Chapter 5

Source Control Practices and Pollution Prevention

Volume 1: Background

Chapter 5

Source Control Practices and Pollution Prevention

5.1 Introduction

Controlling the sources of pollution and preventing pollutant exposure to stormwater are important management techniques that can reduce the amount of pollutants in stormwater and the need for stormwater treatment. Source control practices and pollution prevention can include a wide variety of management techniques that address stormwater and other nonpoint sources of pollution. Most are typically non-structural, require minimal or no land area, and can be implemented with moderate cost and effort as compared to structural treatment practices. In addition to management actions, source control and pollution prevention also include education and outreach.

Developing awareness of potential sources of pollution and ways to modify behavior in order to reduce both the amount of available pollutant and the volume of stormwater runoff are key elements in this approach to stormwater management. This chapter discusses the following source control and pollution prevention practices that are commonly applied in municipal, industrial, commercial and residential settings:

- *Street and Parking Lot Sweeping*
- *Roadway Deicing/Salt Storage*
- *Storm Drainage System Maintenance*
- *Other Road, Highway, and Bridge Maintenance*
- *Illicit Discharge Detection and Elimination*
- *Commercial and Industrial Pollution Prevention Plans*
- *Animal Waste Management*
- *Lawn Care and Landscaping Practices*
- *Model Stormwater Ordinances*
- *Public Education*

5.2 Municipal Practices

5.2.1 Street and Parking Lot Sweeping

Removal and proper disposal of sediment and debris from paved surfaces reduces the exposure of these materials to stormwater washoff and subsequent pollutant export to receiving waters. The reported effectiveness of street sweeping varies considerably among sources (e.g., EPA, 1983; Bannerman, 1999) and is particularly dependent upon the type of sweeper used.

Sweeper Type

Mechanical Broom Sweepers: These are the oldest and most common type of sweeper used for municipal roadway cleaning. They work like a broom and dustpan to pick of particles and only remove large debris. Mechanical broom sweepers are relatively ineffective at removing particles smaller than 60 microns. In addition, the broom action may actually break larger particles into smaller ones, which are more difficult to pick up (Schwarze Industries, Inc., 2001).

Vacuum Sweepers: Vacuum sweepers work in a manner comparable to household vacuum cleaners. Typically, a broom head pushes debris toward a suction inlet or vacuum. Traditional vacuum sweepers use a water-based dust suppression system, but still exhaust a high level of particulates into the atmosphere while in operation (Schwarze Industries, Inc., 2001).

Regenerative Air Sweepers: Regenerative air sweepers use a closed-loop, cyclonic effect to clean. Air is constantly recirculated or regenerated in the unit. It is blasted onto the pavement on one side of the sweeper head, picks up debris as it travels across the width of the head, and is suctioned up on the vacuum inlet on the other side of the sweeper head. Regenerative air sweepers use water for dust suppression and exhaust some particulates into the atmosphere during operation.

Dry Vacuum Sweepers: Unlike water-assisted vacuum sweepers, dry vacuum sweepers use a filtration system and require no water for dust suppression. Consequently, this type of sweeper can also be used in colder weather, since freezing conditions are not an issue for operation. The internal filtration system also results in less fine-grained particulate exhaust to the atmosphere compared to the mechanical sweepers discussed above.

Sweeper Effectiveness

The improvements in sweeper technology over the past 20 years have considerably improved the capability of sweepers to pick up the fine-grained sediment particles that carry a substantial portion of the stormwater pollutant load (EPA, 2002). A study by Terrene Institute in 1998 has shown that mechanical broom sweepers and water-assisted vacuum sweepers reduce nonpoint source pollution by 5-30 percent and nutrient content by 0-15 percent. However, dry vacuum sweepers are reported to reduce non-point source pollution by 35-80 percent and nutrients by 15-40 percent. Bannerman (1999) estimates that, depending upon sweeping frequency, dry vacuum sweepers could achieve a 50-80 percent overall reduction in the annual sediment load for a residential street.

The effectiveness of pavement sweeping in reducing nonpoint source pollution in a particular area is a function of several variables including:

Street Condition: Regular pavement repair and maintenance will encourage a smooth pavement condition and texture which will reduce the amount of particulates shaken from vehicles, increase the ease of street sweeping, and reduce the amount of particulates generated from the deteriorating street surface itself.

Geographic Location: The frequency of precipitation events capable of removing particulates from the paved surface will influence the effectiveness of a sweeping program.

Sweeper Operator's Skill: Optimum pollutant removal is a function of operator control over sweeper speed, brush adjustment and rotation rate, sweeping pattern, and maneuvering around parked vehicles.

Presence of Parked Vehicles: On-street parking of vehicles during sweeping reduces overall effectiveness.

Amount of Impervious Area Devoted to Rooftop (as compared to pavement): Sweeping is obviously more effective in areas where paved surfaces are the major contributor to impervious surfaces in a watershed.

Frequency of Sweeping: More frequent sweeping should improve overall sediment load reductions, and is particularly important for streets or other paved areas with high pollutant loadings.

Type of Mechanical Sweeper Used: As discussed above, dry vacuum and regenerative air sweepers are preferable to mechanical broom and traditional water-assisted vacuum sweepers. State, municipal, commercial, and industrial facilities with street sweepers should consider upgrading to the latest sweeping technology when new equipment is purchased. A 10-year equipment replacement cycle is recommended. (EPA, 2002). In colder climates such as Connecticut, street sweeping can be effectively used during the spring snowmelt to reduce pollutant loads from road salt (see section on deicing for further information) and sand export to receiving waters. In Connecticut, the recommended minimum frequency for street sweeping is once per year as soon as possible after snowmelt and, when possible, before spring rainfall events. In urbanized areas and other areas with higher potential pollutant loadings, streets may require sweeping more than once per year.

Because of the initial capital cost and operation and maintenance costs associated with a street sweeping program, municipalities should prioritize street sweeping activities to achieve the most effective pollution prevention. In general, street sweeping is most effective in urban areas and pollutant removal rates are typically higher on residential roads than for arterial roadways (EPA, 2002). When developing a street sweeping program, more sophisticated sweepers such as dry vacuum sweepers should be used in areas of higher pollutant loading, and these areas should also be considered for more frequent sweeping. Municipalities can also improve the effectiveness of street sweeping programs by enforcing construction site erosion controls, especially the use of anti-tracking pads to minimize excess sediment on paved surfaces; and developing and enforcing regulations for alternate side parking during cleaning operations, litter control, and trash and refuse storage and disposal, especially yard debris.

Disposal of Sweepings

Street sweepings may contain low levels of chemical compounds associated with stormwater runoff such as lead, sodium and compounds associated with asphalt and motor oils. Street sweepings are also likely to contain debris such as leaves, broken glass, and small pieces of metal.

Temporary Storage of Street Sweepings: Temporary storage of street sweepings prior to reuse or disposal should be located in an area where the sweepings will not wash into wetlands or watercourses. Acceptable temporary storage sites include:

- *an empty salt storage shed*
- *a municipal site where sand and salt are normally handled*
- *a paved area that is more than 100 feet from a wetland or watercourse*

Street sweepings should not be combined with sand and debris collected from catch basins. Material removed from catch basins may have higher concentrations of pollutants. Prior to reuse, materials such as trash, leaves and debris should be removed from the street sweepings by screening or other appropriate method and such materials should either be disposed of at a permitted solid waste facility, recycled (e.g. aluminum cans) or composted (e.g. leaves).

