Urban Subwatershed Restoration Manual Series

8

Pollution Source Control Practices

Version 2.0

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CENTER FOR WATERSHED PROTECTION
Manual 8

Urban Subwatershed Restoration Manual No. 8

POLLUTION SOURCE CONTROL PRACTICES

Version 2.0

Prepared by:

Tom Schueler, Chris Swann, Tiffany Wright and Stephanie Sprinkle
Center for Watershed Protection
8390 Main Street, 2nd Floor
Ellicott City, MD 21043
www.cwp.org
www.stormwatercenter.net

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Foreword

We all live and work in a watershed. Collectively, our daily behaviors can have a profound influence on water quality. Quite simply, we are either generating pollution or preventing it, although most people may not fully understand how. The process for educating people about subwatershed pollution sources is the main theme of this manual. The manual shows how each of us can prevent pollution from our home or work place, and how these acts of personal stewardship can improve water quality when multiplied many times over.

Source control practices are a relatively new approach to restore urban watersheds. Much more needs to be learned about the best ways to control pollution sources, promote stewardship in neighborhoods and adopt pollution prevention practices in the workplace. This manual presents a new framework for targeting pollution source control at the subwatershed level. We expected that this manual would be adjusted over time; therefore, we are pleased to release this manual in Version 2.0, in response to user feedback and new resources. And remember, watershed stewardship starts with you. As you read the manual, pick a few behaviors worth practicing in your home or workplace to reduce pollution, and teach them to your friends and neighbors.

Special thanks are extended to three external reviewers whose comments ands insights on an earlier draft greatly improved the utility of this manual. These experts included Charlie MacPherson, Director of Watershed Services at Tetra Tech, Inc. (Fairfax, VA); Neal Shapiro, Administrative Analyst for the City of Santa Monica (CA); and Kathy Shay, Water Quality Education Manager for the City of Austin (TX).

The Center staff team that contributed to this manual includes Ted Brown, Tiffany Wright, Chris Swann, and Stephanie Sprinkle. We are also grateful to Tiffany Wright, Sarah Weammert, Neely Law, Heather Holland, and Lauren Lasher for their able assistance in editing, proofing and otherwise helping to produce this manual.

This manual was produced under a cooperative agreement with US EPA Office of Water CP-82981501. Thanks are extended to our EPA project officer, Robert Goo, for his patience, insights and flexibility during the two years it took to produce this manual series.

Sincerely,

Tom Schueler
Center for Watershed Protection

About the Restoration Manual Series

This is the eighth manual in an 11 manual series that provides detailed guidance on how to repair urban watersheds. The entire series of manuals was written by the Center for Watershed Protection to organize the enormous amount of information needed to restore small urban watersheds into a format that can easily be accessed by watershed groups, municipal staff, environmental consultants and other users. The contents of the manuals are organized as follows.

Manual 1: An Integrated Approach to Restore Small Urban Watersheds

The first manual introduces the basic concepts and techniques of urban watershed restoration, and sets forth the overall framework we use to evaluate subwatershed restoration potential. The manual emphasizes how past subwatershed alterations must be understood in order to set realistic expectations for future restoration. Toward this end, the manual presents a simple subwatershed classification system to define expected stream impacts and restoration potential. Next, the manual defines seven broad groups of restoration practices, and describes where to look in the subwatershed to implement them. The manual concludes by presenting a condensed summary of a planning approach to craft effective subwatershed restoration plans.

Manual 2: Methods to Develop Restoration Plans for Small Urban Watersheds

The second manual contains detailed guidance on how to put together an effective plan to restore urban subwatersheds. The manual outlines a practical, step-by-step approach to develop, adopt and implement a subwatershed plan in your community. Within each step, the manual describes 32 different desktop analysis, field assessment, and stakeholder involvement methods used to make critical restoration management decisions.

The next seven manuals provide specific guidance on how to identify, design, and construct the seven major groups of watershed restoration practices. Each of these "practice" manuals describes the range of techniques used to implement each practice, and provides detailed guidance on subwatershed assessment methods to find, evaluate and rank candidate sites. In addition, each manual provides extensive references and links to other useful resources and websites to design better restoration practices. The seven manuals are organized as follows:

Manual 3: Storm Water Retrofit Practices

The third manual focuses on storm water retrofit practices that can capture and treat storm water runoff before it is delivered to the stream. The manual describes both off-site storage and on-site retrofit techniques that can be used to remove storm water pollutants, minimize channel erosion, and help restore stream hydrology. The manual then presents guidance on how to assess retrofit potential at the subwatershed level, including methods to conduct a retrofit inventory, assess candidate sites, screen for priority projects, and evaluate their expected cumulative benefit. The manual concludes by offering tips on retrofit design, permitting, construction, and maintenance considerations in a series of 17 retrofit profile sheets.

Manual 4: Urban Stream Repair Practices

The fourth manual concentrates on practices used to enhance the appearance, stability, structure, or function of urban streams. The manual offers guidance on three broad approaches to urban stream repair – stream cleanups, simple repairs, and more sophisticated comprehensive repair applications. The manual emphasizes the powerful and relentless forces at work in urban streams, which must always be carefully evaluated in design. Next, the manual presents guidance on how to set appropriate restoration goals for your stream, and how to choose the best combination of stream repair practices to meet them.

The manual also outlines methods to assess stream repair potential at the subwatershed level, including basic stream reach analysis, more detailed project investigations, and priority screenings. The manual concludes by offering practical advice to help design, permit, construct and maintain stream repair practices in a series of more than 30 profile sheets.

Manual 5: Riparian Management Practices

The fifth manual examines practices to restore the quality of forests and wetlands within the remaining stream corridor and/or flood plain. It begins by describing site preparation techniques that may be needed to make a site suitable for planting, and then profiles four planting techniques for the riparian zone, based on its intended management use. The manual presents several methods to assess riparian restoration potential at the subwatershed level, including basic stream corridor analysis, detailed site investigations, and screening factors to choose priority reforestation projects. The manual concludes by reviewing effective site preparation and planting techniques in a series of eight riparian management profile sheets.

Manual 6: Discharge Prevention Practices

The sixth manual covers practices used to prevent the entry of sewage and other pollutant discharges into the stream from pipes and spills. The manual describes a variety of techniques to find, fix and prevent these discharges that can be caused by illicit sewage connections, illicit business connections, failing sewage lines, or industrial/transport spills. The manual also briefly presents desktop and field methods to assess the severity of illicit discharge problems in your subwatershed. Lastly, the manual profiles different "forensic" methods to detect and fix illicit discharges. Manual 6 is also known as the *Illicit Discharge Detection and Elimination Guidance Manual: a guidance manual for program development and technical assessment*, and is referenced as Brown *et al.*, 2004, throughout this manual.

Manual 7: Watershed Forestry Practices

The seventh manual reviews subwatershed practices that can improve the quality of upland pervious areas, which include techniques to reclaim land, revegetate upland areas, and restore natural area remnants. When broadly applied, these techniques can improve the capacity of these lands to absorb rainfall and sustain healthy plant growth and cover. This brief manual also outlines methods to assess the potential for these techniques at both the site and subwatershed scale.

Manual 8: Pollution Source Control Practices

Pollution source control practices reduce or prevent pollution from residential neighborhoods or storm water hotspots. Thus, the topic of the eighth manual is a wide range of stewardship and pollution prevention practices that can be employed in subwatersheds. The manual presents several methods to assess subwatershed pollution sources in order to develop and target education and/or enforcement efforts that can prevent or reduce polluting behaviors and operations. The manual outlines more than 100 different "carrot" and "stick" options that can be used for this purpose. Lastly, the manual presents profile sheets that describe 21 specific stewardship practices for residential neighborhoods, and 15 pollution prevention techniques for control of storm water hotspots.

Manual 9: Municipal Practices and Programs

The ninth manual focuses on municipal programs that can directly support subwatershed restoration efforts. The five broad areas include improved street and storm drain maintenance practices, development/redevelopment standards, stewardship of public land, delivery of municipal stewardship services, and watershed education and enforcement. This last "practice" manual presents guidance on how municipalities can use these five programs to promote subwatershed restoration goals. The manual also contains a series of profile sheets that recommends specific techniques to implement effective municipal programs.

The series concludes with two user manuals that explain how to perform field assessments to discover subwatershed restoration potential in the stream corridor and upland areas.

Manual 10: The Unified Stream Assessment (USA): A User's Manual

The Unified Stream Assessment (USA) is a rapid technique to locate and evaluate problems and restoration opportunities within the urban stream corridor. The tenth manual is a user's guide that describes how to perform the USA, and interpret the data collected to determine the stream corridor restoration potential for your subwatershed.

Manual 11: The Unified Subwatershed and Site Reconnaissance (USSR): A User's Manual

The last manual examines pollution sources and restoration potential within upland areas of urban subwatersheds. The manual provides detailed guidance on how to perform each of its four components: the Neighborhood Source Assessment (NSA), Hotspot Site Investigation (HSI), Pervious Area Assessment (PAA) and the analysis of Streets and Storm Drains (SSD). Together, these rapid surveys help identify upland restoration projects and source control to consider when devising subwatershed restoration plans.

Individual manuals in the series are scheduled for delivery by 2006, and each will be initially available for free downloading, after which they can be ordered online or as hard copies from the Center for a nominal charge. Be sure to check our website, www.cwp.org, to find out when each manual will be available and how it can be accessed.

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List of Acronyms and Abbreviations

The following list describes the many acronyms and abbreviations used in the manual to described the methods, practices, models used to restore small urban watersheds.

DPI: Discharge Prevention Investigation
HHW: Household Hazardous Waste
HSI: Hotspot Site Investigation
IPM: Integrated Pest Management
MTBE: Methyl tertiary butyl ether – an ether oxygenate blended into gasoline
MS4: Municipal Separate Storm Sewer System
NSA: Neighborhood Source Assessment
NOI: Notice of Intent
NPDES: National Pollutant Discharge Elimination System
SARA: Superfund Amendments and Reauthorization Act
SCP: Source Control Plan
SIC: Standard Industrial Classification
STP: Stormwater Treatment Practice
SWPPP: Storm Water Pollution Prevention Plan
USSR: Unified Subwatershed and Site Reconnaissance

Introduction

This manual describes how pollutants can be reduced or minimized by controlling two primary pollution source areas in a subwatershed: residential neighborhoods and storm water hotspots. Neighborhoods generate pollution from common residential behaviors that occur within distinct source areas. Storm water hotspots generate pollution during common operations and activities that occur at certain commercial, industrial, institutional, municipal or transport-related sites. Pollution can be prevented if neighborhood behaviors and business operations are changed to promote greater stewardship within the subwatershed.

Source control is the term for the "carrots" and "sticks" used to change neighborhood behaviors and business operations within a subwatershed. Source control "carrots" emphasize education, training, direct municipal service, subsidies, and recognition to positively reinforce stewardship behaviors that reduce the generation of pollutants and/or runoff. Source control "sticks" include permits, ordinances, inspections, and enforcement to address the most severe pollution sources in the subwatershed.

The nature and distribution of neighborhood pollution sources and storm water hotspots are different in every subwatershed. Many pollution sources usually exist in a subwatershed, but they are not always easy to find. Considerable detective work is needed in the office and field to discover these sources in the subwatershed. This manual outlines a series of methods to discover pollution sources in your subwatershed, and ways to devise a source control plan to manage them.

Organization of the Manual

This manual is organized into six chapters.

Chapter 1 outlines the basics of neighborhood source control and how it can prevent pollutants from reaching streams. The chapter reviews the four major pollution source areas within neighborhoods, the specific pollutants they generate, and the corresponding neighborhood stewardship practices that reduce them. The next part looks at strategies for neighborhood source controls, and profiles the range of carrots and sticks that can influence residential behaviors. The chapter concludes by discussing recent storm water education requirements of municipal storm water permits that can be used as the foundation for a neighborhood source control program.

Chapter 2 reviews the basics of storm water hotspots, and begins by classifying subwatershed hotspot operations based on land use and regulatory status. The next part outlines six common operations that should be investigated at every individual storm water hotspot, with an emphasis on the specific pollutants they generate and the prevention practices that can reduce them. Source control strategies that rely on both sticks and carrots to manage hotspot operations are then reviewed. Lastly, the introduces industrial NPDES storm water permit regulations, which are indispensable for managing storm water hotspots.

Chapter 3 summarizes three field methods to discover individual pollution source areas within a subwatershed: the Neighborhood Source Assessment (NSA), the Hotspot Site Investigation (HSI) and a series of Discharge Prevention Investigations. Each method provides a wealth of useful data to incorporate into a source control plan.

Chapter 4 guides you through the four steps needed to prepare a source control plan (SCP) for your subwatershed. Detailed guidance is provided on how to assemble a source control plan, prioritize outreach targets, choose effective carrots and sticks, and craft a budget and delivery system to implement source controls throughout a hypothetical subwatershed. The

chapter concludes with a discussion on deciding how to apply a SCP, whether on a subwatershed scale or community-wide.

Chapter 5 contains profile sheets describing 21 different neighborhood stewardship practices that can prevent storm water pollution or improve habitat. Each sheet explains how the stewardship behavior influences water quality, and presents social research about its frequency and variation. The profile sheets also recommend practical techniques to promote better stewardship behaviors, and provide useful internet resources and references to consult.

Chapter 6 presents profile sheets that describe 15 different pollution prevention practices that can be applied to storm water hotspots. The sheets are organized by the six common hotspot operations, and explain basic pollution prevention practices, along with key feasibility, implementation, and cost factors to consider. Extensive resources, references and websites are also listed where you can get more information on each pollution prevention practice.

Chapter 1: Basics of Neighborhood Source Control

Residents engage in many behaviors and activities that can influence water quality. Behaviors such as over-fertilizing, oil dumping, littering, and excessive pesticide use can negatively impact water quality. Conversely, positive behaviors such as tree planting, disconnecting rooftops, and picking up pet waste can help improve water quality. Whether your pollution prevention program is designed to discourage negative behaviors or encourage positive ones, neighborhood source control involves targeted education to deliver a specific message that promotes behavioral changes. Education is often supplemented by discounts, subsidies, recognition, and provision of convenient municipal services. In some cases, enforcement measures may also be needed to reinforce appropriate behaviors.

The neighborhood is the fundamental unit for residential source control. Neighborhoods are operationally defined as a large group of residential structures built at the same time or to the same general design standards, preferably with a common form of governance (e.g., neighborhood or homeowners association). Some neighborhoods may include a mix of commercial land uses as well. Most neighborhoods range from 50 to 200 acres in size. Techniques for delineating individual neighborhoods are described in Manual 11.

The nature and distribution of pollution sources normally differ in each neighborhood, since each has a unique age, lot size, turf cover, tree canopy, drainage, street condition and degree of resident awareness. Consequently, pollution sources need to be assessed within every individual neighborhood to customize an effective and targeted source control plan for the subwatershed as a whole. This chapter explores the basics of neighborhood source control, beginning with a description of the five major neighborhood pollution source areas that can contribute to storm water pollution. The next part of the chapter reviews the specific storm water pollutants generated by residential behaviors in each source area, and describes the corresponding stewardship practice that can reduce pollution. Next, the diverse range of "carrot" and "stick" strategies that can influence residential behaviors are reviewed. The chapter concludes by describing how storm water education programs required under municipal storm water NPDES permits can build effective neighborhood stewardship programs.

1.1 Pollution Source Areas in the Neighborhood

Five primary pollution source areas should be systematically evaluated within each individual neighborhood: the condition of the "average" yard and lawn, driveway/sidewalk/curb, rooftop, garage, and common areas in the neighborhood (Figure 1). More than 20 different residential behaviors can potentially generate pollution within these source areas, as outlined in Table 1. This section briefly describes each of the five major neighborhood pollution source areas.

Yards and Lawns - Research has demonstrated that yards can be a significant source of nutrient, pesticide, and sediment loads, which in turn can cause water quality problems in local streams (CWP, 2003). Individual lawns account for nearly 70% of the turf cover in most suburban subwatersheds, and are often intensively managed (Swann, 1999 and Law *et al.*, 2004). At least 10 behaviors in the yard can potentially cause pollutants to wash off in storm water runoff or dry weather flows (Table 1). Some important yard behaviors include improper lawn fertilization, pesticide use, watering, and yard waste disposal. Yard behaviors tend to be homogenous within the same neighborhood, since individual yards are often similar in area, age, turf management and tree canopy coverage.

