

## 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.<sup>11</sup> 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\\_hwrp.htm](http://www.des.state.nh.us/orcb_hwrp.htm).



Aboveground storage tank for heating fuel

<sup>11</sup> 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>



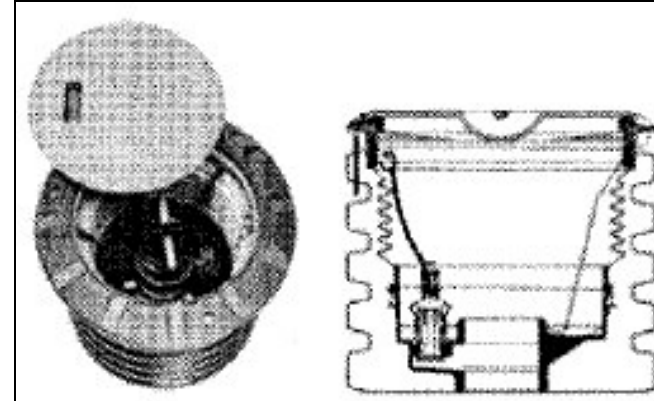
Ground water monitoring of UST secondary containment

- 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.
- 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/ustsystem/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.

**Figure 10. Sample Spill Bucket & Cross Section**



Source: Model Underground Storage Tank Environmental Results Program Workbook

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>.

## 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.<sup>12</sup> 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:

- 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.



Secondary containment for 55 gallon drums

<sup>12</sup> National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

- 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.
- 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:



Example of a spill kit

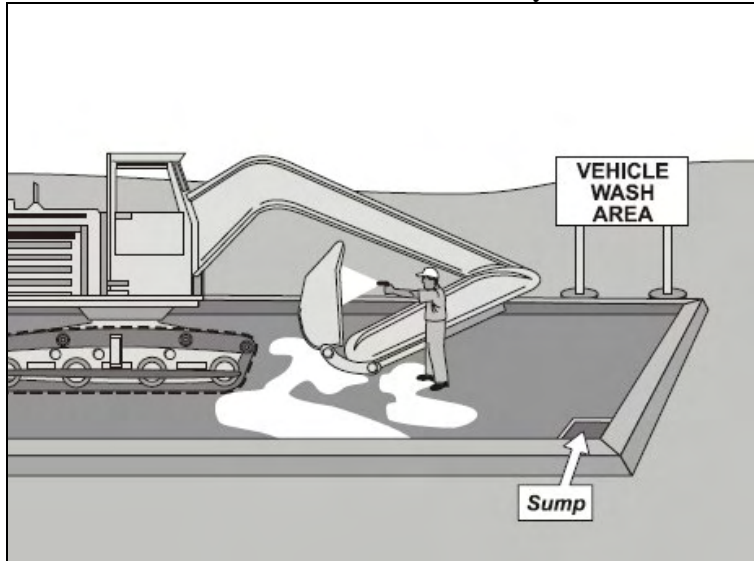
- Indicate that spills must be cleaned up promptly;
- Locations of drains or inlets to storm sewers that should be plugged during spill remediation to prevent off-site contamination
- Specify how each type of material should be handled;
- Discourage the use of water for clean-up;
- List the type of material 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.

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>.

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



Source: California Stormwater BMP Handbook – Construction

### 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."<sup>13</sup> 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 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.

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<sup>13</sup> 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.