Limitations on Reuse of Street Sweepings without Testing: It is acceptable to reuse street sweepings without analyzing the concentration of chemical compounds in the following ways:

- *as fill in road construction projects where the sweepings are used below the paved surface or in the median strip of a divided highway*
- *as aggregate in concrete or asphalt*
- *as daily cover on a permitted landfill*

Limitations on Reuse of Street Sweepings with Testing: Properly tested street sweepings may be used for fill material on an industrial or commercial property, provided the testing for both heavy metals and semivolatile organic compounds, at a frequency of approximately one sample per 500 cubic yards of street sweepings, shows concentrations below the residential direct exposure standards established in the Remediation Standard Regulations found in Appendix A to Sections 22a-133k-1 through 22a-133k-3 in the Regulations of Connecticut State Agencies ("RCSA"). Alternatively, properly tested street sweepings may be reused at other sites in accordance with the regulations for reuse of polluted soil pursuant to Section 22a-133k-2(h) RCSA.

No Use on Residential Property: Street sweepings, regardless of testing status, are not recommended for use on residential property because they may contain broken glass or other sharp debris.

Disposal at Permitted Solid Waste Facility: Street sweepings that are not used in the manner described above should be disposed of at a permitted solid waste facility.

5.2.2 Roadway Deicing/Salt Storage

Salts, sand, gravel and other materials are applied to roadways during the winter months in Connecticut. The salts and other deicing materials discussed below lower the melting point of ice and are applied to reduce icing on roadways. Sand and gravel are applied to roadways to increase traction during and after adverse winter weather conditions.

Common Deicers

Sodium Chloride: Also called rock salt, this is the most commonly used deicing product due to its low cost and effectiveness. Sodium chloride will work at temperatures as low as –7°F, but is most effective at 10-15°F.

Calcium Chloride: This salt is a more expensive deicing agent than sodium chloride. However, it works at temperatures as low as -60°F, but is most effective at approximately -25°F.

Calcium Magnesium Acetate (CMA): CMA is a frequently used alternative to sodium chloride. It is made from dolomitic limestone treated with acetic acid. It is reported to work at temperatures as low as -5°F, but is most effective at approximately 20-25°F (Ohrel, 2000).

Blended Products: These new deicing materials consist of various combinations of sodium, calcium, magnesium, and chloride, as well as other constituents, but typically are lower in sodium chloride (Lucas, 1994).

Environmental concerns related to roadway deicing materials include:

- *Damage to vegetation growing adjacent to roadways receiving salt application (See plant list in* ***Appendix A*** *for a list of more salt-resistant vegetation for roadway plantings)*
- *Residues of chloride ions on the roadway surface that may contaminate groundwater resources*
- *Other substances in deicing chemicals that act to prevent caking (i.e., sodium ferrocyanide) or prevent corrosion may be toxic to human, animal, and fish life (FWHA, 1999)*

Table 5-1 compares the environmental effects of several common roadway deicers as reported in a 1993 study by the Michigan Department of Transportation and cited by Ohrel (2000). Other potential environmental impacts associated specifically with sodium chloride include temporary reductions in soil microbes, sensitivity of certain deciduous trees, and secondary components (3-5 percent of road salt composition)

Table 5-1 Comparison of Environmental Effects of Common Roadway Deicers

Media	Sodium Chloride ($NaCl$)	Calicum Chloride ($CaCl_2$)	CMA ($CaMgC_2H_3O_2$)	Sand (SiO_2)
Soils	Cl complexes release heavy metals; Na can break down soil structure and decrease permeability	Ca can exchange with heavy metals, increase soil aeration and permeability	Ca and Mg can exchange with heavy metals	Gradually will accumulate on soil
Vegetation	Salt spray/splash can cause leaf scorch and browning or dieback of new plant growth up to 50 feet from road; osmotic stress can result from salt uptake; grass more tolerant than trees and woody plants		Little effect	Accumulates on and around low vegetation
Groundwater	Mobile Na and Cl ions readily reach groundwater, and concentration levels can increase in areas of low flow temporarily during spring thaws. Ca and Mg can release heavy metals from soil			No known effect
Surface Water	Can cause density stratification in small lakes having closed basins, potentially leading to anoxia in lake bottoms; often contain nitrogen, phosphorus, and trace metals as impurities, often in concentrations greater than 5 ppm		Depletes dissolved oxygen in small lakes and streams when degrading	No known effect
Aquatic Biota	Little effect in large or flowing bodies at current road salting amounts; small streams that are end points for runoff can receive harmful concentrations of Cl; Cl from NaCl generally not toxic until it reaches levels of 1,000-36,000 ppm.		Can cause oxygen depletion	Particles to stream bottoms degrade habitat

Source: Adapted from Ohrel, 2000.

including nitrogen, phosphorus, and metals that may be released to receiving waters (Ohrel, 2000). The Federal Highway Administration (FHWA, 1999) reports that surface water resources are not as susceptible as groundwater to impacts from deicing chemicals due to the blending and dilution of runoff entering surface waters. However, the impact to surface waters depends on the amount of deicing chemical applied, the intensity of subsequent precipitation events, and the ecological health and use of the receiving water (FHWA, 1999).

Storage

Proper placement and storage of deicing chemicals is also important for preventing contamination of surface water runoff. **Table 5-2** summarizes recommendations for minimizing environmental impacts related to deicer, particularly salt, storage. Storage facilities should not be located within 250 feet of a well utilized for public drinking water, within a mapped Level A aquifer protection area, or within a mapped 100-year floodplain. They should also be at least 100 feet from wetlands or watercourses. Storage piles should be covered. This reduces the loss of deicing compounds from stormwater runoff and subsequent contamination of surface waters. Operationally, this reduces caking and clumping, making it easier to load and apply (EPA, 2002). Ideally, a structure should be provided for storage. At a minimum, all stockpiles should be covered with an appropriately sized, weighted tarp. All stockpile storage should be on impermeable pads.

Application

Proper application of deicers is important for both traffic safety and to prevent increased concentrations in roadway runoff. **Table 5-2** summarizes a few key suggestions for minimizing environmental impacts related to deicer, particularly salt, application. The Connecticut Department of Transportation (DOT) has developed guidelines for mixtures and application rates of sodium chloride and sand on state-maintained roadways in Connecticut (DOT, 1999). The mixture and application rates are a function of the type of roadway (i.e., two-lane versus multi-lane) and the weather and roadway conditions. Connecticut DOT also uses roadway sensors on some roads to create a thermal mapping of roadway temperatures and truck-mounted sensors that read both ambient and pavement temperatures. Since there may be differences between air and pavement surface temperatures, the use of sensors allows Connecticut DOT to tailor application rates to roadway conditions.