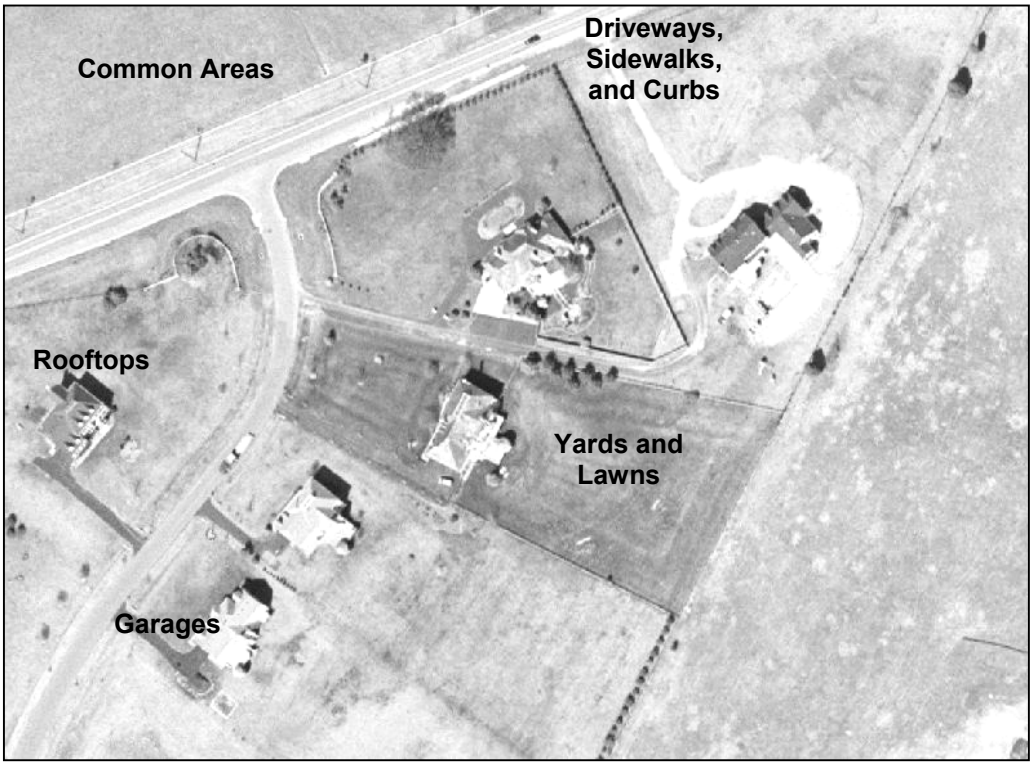


Figure 1: Four Pollution Source Areas in Residential Neighborhoods

Table 1: Key Behaviors Within Neighborhood Source Areas

Source Area	Polluting Behavior
Yards and Lawns	Improper Fertilization
	Improper Pesticide Applications
	Over-Watering
	Extensive Turf Cover
	Tree Clearing
	Improper Yard Waste Disposal
	Soil Compaction
	Soil Erosion
	Failing Septic Systems
	Pool Discharges
Driveways/Sidewalks/ Curbs	Car Wash-water Flows
	Hosing/Leaf-blowing
	Application of Salt and other De-icers
Garages	Dumping of Household Hazardous Wastes
	Dumping of Oil/Antifreeze
Rooftops	Downspout Connections
	Added Impervious Cover/Exposed Soils
Common Areas	Lack of Pet Waste Disposal
	Un-maintained Storm Water Practices
	Buffer Encroachment
	Storm Drain Dumping

Teysott (1999) notes that most neighborhoods tend to have similar socio-economic profiles, which often reinforces lawn care practices as residents seek to gain social acceptance.

Driveways, Sidewalks, Alleys and Curbs - These impervious surfaces are endemic to all modern neighborhoods, and are usually directly connected to the street and storm drain system. As a result, behaviors that occur on driveways and sidewalks can cause pollution to wash off directly to the storm drain system. Notable behaviors include washing cars, hosing or blowing driveway surfaces, and using de-icing compounds during the winter months. These behaviors can potentially introduce nutrients, oil, organic carbon, sediment and chlorides into the storm drain system. The significance of this pollution source area is determined by the accumulation of sediment, organic matter and trash on driveways, sidewalks and curbs. In general, the basic geometry of driveways, sidewalks and curbs tends to be identical within the same neighborhood, reflecting the design standards in force when they were built. Most subwatersheds, however, contain dozens of neighborhoods built in different eras under different design standards, so it is important to assess each neighborhood individually.

Rooftops - Rooftop runoff can contain pollutants such as copper, zinc and organic carbon (CWP, 2003). The key neighborhood variable is the proportion of rooftops that are directly connected to the storm drain system, as they present a possible restoration opportunity. Roof downspouts can be disconnected from the storm drain system using lawn filter strips, rain barrels and rain gardens. Rooftop retrofits can help reduce or delay storm water runoff delivered to a stream. Stream hydrology can be improved and pollutants can be reduced if a large fraction of neighborhood rooftops are disconnected. Rooftop disconnection may not always be practical in every neighborhood; factors such as small lot size, basements, compacted soils and yard slopes can make disconnection difficult. Another pollution source area to evaluate involves “new rooftops” under construction in the neighborhood, such as additions, decks, outbuildings, and residential redevelopment. If significant remodeling or redevelopment activity occurs in the neighborhood, these new rooftops will create more impervious cover and can become a significant source of sediment and storm water pollution.

Garages - These rooftop areas merit special consideration, since garages are where many household hazardous wastes are stored and most car maintenance and fluid changes occur. Garages may or may not be present in every neighborhood, depending on the era in which they were built. Improper disposal of car fluids and household hazardous wastes can be a source of oil, antifreeze, trace metals, pesticides, and toxins to streams if they are dumped into the storm drain system.

Common Areas - Many neighborhoods built in the past few decades have a considerable amount of community open space devoted to stream buffers, protected flood plains, storm water management practices, rights-of-way, and turf. Common areas can be either pollution sources or restoration opportunities, depending on how they are managed. Pollutants can be generated by improper pet waste disposal, buffer encroachment, and storm drain dumping. On the other hand, storm water pond maintenance, bufferscaping and reforestation within common areas can support restoration objectives. Often, the presence of an active and organized homeowners association can make a major difference in how common areas are managed.

1.2 Screening for Pollutants of Concern

Neighborhood source control starts with identifying the pollutant of greatest concern in your subwatershed. Dozens of residential behaviors in each neighborhood can produce a huge number of storm water pollutants, so screening is needed to target pollutants that matter most. Table 2 shows how much potential each residential behavior has to generate sediment, nutrients, metals, bacteria, trash and oil, and can help you identify the residential behaviors generating the pollutant of concern.

Table 2: Comparison of Pollutant Contribution from Various Residential Behaviors

Residential Polluting Behavior	Storm Water Pollutants						
	TSS	Nutrients	Metals	Bacteria	Trash	Oil	Toxins
Improper Fertilization	×	●	×	×	×	×	○
Excess Pesticide Use	×	×	×	×	×	×	●
Over-Watering	○	◉	○	×	○	×	◉
Extensive Turf Cover	○	◉	×	×	×	×	◉
Tree Clearing	◉	◉	×	×	×	×	×
Yard Waste Dumping	◉	●	×	○	○	×	×
Soil Compaction	◉	◉	○	○	×	×	×
Soil Erosion	●	◉	○	○	×	×	×
Failing Septic Systems	○	●	×	●	×	×	○
Pool Discharges	×	×	×	×	×	×	●
Car Washwater Flows	◉	●	◉	×	×	◉	◉
Hosing/Leaf-blowing	●	◉	◉	×	◉	◉	○
Use of De-icers	◉	○	○	×	×	×	◉
HHW Dumping	×	○	●	×	×	●	●
Car Fluid Spills/Dumping	×	×	◉	×	×	●	●
Connected Downspouts	◉	●	●	◉	×	○	○
Added IC and Bare Soil	●	○	◉	×	◉	○	○
Pet Waste Washoff	×	●	×	●	×	×	×
Poor STP Maintenance	●	●	●	◉	●	○	○
Buffer Encroachment	○	○	○	○	○	×	×
Storm Drain Dumping	◉	○	◉	◉	●	●	●

Key ×= not a pollutant source ◉ = moderate pollutant contribution
○ = minor pollutant contribution ● = major pollutant contribution

For example, if sediment is the pollutant of concern, you may want to focus on behaviors such as yard erosion, driveway hosing, soil compaction, construction activity, and poor storm water maintenance. A different group of behaviors should be targeted if nutrients are the primary concern in a subwatershed -- namely, improper fertilization, poor maintenance of septic systems and storm water practices, improper yard waste disposal, pet waste wash off, and downspout connections. Still other behaviors should be investigated if runoff reduction is the restoration objective. In this case, factors such as the fraction of connected rooftops, soil compaction, and tree canopy coverage can play a role in reducing storm water runoff from the neighborhood.

1.3 Neighborhood Stewardship Practices

Pollution sources can be reduced through neighborhood stewardship practices, which are simple, easy, and low-cost alternatives to the polluting behavior in question. For example, if improper fertilization is discovered as a source of nutrient pollution, the corresponding stewardship practice might include reduced fertilization, soil tests, grass-cycling, and conversion of turf into natural landscaping areas.

In many cases, stewardship practices can save the homeowner both time and money, and still create an attractive lawn.

Table 3 lists 21 different stewardship practices that can potentially be applied in neighborhoods, along with the corresponding profile sheet number in Chapter 5 where the practice is more fully described. Each profile sheet describes how the stewardship practice influences water quality or habitat, and estimates how frequently residents engage in the polluting behavior. The profile sheets also describe major challenges to changing residential behaviors, and recommend specific carrots and sticks that work best in this regard. Each profile sheet concludes with case

Table 3: Key Neighborhood Stewardship Practices		
Source Area	**Practice Number**	**Stewardship Practice**
Yard	N-1	Reduced Fertilizer Use
	N-2	Reduced Pesticide Use
	N-3	Xeriscaping
	N-4	Natural Landscaping
	N-5	Tree Planting
	N-6	Yard Waste Composting
	N-7	Soil Reclamation
	N-8	Soil Erosion Repairs
	N-9	Septic System Maintenance
	N-10	Delayed Pool Discharges
Driveways, Sidewalks, and Curbs	N-11	Safe Car Washing
	N-12	Driveway Sweeping
	N-13	Safe De-icer Use
Garage	N-14	Household Hazardous Waste Collection
	N-15	Car Fluid Recycling
Rooftop	N-16	Downspout Disconnection
	N-17	Single Lot Controls
Common Areas	N-18	Pet Waste Pickup
	N-19	Storm Water Practice Maintenance
	N-20	Bufferscaping
	N-21	Storm Drain Marking

studies on innovative local programs to improve stewardship, along with a directory of the best internet resources and educational materials for the practice. The stewardship profile sheets are a useful building block for crafting an effective neighborhood source control program.

1.4 Carrots and Sticks to Promote Neighborhood Stewardship

Effective stewardship requires many people in a neighborhood to take action and/or change their behaviors. Therefore, strategies that will persuade residents to accept and adopt desired stewardship practices must be chosen carefully. A combination of positive reinforcement (carrots) and negative reinforcement (sticks) can be effective at influencing behaviors within a neighborhood. The range of carrot and stick strategies that can be used to promote neighborhood stewardship is outlined in Table 4 and reviewed in the ensuing section.

Table 4: Carrot and Stick Strategies for Neighborhood Source Control
Carrots
1. Passive Residential Education 2. Active Consultation/Training 3. Provision of Direct Municipal Services 4. Subsidies and Discounts 5. Homeowner Recognition Programs 6. Formation of Stewardship Groups
Sticks
1. Adopt Local Ordinance 2. Notification/Signs/Hotlines 3. Restrictions or Bans 4. Enforcement 5. Utility Pricing

Carrots

Six carrot strategies can make residents aware of desired stewardship practices and encourage their voluntary adoption. Carrots rely on education, training, recognition, economic incentives, municipal services and other strategies to reinforce neighborhood stewardship.

1. *Passive Residential Education* - The most common technique for encouraging better stewardship is the passive distribution of educational materials to subwatershed residents. These educational materials are designed to make residents aware of preferred stewardship behaviors and encourage their adoption. Many different materials can be used to deliver the stewardship message, such as brochures, handbooks, posters, refrigerator magnets and other promotional items. Where budgets allow, local newspaper articles and radio or TV spots can be used to transmit the stewardship message. The downside of passive education is that residents must first read or hear the message, and then be sufficiently motivated to change deeply rooted behaviors. MacPherson and Tonning (2003) present comprehensive guidance on how to deliver effective stewardship messages.

2. *Active Consultation and Training* - Many watershed educators believe that lasting behavior change requires direct on-site consultations with individual residents, particularly if the public is not familiar with the desired stewardship behavior (e.g., low-input lawn care). The underlying strategy for this carrot is to create informal opportunities for educators to give advice on stewardship through phone assistance, point-of-sale exhibits, workshops, on-site lawn consultations, and displays at homeowner meetings, garden clubs and community fairs.

3. *Provision of Direct Municipal Services* - Communities can make personal stewardship as easy and convenient as possible by providing municipal services to residents directly. Direct municipal services such as collection of household hazardous wastes, used oil, and yard wastes can produce significant pollutant reductions in many subwatersheds. To be effective, a carefully targeted outreach campaign is often needed to make residents aware of the municipal service, as well as an efficient and timely delivery system for the service itself. In general, participation rates in municipal service programs are strongly linked to how convenient residents perceive them to be.

4. *Subsidies and Discounts* - This carrot relies on economic incentives to reward positive stewardship behaviors, and is frequently used when residents need to invest time and money to practice the desired behavior. Examples include the distribution of free or discounted rain barrels, compost bins, soil compost, tree planting and erosion repair kits. Most communities offer discounts to homeowners in order to gain wider acceptance of new stewardship practices. Like any subsidy, economic incentives should be carefully targeted to the neighborhoods and subwatersheds where stewardship practices will create the greatest benefit.

5. *Homeowner Recognition Programs* - This carrot strategy promotes neighborhood stewardship by recognizing residents or neighborhood associations that are good stewards. Low-cost recognition techniques such as awards, plaques, and signs showcase the people making a real difference in the subwatershed, and can influence and educate peers and neighbors to adopt desired behaviors.

6. *Formation of Stewardship Groups* - The last carrot strategy involves establishing grassroots groups to promote stewardship at the neighborhood or subwatershed scale. The basic idea is to create an active group of residents to spread stewardship advice to their neighborhood peers. Examples of stewardship groups include locally-sponsored programs to adopt streams or storm water ponds, become a master gardener, or plant rain gardens or backyard habitats. Local stewardship groups are perceived as a credible information source since members live in the neighborhood themselves. In some cases, stewardship groups ultimately evolve into watershed organizations that can advocate for even greater awareness and stewardship.

Sticks

Carrots are not always enough to ensure widespread adoption of neighborhood stewardship practices, so a few sticks should always be included to control polluting behaviors causing the most severe water quality impacts. Sticks should always be judiciously administered, since many residents may resent regulation of their daily actions or personal property. Still, most communities rely on a few sticks to handle the really bad actors in the community.

Five basic stick strategies can be applied to regulate polluting behaviors and improve compliance. Stick strategies can include local ordinances, signs, notification, restrictions/bans, the threat of enforcement, and utility pricing, each of which is described below.

1. *Adopt Local Ordinances* - Communities routinely enact ordinances to protect public health and safety, set standards for civic behavior, and protect the local environment. Indeed, communities with a population greater than 50,000 are required to adopt ordinances to prohibit dumping and illegal discharges to their storm drain system. Model water quality ordinances for this purpose can be found in Brown *et al.* (2004).

Other common techniques for regulating residential polluting behaviors include regulations that impose fines for not picking up after pets, prohibit phosphorus content in fertilizers, restrict tree clearing, require immediate repair of failing septic systems, and require regular maintenance of storm water practices.

2. *Notification/Signs/Hotlines* - Simply passing an ordinance or regulation is seldom enough to change behaviors if residents remain ignorant of the new requirements. Therefore, it is important to educate residents about new requirements, explain why they are needed, and spell out the penalties for noncompliance. Notification can be done with signs, posters and brochures, although advertisements on local radio and in community newspapers can also work. Many communities also establish water quality hotlines that residents can call to make complaints or report violations.

3. *Restrictions and Bans* - A locality or utility may elect to ban or temporarily restrict behaviors that cause severe water quality or quantity problems. Examples of this rarely-used stick include outdoor water use restrictions in times of drought, bans on pickup of lawn clippings to preserve landfill capacity, and restrictions on the phosphorus content of fertilizer to protect lakes. Restrictions or bans are reserved for situations where compelling water quality problems can be documented or a clear emergency exists in the community.

4. *Enforcement* - In many cases, the mere threat of enforcement may be sufficient to change residential behaviors. Some discretion and sensitivity is needed when handling potential violators in the neighborhood. The typical process for handling violators is to first send the property owner a letter describing the problem, requesting corrective action and setting a date to re-inspect the property. Enforcement measures are taken as a last resort if the property owner fails to comply in a reasonable timeframe. Fines can be levied, permits can be revoked, or water service denied. Where possible, penalties should be imposed administratively without having to resort to the judicial system. The enforcement system should also have a fair and timely appeals process for violators who feel they were unfairly cited.

5. *Utility Pricing* - The last and most rarely used stick involves using utility pricing to penalize negative behaviors and/or reward positive behaviors. Perhaps the best example of using utility pricing to encourage neighborhood stewardship is the practice of escalating water rates for homes that consume more water for outdoor irrigation. Once a threshold level of use is surpassed, the unit price for additional water increases sharply, creating a strong economic incentive for households to voluntarily conserve water. However, few neighborhood behaviors can be directly tied to water, sewer or electric billing systems, although many can be linked to storm water utility rates, if they exist in a

community. Storm water utilities charge residents a standard fee, based on the average impervious cover on the lot. Several communities offer customers lower rates if they install storm water treatment practices or on-site retrofits.

1.5 Municipal Storm Water Education Opportunities

Until recently, most communities lacked programs to control neighborhood sources of pollution. The few communities that did have programs operated on a shoestring budget. According to Swann (1999), most local storm water education programs were poorly staffed (0.1 to 0.5 staff years), relatively new (within the last five years), and had minuscule annual budgets ($2,000 to $25,000). Given such limited resources, most storm water education programs have relied on low-cost retail education techniques to send out their message.

