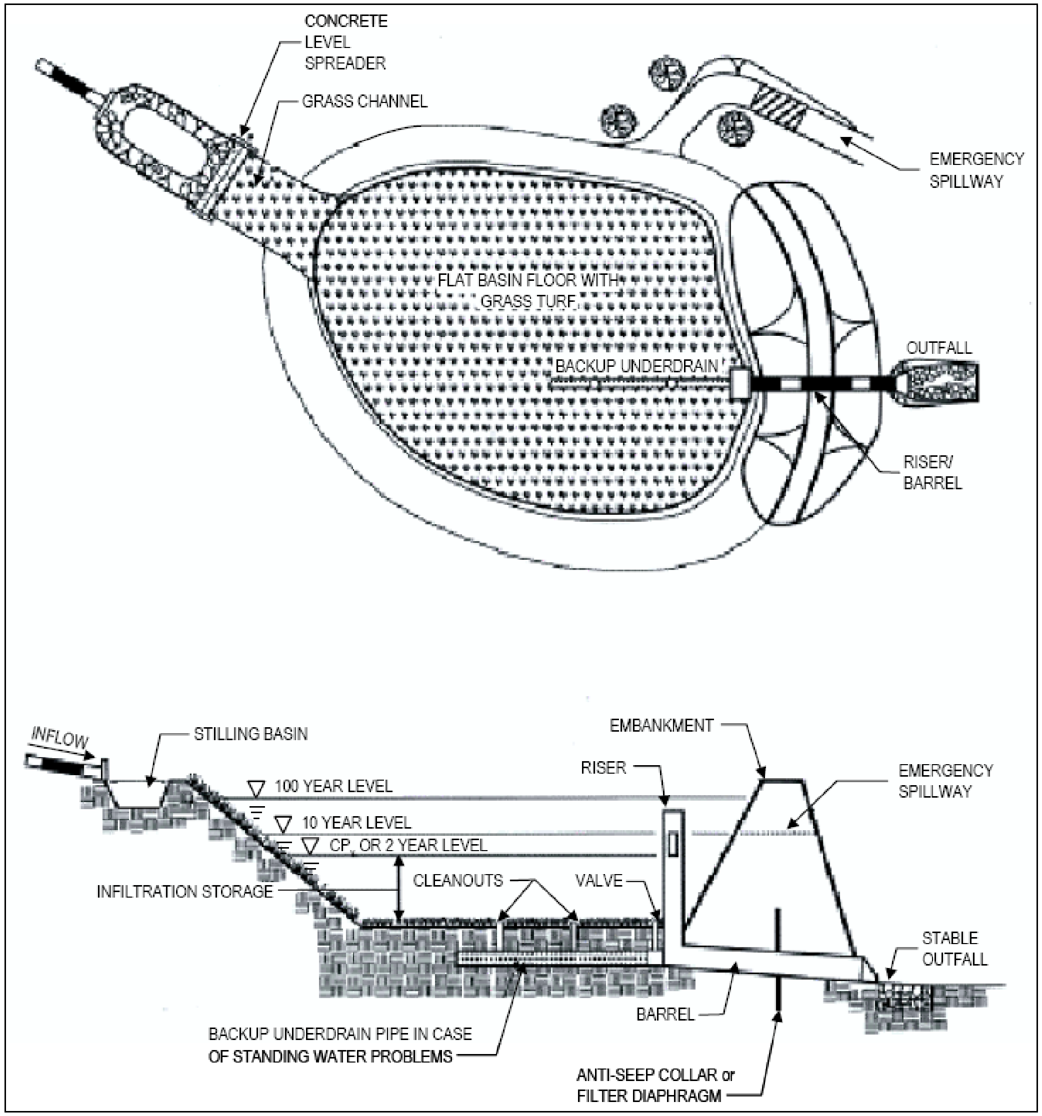
Practice & Specifications	Advantages	Disadvantages	Cold Climate Restrictions
Bioretention *Size of drainage area:* Small *Site requirements:* Widely applicable *Maintenance burdens:* Low to moderate *Longevity:* High *Comparative Cost:* Low	▪ Provides ground water recharge ▪ Enhances aesthetics and provides wildlife habitat ▪ Low maintenance required if properly designed ▪ Can be successfully installed as retrofits in existing development facilities	▪ Can concentrate water, which reduces effectiveness ▪ Ability to remove soluble pollutants highly variable	▪ Reduced treatment effectiveness during cold season ▪ Pretreatment should be used to prevent sedimentation of vegetation ▪ Use cold- and salt-tolerant vegetation if adjacent to treated area
Pond and Wetland BMPs			
Dry Extended detention Pond *Size of drainage area:* Moderate to large *Site requirements:* Deep soils *Maintenance burdens:* High *Longevity:* Moderate to High *Comparative Cost:* Lowest cost alternative in size range	▪ Can provide peak flow control ▪ Possible to provide good particulate removal ▪ Can serve large development ▪ Requires less capital cost and land area when compared to wet pond ▪ Does not generally release water or anoxic water downstream ▪ Provides excellent protection for downstream channel erosion ▪ Can create valuable wetland and meadow habitat when properly landscaped	▪ Removal rates for soluble pollutants are quite low ▪ Not economical for drainage area less than 10 acres ▪ If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors ▪ Longevity low if not maintained properly	▪ Protect inlet/outlet pipes ▪ Use large-diameter (>8") gravel in underdrain of outfall protection ▪ Consider seasonal operation ▪ Provide ice storage volume ▪ Cold-tolerant vegetation

Practice & Specifications	Advantages	Disadvantages	Cold Climate Restrictions
Wet Pond *Size of drainage area:* Moderate to large *Site requirements:* Deep soils *Maintenance burdens:* Low *Longevity:* High *Comparative Cost:* Moderate to High	▪ Can provide peak flow control ▪ Can serve large developments; most cost-effective for larger, more intensively developed sites ▪ Enhances aesthetics and provides recreational benefits ▪ Little ground water discharge ▪ Permanent pool in wet ponds helps to prevent scour and resuspension of sediments ▪ Provides moderate to high removal of both particulate and soluble urban runoff pollutants	▪ Not economical for drainage area less than 10 acres ▪ Potential safety hazards if not properly maintained ▪ If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors ▪ Requires considerable space, which limits use in densely urbanized areas with expensive land and high property values ▪ Not suitable for hydrologic soil groups "A" and "B" (USDANRCS classification) unless a liner is used ▪ With possible thermal discharge and oxygen depletion, may severely impact downstream aquatic life ▪ Hydrologic damage to stream channels and aquatic habitat is possible due to flow volume.	▪ Protect inlet/outlet pipes ▪ Use large-diameter (>8") gravel in underdrain of outfall protection ▪ Consider seasonal operation ▪ Provide ice storage volume ▪ Cold-tolerant vegetation
Constructed Wetland *Size of drainage area:* Moderate to large *Site requirements:* Poorly drained soils, space may be limiting *Maintenance burdens:* Annual harvesting of vegetation *Longevity:* High *Comparative Cost:* Moderate to High	▪ Can provide peak flow control ▪ Can serve large developments; most cost-effective for larger, more intensively developed sites ▪ Enhances aesthetics and provides recreational benefits ▪ Allows ground water infiltration ▪ Permanent pools and vegetation slow the flow of stormwater and help prevent scour and resuspension of sediments ▪ Provides moderate to high removal of both particulate and soluble urban runoff pollutants	▪ Not economical for drainage area less than 10 acres ▪ Potential safety hazards if not properly maintained ▪ Requires considerable space, which limits use in densely urbanized areas with expensive land and high property values ▪ Not suitable for hydrologic soil groups "A" and "B" (USDA NRCS classification) unless a liner is used	▪ Protect inlet/outlet pipes ▪ Use large-diameter (>8") gravel in underdrain of outfall protection ▪ Consider seasonal operation ▪ Provide ice storage volume ▪ Cold-tolerant vegetation