Training of public works personnel or others responsible for deicing in the proper storage and most effective application of deicers is also an important pollution prevention technique. The Salt Institute has developed a "Sensible Salting" training program (The Salt Institute, 2002) that focuses on maximizing the deicing properties of sodium chloride for roadway safety while protecting the environment. The program addresses:

- *Personnel training*
- *Equipment*
- *Calibration of spreaders*
- *Use of automatic controls*
- *Adequate, covered storage*
- *Proper maintenance around storage areas*
- *Environmental awareness for salt applicators*

Public drinking water supplies (potable surface water and groundwater) are particularly susceptible to contamination from roadway deicers. Reduced application rates or alternative deicers (calcium chloride or CMA) are recommended in environmentally sensitive areas such as public water supply watersheds, aquifer protection areas, and areas of high groundwater recharge. Road crews should be familiar with identified sensitive areas that may be affected by roadway deicer application.

Snow Disposal

"Waste" snow accumulated from plowing activities can be a source of contaminants and sediment to surface waters if not properly located. DEP has developed guidance for the disposal of post-plowing snow (DEP, 1995). The "waste" snow piles should be located in upland areas only and should not be located in the following locations:

- *Storm drainage catch basins*
- *Storm drainage swales*
- *Stream or river banks that slope toward the water*
- *Freshwater or tidal wetlands or immediately adjacent areas*

Table 5-2 Recommendations to Reduce Deicer Impacts

Activity	Recommendations
Storage	❍ Salt storage piles should be completely covered, ideally by a roof and, at a minimum, by a weighted tarp, and stored on impervious surfaces ❍ Runoff should be contained in appropriate areas ❍ Spills should be cleaned up after loading operations. The material may be directed to a sand pile or returned to salt piles ❍ Avoid storage in drinking water supply areas, water supply aquifer recharge areas, and public wellhead protection areas
Application	❍ Application rate should be tailored to road conditions (i.e., high versus low volume roads) ❍ Trucks should be equipped with sensors that automatically control the deicer spread rate ❍ Drivers and handlers of salt and other deicers should receive training to improve efficiency, reduce losses, and raise awareness of environmental impacts
Other	❍ Identify ecosystems such as wetlands that may be sensitive to salt ❍ Use calcium chloride and CMA in sensitive ecosystem areas ❍ To avoid over-application and excessive expense, choose deicing agents that perform most efficiently according to pavement temperature ❍ Monitor the deicer market for new products and technology

Source: Adapted from Ohrel, 2000.

- *Within 100 feet of private drinking water supply wells*
- *Within 500 feet of public drinking water supply wells*
- *Public drinking water supply watershed areas*

5.2.3 Storm Drainage System Maintenance

In order to maintain their intended function, stormwater drainage and treatment systems should be inspected at least annually. Deterioration of any part of the system that threatens the structural integrity of the facility should be immediately repaired. Inspection and cleaning of catch basins and stormwater inlets preserves the sediment-trapping function of these devices and also prevents sediment, trash, and other pollutants present in the storm drain system from reaching receiving waters. Removal of sediment and decaying debris from catch basin sumps yields aesthetic and water quality benefits including reduction of foul odors, suspended solids, bacteria, and the load of oxygen demanding substances (EPA, 1999; EPA, 2002). Pitt (1979, 1984) found that cleaning catch basins in urban areas twice a year reduced the loads of total solids and lead in urban runoff by 10 percent and 25 percent, respectively. This maintenance schedule also reduced loads of chemical oxygen demand (COD), total Kjeldahl nitrogen, total phosphorus, and zinc by 5 percent to 10 percent (Wisconsin Department of Natural Resources, 1994).

Catch basins and other stormwater structures that accumulate sediment should be cleaned at least annually. The cleaning should include both removal of sediment from the sump and removal of any trash or debris from the grate. Additional maintenance is recommended in the fall to remove trash, leaves, and other debris. In rural areas and areas that experience significant accumulation of leaves, the recommended fall maintenance should be performed after leaf fall and before the first snowfall. In addition, areas with higher pollutant loadings or discharging to sensitive water bodies should also be cleaned more frequently (WEF and ASCE, 1998). More frequent cleaning of drainage systems may also be needed in areas with relatively flat grades or low flows since they may rarely achieve sufficiently high flows for self-flushing (Ferguson et al., 1997). Deviations from these recommended frequencies may be warranted based on field evaluation of actual sediment and debris accumulation rates, including identification and prioritization of structures that may require more or less frequent cleaning.

In addition to catch basin cleaning, storm drainage system maintenance should include removal of debris from surface basins used for stormwater management (Washington, 2000). The design sections of this Manual contain additional guidance on maintenance of stormwater treatment practices.

Polluted water or sediment removed from the storm drainage system must be disposed of properly. Before disposal, a detailed chemical analysis of the material should be performed to determine proper methods for storage and disposal (EPA, 1999).

Stormwater drainage systems located on private property, but subject to regulatory review and permitting, should be required to have similar operation and maintenance plans to protect receiving waters.

5.2.4 Other Road, Highway, and Bridge Maintenance

The following operation and maintenance practices for roads, highways, and bridges can further reduce stormwater pollutant loadings:

- *Develop an overall inspection program to ensure that general maintenance is performed on urban runoff and nonpoint source pollution control facilities.*
- *The use of chemicals such as soil stabilizers, dust palliatives, sterilants, and growth inhibitors should be limited to the best estimate of optimum application rates. All feasible measures should be taken to avoid excess application and consequent intrusion of such chemicals into surface runoff.*
- *Use techniques such as suspended tarps, vacuums, or booms to reduce, to the extent practicable, the delivery to surface waters of pollutants used or generated during bridge maintenance (e.g., paint, solvents, scrapings).*
- *Maintain retaining walls and pavements to minimize cracks and leakage.*
- *Repair potholes.*
- *Inspect silt fences and replace deteriorated fabrics and wire connections. Properly dispose of deteriorated materials.*
- *Renew riprap areas and reapply supplemental rock as necessary.*
- *Repair/replace check dams and brush barriers; replace or stabilize straw bales as needed.*
- *Regrade and shape berms and drainage ditches to ensure that runoff is properly channeled.*
- *Seed and fertilize, seed and mulch, and/or sod damaged vegetated areas and slopes.*
- *Apply seed and mulch where bare spots appear, and replace matting material if deteriorated.*
- *Ensure that culverts and inlets are protected from siltation.*

- *Inspect all permanent erosion and sediment controls on a scheduled, programmed basis.*
- *Ensure that energy dissipators and velocity controls to minimize runoff velocity and erosion are maintained.*

5.2.5 Illicit Discharge Detection and Elimination

Illicit discharges are non-stormwater flows that discharge into the stormwater drainage system. Failing septic systems, wastewater connections to the storm drain system, and illegal dumping are among the types of illicit discharges that can occur. Depending on the source, an illicit discharge may contain a variety of pollutants that can impact both human health and the aquatic environment. Identifying and eliminating these discharges is an important means of pollution source control in a stormwater drainage system.

This section provides a brief description of several common types of illicit discharges, techniques for illicit discharge detection, and public education and regulatory measures for preventing illicit discharges.