This trend is changing as more communities comply with the National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit program, which requires communities to meet six management measures to control pollutants discharged into their municipal storm water system. The major components of MS4 storm water permits and minimum management measures are summarized in Table 5. The key implication is that most communities now have a legal responsibility to conduct storm water education to control neighborhood sources of pollutants. In particular, three minimum management measures require localities to provide some form of storm water education to improve the following:

- Public education and outreach
- Public involvement and participation
- Municipal pollution prevention/good housekeeping

Table 5: NPDES MS4 Storm Water Permit Program: What It Means		
	Phase I Communities	**Phase II Communities**
Who is covered?	Complex designation, but primarily communities that have a separated storm drain system with a population of more than 100,000.	Very complex designation that includes most communities with a population of more than 50,000 and a population density greater than 1,000 people/square mile. States must also assess whether communities from 10,000 to 50,000 should be covered, based on certain criteria.
Permit status	The first permits were issued in the early 1990s. Extensive permit applications and annual reports. Permit cycle: 5 to 7 years.	General permits issued in December 2002. Permit applications due in 2003. Simpler application and reporting.
What is required?	• Storm water quality monitoring • Mapping of storm drain network • Outfall screening • Removal of illicit discharges • Source identification • Structural and source control measures to reduce pollutants • Erosion/sediment control program • Demonstration of legal authority to control storm water discharges • Fiscal analysis	Control storm water to maximum extent practical, using six minimum management measures: • Public education/outreach • Public participation/involvement • Illicit discharge detection • Construction site runoff control • Post-construction runoff control • Pollution prevention
The skinny	Requires creation of programs, and monitoring, but does not set firm benchmarks for program performance. Extremely uneven administration by both permitting agencies and municipalities so far. Ranges from paper programs to highly innovative and expansive programs, depending on degree of local and/or state leadership.	Requires creation of programs, but does not set firm benchmarks for performance. Stronger emphasis on public education, involvement and pollution prevention than Phase I. No monitoring required. While the minimum control measures do not explicitly call for a watershed approach, they certainly are a strong regulatory driver to improve restoration programs for smaller communities.
Want more information? For Phase II, consult http://cfpub.epa.gov/npdes/storm water/swfinal.cfm. *A summary of the Phase I program can be found in U.S. EPA. 1996. Overview of the Storm Water Program. EPA833-R-96-008. Available online:* http://www.epa.gov/npdes/pubs/owm0195.pdf		

Chapter 2: Basics of Storm Water Hotspots

Storm water hotspots are defined as commercial, industrial, institutional, municipal, or transport-related operations that produce higher levels of storm water pollutants, and/or present a higher potential risk for spills, leaks or illicit discharges. The nature and distribution of storm water hotspots are different in every subwatershed. As a general rule, quite a few hotspots exist, but may be hard to find since many are quite small and out of the way. Consequently, a considerable amount of detective work is needed to find all the storm water hotspots in a subwatershed. Pollution prevention practices at many hotspots may be legally required under local or state storm water permits. This chapter provides guidance on choosing the right pollution prevention practices to address the storm water hotspots in your subwatershed.

2.1 Classification of Storm Water Hotspots

Hotspots can be broadly classified based on their regulatory status. *Regulated hotspots* are known sources of pollution and are subject to federal or state regulations, whereas *unregulated hotspots* are suspected pollution sources, but are not currently regulated. Storm water hotspots can be found in a wide range of land uses in nearly every subwatershed (Figure 2). This section classifies hotspot operations based on land use; an expanded classification system can be found in Appendix A.

Commercial hotspots consist of a small group of businesses associated with a specific activity or operation that generates higher pollutant loads in a subwatershed. Commercial hotspots typically have a great deal of vehicle traffic, generate waste or wash water, handle fuel or repair vehicles, or store products outside. While commercial hotspots are quite diverse, they are often clustered together. Most commercial hotspots are unregulated, although a few are regulated under the NPDES industrial storm water permit program or by local ordinance. Suspected commercial hotspot operations should always be inspected to determine whether they actually represent a real pollution source or risk in a subwatershed.

Each kind of commercial hotspot generates its own blend of storm water pollutants, which can include nutrients, hydrocarbons, metals, trash and pesticides. Typical examples of commercial hotspots include the following:

- Animal care services
- Building material
- Commercial car washes
- Convenience stores
- Laundries and dry cleaners
- Lawn care companies
- Gas stations
- Nurseries and garden centers
- Petroleum wholesalers
- Fast food restaurants
- Shopping centers
- Vehicle maintenance and repair
- Wholesale food and beverage

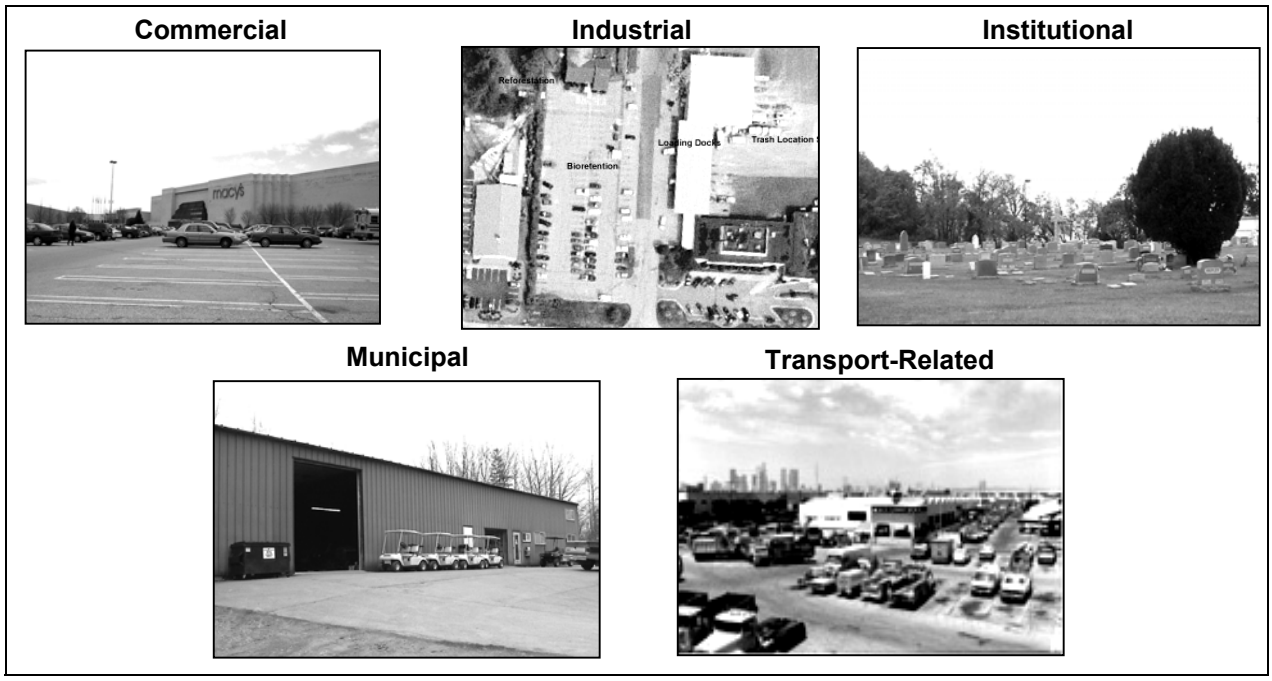


Figure 2: Five Types of Storm Water Hotspots

Industrial hotspots are a major focus for pollution prevention if they use, generate, handle or store pollutants that can potentially be washed away in storm water runoff, spilled, or inadvertently discharged to the storm drain system. Each type of industrial hotspot generates its own blend of storm water pollutants, but as a group, they generally produce higher levels of metals, hydrocarbons and sediment.

Many industrial operations are regulated under the NPDES industrial storm water permit program, although individual owners or operators may be ignorant of their permit status. The specific list of 11 major industries subject to NPDES storm water permits is based on Standard Industrial Classification (SIC) codes to determine permit status, and is provided in Manual 11. An industrial operation can be exempted from the permit program if "no exposure" is demonstrated (i.e., all of its operations are covered by a rooftop).

Industrial hotspots that are regulated under NPDES storm water permits must prepare pollution prevention plans and implement source control practices at the facility. These plans must include spill response and prevention, employee training, and implementation of pollution prevention practices to reduce exposure of products to rainfall or runoff. In some cases, storm water treatment practices may need to be installed at the site to remove pollutants from runoff. Permitted industrial hotspots should be regularly inspected to determine if they are complying with the pollution prevention plan, or even possess a permit. The storm drain system should also be investigated to determine if an industrial hotspot is generating illicit discharges of sewage or other pollutants. Methods to detect and correct illicit discharges are described in Brown *et al.*, 2004.

Common industrial hotspots include the following:

- Auto recyclers
- Boat building and repair facilities
- Recycling centers and scrap yards
- Warehouses

Institutional hotspots include larger, privately-owned facilities that have extensive parking, landscaping, or turf cover. In addition, institutions may contain fleet vehicles and large maintenance operations. By and large,

institutional hotspots are not regulated. The most common pollutants generated by institutional hotspots are nutrients and pesticides applied to maintain grounds and landscaping. In addition, large parking lots can produce storm water runoff and associated pollutants, and are natural targets for storm water retrofitting. Institutional landowners can be important partners in subwatershed restoration, given the importance of their stewardship practices on the open lands they maintain. Examples of common institutional hotspots include the following:

- Cemeteries
- Churches
- Colleges
- Corporate office parks
- Hospitals
- Private schools
- Private golf courses

Municipal hotspots include many local government operations that handle solid waste, wastewater, road and vehicle maintenance and yard waste. Most municipal operations are defined as regulated hotspots in communities that are subject to an NPDES MS4 permit. More details on the MS4 permit program can be found in Table 5. Municipal hotspots must prepare the same pollution prevention plans and implement source control practices like any other regulated hotspots. Municipal hotspots can generate the full range of storm water pollutants, including nutrients, hydrocarbons, metals, chloride, pesticides, bacteria, and trash. Common municipal hotspots include the following:

- Composting facilities
- Fleet storage and school bus depots
- Landfills/solid waste facilities
- Local streets and storm drains
- Pesticide use in rights-of-way
- Public golf courses
- Public schools
- Public works yards
- Maintenance depots
- Solid waste facilities
- Wastewater treatment plants

Transport-related uses are the last category of hotspots to investigate within a subwatershed. Many, but not all, transport-related uses are regulated hotspots. They tend to generate higher loads of hydrocarbons, metals, and sediment in storm water runoff, are often associated with large areas of impervious cover, and have extensive private storm drain systems. Transport-related hotspots may not be present in every subwatershed, but you should always look for the following operations:

- Airports
- Bus depots
- Ports
- Rental car lots
- Railroad stations and associated maintenance facilities
- State and federal highways and associated maintenance facilities
- Trucking companies and distribution centers

2.2 Six Common Hotspot Operations

The site is the fundamental unit for evaluating potential storm water hotspots. Each site has its own unique operations, drainage system and potential pollution risk. As a result, each hotspot must be individually inspected to assess current operations, spill risks, and storm water problems. This inspection is known as a Hotspot Site Investigation (HSI) and systematically evaluates six potential site operations that can contribute to storm water quality problems (Figure 3):

- Vehicle operations
- Outdoor materials
- Waste management
- Physical plant maintenance
- Turf/landscaping
- Unique hotspot operations

Each hotspot often has several site operations associated with activities that generate storm water pollutants or illicit discharges (Table 6). The next section provides more detail on each of the six common hotspot operations.

Figure 3: Six Common Operations to Assess at Potential Storm Water Hotspots

Table 6: Polluting Activities Associated With Common Hotspot Operations	
Hotspot Operation	**Polluting Activity**
Vehicle Operations	• Improper disposal of fluids down shop and storm drains • Spilled fuel, leaks and drips from wrecked vehicles • Hosing of outdoor work areas • Wash water from cleaning • Uncovered outdoor storage of liquids/oils/batteries spills • Pollutant washoff from parking lot
Outdoor Materials	• Spills at loading areas • Hosing/washing of loading areas into shop or storm drains • Wash-off of uncovered bulk materials and liquids stored outside • Leaks and spills
Waste Management	• Spills and leaks of liquids • Dumping into storm drains • Leaking dumpsters • Dumpster juice • Wash-off of dumpster spillage
Physical Plant Maintenance	• Discharges from power washing and steam cleaning • Wash-off of fine particles from painting/ sandblasting operations • Rinse water and wash water discharges during cleanup • Temporary outdoor storage • Runoff from degreasing and re-surfacing
Turf and Landscaping	• Non-target irrigation • Runoff of nutrients and pesticides • Deposition and subsequent washoff of soil and organic matter on impervious surfaces • Improper rinsing of fertilizer/pesticide applicators
Unique Hotspot Operations (Pools, Golf Courses, Marinas, Construction, Restaurants, Hobby Farms)	Varies but includes • Discharge of chlorinated water from pools • Improper disposal of sewage and grease • Wash off of livestock manure • Soil erosion • Runoff of pesticides
Note: Street and Storm Drain practices such as street sweeping, catch basin cleaning, and road maintenance are profiled in Manual 9	

Vehicle Operations - Nearly all hotspots devote some portion of the site to vehicle operations such as maintenance, repair, recycling, fueling, washing or long-term parking. Vehicle operations can be a significant source of trace metals, oil, grease, and hydrocarbons, and are the first operations inspected during a hotspot source investigation. Vehicle maintenance and repair operations often produce waste oil, fluids and other hazardous products, particularly if work areas are connected to the storm drain system.

Automotive fluids and metals can also be exposed to rainfall at operations where vehicles are scrapped/recycled or wrecked vehicles are stored. These operations are always considered major hotspots (Swammikanu, 1994). Another type of vehicle hotspot can exist in outdoor areas where fuel is dispensed, particularly if these areas are not covered. Outdoor vehicle washing can also create a hotspot if wash water enters the storm drain system. Lastly, drips and leaks from vehicles stored at fleet and long-term parking areas can become another pollutant source.

Outdoor Materials - Virtually every hotspot site handles some kind of material that can create storm water problems if not properly handled or stored. The first step is to inventory the type and hazard level of materials at the site. Next, it is important to examine loading and unloading areas to see if materials are exposed to rainfall and/or are connected to the storm drain system. Third, any materials stored outdoors that could potentially be exposed to rainfall or runoff should be investigated. Stains on paved areas usually indicate poor outdoor storage practices.

Waste Management - Every business generates waste as part of its daily operations, most of which is temporarily stored at the site pending disposal. The third common hotspot operation involves the way waste products are stored and disposed of at the site in relation to the storm drain system. In some sites, simple practices such as dumpster management can reduce pollutants, whereas other sites may require more sophisticated spill prevention and response plans.

Physical Plant Practices - The fourth hotspot operation relates to practices used to clean, maintain or repair the physical plant, which includes the building, outdoor work areas and parking lots. Routine cleaning and maintenance practices can cause runoff of sediment, nutrients, paints, and solvents from the site. Sanding, painting, power-washing, resealing or resurfacing roofs or parking lots always deserves particular scrutiny, especially when performed near storm drains.

Turf and Landscaping - The fifth common hotspot operation involves practices used to maintain turf or landscaping at the site. Many commercial, institutional and municipal sites hire contractors to maintain turf and landscaping, apply fertilizers or pesticides, and provide irrigation. Current landscaping practices should be thoroughly evaluated at each site to determine whether they are generating runoff of nutrients, pesticides, organic carbon, or are producing non-target irrigation flows.

Unique Hotspot Operations - Some operations simply resist neat classification, and this last category includes unique hotspots known to generate specific pollutants. Examples include swimming pools, construction operations, golf courses, fairgrounds/racetracks, marinas, hobby farms, and restaurants. The special site investigations and pollution prevention practices applied at unique hotspot operations are described in Chapter 6.

2.3 Pollutants Generated by Hotspots

Hotspot source control should always be linked to the pollutant(s) of greatest concern in your subwatershed. A given subwatershed can contain dozens of storm water hotspots that generate a huge number of pollutants, so some screening is needed to target the right hotspot operations in the subwatershed. The potential for each hotspot operation to generate sediment, nutrients, metals, hydrocarbons, toxins and other pollutants is compared in Table 7. The table can help you quickly screen hotspot operations to find the ones generating the pollutant(s) of

concern. For example, if sediment pollution is a major concern, you may want to focus on hotspot operations such as construction, vehicle washing, outdoor storage, loading/unloading areas, and building/parking lot maintenance.

A different group of hotspot operations is targeted when oil and grease are the primary concern. In this case, vehicle repair, fueling, and storage operations might be targeted for pollution prevention, along with outdoor petroleum storage, parking lot maintenance, and restaurant operations. Yet another group of hotspot operations should be targeted if nutrient reduction is a subwatershed priority. Hotspot sites with intensive turf management and landscaping should be evaluated, along with any vehicle washing operations, golf courses, marinas and other unique hotspots that are present.

2.4 Hotspot Pollution Prevention Practices

Hotspot pollution prevention practices involve simple and low-cost changes to routine operations and practices at a site. For example, the pollution prevention recipe for a vehicle maintenance operation might involve the use of drip pans under vehicles, tarps covering wrecked vehicles, dry cleanup methods for spills, proper disposal of used fluids, and covering and secondary containment for any outdoor storage areas. Each of these practices requires regular employee training and strong management commitment. In most cases, hotspot pollution prevention practices save time and money, reduce liability and do not greatly interfere with normal operations. Examples of common pollution prevention practices are illustrated in Figure 4.