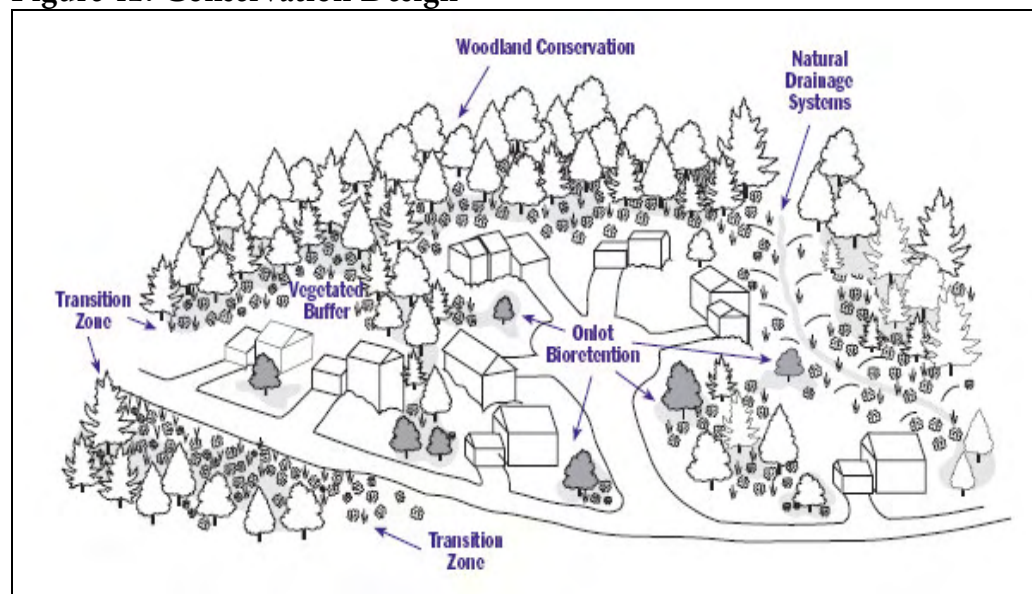
## Conservation Design

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.<sup>14</sup>

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;<sup>11a</sup>
- 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.

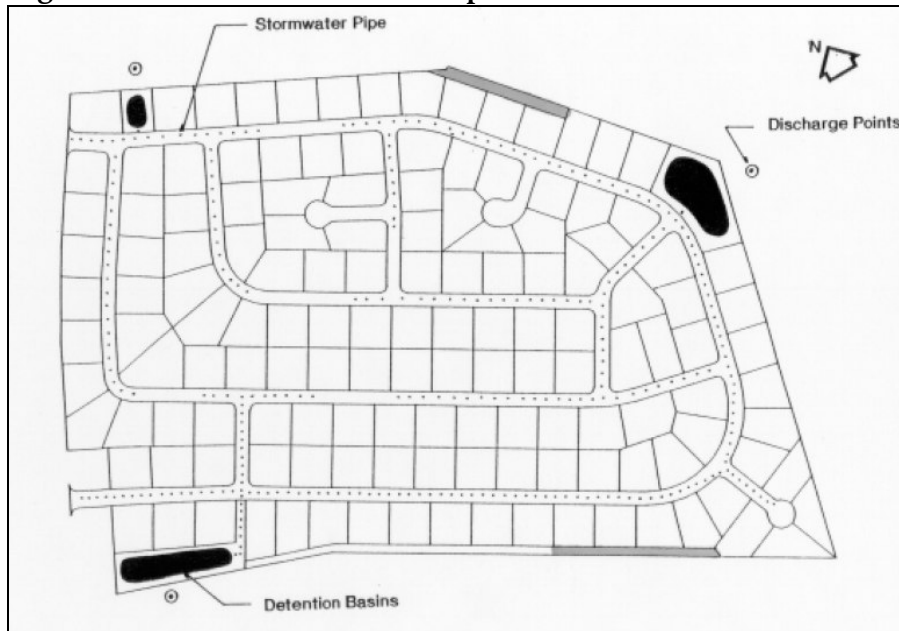
Figure 12. Conservation Design



Source: NHDES

<sup>14</sup> 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

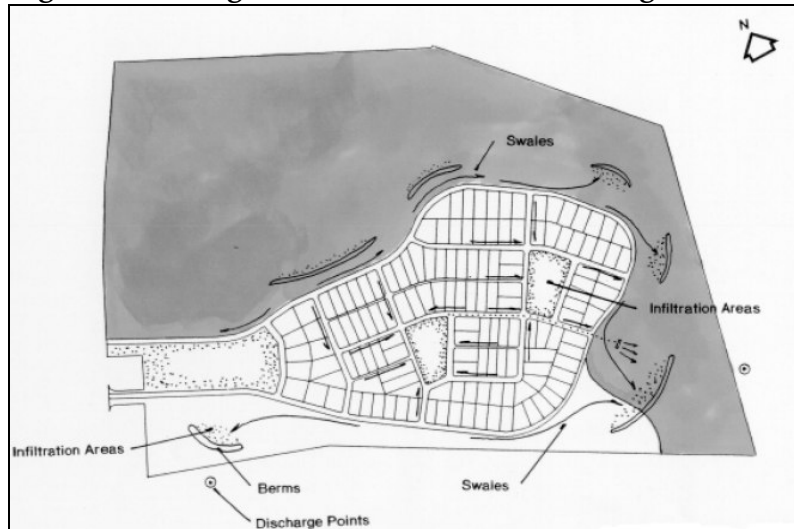
There are several conservation design techniques that can be applied to new developments. Figures 13 – 15 show how these BMPs may look in a conservation design compared to a conventional design. Figure 13 is of a conventional development design and resulting storm water treatment. Storm water treatment 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.<sup>15</sup> 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