Failing Septic Systems

Septic systems are on-site wastewater disposal systems that provide a means of treating domestic wastewater in areas where public sanitary sewers are not available. After separating the solids from the wastewater stream, the septic system discharges the effluent into the ground. A failing septic system discharges effluent into the ground at concentrations that exceed water quality standards. Systems can fail for a number of reasons including unsuitable soil conditions, lack of or improper maintenance, or improper design and installation (EPA, 2002). Failing systems, as well as properly functioning septic systems in some instances, can be significant sources of nutrients, especially nitrogen, and microbial pathogens to both surface water and groundwater. Effluent that pools on the ground surface can be transported by runoff and enter nearby storm drainage systems and surface waters.

Detection of individual failing septic systems typically requires detailed on-site inspection. However, the presence of odors and isolated areas of very green grass or pooling on the ground surface are typical indicators of a failing system. Detection of optical brighteners and the use of color infrared (CIR) aerial photography are two field screening techniques that can be used (EPA, 2002). Optical brighteners are fluorescent white dyes that are used as additives in laundry soaps and detergents and are commonly found in domestic wastewater. The presence of optical brighteners can be detected by placing cotton pads in storm drains, pipes, or surface waters and then exposing them to ultraviolet light (Sargent and Castonguay, 1998). CIR is a relatively quick and cost-effective method that uses variations in vegetation growth or stress patterns to determine potentially failing septic systems (EPA, 2002).

Prevention of discharges from failing septic systems relies heavily on public education to inform homeowners about the need for routine septic system maintenance. Local health departments have educational materials available to assist with public education on this issue. In some cases, municipalities have instituted local ordinances with advanced design standards, mandatory pump-out schedules, required reporting of pump-out activities by private vendors, and inspection of septic systems upon property transfer (EPA, 2002).

Wastewater Connections

Untreated wastewater (e.g., process wastewater, wash waters, and sanitary wastewater) from business or commercial establishments that is discharged to the storm drainage system can introduce heavy metals, oil and grease, solids, sewage, detergents, nutrients, ammonia, chlorine and potassium (EPA, 2002). These contaminants can result in a variety of impacts to human health and the aquatic environment, including eutrophication, aquatic toxicity, reduced oxygen levels, and bacterial contamination (EPA, 2001).

Illicit wastewater discharges may be the result of inadvertent cross-connections between sanitary sewer and storm drainage systems. Floor drains, wash sinks, sump pumps, and solvent sinks are examples of drains that may be inadvertently connected to the storm drainage system as the result of poor mapping on internal facility pumping systems or incorrect sewer mapping (EPA, 2002). In some cases, untreated wastewater may be intentionally discharged to the storm drainage system as an inexpensive or convenient alternative to proper wastewater disposal and treatment (EPA, 2002).

Detection of illicit discharges for commercial and industrial sites can occur during both the design phase and during facility operation. During construction, inspection and verification of facility piping can avoid the need for later detection and evaluation. For facilities in operation, the use of the field screening techniques, source testing protocols, and the visual inspection methods described below can identify improper connections.

Illegal Dumping

The disposal of solid wastes in an unpermitted area, the pouring of liquid wastes or placement of trash into a storm drainage system, and blowing or sweeping of landscape debris into a public right of way or a storm drainage system are common methods of illegal dumping. Runoff from areas of illegal solid waste disposal can enter the stormwater drainage system and pollute receiving waters. Liquids or solids deposited directly into the storm drainage system are also sources of potential contamination. The extent and type of pollution generated by illegal dumping and the subsequent water quality impairment depends upon the characteristics of the illicit discharge.

Most municipalities have ordinances that prohibit illegal dumping and include penalties such as fines, jail time, or community service. However, detection of illegal dumping activities requires public education and awareness to encourage reporting of suspected illegal dumping activities.

Methods of Illicit Discharge Identification

Methods for identifying illicit discharges can vary widely in the level of effort and cost required for implementation. The following field-based methods are often used to identify illicit discharges in storm drainage systems:

Testing of Dry Weather Discharges: Flows from stormwater outfalls during dry weather may indicate an illicit discharge. A combination of visual inspection and chemical analysis of dry weather discharges can aid in identifying potential discharge sources.

Visual Inspection: Examination of piping connections by either physical examination or closed-circuit camera can be used to identify possible illicit connections.

Review of Piping Schematics: Examination of architectural plans and plumbing details can reveal potential sites of improper connections.

Smoke Testing: Injection of a non-toxic vapor (smoke) into the facility plumbing system and following its path of travel can be used to locate connections.

Dye Testing: In this method, appropriate colored dyes are added into the drain water of suspect piping. Appearance of the dyed water in the storm drainage system indicates an illicit discharge. As mentioned in the discussion of septic system discharges, testing for optical brighteners can provide an indication of the presence of domestic wastewater flows.

Infrared, Aerial, and Thermal Photography: Use of aerial, infrared, and thermal photography to locate patterns of stream temperature, land surface moisture, and vegetative growth are emerging techniques to identify potential illicit discharges to stormwater systems.

(EPA, 1999; 2002). In addition to these field methods, building and plumbing codes can help to prevent potential cross-connections between storm drainage and sanitary sewer systems. Municipalities can also prioritize illicit discharge detection efforts based on building age and/or operation type. Older buildings are more likely to have cross connections or other inappropriate discharges. A possible priority system for detecting illicit discharges from businesses is as follows:

1. *Automobile-relatedbusinesses/facilities and heavy manufacturing*
2. *Printers, dry cleaners/laundries, photo processors, utilities, paint stores, chemical laboratories, construction companies, and medium to light manufacturing*
3. *Institutional facilities, private service agencies, retail establishments, and schools*

(EPA, 2002).

5.3 Industrial and Commercial Practices

5.3.1 Stormwater Pollution Prevention Plans

Commercial and industrial facilities, including institutional facilities, can potentially contribute point or nonpoint pollution to stormwater through activities associated with operations, maintenance, and storage. DEP provides general pollution prevention information applicable to a wide variety of industries as well as pollution prevention fact sheets for the following specific industries:

- *Aerospace*
- *Chemical Manufacturers*
- *Coating*
- *Dry Cleaning Businesses*
- *Fabricated Metal*
- *Fiberglass-Reinforced Composite Plastics*
- *Marine Maintenance and Repair*
- *Metal Casting*
- *Metal Manufacturing/Finishing*
- *Metal Parts Cleaning*
- *Paint Manufacturers*
- *Pesticide Applicators*
- *Pesticide Formulating*
- *Pharmaceutical*
- *Photoprocessing*
- *Radiator Service*
- *Printed Circuit Board*
- *Printing*
- *Research and Educational Institutions*
- *Steel*

(DEP, 2002). Stormwater Pollution Prevention Plans (SWPPPs) are one facet of a facility-wide approach to pollution prevention activities. SWPPPs identify potential sources of pollution and outline specific management activities designed to minimize the introduction of pollutants into stormwater. In Connecticut, commercial and industrial facilities required to register under the General Permit for the Discharge of Stormwater Associated with Commercial Activities or the General Permit for the Discharge of Stormwater Associated with Industrial Activities have specific SWPPP requirements. (See Chapter One for a discussion of stormwater regulatory programs) Although each SWPPP must be tailored to an individual facility, as well as any regulatory requirements, the following elements are typically included:

Description of Potential Pollutant Sources: This section of the plan describes potential sources of pollutants that may reasonably be expected to affect stormwater quality at the site or that may result in the discharge of pollutants from the site during dry weather. Activities (e.g., fueling, vehicle and equipment maintenance and cleaning, and loading and unloading) and materials that may be sources of stormwater pollution should be identified. This section of the SWPPP may also include a description of the site drainage showing the direction of stormwater flow, an inventory of materials exposed to precipitation, a list of spills and leaks, and a description of any monitoring done at the site.