Table 7: Storm Water Pollutants Associated With Common Hotspot Operations

Hotspot Operation or Activity	Sediment	Nutrients	Metals	Oil/ Hydrocarbons	Toxics	Others
Vehicle Repair	○	○	●	●	●	
Vehicle Fueling	×	○	●	●	●	MTBE
Vehicle Washing	●	●	⦿	⦿	●	
Vehicle Storage	○	×	⦿	●	○	Trash
Outdoor Loading	●	⦿	⦿	○	○	Organic Matter
Outdoor Storage	●	⦿	⦿	⦿	⦿	
Liquid Spills	○	⦿	⦿	●	●	
Dumpsters	○	⦿	⦿	⦿	●	
Building Repair	●	○	⦿	⦿	⦿	
Building Maintenance	●	×	●	○	⦿	
Parking Lot Maintenance	●	○	⦿	●	⦿	
Turf Management	⦿	●	×	×	●	Pesticides
Landscaping	○	●	×	×	●	Pesticides
Pool Discharges	×	×	×	×	×	Chlorine
Golf Courses	○	●	○	×	●	Pesticides
Hobby Farms/Race Tracks	⦿	⦿	×	×	×	Bacteria
Construction	●	○	○	○	⦿	
Marinas	×	⦿	⦿	⦿	●	Bacteria
Restaurants	○	⦿	×	●	×	Grease

Key × = not a pollutant source ○ = minor pollutant contribution
⦿ = moderate pollutant contribution ● = major pollutant contribution

The 15 basic pollution prevention practices applied at hotspot operations are listed in Table 8, which also indicates the corresponding profile sheet number in Chapter 6 that more fully describes each practice. Each profile sheet explains how the practice influences water quality, and lists the type of hotspot operations where it is normally applied. The sheets also identify the primary people at the hotspot operation that need to be trained in pollution prevention. Next, each sheet reviews important feasibility and implementation considerations, and summarizes available cost data. Each profile sheet concludes with a directory of the best available internet resources and training materials for the pollution prevention practice. The profile sheets can be used to design an effective pollution prevention plan for an individual hotspot or for the subwatershed as a whole.

Wash Water Containment

Secondary Containment of Outdoor Storage

Covered Loading Area

Figure 4: Examples of Common Pollution Prevention Practices at Hotspots

Table 8: Pollution Prevention Practices for Hotspot Operations

Hotspot Operation	Profile Sheet	Pollution Prevention Practices
Vehicle Maintenance and Repair	H-1	Drip pans, tarps, dry clean-up methods for spills, cover outdoor storage areas, secondary containment, discharge washwater to sanitary system, proper disposal of used fluids, disconnect storm drains, automatic shutoff nozzles, signs, employee training, spill response plans
Vehicle Fueling	H-2	
Vehicle Washing	H-3	
Vehicle Storage	H-4	
Loading and Unloading	H-5	Cover loading areas, secondary containment, storm drain disconnection or treatment, inventory control, dry cleaning methods, employee training
Outdoor Storage	H-6	
Spill Prevention and Response	H-7	Inventory materials, employee training, spill planning, spill clean up materials,
Dumpster Management	H-8	Dumpster management, disconnect from storm drain or treat. Liquid separation/containment
Building Repair and Remodeling	H-9	Temporary covers/tarps, contractor training, proper cleanup and disposal procedures, keep wash and rinse-water from storm drain, dry cleaning methods
Building Maintenance	H-10	
Parking Lot Maintenance	H-11	
Turf Management	H-12	Integrated pest management, reduce non-target irrigation, careful applications, proper disposal of landscaping waste, avoid leaf blowing and hosing to storm drain
Landscaping/Grounds Care	H-13	
Swimming Pool Discharges	H-14	Varies, depending on the unique hotspot operation
Other Unique Hotspots	H-15	

2.5 Sticks and Carrots to Implement Pollution Prevention

Traditionally, permits and other regulatory sticks have been applied to manage hotspot operations, although many communities also offer a few carrots to enhance compliance. You should carefully consider what combination of carrots and sticks will persuade operators to accept and adopt pollution prevention practices. The basic stick and carrot strategies to promote pollution prevention are outlined in Table 9, and are described in detail in this section.

The choice of which sticks and carrots to employ depends on the severity and regulatory status of the storm water hotspots found in the subwatershed, as well as operator awareness and the size of hotspot businesses. For example, if most hotspots are small, unregulated businesses whose owners lack awareness of their pollution problems, you may initially want to use more carrots than sticks. By contrast, if the hotspots are large regulated industries, you may want to fully utilize all permit sticks to ensure compliance.

Sticks

Six basic stick strategies can be applied to regulate polluting behaviors at storm water hotspots. Sticks include NPDES permits, local regulation, certification programs, compliance inspections, and enforcement (or the threat of enforcement). Sticks are certainly warranted at hotspot operations causing severe water quality impacts, but should always be administered to produce environmental results rather than excessive paperwork. Most communities rely on a combination of several stick strategies to promote pollution prevention practices at known hotspots.

Table 9: Stick and Carrot Strategies for Pollution Prevention
Sticks
1. Industrial NPDES Storm Water Permits
2. Refer Permit Non-Filers
3. Regulate Hotspots with Local Ordinances
4. Inspections
5. Certification Programs
6. Hotspot Compliance and Enforcement
Carrots
1. Passive Business Outreach
2. On-site Technical Assistance
3. Employee/Contractor Training
4. Subsidies and Discounts
5. Business Recognition Programs

1. *Industrial NPDES Storm Water Permits* – Industrial NPDES storm water permits are an extremely important stick at many hotspot operations. NPDES permits require operators to prepare a pollution prevention plan for the site and implement the practices specified in the plan. Significant penalties can be imposed for non-compliance. State and federal regulators are still grappling with the administration of industrial storm water permits, and they remain an imperfect tool for several reasons. First, the permit system allows hotspot operators to submit their own pollution prevention plan, which may only be a paper exercise. Second, very few trained state or federal-level inspectors are available to inspect and enforce the thousands of industrial sites covered by the permit program. Third, although communities usually have the best understanding of how the local storm water network works, they lack direct authority to inspect or enforce regulated hotspots, although they can refer them to state agencies for enforcement. All three problems can be overcome if the locality works with state regulatory agencies to share hotspot inspection and enforcement responsibilities as part of their MS4 permit. Portland (OR) recently negotiated such an agreement to expand the reach of their hotspot inspection program (Pronold, 2000).

2. *Refer Permit Non-filers* – To date, compliance with the industrial storm water permit program has been spotty, and a significant fraction of regulated industries have failed to file their required permits. According to Duke and Shaver (1999) and Pronold (2000), only 50% of industrial sites that are required to have a permit actually have one. The remaining sites are termed “non-filers,” and are often small businesses or operations that are unaware of the relatively new regulations. It is therefore quite

likely that many hotspots in your subwatershed may not have a valid NPDES permit. These operations should be educated about the industrial permit program, and encouraged to apply for a permit. Persistent non-filers should be referred for state enforcement, and may face stiff fines.

3. *Regulate Hotspots with Local Ordinances* – Communities have the authority to enact ordinances under their own NPDES MS4 storm water permit to regulate a broader range of hotspots than is defined under the industrial NPDES storm water permit program. Indeed, MS4 communities must adopt ordinances that make it illegal to dump or discharge pollutants into the storm drain system, and can specify certain business operations or activities where pollution prevention will be regulated. Model hotspot and illicit discharge ordinances that can be used for this purpose can be found in Brown *et al.* (2004).

4. *Inspections* – Permits are just a piece of paper until an inspector shows up. Consequently, inspections are an important stick for improving compliance at regulated hotspots. Inspectors should frequently observe site operations to ensure the right mix of pollution prevention practices is routinely employed. Communities with MS4 permits have authority to inspect storm water NPDES sites that discharge to their storm drain system, and refer any violations for subsequent state or federal enforcement.

Voluntary inspections of non-regulated storm water hotspots are a good tool for educating owners/operators about recommended pollution prevention practices. When non-regulated hotspots are inspected, existing fire, building or health inspectors should be used since they are already acquainted with how to deal with small businesses. Communities that possess an MS4 permit have the authority to inspect non-regulated hotspots that connect to the municipal storm drain system they operate.

5. *Certification Programs* - Another stick for promoting pollution prevention is establishing professional certification programs for certain businesses that routinely provide a potentially polluting service, such as lawn care and landscaping, mobile power washing, septic system maintenance, pesticide application, and construction services. Certification programs work by requiring employees to attend short classes where they learn proper storm water pollution prevention practices related to their profession. After passing a test, employees are conditionally certified to perform these services. If they fail to follow appropriate practices, their certification can be revoked, which can be an extremely powerful incentive if certification is a condition of employment or municipal contracting.

6. *Hotspot Compliance and Enforcement* - As noted earlier, state agencies are normally delegated authority to inspect industrial NPDES storm water hotspot sites and enforce requirements. A formal compliance investigation begins by checking whether the operation maintains a current Storm Water Pollution Prevention Plan (SWPPP) at the site. The SWPPP must include a site plan that shows how storm water runoff is managed using appropriate pollution prevention and documents storm water treatment practices, a schedule for maintenance, inspection and visual monitoring, and a record-keeping process. In most cases, the mere threat of enforcement is sufficient to prompt compliance with pollution prevention practices, and enforcement actions are used as a last resort. However, if corrective actions are not taken in a timely manner, fines may be levied.

Carrots

Like anyone else, businesses respond better to carrots than sticks. Five basic carrot strategies can be used to educate operators and encourage them to adopt pollution prevention practices: business outreach, technical assistance, training, recognition, and economic incentives.

1. *Passive Business Outreach* - The most common method for promoting pollution prevention is the targeted distribution of educational materials to specific business sectors in the subwatershed. Outreach materials are designed to educate owners and employees

about polluting behaviors, recommend appropriate pollution prevention practices, and notify them of any local or state regulations. Useful outreach materials include brochures, training manuals, posters, directories of pollution prevention vendors, and signs. Passive business outreach works best when it is specially adapted and targeted to a specific business sector (i.e., vehicle repair, landscaping, or restaurants) and is directly presented to local business groups and trade associations. Business outreach requires workers to read or hear the pollution prevention message and then take active steps to change their behavior.

2. *On-site Technical Assistance* - A customized pollution prevention plan should be developed for each individual hotspot, but many operators are confused about what they really need to do to comply. This carrot strategy provides direct technical assistance between the local government and the business to inspect the site and develop an effective pollution prevention plan. In other cases, pollution prevention workshops or model plans are offered to business and trade groups that represent specific hotspot sectors. The basic idea is that the locality acts as a partner to provide technical assistance and ongoing consultation to individual businesses to support their pollution prevention efforts. This carrot is particularly useful for small hotspots within defined business sectors, although it can be very staff-intensive to implement.

3. *Employee and Contractor Training* – Continuous employee training is an essential component of any pollution prevention plan, particularly at hotspots where the work force turns over frequently. Many businesses perceive time devoted to training as subtracting from their bottom line, and may be hesitant to develop training materials or allocate time for training. Consequently, this carrot strategy relies on local support for pollution prevention training. In some cases, local agencies supply free or low-cost videos, posters, shop signs, or training brochures (often in multilingual versions). In other cases, short training classes for employees or supervisors are scheduled for down times of the year (e.g., winter classes for landscaping companies or construction contractors), or offered as part of regular employee safety meetings.

4. *Subsidies and Discounts* – Some pollution prevention practices require individual businesses to invest time and money in cleanup materials, permanent coverings, secondary containment, and storm water treatment practices. Economic incentives can be a powerful tool for motivating operators to make needed investments, particularly for small businesses with limited access to capital. Subsidies and discounts are commonly offered as carrots to reduce the financial burden of compliance. Examples can include providing low-interest loans through small business programs, discounted cleanup materials, and tax breaks. Another option is to provide a regulatory "safe harbor" for businesses that voluntarily request local assistance to deal with pollution problems on their premises (the safe harbor limits the liability of these volunteer operators for any water quality violations discovered when local assistance is offered).

5. *Business Recognition Programs* – This carrot strategy recognizes businesses that practice sound pollution prevention practices through awards, plaques, seals, signs or advertising. Business recognition programs promote pollution prevention by showcasing the business leaders that are making a real difference on the ground. Recognition programs are attractive to businesses, since they advertise the company's community involvement and environmental stewardship to their customers. Examples of business recognition programs include clean marinas, green lawn companies and certified golf courses.

2.6 Regulations Governing Storm Water Hotspots

Extensive reference has already been made to the industrial NPDES storm water permit program. A good understanding of how the industrial permit program works and who exactly is covered is essential to develop an effective hotspot source control program. This

may not be easy, since the industrial permit program can be complex, confusing and ambiguous. While a full description of industrial storm water permitting is beyond the scope of this manual, some key requirements are summarized in Table 10, which also lists several websites with more detailed information.

Perhaps the best way to become familiar with industrial permits is to directly contact the permit writers and inspectors at the state regulatory agency responsible for administering the program.

Table 10: Industrial NPDES Storm Water Permits: What They Really Mean

What is an industrial storm water permit?	These permits regulate 11 categories of industrial activities that discharge storm water to surface waters or into a municipal separate storm sewer system.
Who is covered?	Three kinds of permits are available: group, individual and multi-sector. This table emphasizes the 11 major industrial groups that may need individual permits. An industrial site can be excluded from the permit system if the operator can certify "No Exposure," which means that all industrial materials and activities are protected by a storm-resistant shelter that prevents exposure to precipitation and/or runoff.
What do they really have to do?	There are two basic requirements associated with an industrial storm water permit. First, the applicant must file a Notice of Intent (NOI) to get a permit. Some states charge an application fee at this point. Second, the applicant must develop a Storm Water Pollution Prevention Plan (SWPPP) that must be kept on-site. The SWPPP must include a site evaluation of how and where pollutants may be mobilized by storm water and discharged; a site plan for managing storm water runoff that includes appropriate structural and non-structural controls to reduce storm water pollution; a schedule for maintenance, inspection and visual monitoring; and a record-keeping process.
Who administers and enforces the permit?	State water quality agencies that have been given permitting authority by EPA administer the permit system, and have inspection and enforcement authority. Local agencies have no direct role in enforcement, although they can refer a problem hotspot or non-filer to the state agency for enforcement. Indeed, local governments have their own municipal hotspot operations that are regulated by the state. A few communities have engaged in a memorandum of understanding to share the inspection, training and enforcement.
The skinny	To date, few state agencies have had enough staff resources to do more than handle the paper side of the permit program (i.e., processing and issuing permits). On-site inspections are fairly rare, and high rates of non-filers have been observed, particularly among small businesses. Progress in the permitting program may require greater coordination between local and state agencies to fill in major inspection, training and education gaps.
Want more information? Many guidance manuals, policy documents and fact sheets can be found on EPA's website at www.epa.gov/npdes/stormwater.	

Chapter 3: Finding Pollution Sources in Your Subwatershed

This chapter briefly describes the detective work needed to find pollution sources in your subwatershed. While some pollution sources can be found by desktop analysis, most require intensive field investigation. This chapter summarizes three field methods to discover individual pollution source areas within subwatersheds: the Neighborhood Source Assessment (NSA), the Hotspot Site Investigation (HSI) and the Discharge Prevention Investigation (DPI). Each method provides a wealth of useful data that can be incorporated into a Source Control Plan (SCP) for the subwatershed.

3.1 The Subwatershed Context for Pollution Source Control

Every subwatershed has its own unique mix of land uses. Some subwatersheds are entirely residential, whereas others include a mix of residential, commercial and industrial land uses. As a result, the magnitude and distribution of pollution sources differs in each subwatershed. Therefore, it is important to investigate potential pollution sources at each individual neighborhood and every suspected storm water hotspot site in the subwatershed.

The Unified Subwatershed and Site Reconnaissance (USSR) is a useful tool for discovering neighborhood pollution sources and storm water hotspots within individual subwatersheds (Figure 5). The primary assessment components of the USSR are the Neighborhood Source Assessment (NSA) and the Hotspot Site Investigation (HSI). Manual 11 presents a guidance manual on how to prepare for the USSR, conduct field investigations, and organize and interpret data back in the office. It's helpful to become familiar with Manual 11 so you can rapidly evaluate the neighborhood pollution sources and hotspot operations that deserve the most attention in your subwatershed.

3.2 Neighborhood Source Assessment (NSA)

The Neighborhood Source Assessment (NSA) is a rapid field survey that quantifies potential pollution sources within neighborhoods, and identifies potential stewardship and restoration practices. Conducting the NSA involves driving every street in the neighborhood to systematically assess the residential behaviors that contribute to storm water problems by sub-sampling individual lots, curbs, catch basins, and common areas. The NSA field form evaluates five parts of the average neighborhood:

Neighborhood Characterization – Compiles basic information about the neighborhood.

Yard and Lawn Conditions – Assesses vegetative cover and management practices on the typical lawn.

Driveways, Sidewalks, and Curbs – Estimates pollutant accumulation and practices on impervious areas of a lot.

Rooftops – Quantifies how rooftop runoff is managed on the average residential lot.

Common Areas – Evaluates practices in common areas of a neighborhood such as storm water ponds, buffers, and flood plains.

The NSA collects data on more than 30 neighborhood factors linked either to pollution sources or potential stewardship practices, as summarized in Table 11. The last part of the NSA form identifies key residential behaviors causing pollution in the neighborhood, and computes an index that rates the overall severity of non-point source pollution for the neighborhood as a whole. NSA data from individual neighborhoods is then used to generate counts, maps, and metrics needed for the Source Control Plan.