Source: Adapted from *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*

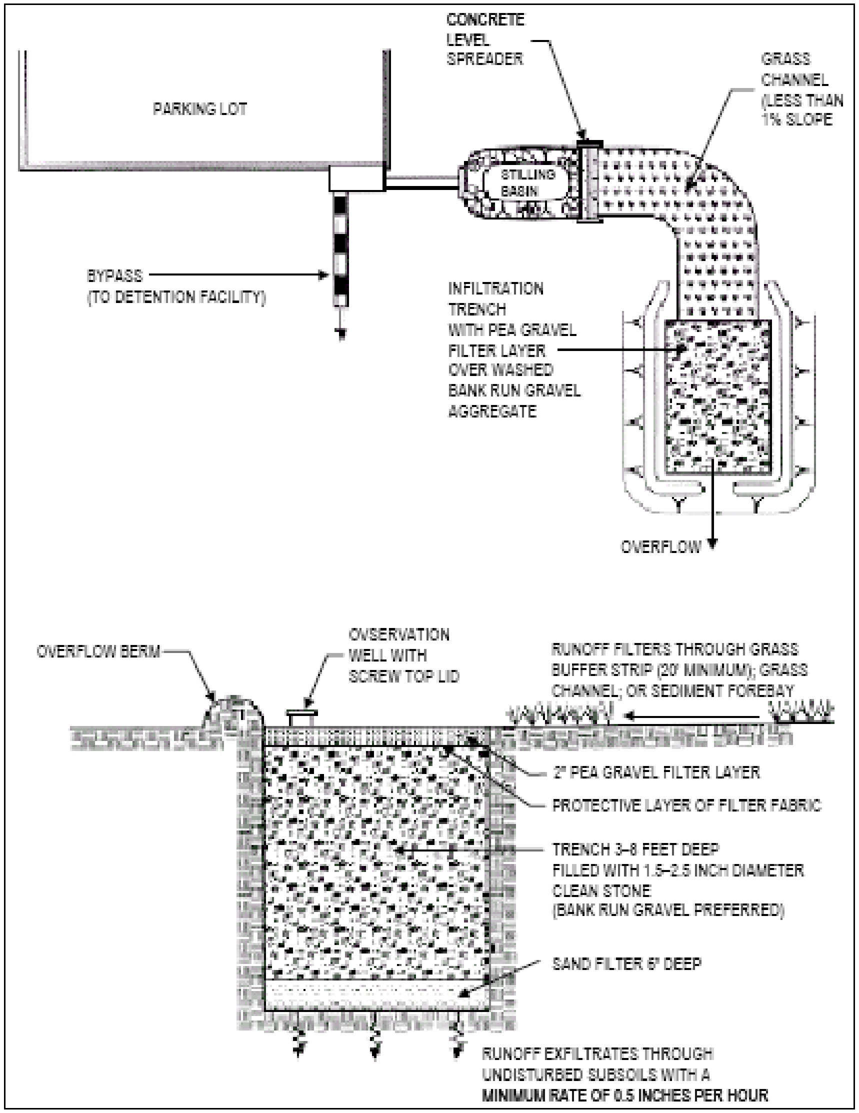
Appendix C. Schematics of Site Design (Structural) BMPs

Schematic of an Infiltration Basin



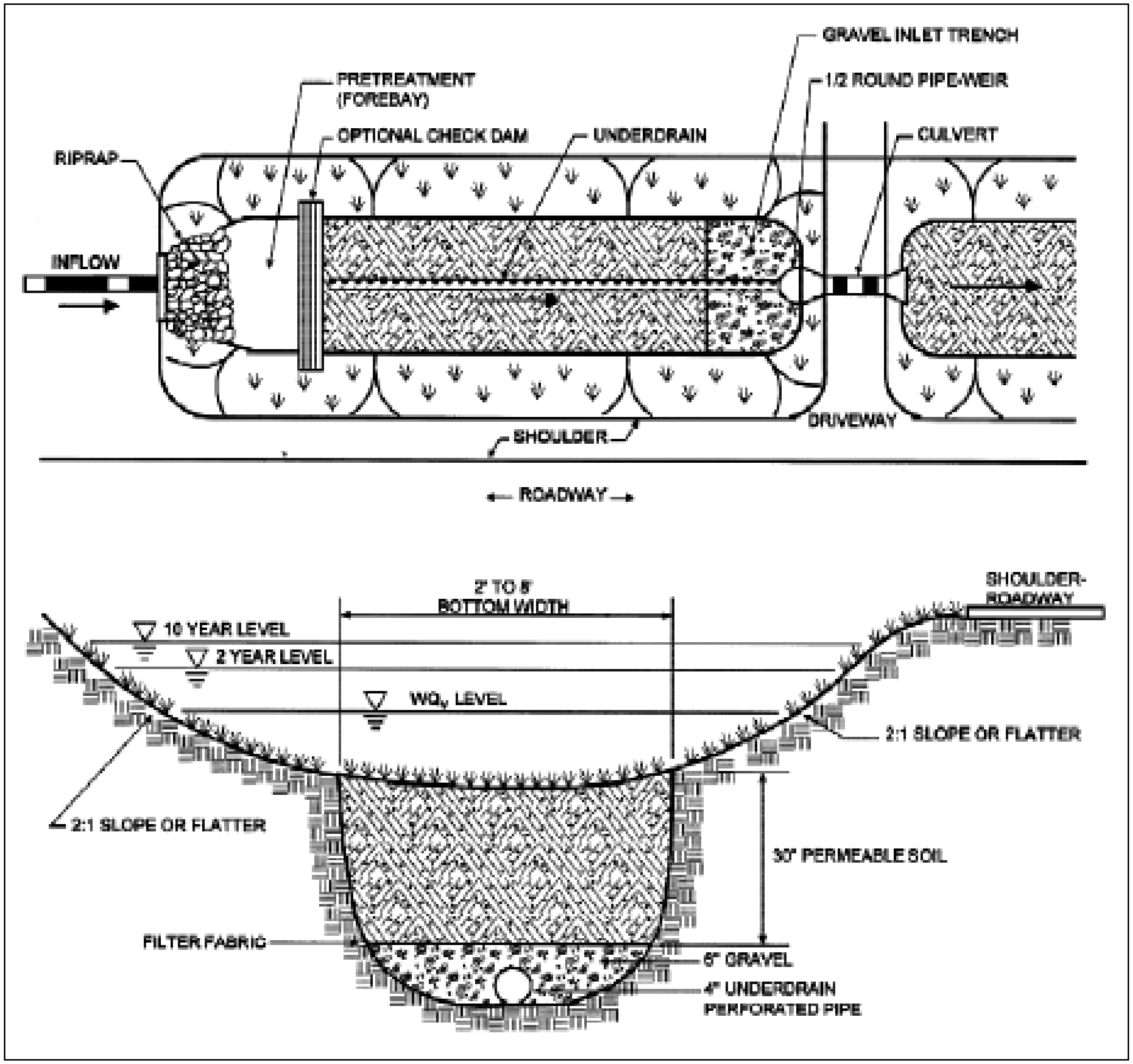
Source: National Management Measures to Control NPS Pollution from Urban Areas