Stormwater Management Measures and Controls: This section of the plan describes stormwater management measures and controls for the facility and a schedule for their implementation. Typical elements discussed in this section of the SWPPP include good housekeeping practices, vehicle or equipment washing, sediment and erosion control, preventive maintenance, sweeping, spill prevention and response, outside storage, employee training, non-stormwater discharges, facility inspection, and stormwater runoff management and treatment.

Comprehensive Site Compliance Evaluation: A qualified individual knowledgeable about the General Permit requirements and the objectives and contents of the SWPPP should conduct an evaluation of the site for compliance with the provisions of the SWPPP on a regular basis. The frequency of the evaluation depends on specific permitting requirements, but typically is at least annually for commercial sites and twice per year for industrial facilities in Connecticut. The evaluation should include a visual inspection of potential pollutant sources identified in the plan to determine evidence of, or potential for, pollution entering the stormwater system; an evaluation of the management measures identified in the plan to assure that they are in place and operating correctly; and visual inspection of equipment (e.g., spill response equipment) needed to implement the plan. If possible, inspections should be conducted during rainfall events and a written report of the inspection and its findings should be prepared and retained with the SWPPP.

Pollution Prevention Team: A pollution prevention team, consisting of one or more individuals, should be identified in the plan. The team will be responsible for developing, implementing, maintaining, and revising the plan.

Record Keeping: Record keeping elements in the plan should include inspections and evaluations of the site, a list of the pollution prevention team members and their assigned responsibilities, spill control and response plans, training schedules, and stormwater-related maintenance schedules (e.g., structure cleaning, sweeping, etc.), as well as stormwater quality monitoring results.

Certification: If the SWPPP is a regulatory requirement, the plan will also require certification by a professional engineer, licensed to practice in Connecticut, stating that the SWPPP meets the requirements of the General Permit.

5.4 Lawn Care and Landscaping Practices

Source control and pollution prevention techniques related to landscaping and gardening activities rely on public education and awareness. The use of alternative landscaping techniques and judicious use of fertilizers and pesticides in landscaping and gardening require voluntary cooperation from the public, business owners, and landscaping professionals. While municipalities can establish landscaping practices for their public works or other departments that perform landscaping functions, public education is the primary method for encouraging private homeowners to adopt more environmentally friendly landscape and gardening practices. The UConn Cooperative Extension System's Residential Water Quality Program has educational workshops and materials to assist with this public education (http://www.nemo.uconn.edu).

5.4.1 Xeriscaping and General Landscape Management

Xeriscaping is landscaping to minimize water usage ("xeri" is the Greek prefix meaning "dry") and incorporates two essential components:

- *Using native plants that are adapted to Connecticut's climate and that require minimal watering, fertilizer, and pesticide application*
- *Improving soils by adding soil amendments or using mulches to reduce the need for watering by increasing the moisture retained in the soil*

(Salsedo and Crawford, 2000). In addition to promoting water conservation, minimizing water use and water loss will reduce the transport of pollutants into downstream surface waters. Because xeriscaping typically results in a reduced need for pesticides and fertilizers as part of landscape maintenance, this approach to lawn and turf management also reduces nutrient and pesticide contamination in stormwater runoff.

Residential and commercial property owners, as well as municipalities and other government agencies responsible for maintaining large vegetated areas, can use Xeriscaping. Xeriscaping incorporates seven basic principles that are also generally applicable to lawn and turf management:

Planning and Design: Appropriate and thoughtful planning and design is critical for the long-term success of the xeriscaped landscape. Landscape planning should consider soil and topographic characteristics, light conditions, drainage, existing plantings to be preserved, and owner preferences such as the desired level of maintenance, budget constraints and plant and color preferences (NYCDEP, 2002).

Soil Improvements: Improving soil conditions will help to retain water in the soil. Soil should be analyzed to determine current conditions and needed soil amendments. Addition of organic matter such as compost or peat moss to the soil will improve soil moisture retaining capabilities. The soil below the surface layer should be examined to identify limitations such as compaction.

Practical Turf Areas: Because of the water requirements of many turf grasses, limit or reduce the amount of turf areas (EPA, 2002), or convert existing turf areas to the alternatives described below. Groundcovers, planting beds or permeable surfaces like wood decks and brick-on-sand walkways are options for reducing turf areas (Salsedo and Crawford, 2000). Turf areas should be designed in rounded, compact shapes to water and mow more efficiently and appropriate turf varieties should be selected for the site. See the plant list in **Appendix A** for suggestions.

Appropriate Plant Selection: Selecting trees, shrubs, flowers, grasses, and groundcovers that are either native to the region or are non-invasive, non-native adapted species will reduce the amount of watering needed. These plants are adapted to the soil and rainfall conditions in Connecticut and in many cases will require minimal or no watering after an establishment period. Choosing a variety of plants will avoid a monoculture, which may be more susceptible to pest or insect problems than more stable and diverse plant populations (Greenbuilder, 2001). Native plants are also less susceptible to pests or disease (DEP, 1999b). In addition, it is advisable to select plants from reputable nurseries since these plants are often more viable. A partial list of native species is provided in **Appendix A**. For additional information on native species selection and availability, refer to the Additional Information Sources at the end of this chapter.

Efficient Irrigation: Irrigation techniques can be used to reduce overall water use. Encouraging the growth of deep roots enables plants to reach deeper into the soil for moisture. Watering only when needed and allowing the water to penetrate deeper into the soil will encourage deeper root growth (EPA, 2002). A soil moisture sensor can also be used to determine when watering is necessary. Using a soaker hose or drip irrigation system will target watering and result in less evaporation than occurs with sprinkler systems. Watering in the early morning and evening will also reduce evaporation losses. Collection of residential roof runoff in a rain barrel or cistern can provide a reservoir for landscape watering with high quality water (Salsedo and Crawford, 2000). In addition to these irrigation techniques, plants should also be grouped by water needs to reduce overall water usage.

Effective Use of Mulches: Use of mulch helps to maintain soil moisture, reduce weed growth, and prevent erosion (EPA, 2002). Organic mulches such as peat moss, compost, wood chips, shredded bark or bark nuggets, pine needles, cocoa bean shells, leaves, and sawdust retain soil moisture and provide nutrients to the soil for plant growth. Inorganic mulches such as sheeting, stone, or gravel will also reduce moisture loss, but will not provide nutrients and are recommended only for unplanted areas. Mulch typically should be placed in layers three to four inches thick and should be set back a few inches from shrub stems or tree trunks to avoid possible rodent damage to the bark.