Figure 5: USSR Assessment Field Forms

Table 11: NSA Factors Assessed and Corresponding Neighborhood Stewardship Practice

Neighborhood Feature	Neighborhood Factor Assessed	Corresponding Stewardship Practice*
Yards and Lawns	High management turf	Reduced fertilizer use (N-1, N-7)
	Potential pesticide use	Reduced pesticide use (N-2)
	Non-target irrigation	Xeriscaping (N-3)
	Extensive turf cover	Natural landscaping (N-4)
	Average forest canopy	Tree planting (N-5)
	Improper yard waste disposal	Yard waste composting (N-6)
	Soil erosion	Erosion repair (N-8)
	Construction activity	Single lot controls (N-17)
	Presence of septic systems	Septic system maintenance (N-9; D-7 and -8**)
	Presence of swimming pools	Safe pool discharge (N-10)
Driveways, Sidewalks And Curbs	Driveway/curb flows	Safe car washing (N-11)
	Sidewalk zone conditions	Pet waste pickup (N-18)
	Driveway conditions	Driveway sweeping (N-12, N-13)
Garages	HHW dumping	Household hazardous waste collection (N-14)
	Outdoor car maintenance	Car fluid recycling (N-15)
Rooftops	Downspout connection	Downspout disconnection (N-16)
	Index of Redevelopment/Remodeling	Single lot controls (N-17)
Common Areas	Evidence of pet waste	Pet waste pickup (N-18)
	Presence of storm water ponds	Storm water practice maintenance (N-19)
	Turf cover in open space	Bufferscaping (N-20), tree planting (N-5)
	Condition of storm drain inlets	Storm drain marking (N-21)
	Evidence of dumping	Prevention/removal of dumping (D-1)**

**The code in parentheses refers to the stewardship profile sheet in Chapter 6.*
*** These profile sheets can be found in Manual 5.*

3.3 Hotspot Site Investigation (HSI)

The Hotspot Site Investigation (HSI) is a rapid survey to assess the impacts of hotspot operations in urban subwatersheds. The HSI investigates six distinct pollution sources at each suspected hotspot, and identifies pollution prevention practices to address those sources. The HSI produces a comprehensive database of confirmed hotspots for each subwatershed ranked by their relative severity. The database can be used to determine what, if any, pollution prevention or discharge prevention strategies should be incorporated into the overall subwatershed restoration plan. The HSI field form consists of seven parts:

Site Data and Basic Classification – Collects basic location and land use information about the hotspot site, and briefly describes its actual operation.

Vehicle Operations – Evaluates routine vehicle maintenance and storage practices at the site, as well as any vehicle fueling or washing operations.

Outdoor Materials – Examines the type and exposure of any outdoor materials that are stored at the site.

Waste Management – Assesses housekeeping practices for waste materials generated at the site.

Physical Plant – Assesses maintenance practices used for cleaning, remodeling or repairing buildings, outdoor work areas and parking lots.

Turf/Landscaping Areas – Examines the practices used to maintain lawn or landscaping areas, with special emphasis on fertilizer use and non-target irrigation.

Storm Water Infrastructure – Evaluates the condition of practices used to convey or treat storm water, including curbs and gutters, catch basins, and any storm water treatment practices. The HSI collects data on more than 20 site factors linked either to pollution sources or potential pollution prevention practices (Table 12). The HSI form provides a grid to sketch the site and locate potential pollution prevention practices. Photos are also taken to document site conditions. The last part of the HSI evaluates the overall pollution potential for the site and designates it as either a potential, confirmed, or severe hotspot, or not a hotspot at all. The hotspot designation dictates the type of follow-up actions needed for the site. HSI data for the subwatershed as a whole are then entered into a database or GIS system to examine both hotspot density and severity. The resulting counts, maps, and metrics are then incorporated into the Source Control Plan.

3.4 Suspicious Discharge Investigations

Any suspicious dry weather flow encountered during field work or reported by the public should be immediately assessed as a potential pollutant source. These flows may be illicit discharges of sewage or other pollutants, and can occur on a continuous, intermittent or episodic basis. The location of manholes, channels or outfall pipes generating suspicious flows should be referred for subsequent discharge investigations to determine the composition of the flow and trace it back to its source. Brown et al.(2004) outlines different types of discharge prevention investigations that can be used for this purpose:

- Outfall Reconnaissance Investigation
- Outfall Indicator Monitoring
- In-stream Dry Weather Sampling
- In-Pipe Investigations
- Hotlines and Citizen Reporting
- Dye, Smoke and TV Tests
- Infrared Aerial Thermography
- Finding Failing Septic Systems

Table 12: HSI Assessment Factors and Corresponding Pollution Prevention Practices	
Hotspot Factor Assessed	**Corresponding Pollution Prevention Practice***
Potential, Confirmed or Severe Hotspot	Permit enforcement (M-9)
Vehicle Source Areas	Vehicle pollution prevention practices (H-1 to H-4)
Outdoor Storage Source Areas	Storage pollution prevention practices (H-5/6
Waste Management Source Areas	Waste pollution prevention practices (H-7/8)
Physical Plant Operations	Maintenance pollution prevention (H-9 to 11)
Turf/Landscaping Source Areas	Landscaping pollution prevention practices (H-12/13)
Uncontrolled Storm Water Discharge	Parking lot retrofit (SR-6, OS-7 through 11)
Suspected Source of Illicit Discharge	Discharge investigations (M-6)
Observed Spill or Illicit Discharge	Contain and cleanup (M-6 and H-7)
Unique Hotspots	Special pollution prevention practices (H-14, 15)
Catch Basin Accumulation	Catch basin cleanouts (M-9)
**The code in parentheses refers to the pollution prevention profile sheet number.* *H- sheets can be found in Chapter 6 of this manual* *SR- and OS- sheets can be found in Manual 3* *M-9 = Manual 9: Municipal Practices and Programs* *M-6 = Illicit Discharge Detection and Elimination Guidance Manual (Brown et al. 2004)*	

Chapter 4: Subwatershed Source Control Plans

Although source control relies on non-structural practices to prevent pollution, it should be treated like any other structural restoration practice installed in a subwatershed. Source control practices should be carefully designed, effectively targeted, and continuously maintained. This chapter outlines a process to implement source controls at the subwatershed level to reduce pollutants.

A pollution source control plan should be developed for every subwatershed, since each has its own unique pollution sources and control opportunities. The Center has developed a planning framework to define the focus, targets, methods and delivery of source control practices within individual subwatersheds, known as a Source Control Plan (SCP). The SCP is a simple desktop analysis to develop cost-effective strategies to promote better stewardship and pollution prevention practices. The SCP evaluates subwatershed conditions to answer 11 basic source control questions:

1. What is the primary **pollutant of concern** in the subwatershed?

2. Which subwatershed behaviors are most directly linked to it?

3. What specific **neighborhoods** and business **sectors** are generating the pollutant?

4. Who are the specific individuals and groups that should be **targeted** for outreach?

5. What are the most appropriate **carrot and stick strategies** to apply in the subwatershed?

6. What is the most clear and direct **message** to promote desired behaviors?

7. What **outreach techniques** are most effective at sending the message out?

8. What specific **source control practices** will most effectively change behaviors?

9. How much will the source control practices **cost**?

10. Which partners will be responsible for **distributing** the source control practices?

11. How will **progress** made in source control be evaluated?

The SCP systematically answers these 11 questions within the context of an individual subwatershed. To be sure, many questions require careful analysis and rely on professional judgment, since hard data may be lacking. Still, the questions provide a good framework to organize your thinking about pollution sources and control opportunities. This chapter provides guidance on how to design an SCP for your subwatershed, and concludes with an example for the hypothetical “Stewardship Branch” watershed.

4.1 Basics of a Subwatershed Source Control Plan

The SCP represents the “design” of a program to effectively target source control practices to reduce priority pollution source areas within a subwatershed, along with a budget and delivery system to implement the practices. The 11 steps involved in the SCP mirror the design questions outlined above. The step-by-step process is depicted in Figure 6, and each step is described at greater length in the remainder of this section.

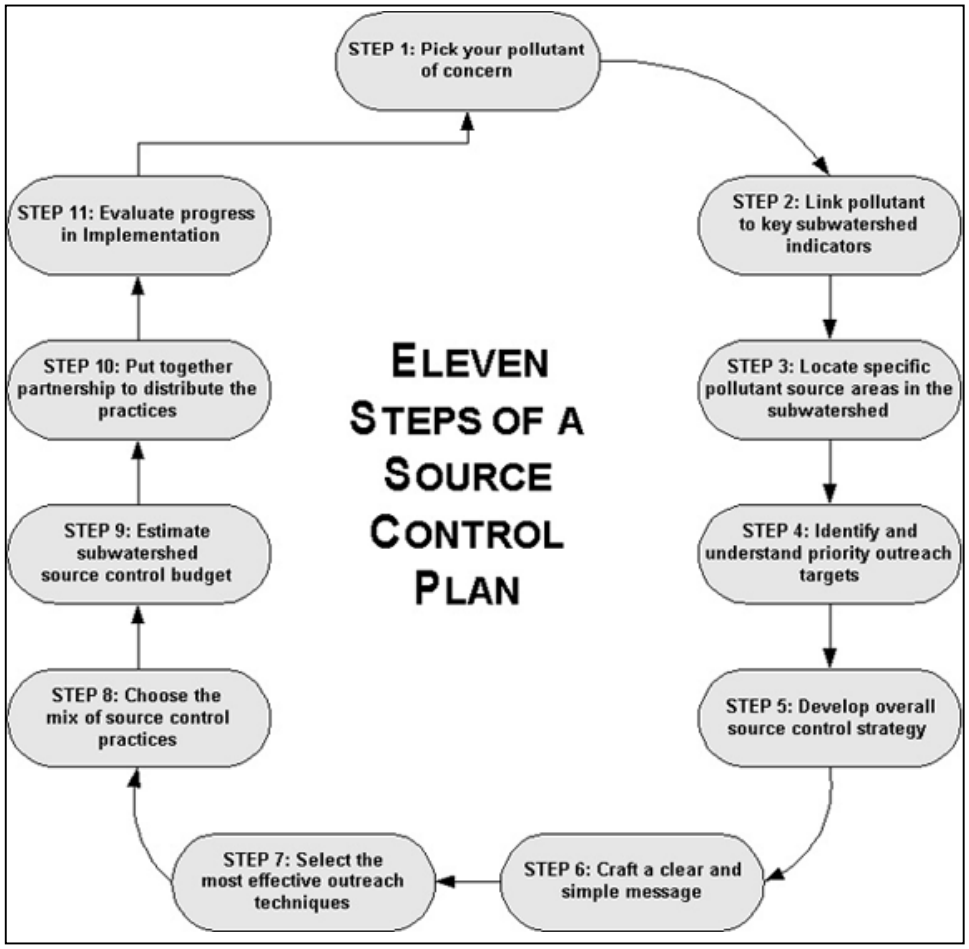


Figure 6: Steps to Prepare a Source Control Plan

Step 1: Pick Your Pollutant of Concern

The first and most important step is to choose the pollutants that will become the primary focus of the source control plan. It is important to restrict your initial efforts to only one or two pollutants from the much larger list of possible storm water pollutants (e.g., nutrients, bacteria, sediment, trash, oil, pesticides). Often, the pollutant of concern will have been identified earlier in the restoration planning process, or may emerge from field observations with the subwatershed.

Step 2: Link Pollutant to Key Subwatershed Indicators

Once you've targeted a pollutant, the next step is to identify the particular behaviors or operations in the subwatershed directly linked to that pollutant. This is done by looking at specific pollutant indicator data generated from subwatershed NSA and HSI survey data. Table 13 summarizes common behaviors and operations that are potential indicators of eight categories of storm water pollutants.

Pollutant indicators only suggest the *potential* for a behavior or operation to be an actual pollution source. NSA and HSI survey data needs to be analyzed further to confirm that the behavior or operation is indeed a source of

pollution. Key tests include whether the following conditions exist:

- Behavior or operation is directly connected to storm drain system
- Pollutant is accumulating on impervious surfaces, curbs, or catch basins
- Pollutant is detected in the stream or storm water runoff

The product of this step is a short list of the most important neighborhood behaviors and/or business operations generating the pollutant of concern.

Table 13: NSA and HSI Pollutant Indicators in a Subwatershed

Nutrient Pollution Indicators	Sediment Pollution Indicators
• Extensive high input turf • High turf cover as % of lot area • Presence of septic systems • Evidence of pet wastes • Organic matter accumulation in curbs and catch basins • Evidence of car washing • Poor STP maintenance • Buffer encroachment • Connected commercial landscaping • Hotspot vehicle washing • Unique hotspots (golf courses, marinas)	• Extensive bare soil on lots • High index of redevelopment/remodeling • Sediment accumulation in curbs • Sediment accumulation in catch basins • Improper yard waste disposal • Construction sites • Hotspot vehicle washing • Building repair and maintenance • Parking lot maintenance • Outdoor bulk storage • Loading and unloading operations
Bacteria Pollution Indicators	**Runoff Indicators**
• Presence of pet waste • Presence of septic systems • Organic matter accumulation in curbs • Poor storm water practice maintenance • Unique hotspots (marinas, hobby farms) • Transients/homeless	• Percent of disconnectable rooftops • High impervious cover • Evidence of non-target irrigation • Evidence of soil compaction • Poor tree canopy coverage on lot • Curb and gutter
Trash and Debris Indicators	**Oil and Grease Indicators**
• Poor neighborhood housekeeping • Evidence of hosing/leaf blowers • Trash accumulation in curbs and catch basins • Lack of storm drain stencils • Overloaded or uncovered dumpsters	• Car washing • Driveway or parking lot staining • Oil sheens in catch basins • Restaurants • Vehicle fueling, maintenance and repair • Outdoor car maintenance • Streets and alleys
Trace Metal Indicators	**Pesticide Indicators**
• Connected residential rooftops • Connected comm./industrial rooftops • Vehicle operations • Building and parking lot maintenance • Storage of household hazardous wastes • Streets and parking lots	• High turf cover as % of lot area • Residential non-target irrigation • High input turf and landscaping (hotspot) • Unique hotspots (golf courses, marinas) • Utility right-of-way corridors

Note: Indicators only show potential for pollution to be generated. To be confirmed, the pollutant generating behavior should be connected to the storm drain system; some physical evidence should be present on streets, curbs, catch basins or streams; and it should be widely distributed or tightly clustered in the subwatershed.

Step 3: Locate the Specific Pollutant Source Areas in the Subwatershed

Given limited resources, you won't be able to reach every neighborhood or hotspot in a subwatershed. Therefore, it is important to prioritize where source control practices will be targeted. As a result, the third step involves locating the specific pollutant source areas generating the pollutant within the subwatershed. The basic method is to spatially analyze NSA and HSI data to determine the specific neighborhoods and hotspot operations thought to be contributing pollutants to the subwatershed. Four methods can be used to locate problem sites:

1. NSA or HSI counts – The simplest method counts major NSA or HSI outputs linked to the pollutant of concern. For example, you may want to count the number and distribution of the following:

- Neighborhoods with a large proportion of high input turf
- Neighborhoods with high or low forest canopy coverage
- Potential, confirmed, and severe hotspots
- Potential generating land uses for illicit discharges

2. Mapping Neighborhood Index Data – NSA data can be used to derive an overall index of the severity of pollution sources for individual neighborhoods (see Manual 11). Simple maps can be generated that compare neighborhood index scores to quickly screen neighborhoods with the greatest pollution potential. Figure 7 illustrates how NSA index scores are used to identify neighborhoods for priority source control within a subwatershed.

3. Mapping Hotspot Clusters – The type and distribution of storm water hotspots should be mapped in each subwatershed to look for hotspot "clusters," or high density of hotspots. Hotspot clusters are natural targets for source control, particularly if they exist within the same business sector.

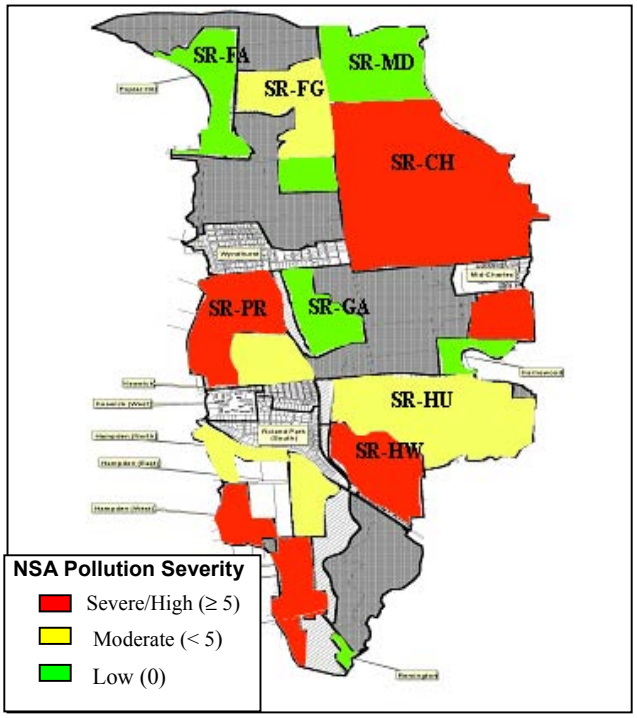


Figure 7: Example of an NSA Severity Index Map to Target Source Control

4. Screening Based on Neighborhood Metrics— "Neighborhood metrics" describes the process of aggregating data from individual NSA forms to get a clearer picture of what is happening at the neighborhood scale. An example of a neighborhood metric is the acreage of high input turf. This metric can be directly computed from the NSA form by multiplying the fraction of turf cover on the average lot by the proportion of high input lawns in the neighborhood. This fraction can then be multiplied by total neighborhood area to get a planning estimate of the acreage of high input turf for the neighborhood as a whole.