Schematic of an Infiltration Trench



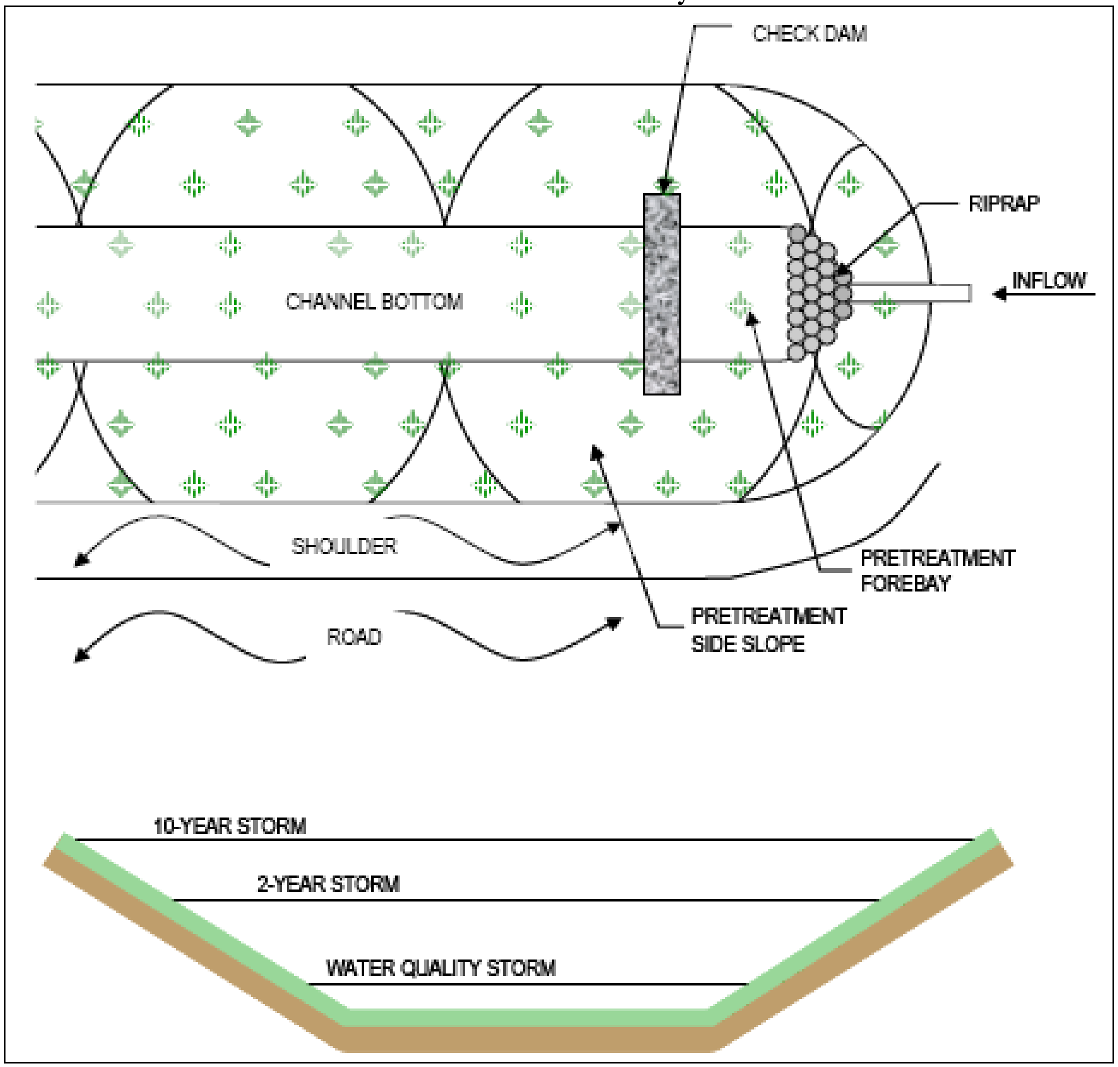
Source: National Management Measures to Control NPS Pollution from Urban Areas

Schematic of a Grass Swale



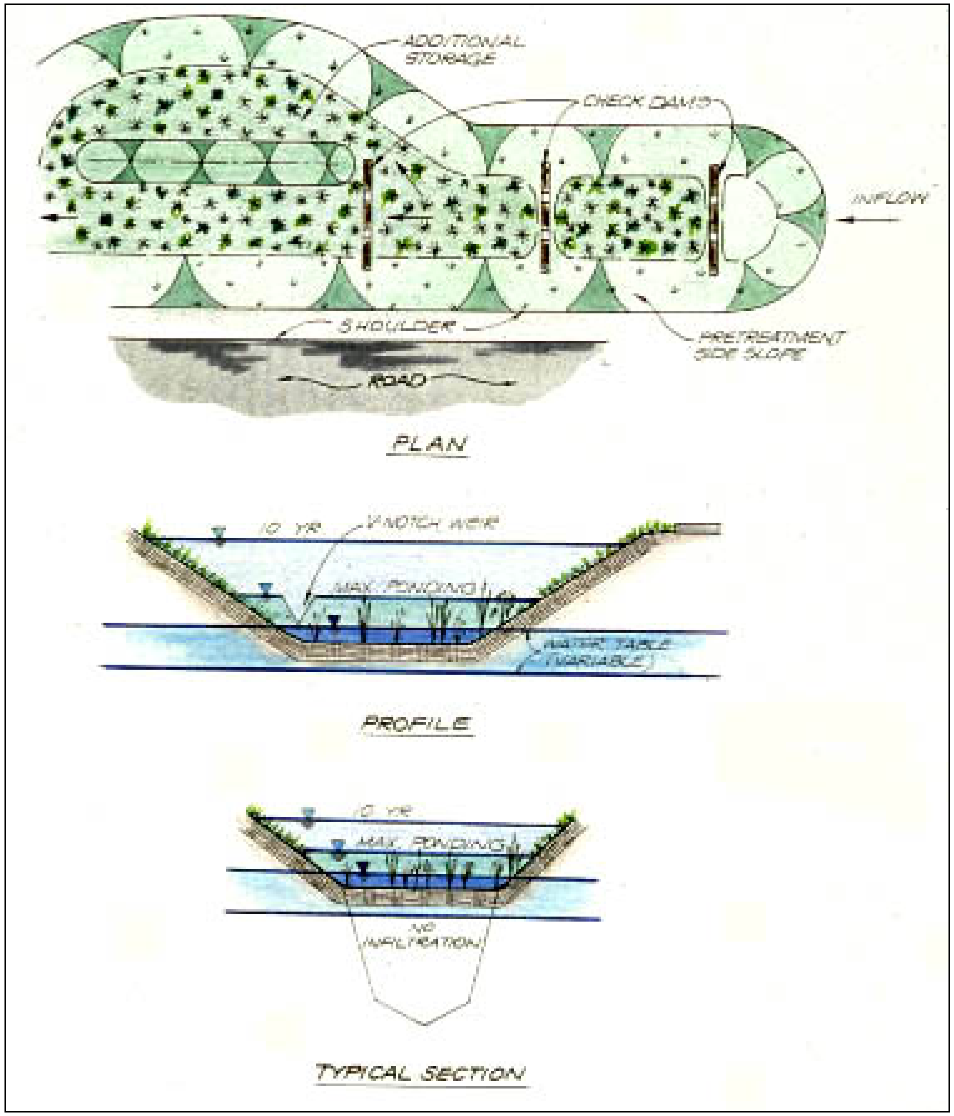
Source: National Management Measures to Control NPS Pollution from Urban Areas