Appropriate Regular Maintenance: Properly timed maintenance such as pruning, liming and fertilizing (only when indicated by soil testing), weeding, pest control and mowing will encourage the long-term viability of the xeriscaped landscape (NYCDEP, 2002). A composting area for yard and household waste will provide mulch and reduce solid waste disposal. Alternatively, designation of several smaller planting beds or areas in the landscape where grass clippings, pine needles or leaves can be recycled as mulch can decrease overall maintenance and create conveniently located supplies of organic mulch (Salsedo and Crawford, 2000). Mowing turf areas high and often lowers the stress on grasses and reduces watering needs. By setting mower blades at three inches and mowing when the lawn is at approximately four inches, clippings are less likely to mat and will provide nutrients for the lawn (DFWELE, 2001).

In addition to the xeriscaping concepts described above, no landscaping debris (grass clippings, leaves, brush, prunings, mulch, soil, etc.) should be deposited, dumped, blown, or swept directly into a watercourse, wetland, storm drainage system, or public right of way.

5.4.2 Fertilizer and Pesticide Management

Landscaping and gardening activities can result in contamination of stormwater through fertilizer and pesticide runoff. Over-application or mis-application of fertilizers can be a significant source of nutrients such as phosphorus and nitrogen in stormwater runoff. Pesticides in stormwater runoff may be toxic to aquatic organisms. The selection, rate, and timing of application of both fertilizers and pesticides are key for minimizing possible runoff contamination. These source control measures can be implemented by citizens, businesses, municipalities, and government agencies to minimize stormwater contamination.

Soil testing should be done prior to fertilizer application to ensure that appropriate fertilizers are selected and that the rate of fertilizer application is suitable for the soil conditions. Soil often contains adequate levels of phosphorous, and most fertilizer mixes contain significantly more phosphorous than necessary. Therefore, low-phosphorous fertilizers may be appropriate under most conditions. Phosphorous application is typically most critical when seeding. Slow-release organic fertilizers are recommended, as they are potentially less toxic than other types of commercial fertilizers and are less likely to enter stormwater runoff (EPA, 2002).

Fertilization should be timed so that it is most beneficial to the target species. For example, warm season grasses such as Creeping Red Fescue (Festuca rubra), Big Bluestem (Andropogon gerardii), or Little Bluestem (Schizachyrium scoparius) should be fertilized in small frequent doses in the summer while cool season grasses such as Kentucky bluegrass (Poa pratensis) benefit from fall fertilization (EPA, 2002). Research has shown that there is little or no benefit to applying fertilizers to turf after mid-September in Connecticut since nitrogen is leached into the soil with minimal or no benefit to the vegetation. In addition, to minimize mobilization of fertilizer into surface water runoff, fertilizer should not be applied on a windy day or immediately before a heavy rain.

Pesticides, which include herbicides, insecticides, fungicides, and rodenticides, should only be utilized when absolutely necessary and should be selected to specifically target the pests of concern. Potential pests, which may be weeds, diseases, insects, or rodents, should be positively identified in order to determine if they pose an actual threat to the landscape and to enable the targeted selection of pesticides. If possible, the use of chemical pesticides should be avoided. When chemical pesticide use is unavoidable, the least toxic pesticide that targets the pest of concern should be selected. This approach to pesticide usage is formalized in a management technique called Integrated Pest Management (IPM). IPM developed in the turfgrass management field to produce high quality ornamental turfgrass with the most judicious use of pesticides. The principals of IPM are applicable to any landscape. IPM combines monitoring, pest trapping, establishment of action thresholds, use of resistant varieties and cultivars, cultural, physical, and biological controls, and precise timing and application of pesticide treatments (DEP, 1999b).

As discussed in the section on xeriscaping, native plant species are typically better adapted to the local environment and require less fertilization and are less susceptible to pests and disease.

5.4.3 Animal Waste Management

The fecal matter of domestic pets and waterfowl can be carried by stormwater runoff into nearby waterbodies or storm drainage systems. In addition to contributing solids to stormwater, animal fecal matter is a source of nutrients and pathogens, such as bacteria and viruses, in stormwater runoff (EPA, 2002). Nutrients can contribute to eutrophication of waterbodies, which together with the oxygen consumption caused by decaying fecal matter, can encourage oxygen-depleting conditions in water bodies.

Recommended methods for proper disposal of domestic pet waste include:

- *Bagging the waste and disposing of it in household trash (EPA, 2002)*
- *Burying it in at least 5 inches of soil away from vegetable gardens and water supplies (University of Wisconsin – Extension, 1999)*

Source control and pollution prevention techniques for pet waste management rely on modification of the behavior of pet owners and typically involve the combined use of public education campaigns and local ordinances. Many people are not aware of the potential pollution caused by their pets. Information on both the pollution effects of pet waste and the proper methods for collection and disposal of the waste can be distributed to pet owners through direct mailings or municipal utility/tax bill enclosures, local veterinarians, local pet stores, and as part of a municipal dog or pet licensing process.

Creating an environment that encourages proper pet waste disposal in areas such as public parks where pet waste is likely to be found is an additional method of pollution prevention. Signage requesting that owners pick up and dispose of pet waste as well as the availability of plastic bags, scoops, and disposal receptacles are common techniques used. Local ordinances mandating pet waste removal and disposal are an additional tool. Such "pooper-scooper" laws typically require pet owners to remove and dispose of any waste generated by their pet at a location other than the owner's property and may include fines. In areas of sensitive water resources, such as bathing beaches, public water supplies or shellfish areas, prohibition of domestic pets is an additional source control mechanism.

In addition to domestic pets, waterfowl can be a significant source of nutrient and pathogen loading to surface waters. Canada geese are Connecticut's largest native waterfowl population and, along with gulls, are the primary sources of waterfowl-related water quality impacts. Since the 1950s, the "resident" population of Canada geese has grown dramatically. Unlike migrant populations that travel south in the winter, resident geese are well adapted to suburban habitat and live year-round in areas that provide a combination of open water, cover, and grazing areas. Park ponds, reservoirs, and golf courses are examples of areas that typically provide a combination of these habitat features. (DEP, 1999c).

Lethal methods of waterfowl control, such as hunting, are among the most effective, but are typically not feasible in the suburban and urban areas where waterfowl management is of greatest concern (DEP, 1999c). Other control methods for waterfowl, especially geese, consist of:

Habitat Modification: This method focuses on changes in the vegetation available for grazing and/or the alteration of the relationship between open water and grazing habitat. Geese are especially attracted to ponds and lakes that have gradually sloping banks and lawn or other similar vegetation, allowing them to easily walk between open water and land. Planting unpalatable species such as pachysandra or allowing vegetation to grow tall in areas adjacent to water bodies will make these areas unattractive for grazing. Planting of species that also create a visual and physical barrier (see below) between land and open water will also make the habitat less conducive to geese populations. In addition, it is important that people do not artificially feed geese (i.e., bread or grain), which can be a particularly prevalent problem in public parks.