The high input turf metric provides insight into the significance of lawns as a potential nutrient source, and can target lawn care education efforts at the neighborhood level. Metrics have considerable value to screen or rank the source control potential among groups of neighborhoods. The basic approach is simple: select the metrics most important to your source control objectives, and then see how individual neighborhoods rank in the process. This simple ranking approach can identify priority

neighborhoods within a subwatershed to target education efforts.

Detailed methods for deriving counts, maps, or metrics of subwatershed pollution sources are described in Manual 11.

Step 4: Identify and Understand Priority Outreach Targets

Once priority pollution source areas are located, the next step is to identify the specific individuals or groups to target for outreach. The goal is to assemble an outreach database that contains up-to-date contact information for residents and businesses located with priority pollution source areas in the subwatershed. Ideally, the database should contain names, mailing addresses, phone numbers, or e-mail addresses for your priority outreach targets. Often, it is a good idea to start by consulting "outreach multipliers" that already possess good contact information, which include civic associations, local planning agencies, the chamber of commerce, trade groups and local advertisers. The contact database is a key tool used in subsequent steps to target outreach efforts.

This step is also a good time to learn more about the outreach population, and discover the reasons why they engage in the particular behavior. For example, is the behavior rooted in a lack of awareness, economics, peer pressure, convenience or some other factor? Also, how willing or receptive will the outreach population be to changing the behavior? A good understanding of the outreach population is extremely helpful when choosing the right combination of carrots and sticks to include in your overall source control strategy. Simple techniques for learning about your outreach population include phone surveys, focus groups, interviews with community leaders, and informal conversations with individual homeowners or operators.

Step 5: Develop an Overall Source Control Strategy

Chapters 1 and 2 reviewed the wide range of carrot and stick strategies available for subwatershed source control. Step 5 involves choosing the right combination of carrots and sticks to apply in your overall source control strategy. While the choice of which carrots and sticks to apply is fundamentally determined by the attitudes and receptivity of the outreach population, five effectiveness factors also come into play:

- *Hit Rate* - how effective is the strategy in reaching your target audience?
- *Adoption Rate* - what proportion of the target audience will adopt the practice after learning about it?
- *Startup Cost* - how much does it cost to initially implement the strategy, including outreach?
- *Ongoing Cost* - how much will it cost to maintain the strategy over several years?
- *Expertise* - how much specialized knowledge or training is needed to implement the strategy?

Tables 14 and 15 compare how each carrot and stick strategy ranks based on the five factors. The tables can be used to choose the combination of carrots and sticks with the greatest potential to influence neighborhood stewardship and hotspot pollution prevention practices in the subwatershed.

Table 14: Comparing Carrot and Stick Strategies to Promote Neighborhood Stewardship Practices					
	Comparative Factors				
	Hit Rate	Adoption Rate	Startup Cost	Ongoing Cost	Expertise
Carrots					
Passive Education	●	○	$$	$$	○
Active Consultation	○	●	$	$$	●
Direct Municipal Service	●	◉	$$$	$$$	○
Subsidies and Discounts	◉	◉	$$	$$$	○
Recognition Programs	○	●	$	$	◉
Stewardship Groups	○	●	$$	$$	◉
Sticks					
Local Ordinance	○	◉	$$	$	◉
Notification/Signs/Hotlines	◉	○	$$	$	○
Restrictions/Bans	●	●	$	$	◉
Enforcement	○	●	$	$	◉
Utility Pricing	◉	◉	$$	$	◉
Key: ○ Low ◉ Medium ● High $ Low $$ Medium $$$ High					

Table 15: Comparing Stick and Carrot Strategies to Promote Pollution Prevention Practices					
	Comparative Factors				
	Hit Rate	Adoption Rate	Startup Cost	Ongoing Cost	Expertise Needed
Sticks					
Industrial NPDES Permits	○	◉	$	$	○
ID and Refer Non-filers	○	◉	$$	$	◉
Local Hotspot Regulation	◉	◉	$$	$$	◉
Inspections	◉	●	$$	$$$	●
Certification Programs	◉	●	$$$	$$$	●
Hotspot Enforcement	●	●	$	$$	◉
Carrots					
Passive Business Outreach	◉	○	$$	$$	◉
On-site Tech. Assistance	○	●	$$	$$$	●
Training	○	●	$$$	$$$	●
Subsidies and Discounts	○	◉	$$	$$$	◉
Business Recognition	○	◉	$	$	◉
Key: ○ Low ◉ Medium ● High $ Low $$ Medium $$$ High					

Step 6: Craft a Clear and Simple Message

A clear and simple educational message must be crafted to attract the attention of residents and business owners who are bombarded by dozens of other competing messages every day. The message should clearly describe how to practice the desired behavior, and explain how the practice will benefit the individual resident or business. Several tips on crafting an effective message are offered below:

1. Link your message to a recognized community problem – Your message should always link the watershed behavior to the undesirable water

quality problem it causes (e.g., fish kills, beach closure, green lakes, flooding).

2. The message should never presume much awareness -- The average person doesn't know much about storm water runoff, nonpoint source pollution or watersheds, so remember to stress the connection between the home, storm drains and downstream waters in every message you send. Pictures and simple drawings are more effective than words in increasing storm water awareness.

3. Keep your message uncluttered – It can be tempting to try to change all 21 neighborhood behaviors and 15 hotspot operations at one time. Don't even think about it. Most people can only absorb a few new things at a time, so confine your message to two or three key headlines. You can always sprinkle in additional stewardship messages later.

4. Keep the message simple and funny – Source control messages should never be preachy, complex, ambiguous or depressing. Indeed, the most effective messages are direct and interesting with a dash of humor. The basic rule is that your core message should be expressed in a single sentence.

5. Package your message in small, slick and durable units – It can be a real struggle to impart detailed information to residents and businesses without losing their interest. One solution is to create small, colorful and durable packets that contain the key essentials about watershed stewardship, and contact information on where to get more advice. These packets can be stuck on the refrigerator, the kitchen drawer, or the lunchroom for handy reference when the impulse for better watershed behavior strikes.

6. Understand your audience – Your message should always be customized to reflect the unique demographics of your subwatershed. In some cases, you may want to analyze census data to understand the demographics of priority neighborhoods, such as age, income, and ethnicity. Similarly, you may want to investigate workforce demographics within hotspot clusters in order to craft a message that reflects the education levels, turnover and languages spoken by workers. For example, middle-age males with higher incomes and education levels are often considered a prime outreach target, as surveys indicate they engage in more potentially polluting behaviors than other sectors of the population (Swann, 1999). By contrast, if residents speak English as a second language, the message should be sent in their primary language.

Step 7: Select the Most Effective Outreach Techniques

Once you've crafted the perfect message, you need to select the best outreach techniques to deliver it to the outreach population. To do this, you need to carefully define the size of the outreach population, establish the desired exposure frequency and choose the best mix of outreach techniques to advertise source controls. Each of these important tasks is described below.

1. Define the size of the outreach population – The size of the outreach population can be easily quantified from subwatershed data generated earlier in the SCP. The basic idea is to get an accurate count of the following:

- Subwatershed households
- Households in priority neighborhoods
- Potential training/workshop population - usually assumed to be no more than 2 - 5% of total subwatershed population
- Active neighborhood associations
- Suspected or confirmed hotspot sites
- Subwatershed education outlets - sum of malls, libraries, schools, retails, nature centers, municipal buildings in the subwatershed that could distribute outreach materials

2. Estimate the exposures and timing needed for your message – Exposures are defined as the number of times the average resident or business hears or sees your educational message. Marketing studies suggest anywhere from three to 12 exposures are needed for an education message to truly sink in. The number of

exposures needed is also related to the complexity, length and immediacy of your core message. More exposures are needed if the message is long or complex, or must be sustained over a long period of time. At a minimum, try to achieve at least three exposures for your target population, using different outreach techniques.

The timing of exposures can also be critical. For example, many residential behaviors are seasonal in nature, and exposures should be scheduled when behavior is the highest (e.g., lawn fertilization in the spring).

3. Select several outreach techniques to spread your message – Surveys have discovered which outreach techniques are most influential in attracting the attention of residents and businesses (Swann, 1999). In general, messages transmitted via television, radio and local newspapers are most influential, with up to 30% recall rates in the subwatershed population. By contrast, messages sent through meetings, brochures, local cable and videos are recalled by a much smaller fraction of the population.

Table 16 lists 30 different outreach techniques that can be used to communicate your message. These techniques are divided into two categories based on their comparative costs: "low-cost" techniques cost a few cents per subwatershed resident exposed, while "high-cost" techniques can cost a few dollars per exposure, but may be more influential in changing behaviors. Low-cost techniques are cost-effective in increasing watershed awareness and sending messages about negative watershed behaviors. On the other hand, high-cost techniques are better at promoting more sophisticated stewardship practices in the home, lawn and workplace. It is important to remember that no single outreach technique is ever recalled by more than 30% of the population, so a mix of techniques is needed to send the message across to enough residents to make a difference in a subwatershed.

Table 16: Range of Outreach Techniques

Lower unit cost	
• Brochures • Decals • Fact Sheets • Flyers • Letters • Mailings • Newsletters • Posters	• Presentations • Public displays • Refrigerator Magnets • Signs • Utility bill inserts • Watershed maps • Word-of-mouth
Higher unit cost	
• Billboards • Classes • Community fairs • Meetings • Newspaper ads • Newspaper articles • Newspaper inserts • Pollution Hotlines	• Public notices • Radio PSAs • Retail exhibits • TV PSAs • Videos • Watershed Festivals • Workshops

Keep in mind that many excellent outreach resources already exist, so you don't need to invent an outreach campaign from scratch. Two of the best resources to consult are the *Getting in Step* guides produced by Tetratech, Inc. for the U.S. EPA, which can be found here: http://www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf and http://www.epa.gov/owow/watershed/outreach/documents/stakeholderguide.pdf

Step 8: Choose the Mix of Source Control Practices

During this step, you choose specific source control practices to apply in the subwatershed from more than 100 available practices. Table 17 lists 92 neighborhood stewardship practices, and Table 18 features 22 hotspot pollution prevention practices. More details on each practice can be found in Chapters 5 and 6.

At this point, selecting the right practices from such a long menu is relatively easy, since you already know the pollutant of concern, the key behaviors and operations to target, and the types of carrots and sticks you plan to employ. Once again, it is a good idea to choose several different source control practices to apply in your subwatershed, and get feedback from stakeholders, residents, and businesses on how receptive they will be to adopting them.

Table 17: 92 Tools to Promote Better Neighborhood Stewardship

-----YARDS AND LAWNS-----

Carrots

- Create demonstration lawn and garden programs
- Create "bayscapes" program
- Create master gardener programs
- Create backyard habitat/butterfly gardens
- Create homeowner stewardship recognition
- Distribute coupons for septic system cleanouts
- Distribute free or discounted
  - Compost bins
  - Mulch
  - Grass patch repair kits
  - Native plant material/seeds
  - Seedlings of native trees
  - Native tree planting guidebooks
- Offer direct lawn care consultations
- Offer pest advice through hotlines
- Offer non-regulatory erosion control consultations
- Offer free septic system inspections
- Offer lawn and garden advice on the radio
- Offer direct tree planting assistance
- Offer assistance in lawn composting
- Promote low-input lawn care guides
- Promote integrated pest management techniques
- Promote summer water conservation
- Promote grass-cycling mowers
- Promote garden clubs and native plant societies
- Promote native plant nurseries
- Provide regular yard waste pickup
- Provide fall leaf pickup
- Provide free or discounted soil tests
- Provide natural landscaping guides
- Provide invasive species alerts
- Set up exhibits at lawn care and garden centers, and retail outlets that sell pool chemicals

Sticks

- Adopt tree clearing ordinances and permits
- Adopt ordinance to prevent pool discharges
- Adopt erosion control and nuisance ordinances
- Ban pickup of lawn clippings
- Create septic management districts
- Impose mandatory outdoor water restrictions
- Require certification/licensing of pesticide applicators
- Require certification of lawn care contractors
- Require certification of septic systems at sale
- Require certification of septage haulers
- Require mandatory septic system inspections
- Repeal local weed ordinances
- Restrict phosphorus content in fertilizer
- Set water rates to discourage outdoor water use

-----GARAGES-----

Carrots

- Provide more frequent HHW collection days
- Provide mobile and curbside pickup options for HHW
- Provide HHW disposal fee waivers at landfills
- Provide directories of used oil collection stations
- Provide discounted used oil disposal containers
- Provide fluid recycling at auto parts stores/gas stations

Table 17: 92 Tools to Promote Better Neighborhood Stewardship

-----DRIVEWAYS/SIDEWALKS/CURBS-----

Carrots

- Distribute discounts for commercial car washes
- Distribute directories of used oil collection stations
- Distribute used oil disposal containers
- Distribute storm drain plugs for charity car wash events
- Promote hose nozzles with shut-off valves
- Promote safe car washing products at point of sale
- Promote safe de-icer use by local TV weathermen
- Promote fluid recycling at auto parts stores/gas stations

Sticks

- Post signs to keep leaves out of gutters during fall leaf collection
- Train contractors on proper leaf blower use

-----ROOFTOPS-----

Carrots

- Create rain garden demonstration projects
- Distribute free or discounted rain barrels
- Offer technical assistance on design/installation
- Promote rain garden/rain barrel installation
- Subsidize disconnections through utility credits

Sticks

- Require downspout disconnection in targeted subwatersheds
- Require single lot storm water and ESC plans
- Set storm water rates based on actual impervious cover

-----COMMON AREAS-----

Carrots

- Create an “Adopt-a-storm water pond” program
- Create an “Adopt-a-stream” program
- Create designated “dog parks”
- Create storm water pond beautification awards
- Install “pooper scooper” stations in common areas
- Offer community buffer walks
- Offer consultations with homeowner associations
- Offer pondscaping assistance
- Offer storm water inspections/contractor referral
- Offer storm water maintenance classes
- Promote bufferscaping through outreach guides
- Promote pet waste pickup through education
- Promote pet waste pickup using signs
- Provide seedlings to reforest open space
- Provide storm drain marking/stenciling kits

Sticks

- Adopt ordinances to:
  - Define and prevent unacceptable stream buffer uses
  - Prevent illegal dumping
  - Prevent storm drain discharges
  - Require storm water practice maintenance
- Enforce “pooper scooper” ordinances
- Ban dogs from beaches and public spaces
- Inspect and enforce stream buffer boundaries
- Post stream buffer boundary signs

Table 18: 22 Tools to Promote Hotspot Pollution Prevention Practices
Sticks
• Adopt local ordinance to pick up non-regulated hotspots • Certify lawn care/landscaping/power-washing contractors • Check and review on-site storm water pollution prevention plans • Conduct on-site illicit discharge investigations • Conduct regular site inspections • Identify NPDES non-filers and refer for state enforcement • Issue fines, stop work orders, and other enforcement actions • Review of spill response plans
Carrots
• Assemble vendor and contractor directories • Conduct non-regulatory site inspections • Coordinate inspections with fire, building, and food handling inspectors • Coordinate with corporate safety and compliance officers • Develop multilingual outreach materials • Distribute pollution prevention training videos • Establish business recognition programs • Mail outreach materials to target business groups • Make presentations to business groups • Offer small business loans to install structural practices • Provide discounted spill response kits, storm drain plugs, drip pans, tarps • Provide free assistance in pollution prevention plans • Provide free employee training on pollution prevention • Provide pollution prevention posters and signs

Step 9: Estimate Subwatershed Source Control Budget

The next step involves deriving a budget to implement source control practices at the subwatershed level. Decent planning estimates can be derived using a four-step unit cost budgeting approach, as shown below:

1. Define time frame for source control implementation -- The first budget decision is to choose the time horizon over which source control practices will be applied. Based on our experience, a minimum horizon of three years is recommended, since lasting behavior change usually requires multiple exposures over time.

2. Estimate direct outreach costs -- The second budget step involves estimating the direct costs for the outreach techniques used to advertise source control practices. Outreach costs are calculated as the product of the outreach population, the number of exposures needed, and the unit cost for each outreach exposure. For example, if a brochure is sent three times to 2,000 households in a subwatershed, and the cost to produce and mail each brochure is 75 cents per copy, then the direct outreach cost would be:

$$(3)\ (2000)\ (\$0.75) = \$4{,}000.$$

Unit costs for some common outreach techniques are provided in Table 19.

3. Estimate direct costs for source control practices -- The third budgeting step involves computing the annual cost to directly implement source control practices, which is projected based on unit costs (e.g., cost per capita, household, neighborhood, or hotspot). Some direct costs are fairly easy to estimate, such as the cost of an individual educational brochure, installation of a rain barrel, or a lawn care consultation. A budget item should be developed for each source control practice recommended in your plan. Budgeting guidance for various neighborhood stewardship and hotspot pollution prevention practices is provided in Tables 20

and 21, respectively. These cost estimates were derived from communities across the country and should be viewed as planning level estimates. More detailed local cost analysis may be needed to get more accurate budget estimates.