Schematic of a dry swale



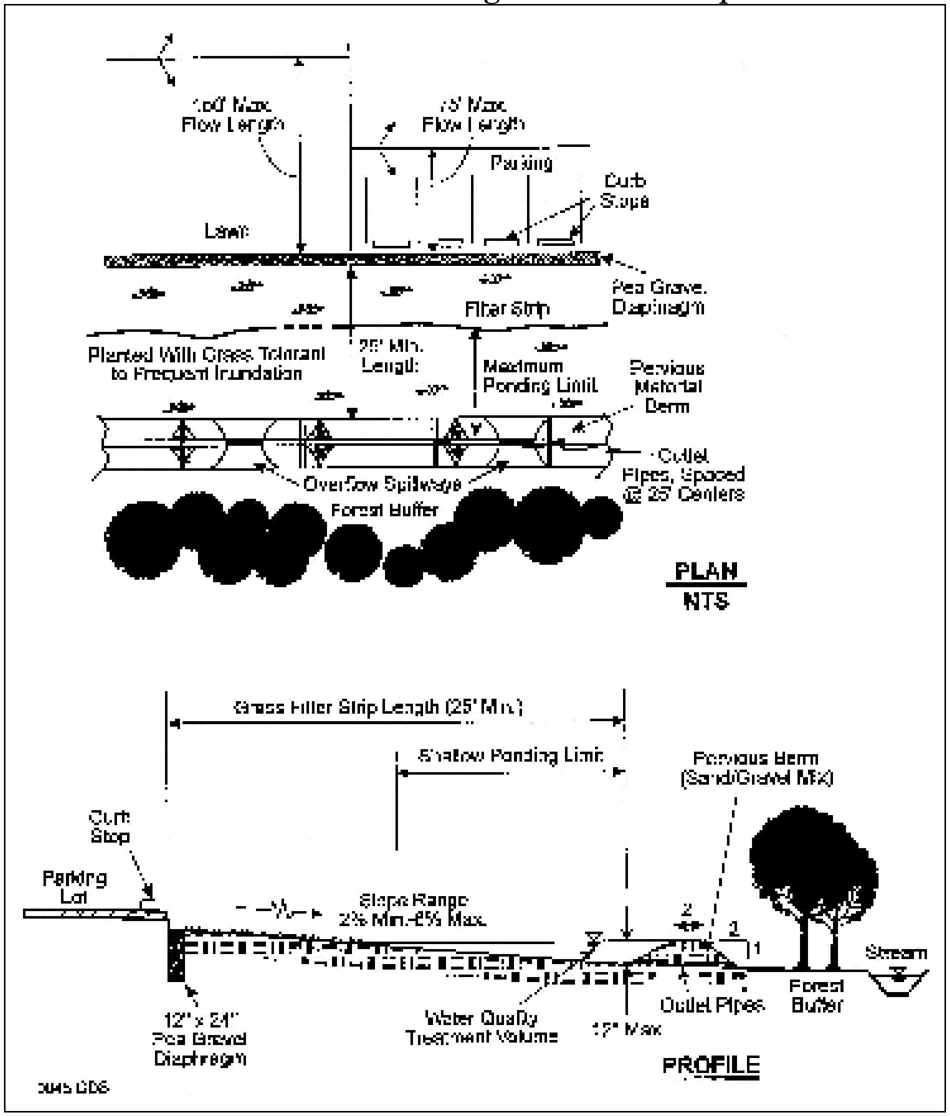
Source: National Management Measures to Control NPS Pollution from Urban Areas