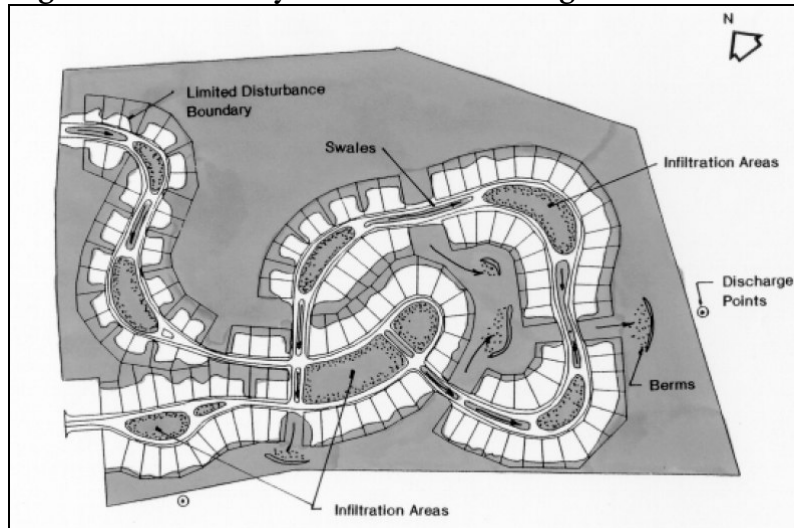
<sup>15</sup> Conservation Design for Storm water Management. A Design Approach to Reduce Storm water Impacts from Land Development and Achieve Multiple Objectives Related to Land Use. DE DNREC and Brandywine Conservancy. September 1997.

**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

- Disconnect impervious surfaces (e.g., slope drive-ways towards lawns or vegetated areas rather than the street).
- 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 (\$)**

Site Improvement	Conventional		Cluster	
	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
<b>Total</b>	<b>6,067,945</b>	<b>12,856</b>	<b>3,969,539</b>	<b>8,512</b>
<b>Cost difference on a per lot basis</b>		<b>4,344</b>		
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.<sup>16</sup>

<sup>16</sup> 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.



## **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.

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



Infiltration basin for large parking area with check dam at inflow

capacity of the ground. This should be taken into consideration when designing the infiltration structure.

### 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.<sup>17</sup> 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.

### 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



Source: Center for Watershed Protection  
**Infiltration basin clogged due to sediments**



Source: Center for Watershed Protection  
**Infiltration trench next to parking lot with vegetated swale as pretreatment**

<sup>17</sup> National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

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.

### **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.



**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.

### 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.



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



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.<sup>18</sup>

### 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.



Wet swale adjacent to a commercial parking lot

Source: LRPC



A vegetated filter strip is ideally suited for a residential development

Source: Center for Watershed Protection

### 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.

<sup>18</sup> National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

### 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. 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.<sup>19</sup> 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.



Source: Center for Watershed Protection

Underground sand filter during construction

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<sup>19</sup> 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.<sup>20</sup>

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 not 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.



Source: Containment Solutions, Inc.

Underground oil/water separator



Source: Center for Watershed Protection

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

<sup>20</sup> National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.



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 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.

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.<sup>21</sup> 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.<sup>22</sup> 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.



**This curb cut directs runoff to a bioretention area**



**Retrofits to these parking lot islands can create successful bioretention areas**

<sup>21</sup> National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

<sup>22</sup> Bioretention Applications. USEPA. EPA-841-B00-005A. October 2000.

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.

#### Section 4: Pond and Wetland BMPs

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.<sup>23</sup> 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).