Barriers and Exclusion: Barriers for goose control should be at least 3-feet high. Effective barriers can consist of either vegetation or structural materials. Dense shrub plantings or mixed-vegetation buffer zones 20 to 100-feet wide along a shoreline are possible vegetative barriers. Wooden snow fence, soft or hard nylon fencing, or chicken wire or weld wire fences are artificial barriers that can be effective, although not aesthetically pleasing, for excluding geese from freely crossing between open water and grazing areas (DEP, 1999c; Metropolitan Council, 2001).

Non-Toxic Repellants: Repellants that either change the reflective property of the grass and make it look unnatural to geese or irritate the throats of the geese can be sprayed on feeding areas.

Frightening Methods: In order to be effective, frightening methods need to be employed before geese establish a feeding pattern at a particular location because they may become accustomed to repetitious frightening methods once they realize that there is no real danger (DEP, 1999c). Typically, frightening methods are most effective when they coincide with feeding times, typically sunrise and sunset. Frightening techniques can consist of pyrotechnics that create loud noises. Visual methods such as helium balloons, flags, and scarecrows are often effective because geese are uncomfortable with moving objects overhead. Mylar plastic flash tape, strung like a string fence at one to two feet above the ground is another visual frightening method. Where feasible, free-ranging dogs trained to chase geese or even tethered dogs that are allowed extensive movement can be effective.

Mute swans are also an increasing problem in natural and constructed ponds/wetlands. These exotic birds are very territorial and chase away native waterfowl. In addition to increased loadings of fecal matter, these birds can damage planted and established vegetation and can uproot submerged plants. Mute swans have been identified as a significant cause of eelgrass bed decline in Long Island Sound.

5.5 Model Stormwater Ordinances

Municipal ordinances provide the legal authority for resource protection on the local level. Although ordinances need to be specific to the particular conditions of a community, stormwater-related ordinances typically contain the following basic elements:

Finding of Fact/Purpose and Objectives: This section addresses why the ordinance is necessary and what its objective and purpose is.

Authority/Jurisdiction: This section describes the authority for the adoption of the ordinance and the jurisdiction covered under the ordinance.

Definitions: Key terms used in the ordinance are clearly defined in this section.

Requirements and Standards: These elements may vary considerably depending upon the topic of the ordinance and the content of other ordinances already in place. These sections describe the actual elements of resource protection.

Enforcement: This section describes violations of the ordinance, notices of violations, and penalties.

Appeals and Variances: These sections describe the mechanism and requirements for appeals and variances under the ordinance.

(Wisconsin Department of Natural Resources, 1994; EPA, 2000). As described in prior sections of this chapter, municipal ordinances provide an enforceable method of instituting the following pollution prevention and source control measures:

Illicit Discharges: An illicit discharge ordinance regulates non-stormwater discharges to municipal stormwater drainage systems. A critical element of illicit discharge ordinances is a guaranteed "right of entry" to private property, giving the authority to inspect properties suspected of releasing contaminated discharges into the stormwater drainage system (CWP, 2002a). **Appendix C** contains a model illicit discharge detection and elimination ordinance developed by DEP in conjunction with the Stormwater Phase II Municipal Separate Storm Sewer System (MS4) General Permit.

Post-Construction Stormwater Controls: Ordinances for post-construction stormwater controls are useful for communities that have no existing ordinances addressing stormwater management. Typically a post-construction stormwater control ordinance will include language referring to the latest version of a stormwater guidance manual so that the ordinance itself will not need to be updated to reflect technological advances or changes in stormwater management techniques. The ordinance should also require a post-construction stormwater management plan, including plan contents and operation and maintenance requirements (CWP, 2002b).

To ensure that new and redevelopment projects include stormwater management plans, municipal planning and zoning commissions should review and revise their site and subdivision plan submission requirements to require such plans. Chapter Nine describes how to develop a site stormwater management plan.

Stormwater Operation and Maintenance: For communities with existing ordinances that address stormwater management, but do not include provisions for post-construction operations and maintenance, a stormwater operation and maintenance ordinance can augment existing local stormwater management ordinances. Like the model ordinance in **Appendix C**, a stormwater operation and maintenance ordinance should specify requirements for an operation and maintenance plan, the entity responsible for long-term maintenance, and the frequency of inspections (CWP, 2002c).

The Center for Watershed Protection (www.cwp.org) and the U.S. Environmental Protection Agency Office of Water (www.epa.gov/nps/ordinance/index.htm) provide information on local stormwater-related ordinances, including model ordinances and examples of local ordinances from communities across the United States.

The model ordinances in **Appendix C** of this Manual are provided for informational purposes only and should not be adopted as a legal requirement without modification to fit the specific needs of the municipality and the local water resource conditions.

5.6 Public Education and Outreach

Nearly all source control and pollution prevention techniques rely on some level and form of public education. In some cases, education efforts must be targeted at municipal officials and public works employees (e.g., stormwater ordinances, roadway deicing application, storm drainage system maintenance). The general public, including business owners and operators, plays an important role in almost all of the source control and pollution prevention measures described in this chapter. Often, the public is not aware of the critical role they have in protecting water resources. Public education is an important part of an overall pollution prevention and source control program because it raises awareness of both personal responsibilities and the responsibilities of others relative to environmental protection, and teaches people what individual actions they can take to prevent pollution. This increased understanding has the additional benefit of fostering support for other stormwater management efforts.

This section describes some common general techniques for public education that can be used in addition to the specific methods described in earlier sections.

Public Education Materials

Public education campaigns can consist of a variety of elements including:

- *Educational displays, pamphlets, booklets, and utility stuffers*
- *Use of the media (newspapers, television, radio)*
- *Promotional giveaways (hats, t-shirts, bumper stickers, etc.)*
- *Stormwater educational materials*
- *Classroom education*

The choice of outreach materials is dependent upon the resources available and the target audience. A variety of general educational materials on stormwater and pollution prevention are available from state and federal government agencies, as well as education and industry groups (see references below for a partial list of such contacts).

Businesses

Because many commercial activities can potentially contribute to stormwater pollution, businesses are a common target for public education. Public outreach activities should be targeted to the specific business audience, i.e., automotive-related, dry cleaners, etc. Materials can include posters, calendars, flyers, brochures, handbooks, and best management practice (BMP) fact sheets targeted to the specific industry. Because of the wide variety of businesses, public education and outreach programs should prioritize efforts on business types that might have the most potential to contribute to stormwater pollution or might be most receptive to outreach.

Municipal Officials

Because of their involvement in establishing and implementing local source control and pollution prevention measures, municipal officials are an important target audience for education related to stormwater management and pollution prevention. The Nonpoint Education for Municipal Officials (NEMO) Project (http://www.nemo.uconn.edu) is an educational program for Connecticut local land use officials that addresses the relationship between land use and natural resource protection. NEMO is a collaboration between three branches of the University of Connecticut: the Cooperative Extension System, the Natural Resources Management and Engineering Department, and the Connecticut Sea Grant College Program. NEMO's educational programs are available to communities free of charge. In addition, the program provides educational publications and in some cases, maps, web-based information, and individual consultation. The materials cover a range of topics from open space planning to site plan review for stormwater management.