Schematic of a wet swale



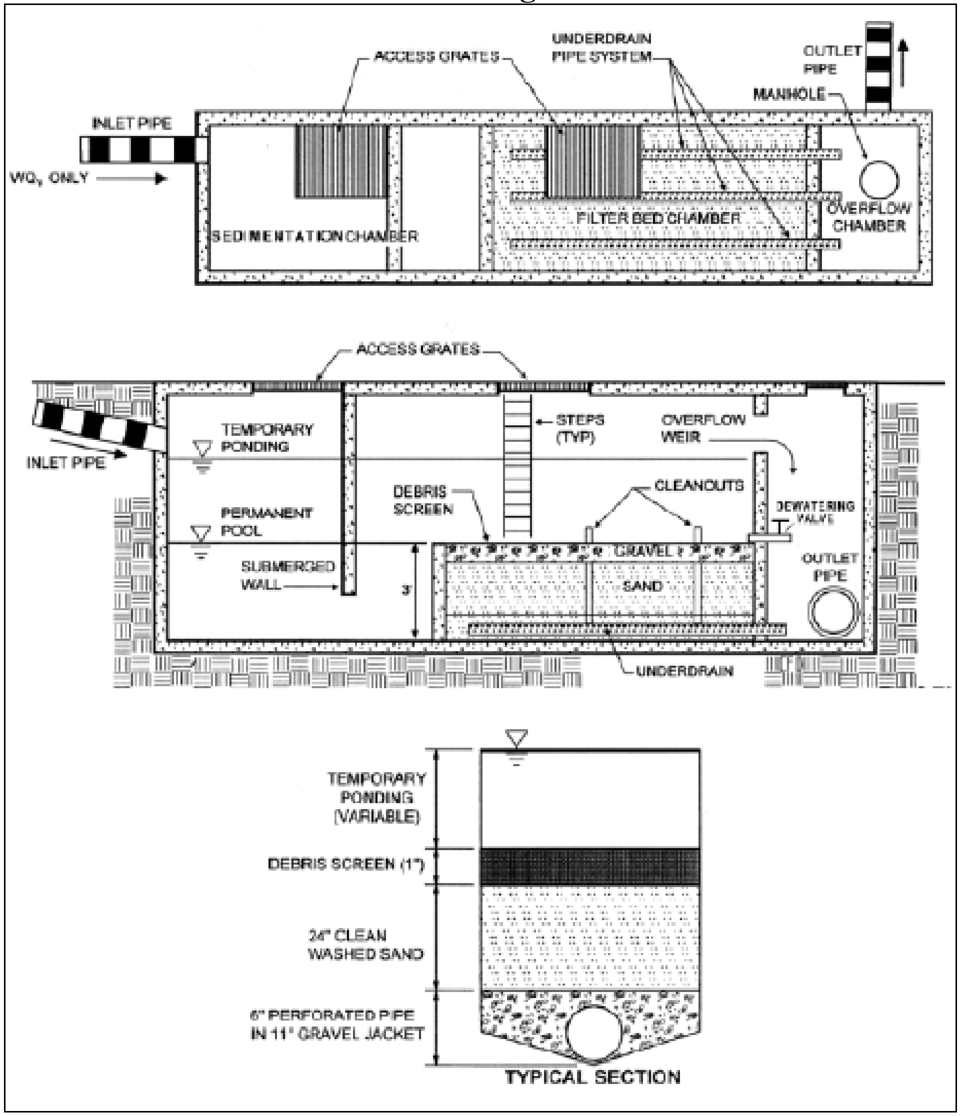
Source: Center for Watershed Protection

Schematic of a Vegetated Filter Strip



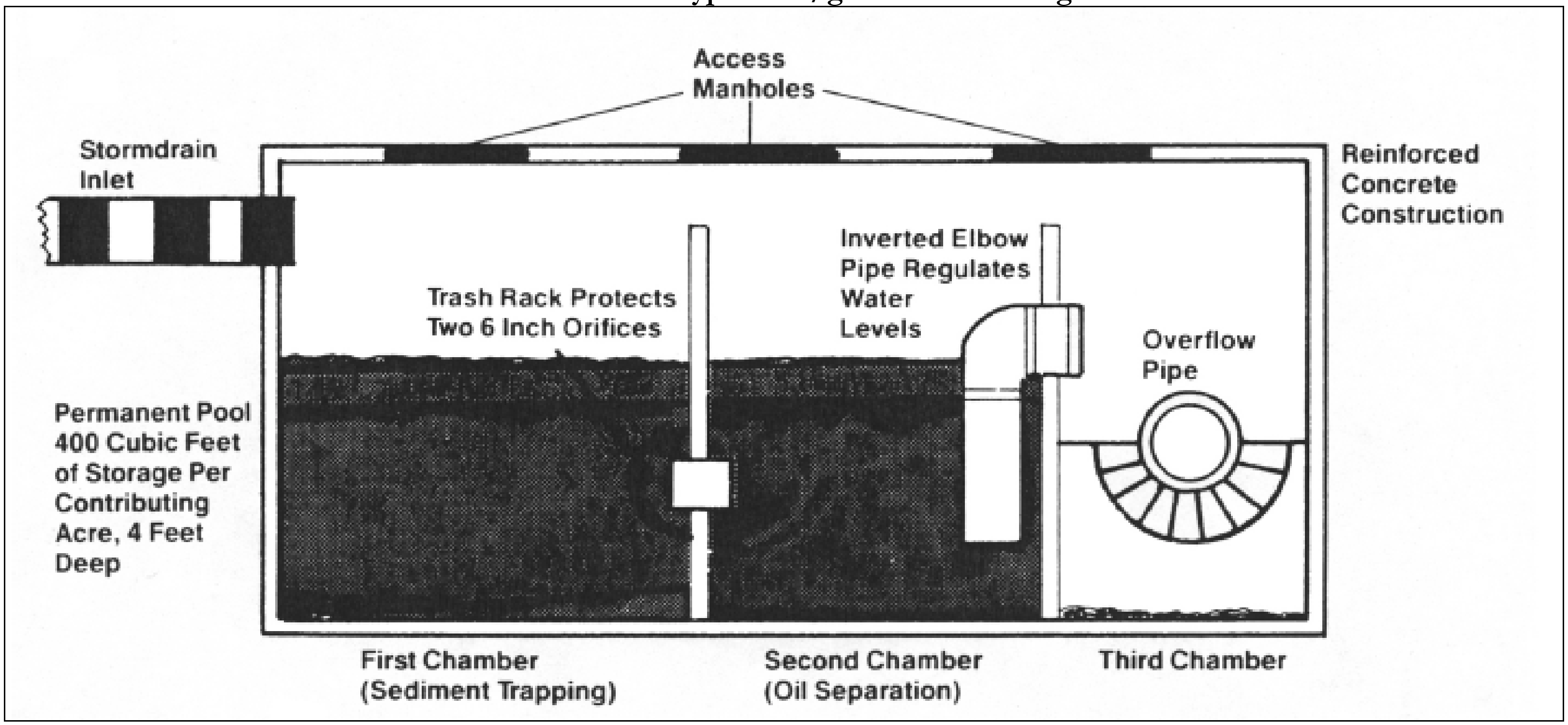
Source: Center for Watershed Protection

Schematic of an underground sand filter



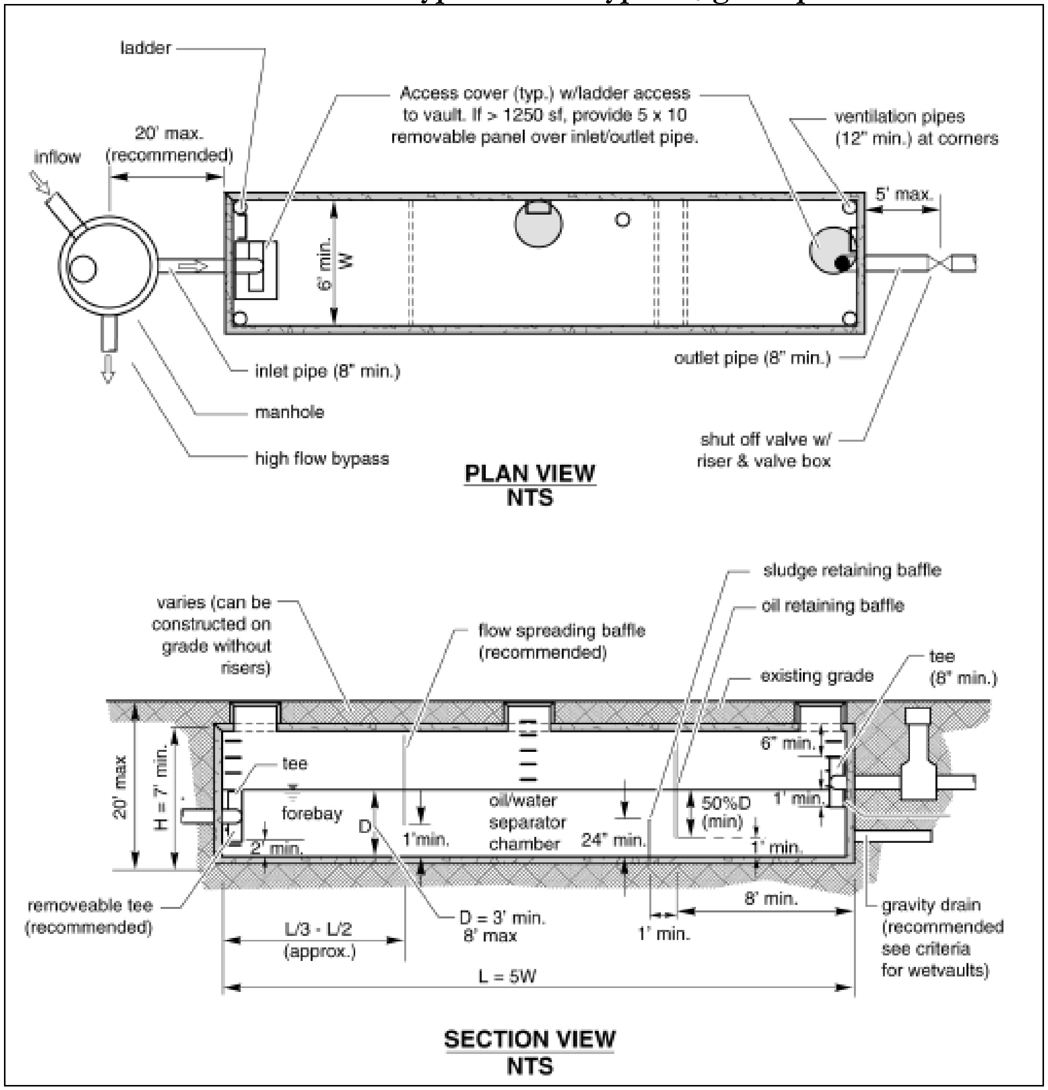
Source: National Management Measures to Control NPS Pollution from Urban Areas