##### 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



Source: Center for Watershed Protection  
The shape of this pond is aesthetically pleasing and enhances pollutant removal



Source: Center for Watershed Protection  
Dry ED pond for large runoff capacity - lack of woody vegetation on embankments protects structural stability

<sup>23</sup> 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.



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.)

#### 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.



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



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



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.<sup>24</sup>

### 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 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



Source: LRPC

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



Source: Center for Watershed Protection

**This wetland incorporates a safety bench and aquatic bench**

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

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

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



Source: Town of Belmont  
Construction site with poor/no ESC 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.<sup>25</sup> 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:<sup>26</sup>

- 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.



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



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

<sup>25</sup> Stormwater Management Manual for the Puget Sound Basin. Washington State Department of Ecology, Olympia, Washington. 1991.

<sup>26</sup> 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.



- 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 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



Source: Landscape Development, Inc.

**Concrete wash-out station**



common to construction sites that could be potentially hazardous to ground water and the recommended BMPs.

**Table 7. BMPs for Potentially Hazardous Construction Materials**

Material	BMP
Pesticides	<ul style="list-style-type: none"> <li>▪ Store pesticides in a secure, dry, covered area that has an impermeable floor.</li> <li>▪ Provide curbs or dikes around the storage area to prevent spills and leaks from reaching unprotected areas.</li> <li>▪ Provide site personnel with the proper pesticide spill response training and have adequate measures on-site to contain and clean up pesticide spills.</li> <li>▪ Strictly follow recommended application rates and application methods.</li> <li>▪ 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.</li> </ul>
Petroleum Products	<ul style="list-style-type: none"> <li>▪ 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.</li> <li>▪ 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.</li> <li>▪ Conduct periodic preventive maintenance of on-site equipment and vehicles to prevent leaks.</li> </ul>
Fertilizers and Detergents	<ul style="list-style-type: none"> <li>▪ 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.</li> <li>▪ Apply fertilizers more frequently but at lower application rates.</li> <li>▪ 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.</li> <li>▪ 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.</li> <li>▪ Do not mix surplus products together unless following specific instructions from the manufacturer.</li> </ul>
Hazardous Products	<ul style="list-style-type: none"> <li>▪ 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.</li> <li>▪ 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.</li> <li>▪ 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.</li> <li>▪ Do not remove the original product label from the container. It contains important use, safety, and disposal information about the product.</li> </ul>

**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 <ul style="list-style-type: none"> <li>▪ Trees and shrubs removed during clearing and grubbing</li> <li>▪ Packaging materials such as wood, paper, plastic, and polystyrene</li> <li>▪ Scrap or surplus building materials such as scrap metal, rubber, plastic, glass, and masonry</li> <li>▪ Paints and paint thinners</li> <li>▪ Demolition debris such as concrete rubble, asphalt, and brick</li> </ul>	<ul style="list-style-type: none"> <li>▪ Select a designated on-site waste collection area.</li> <li>▪ All regulated or hazardous wastes should be stored and handled according to procedures approved by the proper regulatory agency.</li> <li>▪ Provide an adequate number of containers with lids or covers that can be placed over the containers prior to rainfall.</li> <li>▪ Locate containers in a covered area when possible.</li> <li>▪ Arrange for waste collection before containers overflow.</li> <li>▪ 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.</li> <li>▪ Implement appropriate response procedures immediately when a spill does occur.</li> <li>▪ Plan for additional containers and more frequent pickups during the demolition phase of construction activities.</li> <li>▪ 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.</li> </ul>
Hazardous products	<ul style="list-style-type: none"> <li>▪ Follow manufacturer's recommended disposal method on product label – the materials have different properties and requirements for disposal.</li> </ul>
Contaminated soils	<ul style="list-style-type: none"> <li>▪ Clean on-site or excavate and remove to a designated location approved by the proper regulatory agency</li> </ul>
Concrete truck waste	<ul style="list-style-type: none"> <li>▪ Prevent residual wash-out from entering runoff</li> <li>▪ Construct dikes around wash-out area to allow concrete to harden before disposing as solid waste</li> </ul>
Sandblasting grits	<ul style="list-style-type: none"> <li>▪ Residue may be a hazardous waste depending on metal content</li> <li>▪ Do not direct residue to ground or storm sewer</li> <li>▪ Dispose of it as a hazardous waste or solid waste depending on metals content</li> </ul>
Sanitary waste	<ul style="list-style-type: none"> <li>▪ Contract waste hauler to dispose of sanitary waste and maintain the facilities</li> <li>▪ Do not discharge any waste to sanitary sewer system or septic system</li> </ul>