Table 19: Unit Costs for Outreach Techniques		
Technique	**Unit**	**Estimated Cost**
Overall residential outreach	Per year	$.14 - $1.11
Designer for material layout	Per hour	$100 - $150
Coloring books	Per 1,000 produced	$.45
Decals	Per 1,000 produced	$.17
Magnets	Per 1,000 produced	$.30
Posters (4 double-sided, color, 11x17)	Per 1,000 produced	$2.75
Printed materials (Flyers)	Per 1,000 produced	$.60-$.84
Printed materials (Tri-fold panel brochure)	Per 1,000 produced	$1.60 -$2.40
Stickers	Per 1,000 produced	$.08
Tote bags	Per 1,000 produced	$3.50
Billboards	Per billboard/per month	$550 -$1,850
Exterior bus advertisements	Per bus/per month	$750 - $1,450
Tabletop display	Per display	$500-$800
Educational video	Per minute of video	$1,800
Movie theatre slides	Per month	$150 -$1,400
Newspaper ads in small local paper	Per advertisement	$260 -$450
Photo displays	Per display	$121
Public attitude phone survey	Per survey of 1,000	$15,000
Radio public service announcement *	Per announcement	$40-60
TV public service announcement *	Per announcement	$2,750 - $4,000
** Assumes free airtime* *Sources: Council of State Governments, 1998; MacPherson and Tonning, 2003; National Oceanic and Atmospheric Administration, 1988; Water Environment Research Federation, 2000; and Center for Watershed Protection, 1998.*		

Table 20: Unit Costs for Neighborhood Stewardship Practices		
Techniques	**Unit**	**Estimated Cost**
Lawn care advice	Per household	$1.75 – $3.20
Rain barrel	Per household	$20 - $45
Septic system inspections	Per household	$150-$260
Municipal Composting	Per household	$1.85 – $2.40
Soil testing	Per household	$8-$12
Compost bins	Per household	$18-$62
Curbside recycling	Per household	$29
Curbside leaf/yard waste pickup	Per household	$11.60
Household hazardous waste collection	Per household	$1.75 - $8.09
Adopt an ordinance	Per ordinance	$13,000 - $15,000
Provide stenciling materials	Per neighborhood	$300 -$400
Rain garden demonstration project	Per square foot	
	Residential	$3 to $4
	Commercial	$10 to $40
Signage	Per sign	$20-$50
“Pooper bag” stations	Per station	$250 - $300
Tree plantings	Per tree	$3.25 -$19
Pesticide advice hotline	Per year	$8,500
Non-commercial pesticide applicator licensing	Per individual	$15-$45
Cost derived from a survey of various communities across the country		

Table 21: Unit Costs for Hotspot Pollution Prevention Practices		
Technique	**Unit**	**Estimated Cost**
Regular site inspections	Per facility	$75 - $175
Commercial lawn care/landscaping/power-washing contractors	Per individual	$25 - $75
Local ordinance to pick up non-regulated Hotspots	Per ordinance	$13,000 - $15,000
On-site illicit discharge investigations	Per facility	$220 - $900
Outreach materials to target business groups	Per hour	$30 - $45
Presentations to business groups	Per hour	$40 - $60
Non-regulatory site inspections	Per facility	$30 - $80
Business recognition programs	Per facility	$40 - $75
Discounted spill response kits, storm drain plugs, drip pans, tarps	Per facility	$60 - $250
Cost derived from a survey of various communities across the country		

4. Estimate program staffing costs-- The final budgeting step involves estimating staff costs to plan, coordinate and administer the source control program. Staffing costs can be a difficult budget item to project, and vary depending on whether staff are paid or volunteer. Some commitment of local agency staff or contract dollars is almost always needed to get the source control program started. For example, you should plan on at least 200 to 400 hours of time per subwatershed/year for an outreach coordinator to administer the source control program, and an equivalent amount to conduct USSR surveys and develop the SCP. Additional staff costs may be needed to oversee implementation of source control practices.

Step 10: Put Together a Partnership to Distribute the Practices

Source control practices require an on-the-ground delivery system to connect with individual residents or businesses and provide them with the desired level of education, training, direct services or enforcement. This step examines the best way to manage the distribution of source control practices in a subwatershed. Often, local storm water agencies will spearhead the effort, but other partners can play an important role.

A single outreach coordinator really can't do much alone. Indeed, the success of the SCP depends on the number and commitment of partners who can spread the stewardship or pollution prevention message. Partners can often offer more direct, convenient and less expensive ways to distribute source control practices to the target population over the long run. Potential partners include community volunteers, watershed groups, local educators, private sector allies, water and sewer utilities, other government agencies and the local media. This step describes the strategies to recruit and motivate potential partners to become involved in your source control plan.

1. Community Volunteers -- Community volunteers are an effective way to spread the stewardship message. The pool of potential volunteers in a community may be greater than you think. According to Roper Surveys, one in 10 residents can be characterized as "community influential" (NEETF, 2003). These people take an active interest in running their community, and are five times more likely to attend a community meeting than their peers. This group actively seeks environmental information and is predisposed to support and adopt environmentally sound stewardship practices. The real trick is to find the best way to reach the "influentials" that live or work in your subwatershed. In general, this group is well informed, and can be reached through local newspapers and community meetings.

2. Watershed Groups-- Watershed groups should always be courted as source control partners if they exist near the subwatershed. Watershed groups are often credible, low-cost stewardship retailers directly connected to the community. Existing watershed groups should be invited to play a major role in delivering a local source control program, and communities may want to directly contract or out-source storm water education and other source control functions to them. If no group exists, you may want to consider forming one by investing seed money.

3. Local Educators-- A surprisingly large number of educators in the community can expand your source control partnership. Many educators are already promoting similar stewardship messages, such as the local cooperative extension office, soil conservation district, community forester, or state natural resource agency. Other educators can be found in local schools, nature centers, museums, aquariums, and libraries. Local educators can contribute expertise, resources and an existing distribution network to your source control program, and can be tapped to recruit volunteers. It is always a good idea to enlist fellow local educators in your source control partnership.

4. Private Sector Allies -- Many private sector companies stand to potentially profit from improved watershed stewardship. For example, better stewardship can drum up more sales for companies such as septic tank cleaners, commercial car washes, and quick oil change franchises, although they may need help crafting their stewardship marketing pitch.

Lawn care companies and landscaping services can also be helpful private sector allies. Nationally, lawn care companies are used by seven to 50% of consumers, depending on neighborhood income and lot size. Lawn care companies exercise considerable authority over the practices applied to the lawns they tend, as long as they can still produce a sharp-looking lawn. For example, 94% of lawn care companies reported that they had authority to change lawn care practices, and that about 60% of their customers were "somewhat receptive to new ideas" according to Israel *et al.* (1995). De Young (1997) also found that most homeowners express a high level of trust in their lawn care company. A small but growing number of lawn care companies feel that environmental advertising makes good business sense and can increase sales (Israel *et al.*, 1995). If companies can be properly trained in practices to reduce fertilizer and pesticide inputs, their services should be actively promoted by the source control partnership. Lawn and garden centers are another potential source control ally. Marketing research consistently indicates that product labels and store attendants are the primary source of lawn care information for the average resident (Swann, 1999). The key strategy is to substitute watershed-friendly products and train store attendants to demonstrate them at the point of sale.

5. Water and Sewer Utilities-- Utilities routinely reach out to residents via the dreaded service bill, which is often accompanied by a cheerful insert. Water utilities already educate the public about water conservation and drinking water quality. Indeed, most water utilities are required to provide annual summaries of drinking water quality under the Safe Drinking Water Act. In addition, sewer utilities may need to publicize hotlines to report sewage discharges. As a result, local utilities should have a common interest in your source control plan, and may be willing to share space in bill inserts and other educational products they routinely disseminate.

6. Other government agencies-- Residents and businesses routinely intersect with local government in many ways —not just through the local storm water agency. Therefore, it is a good idea to investigate whether other agencies could serve as a distribution outlet for source control materials. Examples include city halls, building permits, local inspectors, park events, and community planning efforts. Each of these represents an opportunity for free or low-cost source control interaction. In addition, state and federal enforcement agencies should always be consulted to make sure they are ready to wield the permit stick when needed.

7. Local Media -- Community newspapers, local broadcasters, and community cable access channels can become important source control partners. Local media offer a direct and low-cost way to spread a stewardship message to a large segment of the local population, although the message needs to be condensed and repackaged to fit into the small bits of time or space available (i.e., a few seconds or minutes of air time or a couple of column inches of newsprint). Initially, the best way to utilize local media is to have them advertise the source control practices that directly serve the community (i.e., availability of free soil tests, notification of HHW pick-up days, lawn care consultations). Most local and community outlets are willing to announce community events and free services. If you want to send a more complex stewardship message, meet with local editors and producers to find the best format.

It also helps to develop a good relationship with your local weathercaster. Surveys indicate that the public regards weathercasters as the most trusted scientists in the community, and they can be helpful to impart brief source control messages in their daily and seasonal weather stories (NEETF, 2003). Tips on training weathercasters to communicate environmental stewardship messages can be found at www.neetf.org. In larger television markets, weathercasters have developed websites to provide the more detailed information about stewardship that can't fit into the few minutes each day they have to tell the weather story. An excellent example of this approach is the www.watershed.interactive-environment.com website, which gets millions of hits from viewers each year.

Step 11: Evaluate Progress in Implementation

The last step in the SCP involves deciding how to evaluate the effectiveness of your source control implementation. Regrettably, the impact of source control plans on pollutant reduction has seldom been assessed. Measurable performance indicators are essential to improve the delivery of source control practices so that communities can make better investment decisions. Seven different kinds of surveys or monitoring have been used to evaluate source control programs, including the following:

1. *Awareness surveys* – are residents aware of water quality problems, and are they receptive to change?
2. *Practice surveys* – what are the actual practices occurring in neighborhood or hotspots, and why are they being done?
3. *Recall surveys* – have residents/operators actually heard or seen your source control message?
4. *Program effort* – counts of participation rates, exposures, inspections in your source control program.
5. *Before/after behavior surveys*—how much have behaviors/operations changed in the subwatershed as a result of your source control program?
6. *Water quality surveys*—have measurable water quality improvements occurred in dry weather flows, stream quality or pond sediments as a result of source control practices?
7. *Sustaining stewardship*—has the responsibility for source control shifted from local government to private stewardship groups?

Many communities will need to evaluate their source control programs in the coming years to comply with municipal NPDES storm water permits. The permits require communities to develop measurable goals and implementation milestones for their storm water education and pollution prevention programs. Surveys and other types of monitoring will be needed to evaluate source control implementation.

Maintaining Source Controls Over Time

By their very nature, subwatersheds are quite dynamic. People move in and out, business operations come and go, and new neighborhoods are built or redeveloped. As a result, source control programs must continually evolve to respond to population changes in the

subwatershed. Source control should never be considered a one-shot deal, but rather an ongoing program that is maintained and enhanced over time. In many cases, the basic stewardship message is gradually expanded to incorporate additional behaviors and pollution sources. At the same time, the original stewardship message must be continually repeated until the desired stewardship or pollution prevention practices are widely adopted by the target population.
Maintaining source control programs over the long run can be a daunting challenge, given local budget cycles and competing spending priorities. While no firm time frame can be given, it is doubtful whether most behaviors and operations can be widely adopted in less than three years.

Communities have employed several strategies to maintain source controls over the long run. First, they have expanded their source control partnerships to attract ongoing budget support and distribute program responsibility. Second, they have sought to gradually "privatize" source control functions, using watershed groups, volunteers, local educators and private sector allies. Lastly, they have sought to demonstrate the effectiveness of source control practices through water quality monitoring and attitude surveys.

4.2 An Example Source Control Plan for Stewardship Branch

This section presents an example of how to design and implement an effective source control plan for a hypothetical subwatershed, known as Stewardship Branch (Figure 8). This 10 square mile subwatershed has suburban residential land comprising 80% of the land use, including more than 20 neighborhoods. The remaining land use in the subwatershed comprises a mix of commercial, institutional and light industrial.

Step 1: Pick Pollutant of Concern

Stewardship Branch flows to a drinking water reservoir experiencing problems with nutrient enrichment. Therefore, the design team had no difficulty agreeing that nutrients would be the primary pollutant of concern, but had interest in reducing bacteria inputs to the reservoir, as well.

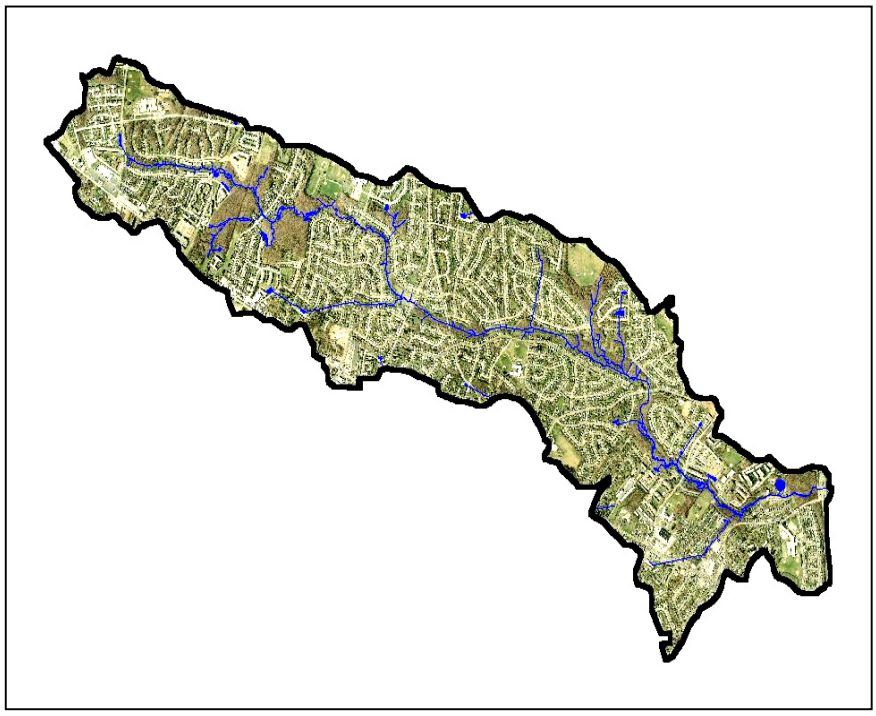


Figure 8: Aerial Photo of Stewardship Branch

Step 2: Link Pollutant to Key Subwatershed Indicators

The design team then surveyed the entire subwatershed using the NSA and HSI components of the USSR. After reviewing their NSA data, the team discovered several potential nutrient indicators within several neighborhoods:

- High input turf
- Accumulation of organic matter in curbs and catch basins
- Presence of pet waste in the sidewalk zone
- Presence of septic systems
- Poor yard waste management

After further checks for hydraulic connections and pollutant accumulation, the team initially identified lawn fertilization, pet waste pickup and failing septic systems as the three most probable nutrient sources in the subwatershed. Pet waste was also identified as a bacteria source.

Similar analysis of HSI data revealed three potential indicators of nutrient pollution in the subwatershed:

- Commercial landscaping
- Carwash
- Golf course

Subsequent review of HSI data for the commercial landscaping and carwash operations revealed the operations were not hydraulically connected to the storm drain system, so they were not given further consideration. The golf course was deemed a probable nutrient source, and was targeted for special management.

Step 3: Locate Specific Pollutant Source Areas in the Subwatershed

The design team then examined where nutrient indicators were located across the entire subwatershed. Maps and metrics were prepared that indicated high input turf and pet waste were distributed across many neighborhoods in the subwatershed, but septic systems were confined to a very small cluster in a single neighborhood. Based on their analysis, the design team decided to concentrate on lawn fertilization, pet waste disposal and golf course management as priority nutrient sources in the subwatershed.

Since Stewardship Branch is primarily residential, the design team wanted to determine which of the 20 neighborhoods had the greatest potential to generate nutrient pollution. To do this, they developed a simple neighborhood screening process that focused on four neighborhood metrics thought to be strong nutrient indicators: the proportion of high input turf, overall turf cover, and the presence of pet waste and lawn clippings in the sidewalk zone. An example of the neighborhood screening process developed by the design team is shown in Table 22. In this example, neighborhood 8 was targeted as a priority since it scored highest for three of the four nutrient metrics. Based on the entire screening analysis, the design team targeted 11 of the 20 neighborhoods in Stewardship Branch for intensive nutrient education, along with the golf course noted earlier.

Step 4: Define Priority Outreach Targets

The design team then assembled a contact database for subsequent outreach for the 11 priority neighborhoods and the golf course, using mailing lists obtained from active neighborhood associations, a local direct mailing firm and personal contacts. The final database

Table 22: Example of NSA Metrics Used to Screen Neighborhoods

	% High Input Turf	Turf Cover as % of Lot Area	Pet Waste Scores	Front Yard Clippings
Neighborhood 8	65	70	Yes	15
Neighborhood 9	10	35	No	12
Neighborhood 10	5	35	No	17

included contact information on the 1,200 individual homeowners within Stewardship Branch that comprised the target outreach population.

The design team then consulted with neighborhood association leaders and others to get a better handle on resident attitudes toward lawn care and pet waste pickup. From this mini-survey, they quickly learned that many behaviors were deeply rooted in older neighborhoods, and peer pressure was a major motivation factor for current lawn care practices.

Step 5: Develop an Overall Source Control Strategy

The design team then met to choose the specific behaviors they wanted to focus on in their source control strategy. The team agreed that low-input lawn care (N-1) and pet waste pickup (N-18) would be the initial priorities, although other lawn behaviors could be added in future years. Given current resident attitudes, the team felt that a carrot strategy would be most appropriate to promote low-input lawn care, emphasizing passive education, active training, a few subsidies and discounts and the formation of a lawn stewardship group. By contrast, they felt pet waste pickup would be best improved through a stick strategy, beginning by notifying residents about the existing pooper scooper ordinance, followed by selective enforcement.