Schematic of a typical oil/grit chamber design



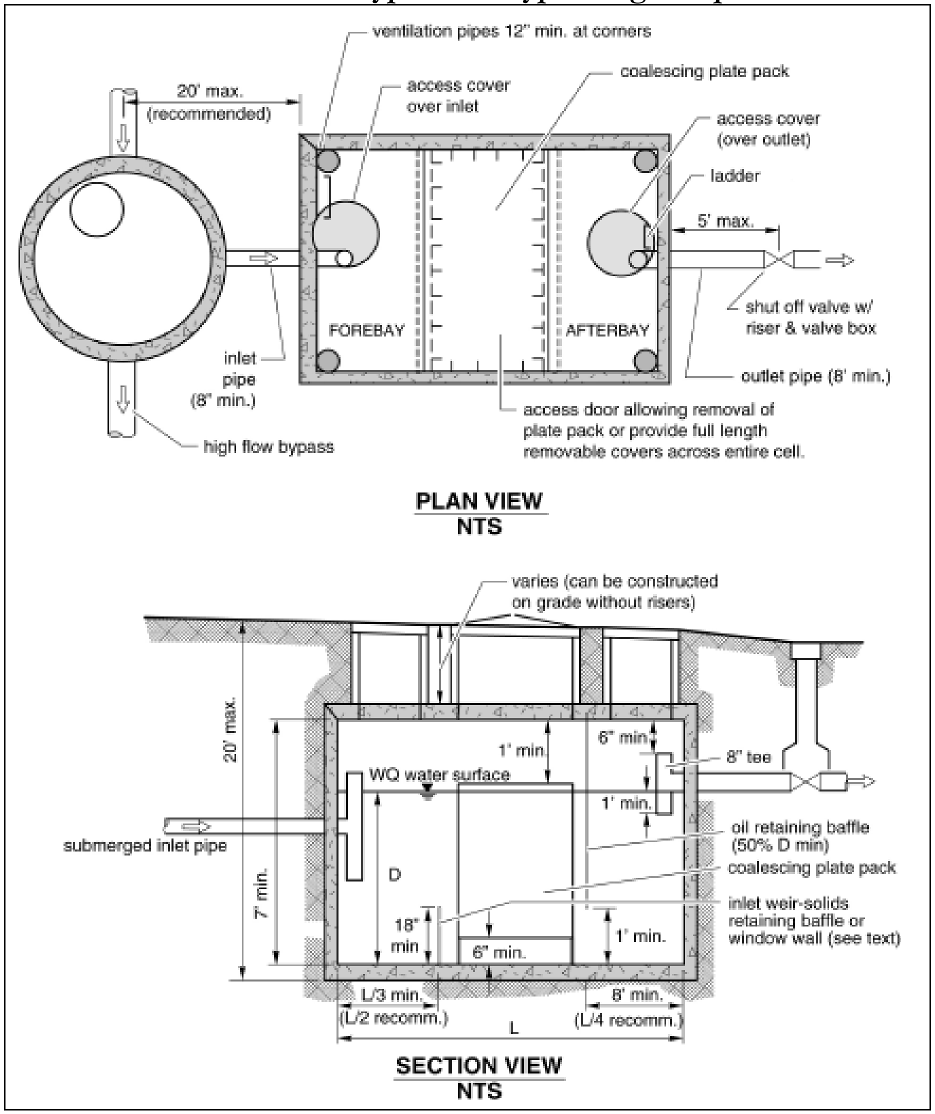
Source: Minnesota Urban Small Sites BMP Manual

Schematic of a typical baffle-type oil/grit separator



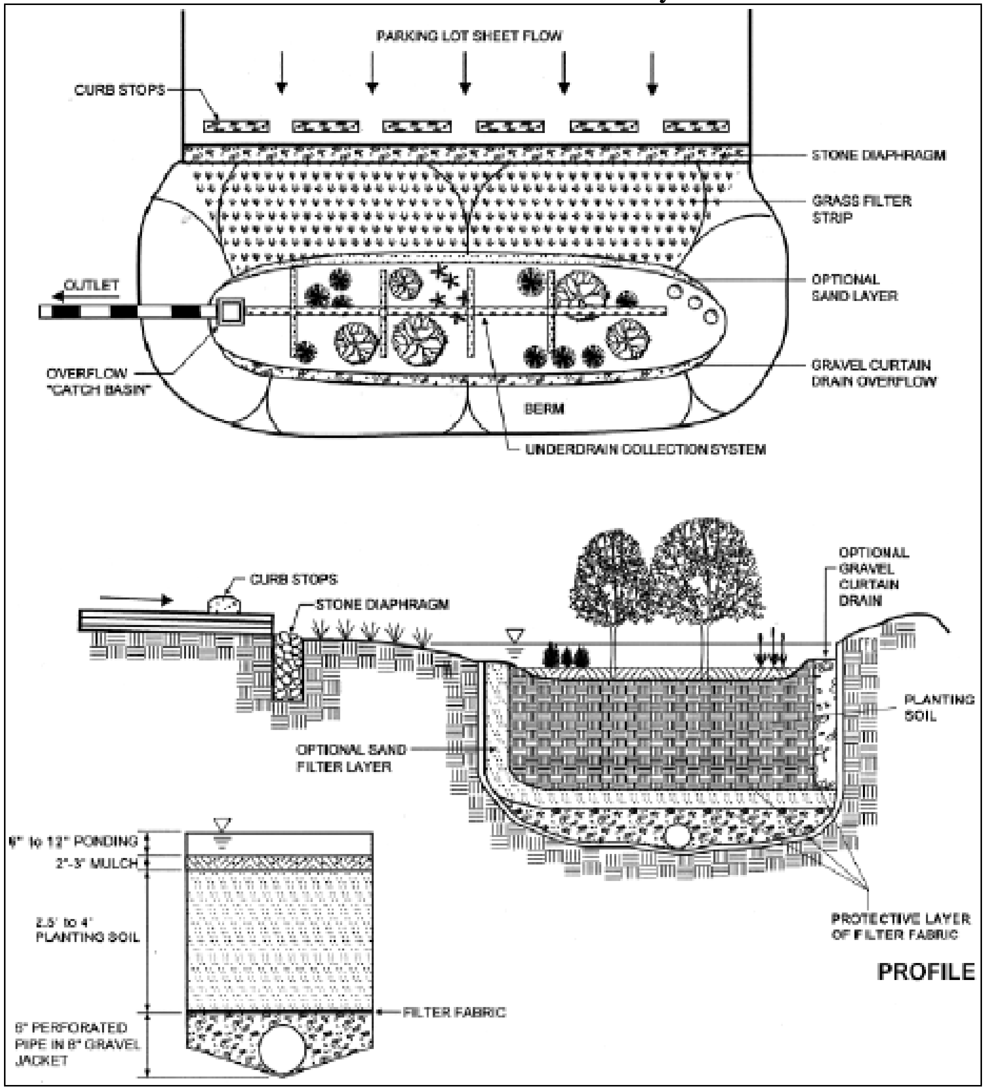
Source: Minnesota Urban Small Sites BMP Manual