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

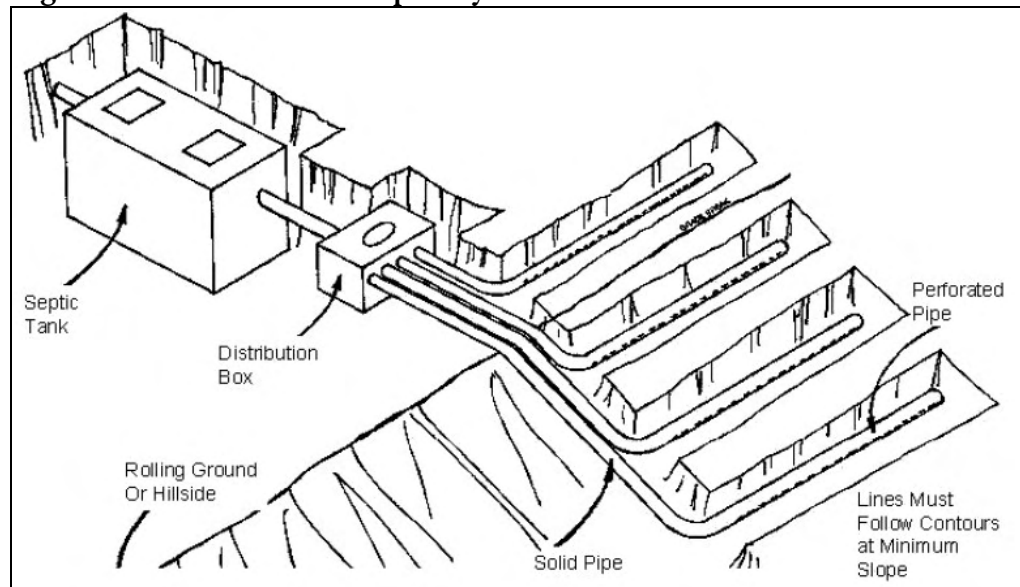


## Septic System BMPs

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.<sup>27</sup> 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.<sup>28</sup> 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

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

<sup>28</sup> Septic System Failure Summary. Parsons Engineering Science, prepared for USEPA. 2000

## 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.

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:<sup>29</sup>

- 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.

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<sup>29</sup> National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.



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.

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/>.

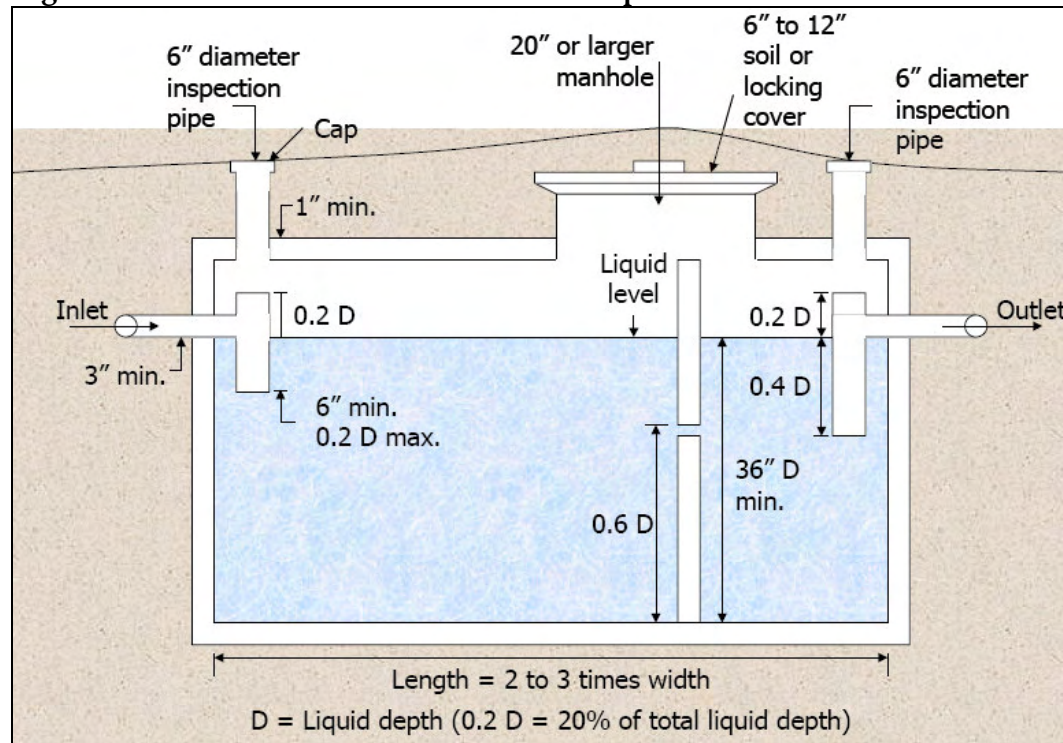
Regardless of the type of septic system being used, either conventional, innovative, or a combination, all systems require appropriate design, installation, and maintenance to function properly. The type of maintenance needed depends on the type of system being used and should be matched to those standards. 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:

- 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.

Figure 17. Illustration of a Conventional Septic Tank



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

- 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:



Source: LRPC

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](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	<ul style="list-style-type: none"><li>▪ Low cost (\$30-40/ton)</li><li>▪ Readily available</li></ul>	<ul style="list-style-type: none"><li>▪ Negative impact on the environment</li><li>▪ Corrosiveness</li></ul>
Alternative deicing chemicals	<ul style="list-style-type: none"><li>▪ Reduced corrosivity</li><li>▪ Reduced impact on the environment</li><li>▪ CaCl<sub>2</sub> can be used in very low temperatures (-20°F)</li></ul>	<ul style="list-style-type: none"><li>▪ Higher cost (from several hundred dollars per ton to several thousand per ton)</li><li>▪ CMA starts to act at a slower rate than salt</li></ul>

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

Source: LRPC

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.<sup>30</sup> 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.

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<sup>30</sup> 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

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](http://www.des.state.nh.us/StormWater/NH_IDDE_SOP.pdf).



Storage facility for salt and sand



## 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](http://www.des.nh.gov/rules/swrules.pdf) and [www.des.nh.gov/orcb/412.htm](http://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

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.



Household chemicals collected at the Household Hazardous Waste Collection Day



Source:

Recycled batteries and oil at the Household Hazardous Waste Collection Day

- 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.

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.



Source:

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:*

Ammonia-based cleaner  
Toilet/bathroom cleaner  
Abrasive cleaners  
Furniture polish  
Silver polish  
Disinfectants  
Drain cleaner  
Enamel/oil-based paints  
House plant insecticide  
Flea collars and spray  
Roach killer  
Ant killer  
Powdered detergents  
Chlorine bleach

#### *Use this:*

Vinegar, salt & water mixtures for surface cleaning  
Baking soda and water  
Rub with half a lemon dipped in borax, rinse  
1 part lemon juice, 2 parts olive/vegetable oil  
Soak in boiling water with baking soda, salt, piece of aluminum foil  
½ cup borax in 1 gallon water  
Plunger, flush with boiling water, ¼ cup baking soda, ¼ cup vinegar  
Latex or water-based paints  
Old dishwater or bar soap mixed with water (spray leaves and rinse)  
Gradually add brewer's yeast to pet's diet  
Powdered baking soda,  
Chili powder at doorsteps hinders entrance  
Liquid laundry detergents (do not have phosphates)  
Borax

Source: The Homeowner's Conservation Guide. 2<sup>nd</sup> 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.<sup>31</sup> Furthermore, research on diazinon indicates that even proper use, according to the label instructions, can result in harmful levels of diazinon in urban streams.<sup>32</sup> These findings suggest modifications to conventional landscaping practices are necessary to protect the aquifer from runoff and recharge in residential and commercial areas.

<sup>31</sup> National Management Measures to Control Nonpoint Source Pollution from Urban Areas. USEPA. EPA-841-B-05-004.

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



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 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.”<sup>33</sup> 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>.

<sup>33</sup> Wikipedia [[http://en.wikipedia.org/wiki/Integrated\\_Pest\\_Management](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:

- 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.

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

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.