In addition to the information and assistance available through NEMO, DEP and other government and non-profit agencies provide a variety of outreach programs and materials focused on educating local decision-makers about stormwater management and pollution prevention.

Additional Information Sources

Connecticut Department of Environmental Protection (DEP). No date. Connecticut *Native Tree and Shrub Availability List.*
URL: http://www.conncoll.edu/ccrec/greennet/arbo/treeavailability.pdf.

Connecticut Department of Environmental Protection (DEP). 2002. *Pollution Prevention for Business.*
URL: http://www.dep.state.ct.us/wst/p2/industry/p2industryhome.htm.

Connecticut Department of Environmental Protection (DEP). 1998. *Guidance Document Stormwater Pollution Prevention Plan for Industrial Activities.*

Connecticut Department of Environmental Protection (DEP). 1995a. *Stormwater Management Plan for the General Permit for the Discharge of Stormwater Associated with Commercial Activity.*

Mehrhoff, L.J., K.J. Metzler, and E.E. Corrigan. 2001. *Non-native and Potentially Invasive Vascular Plants in Connecticut.* Center for Conservation and Biodiversity, University of Connecticut, Storrs, CT.

United States Environmental Protection Agency (EPA). 2002. *Stormwater Pollution Prevention,*
URL: http://www.epa.gov/reg3wapd/stormwater.

References

Bannerman, R. 1999. "Sweeping Water Clean". *American Sweeper Magazine*. Vol. 7, No. 1.

Center for Watershed Protection (CWP). 2002a. *Illicit Discharge Detection and Elimination.* URL http://www.stormwatercenter.net.

Center for Watershed Protection (CWP). 2002b. *Post-Construction Runoff Controls.* URL http://www.stormwatercenter.net.

Center for Watershed Protection (CWP). 2002c. *Operation and Maintenance.* URL http://www.stormwatercenter.net.

Connecticut Department of Environmental Protection (DEP). 1995b. *Best Management Practices for Disposal of Post-Plowing Snow Accumulations from Roadways and Parking Lots.*

Connecticut Department of Environmental Protection (DEP). 1995c. *General Permit for the Discharge of Stormwater Associated with Commercial Activity.*

Connecticut Department of Environmental Protection (DEP). 1997. *General Permit for the Discharge of Stormwater Associated with Industrial Activity.*

Connecticut Department of Environmental Protection (DEP). 1999a. *Municipal Management Practices for the Reuse of Road Sand Sweepings. Bureau of Water Management, Hartford, Connecticut.*

Connecticut Department of Environmental Protection (DEP). 1999b. *Pollution Prevention Fact Sheet - Integrated Pest Management: What Is It?* URL: http://dep.state.ct.us/wst/p2/ipm/IPM.htm.

Connecticut Department of Environmental Protection (DEP). 1999c. *Wildlife in Connecticut Informational Series: Canada Goose. Wildlife Division.*

Connecticut Department of Environmental Protection (DEP). 2002. *Pollution Prevention Options for Industry.* URL: http://www.dep.state.ct.us/wst/p2/industry/optindex.htm.

Connecticut Department of Transportation (DOT). 1999. *1999/2000 Snow and Ice Policy Manual.* Bureau of Engineering and Highway Operations, Office of Maintenance.

Federal Highway Administration (FHWA). 1999. "Is Highway Runoff a Serious Problem?", *Federal Highway Technology Brief.* Office of Infrastructure Research and Development. McLean, VA. URL: http://www.tfhrc.gov/hnr20/runoff/runoff.htm.

Ferguson, T., R. Gignac, M. Stoffan, A. Ibrahim, and H. Aldrich. 1997. *Rouge River National Wet Weather Demonstration Project Cost Estimating Guidelines: Best Management Practices and Engineered Controls.* Rouge River National Wet Weather Demonstration Project. Wayne County, MI.

Greenbuilder. 2001. *Sustainable Building Sourcebook – Xeriscaping Guidelines.* URL: http://www.greenbuilder.com/sourcebook.

Lucas, N. 1994. "De-Icing Technology". *American Sweeper.* Vol. 3, No. 3.

Massachusetts Department of Fisheries Wildlife and Environmental Law Enforcement (DFWELE). 2001. "Advocating for Better River Flows". *Stream Advocate.*

Metropolitan Council. 2001. *Minnesota Urban Small Sites BMP Manual: Stormwater Best Management Practices for Cold Climates.* Prepared by Barr Engineering Company, St. Paul, Minnesota.

New York City Department of Environmental Protection (NYCDEP). 2002. *Seven Steps to a Water Saving Garden.* URL: http://www.nyc.gov/html/dep/html/xeris.html.

Ohrel, R. 2000. "Rating Deicing Agents: Road Salt Stands Firm" in *The Practice of Watershed Protection.* ed. T.R. Schueler and H.K. Holland. Center for Watershed Protection, Ellicott City, MD.

Pitt, R. 1979. *Demonstration of Nonpoint Pollution Abatement Through Improved Street Cleaning Practices.* EPA-600/2-79-161. U.S. Environmental Protection Agency, Cincinnati, Ohio.

Pitt, R. 1984. *Characterization, Sources, and Control of Urban Runoff by Street and Sewerage Cleaning.* Contract No. R-80597012, U.S. Environmental Protection Agency and the City of Bellevue (WA), Cincinnati, Ohio.

Salsedo, C.A. and H.M. Crawford. 2000. Fact Sheet 5: *Conservation Landscaping for Water Quality.* URL: http://www.seagrant.uconn.edu. Available from: Connecticut Sea Grant, 1084 Shennecossett Rd., Groton, CT 06340.

Sargent, D and W. Castonguay. 1998.
An Optical Brightener Handbook.
URL: http://www.thecompass.org/8TB/pages/SamplingContents.html.

Schwarze Industries, Inc. No date. *An Overview of Sweeping Equipment Technology.*
URL: http://www.americansweeper.com/topics/overviewofsweepers.html.

The Salt Institute. 2002. *Highway Deicing and Anti-Icing for Safety and Mobility.*
URL: http://www.saltinstitute.org/30.html.

The Terrene Institute (Terrene Institute). 1998. "A Clean Sweep Now Possible". *Runoff Report.* Vol. 6, No. 4.

University of Wisconsin – Extension. 1999. *Pet Waste and Water Quality.*

United States Environmental Protection Agency (EPA). 2000. *Model Ordinances to Protect Local Resources – Preface.* URL:
http://www.epa.gov/owow/nps/ordinance/ preface.htm.

United States Environmental Protection Agency (EPA). 1999. *Storm Water O&M Fact Sheet: Catch Basin Cleaning.* EPA 832-F-99-011. Washington, D.C.

United States Environmental Protection Agency (EPA). 1999. *Storm Water Management Fact Sheet: Non-Storm Water Discharges to Storm Sewers.* EPA 832-F-99-022. Office of Water, Washington, D.C.

Washington State Department of Ecology (Washington). 2000. *Stormwater Management Manual for Western Washington, Final Draft.* Olympia, Washington.

Wisconsin Department of Natural Resources. 1994. *The Wisconsin Stormwater Manual.* Publication Number WR-349-94.