Schematic of a typical CP-type oil/grit separator



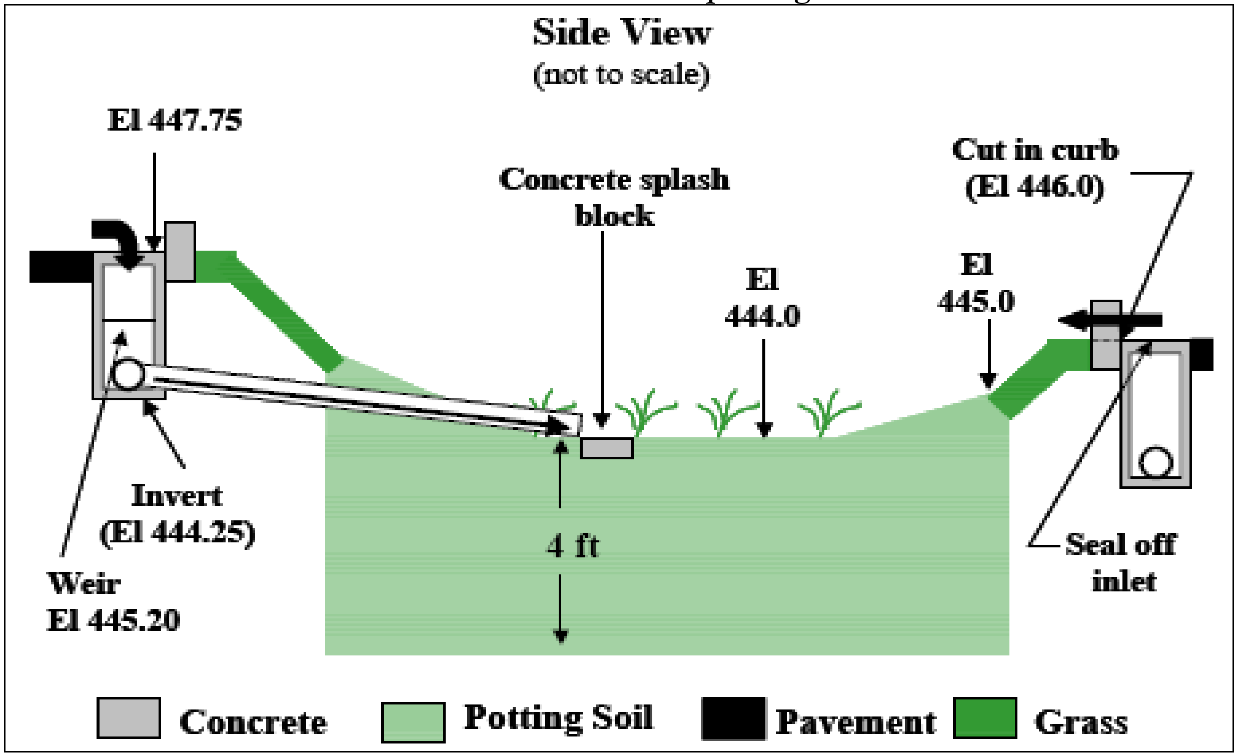
Source: Minnesota Urban Small Sites BMP Manual

Schematic of a Bioretention system



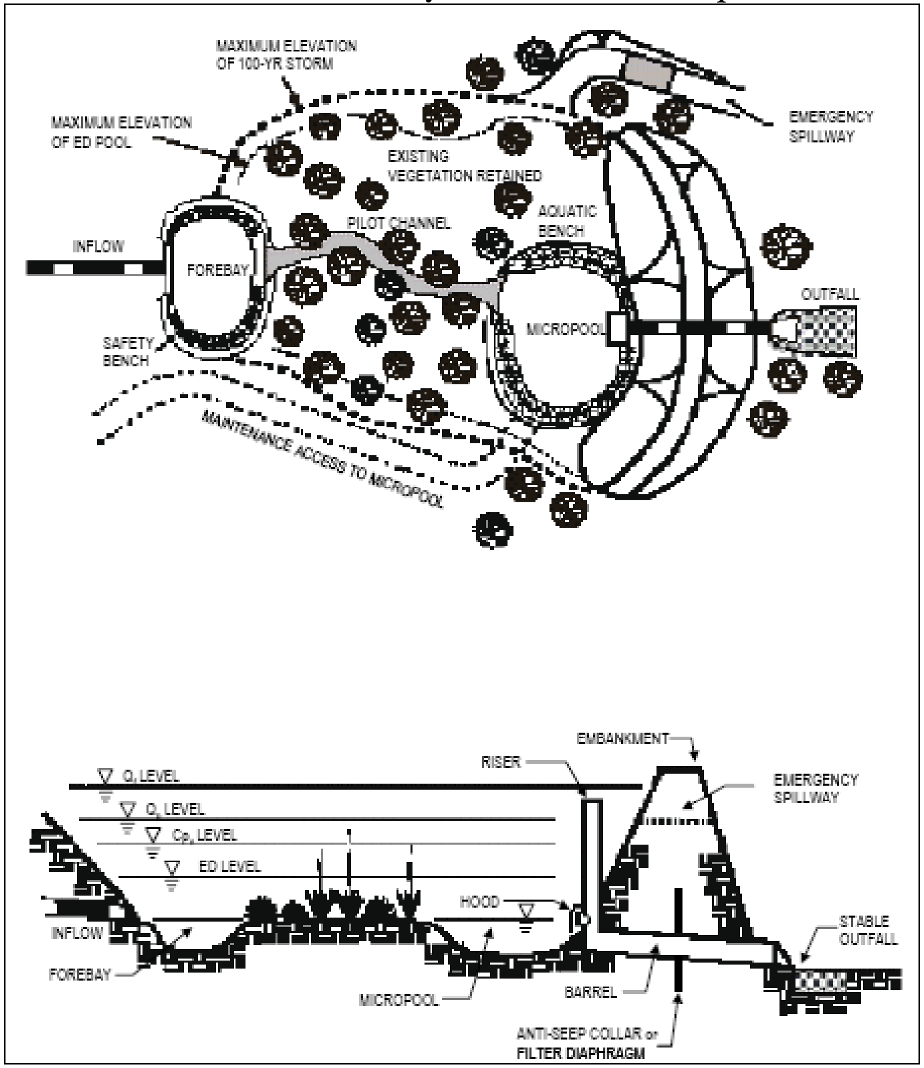
Source: National Management Measures to Control NPS Pollution from Urban Areas

Schematic of a Bioretention parking lot island



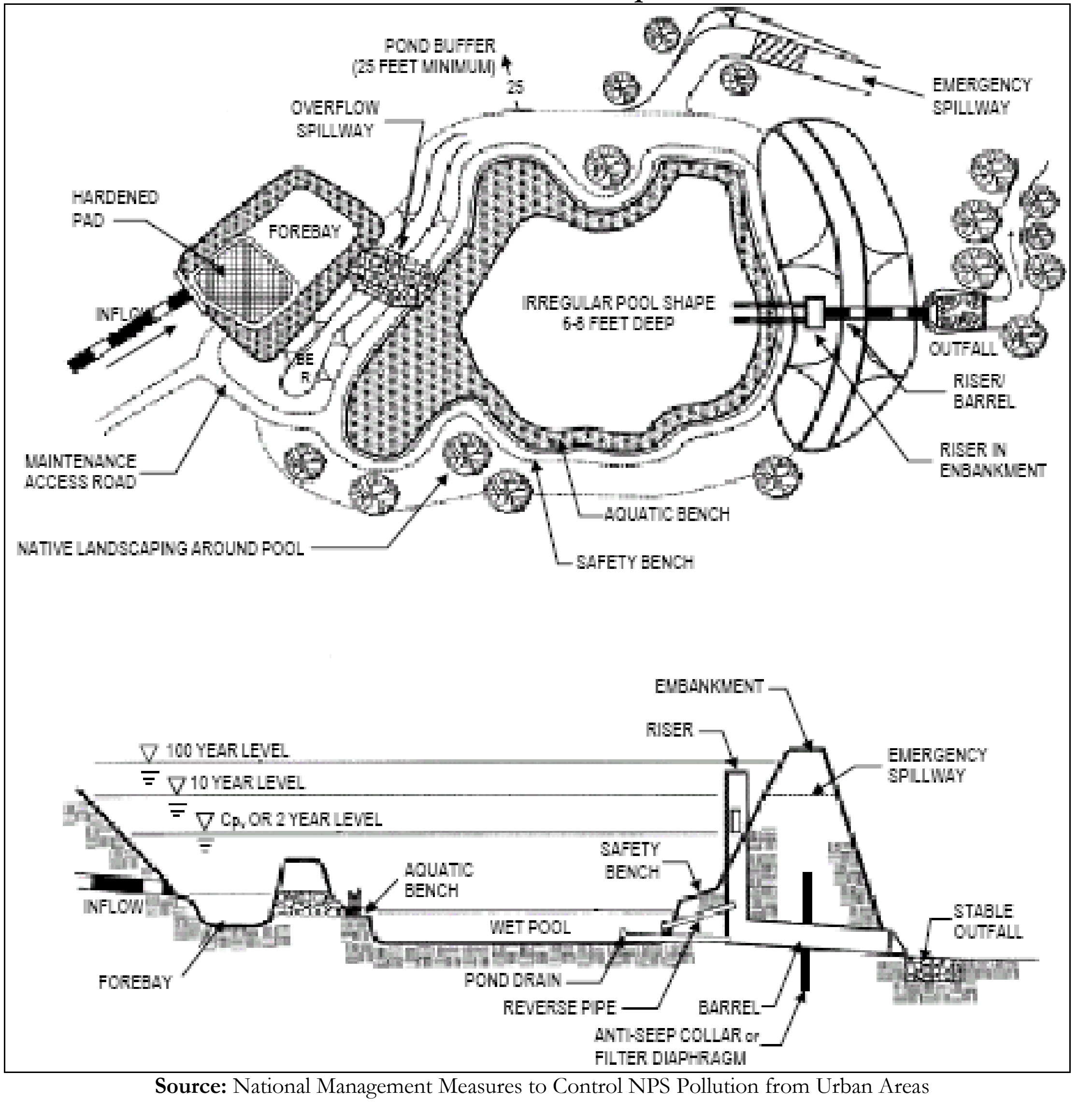
Source: National Management Measures to Control NPS Pollution from Urban Areas

Schematic of a dry extended detention pond



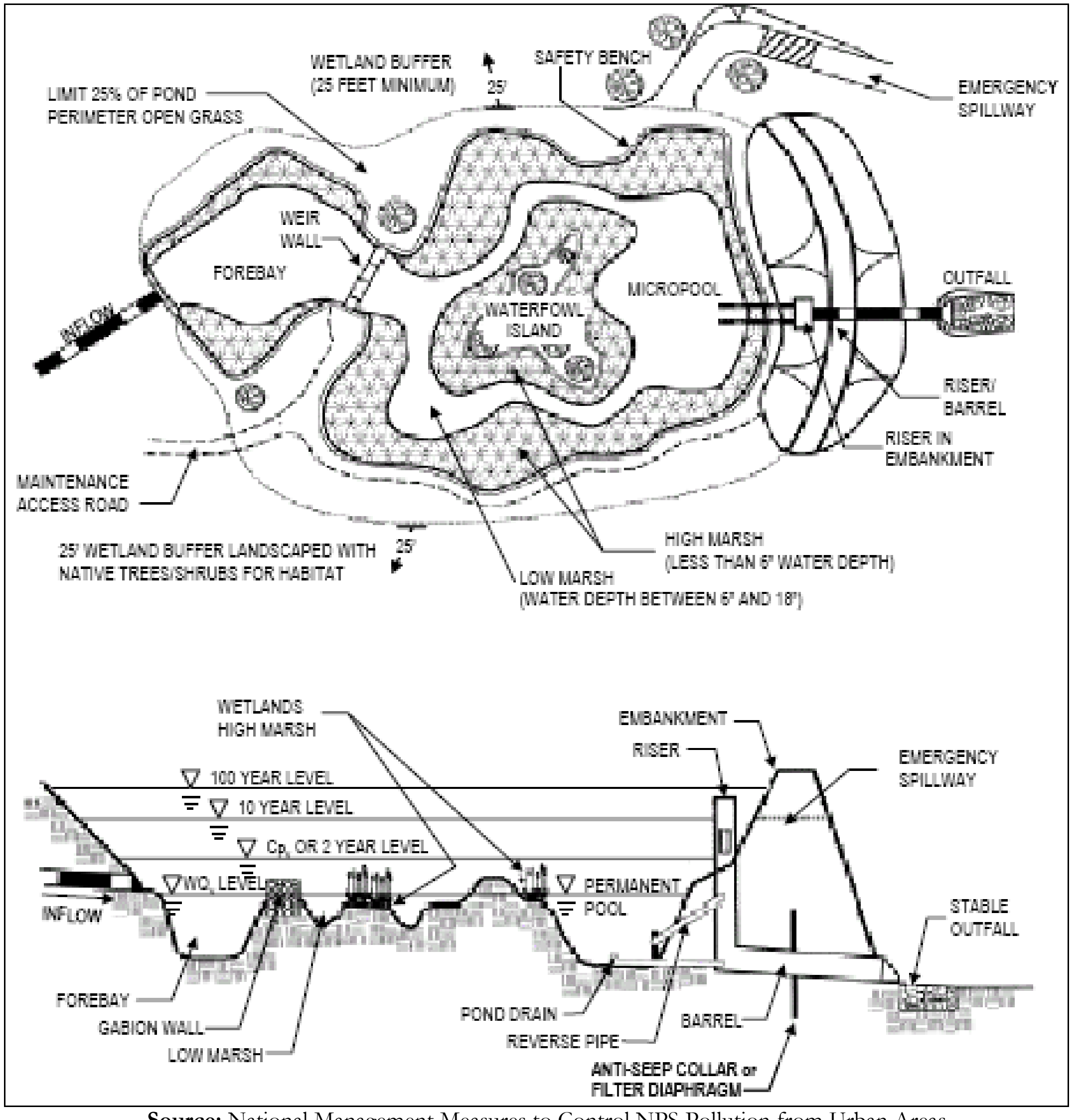
Source: National Management Measures to Control NPS Pollution from Urban Areas

Schematic of a wet pond



Source: National Management Measures to Control NPS Pollution from Urban Areas

Schematic of a constructed wetland



Source: National Management Measures to Control NPS Pollution from Urban Areas