Step 6: Craft a Clear and Simple Message

The design team thought long and hard about how to craft the most effective message for low-input lawn care, since the practice requires residents to learn and adopt many new behaviors. The basic prescription of using less fertilizer, using slow-release fertilizers in the right season, testing soils, and using grass-cycling mowers to keep clippings on the lawn is fairly complex. The team initially considered a direct and simple message to stop lawn fertilization and reduce turf area, but felt it would not be well received. Instead, the team settled on a message, "Green Lawns not Green Lakes," that would be accompanied by information on how residents could access a range of free services and resources to practice natural lawn care. The team also crafted a secondary message, "Scoop Your Poop or End up Drinking It," to address the pet waste issue.

Step 7: Select the Most Effective Outreach Techniques

The design team quickly estimated their target outreach population, which consisted of 1,200 households in priority neighborhoods (out of a total of 2,500 for the subwatershed as a whole), nine active neighborhood associations, six educational outlets, an estimated training audience of 80 individuals, and a single golf course.

Given that lawn care is inherently seasonal, the design team scheduled their outreach campaign to achieve 3-4 exposures from April to July each year. Given a modest budget, the design team elected to use lower cost outreach techniques to advertise the lawn care campaign, including direct mail, door hangers, exhibits at education outlets, presentations at neighborhood associations, and articles in the community newspaper. The team felt a more direct strategy should be employed for pet waste pickup, and elected to provide continuous exposure in the area that had the greatest dog-walking traffic (using signs).

Step 8: Choose Mix of Source Control Practices

The design team then shifted its focus to choose the specific source control practices to apply in the subwatershed. After reviewing its options, the design team selected eight source control practices to implement in Stewardship Branch:

- Distribute a slick packet on low-input lawn care to all households in priority neighborhoods
- Establish a "Lawn Master" program to train homeowners on natural lawn care
- Set up lawn care exhibits at lawn/garden centers

- Offer free soil tests
- Offer free on-site lawn care consultation
- Establish a lawn care recognition program
- Develop a nutrient management plan for the golf course
- Install five pet waste "pooper scooper" stations and signs

Step 9: Estimate Subwatershed Source Control Budget

The design team computed a budget for the source control plan that phased in the eight source control practices over a three-year period. The budget was based on unit costs and is summarized in Table 23. Overall, the total budget to implement the source control plan was estimated to be $15 per subwatershed household per year, or roughly the cost to construct a single off-site storage retrofit.

Step 10: Put Together Partnership to Deliver Outreach Practices

The design team felt that the source control plan would initially be delivered by a part-time local outreach coordinator, although the soil tests and lawn care consultations would be provided by the local cooperative extension service office. The ultimate goal, however, was to shift many source control responsibilities to the volunteer lawn masters stewardship club within three years.

Step 11: Measure Progress in Implementation

The design team developed several performance indicators to measure progress made in subwatershed source control, including the following:

- Total number of educational exposures achieved in the subwatershed
- Number of free soil tests provided
- Number of residents who actively participated in the lawn masters club or requested lawn care consultations
- Development and implementation of a nutrient management plan for the golf course
- Change in pet waste accumulation in common areas

In addition, the design team added $10,000 to the overall budget to perform a phone survey about residential lawn practices at the beginning and end of the three-year source control program. The survey was intended to track changes in homeowner awareness and lawn care practices adoption rates over time.

Table 23: Subwatershed Source Control Budget for Stewardship Branch

Practice	Year 1	Year 2	Year 3	Total
Passive lawn care outreach	$10,200	$6,800	$4,800	$21,800
Lawn masters club	$4,600	$9,600	$9,600	$28,800
Lawn care exhibits	$3,200	$1,600	$1,600	$6,400
Free soil tests	$2,000	$3,000	$3,000	$8,000
On-site lawn consultation	$5,000	$8,000	$8,000	$22,000
Green lawn care awards	-0-	-0-	$3,000	$3,000
Pet waste signs	$2,000	-0-	-0-	$2,000
Golf course management plan	$3,000	$1,000	-0-	$4,000
Total	$30,000	$30,000	$30,000	**$90,000**

4.3 Source Controls: Apply on a Subwatershed or Community-Wide Basis?

This manual has presented a retail approach to deliver pollution source controls at the subwatershed scale. While a targeted approach makes sense in the context of subwatershed restoration, it may not be the only option for delivering storm water education and source control practices within a community. In some cases, it may make sense to adopt a "wholesale" approach that broadcasts the stewardship message across the entire community. Indeed, it may be more cost-effective to send some stewardship messages to the entire community, since many outreach techniques naturally lend themselves to a broader geographic area or audience. For example, the influence of television, radio, bus signs and newspapers normally extends well beyond a single subwatershed.

Similarly, certain source control practices, such as ordinances, permit enforcement and direct municipal services, can only be fairly and equitably administered if they apply to all the residents in a community-- not just the ones located in targeted subwatersheds.

Ideally, a community should adopt both a retail and wholesale strategy for source control. The targeted retail approach applied to individual subwatersheds can be reinforced by a broader wholesale campaign for the community as a whole.

Chapter 5: Neighborhood Stewardship Profile Sheets

This chapter contains profile sheets describing 21 different neighborhood stewardship practices that can prevent storm water pollution or improve habitat. Each sheet explains how the stewardship behavior influences water quality, and presents social research about its frequency and variation. The profile sheets also recommend practical techniques to promote better stewardship behaviors, and provide useful internet resources and references to consult. Neighborhood stewardship practices profiled in this chapter include:

Profile Sheet **Page**

N-1	Neighborhood Source Area: Yard	
	REDUCED FERTILIZER USE	

Description

The ideal behavior is to not apply fertilizer to lawns. The next best thing for homeowners who feel they must fertilize is to practice natural lawn care: using low inputs of organic or slow release fertilizers that are based on actual needs as determined by a soil test. The obvious negative watershed behavior is improper fertilization, whether in terms of the timing, frequency or rate of fertilizer applications, or a combination of all three. The other important variable to define is who is applying fertilizer in the neighborhood. Nationally, about 75% of lawn fertilization is done by homeowners, with the remaining 25% applied by lawn care companies (Figure 1). This split, however, tends to be highly variable within individual neighborhoods, depending on its income and demographics.

How Fertilizer Influences Water Quality

Recent research has demonstrated that lawn over-fertilization produces nutrient runoff with the potential to cause downstream eutrophication in streams, lakes, and estuaries (Barth, 1995a and 1995b). Scientists have also discovered that nitrogen and phosphorus levels in lawn runoff are about two to 10 times higher than any other part of the urban landscape such as streets, rooftops, driveways or parking lots (Bannerman *et al.*, 1993; Steuer *et al*., 1997; Waschbusch *et al*., 2000; Garn, 2002).

Figure 1: Lawn Care Company Truck

Percentage of People Engaging in Fertilizer Use

Lawn fertilization is among the most widespread watershed behaviors in which residents engage. A survey of lawn care practices in the Chesapeake Bay indicated that 89% of citizens owned a yard, and of these, 50% applied fertilizer every year (Swann, 1999). The average rate of fertilization in 10 other regional lawn care surveys was even higher (78%), although this may reflect the fact that these surveys were biased towards predominantly suburban neighborhoods and excluded non-lawn owners. Several studies have measured the frequency of lawn fertilization, and have found that lawns are fertilized about twice a year, with spring and fall being the most common season for applications (Swann, 1999).

A significant fraction of homeowners can be classified as "over-fertilizers" who apply fertilizers above recommended rates. Surveys indicate the number of over-fertilizers at 50% to 70% of all fertilizers (Morris and Traxler, 1996; Swann, 1999; Knox *et al*., 1995). Clearly, many homeowners, in a quest for quick results or a bright green lawn, are applying more nutrients to their lawns than they actually need.

Variation in Fertilization Behavior

Many regional and neighborhood factors influence local fertilization behavior. From a regional standpoint, climate is a very important factor, as it determines the length of the growing season, type of grass, and the irrigation needed to maintain a lawn. A detailed discussion of the role these factors play in fertilization can be

found in Barth (1995a). A host of factors also comes into play at the individual neighborhood scale. Some of the more important variables include average income, market value of houses, soil quality, and the age of the development (Law *et al.*, 2004). Higher rates of fertilization appear to be very common in new suburban neighborhoods where residents seek to establish lawns and landscaping. Also, lawn irrigation systems and fertilization are strongly associated.

Difficulty in Changing Behavior

Changing fertilization behaviors can be hard since the desire for green lawns is deeply rooted in our culture (Jenkins, 1994; Teyssott, 1999). For example, the primary fertilizer is a man in the 45 to 54 year age group (BHI, 1997) who feels that "a green attractive lawn is an important asset in a neighborhood" (De Young, 1997). According to surveys, less than 10% of lawn owners take the trouble to take soil tests to determine whether fertilization is even needed (Swann, 1999; Law *et al.*, 2004). Most lawn owners are ignorant of the phosphorus or nitrogen content of the fertilizer they apply (Morris and Traxler, 1996), and are unaware that grass-cycling can sharply reduce fertilizer needs.

Most residents rely on commercial sources of information when making their fertilization decisions. The average consumer relies on product labels, store attendants, and lawn care companies as their primary, and often exclusive, sources of lawn care information. Consumers are also influenced by direct mail and word of mouth when they choose a lawn care company (Swann, 1999 and AMR, 1997).

Two approaches have shown promise in changing fertilization behaviors within a neighborhood, and both involve direct contact with individual homeowners. The first relies on using neighbors to spread the message to other residents, through master gardening programs. Individuals tend to be very receptive to advice from their peers, particularly if it relates to a common interest in healthy lawns. The second approach is similar in that it involves direct assistance to individuals at their homes (e.g., soil tests and lawn advice) or at the point of sale.

Techniques to Change Behavior

Most communities have primarily relied on carrots to change fertilization behaviors, although sticks are occasionally used in phosphorus-sensitive areas. The following are some of the most common techniques for changing fertilization behaviors:

- Seasonal media awareness campaigns
- Distribution of lawn care outreach materials (brochures, newsletters, posters, etc.; Figure 2)
- Direct homeowner assistance and training
- Master gardener program
- Exhibits and demonstration at point-of-sale retail outlets
- Free or reduced cost for soil testing
- Training and/or certification of lawn care professionals
- Lawn and garden shows on radio
- Local restrictions on phosphorus content in fertilizer

Good Examples

King County, Washington- Northwest Natural Yard Days. This month-long program offers discounts on natural yard care products and educational information about natural yard care in local stores throughout King County and Tacoma. Education specialists came to Saturday and Sunday events at some stores and spent time with buyers to help them make good choices and learn about natural yard care, including the use of organic fertilizers that don't wash off into streams and lakes as easily as "quick release" chemical fertilizers. For more details, consult: http://dnr.metrokc.gov/swd/ResRecy/events/naturalyard.shtml

North Carolina Department of Agriculture Free Residential Lawn Soil Testing. Residents can get a free soil test to determine the exact fertilizer and lime needs for their lawn, as well as for the garden, landscape plants and fruit trees. Information sheets and soil boxes are available from various government agencies, or local garden shops and other businesses. For more information, consult:
http://www.ncagr.com/agronomi/stfaqs.htm

Minnesota Department of Agriculture Phosphorus Lawn Fertilizer Use Restrictions. Starting in 2004, these restrictions limit the concentration of phosphorus in lawn care products and restrict its application at higher rates to specific situations based on need.
http://www.mda.state.mn.us/appd/ace/lawncwaterq.htm

Top Resources

Cornell Cooperative Extension. The Homeowner's Lawn Care Water Quality Almanac.
http://www.gardening.cornell.edu/lawn/almanac/index.html

University of Rhode Island Cooperative Extension Home*A*Syst Healthy Landscapes Program
http://www.healthylandscapes.org/

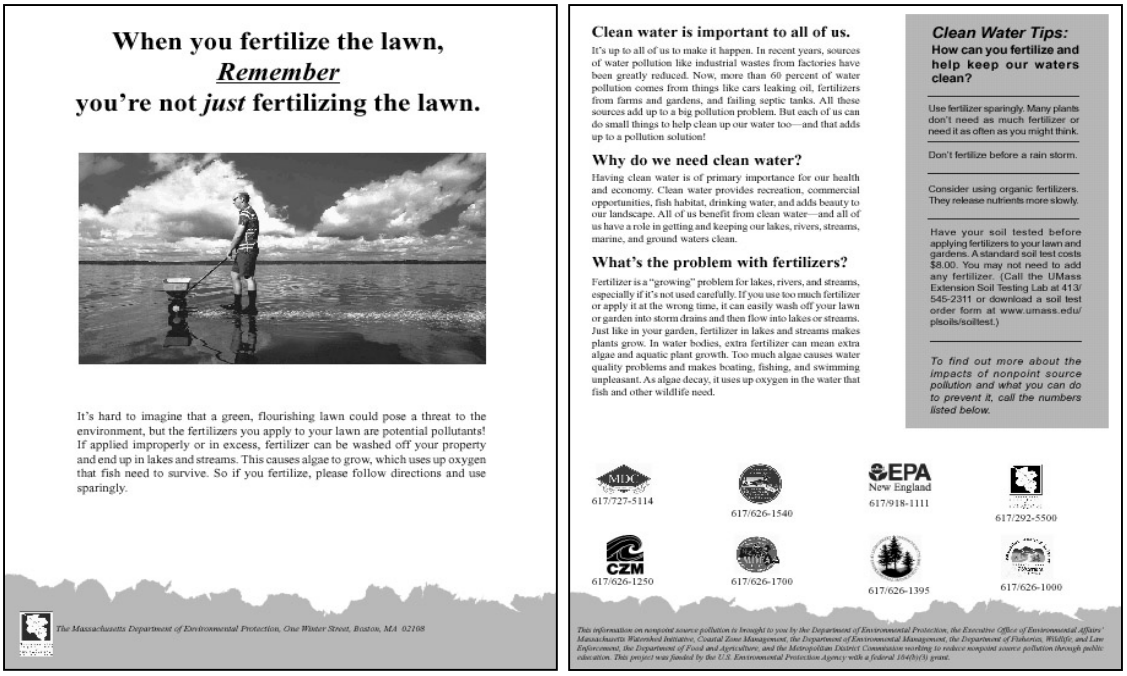
University of Maryland Cooperative Extension - Home and Garden Information Center.
http://www.agnr.umd.edu/users/hgic/

Turf and Landscape Best Management Practices. South Florida Water Management District and the Broward County Extension Education Division
http://www.sfwmd.gov/org/exo/broward/c11bmp/fertmgt.html

Florida Yards and Neighborhoods Handbook: A Guide to Environmentally Friendly Landscaping
http://hort.ufl.edu/fyn/hand.htm

University of Minnesota Extension Service Low-Input Lawn Care (LILaC)
http://www.extension.umn.edu/distribution/horticulture/DG7552.html

Austin TX, Stillhouse Spring Cleaning
http://www.ci.austin.tx.us/growgreen/stillhouse.htm



When you fertilize the lawn,
Remember
you're not *just* fertilizing the lawn.

It's hard to imagine that a green, flourishing lawn could pose a threat to the environment, but the fertilizers you apply to your lawn are potential pollutants! If applied improperly or in excess, fertilizer can be washed off your property and end up in lakes and streams. This causes algae to grow, which uses up oxygen that fish need to survive. So if you fertilize, please follow directions and use sparingly.

The Massachusetts Department of Environmental Protection, One Winter Street, Boston, MA 02108

Clean water is important to all of us.

It's up to all of us to make it happen. In recent years, sources of water pollution like industrial wastes from factories have been greatly reduced. Now, more than 60 percent of water pollution comes from things like cars leaking oil, fertilizers from farms and gardens, and failing septic tanks. All these sources add up to a big pollution problem. But each of us can do small things to help clean up our water too—and that adds up to a pollution solution!

Why do we need clean water?

Having clean water is of primary importance for our health and economy. Clean water provides recreation, commercial opportunities, fish habitat, drinking water, and adds beauty to our landscape. All of us benefit from clean water—and all of us have a role in getting and keeping our lakes, rivers, streams, marine, and ground waters clean.

What's the problem with fertilizers?

Fertilizer is a "growing" problem for lakes, rivers, and streams, especially if it's not used carefully. If you use too much fertilizer or apply it at the wrong time, it can easily wash off your lawn or garden into storm drains and then flow into lakes or streams. Just like in your garden, fertilizer in lakes and streams makes plants grow. In water bodies, extra fertilizer can mean extra algae and aquatic plant growth. Too much algae causes water quality problems and makes boating, fishing, and swimming unpleasant. As algae decay, it uses up oxygen in the water that fish and other wildlife need.

Clean Water Tips:
How can you fertilize and help keep our waters clean?

Use fertilizer sparingly. Many plants don't need as much fertilizer or need it as often as you might think.

Don't fertilize before a rain storm.

Consider using organic fertilizers. They release nutrients more slowly.

Have your soil tested before applying fertilizers to your lawn and gardens. A standard soil test costs $8.00. You may not need to add any fertilizer. (Call the UMass Extension Soil Testing Lab at 413/545-2311 or download a soil test order form at www.umass.edu/plsoils/soiltest.)

To find out more about the impacts of nonpoint source pollution and what you can do to prevent it, call the numbers listed below.

MDC 617/727-5114
617/626-1540
EPA New England 617/918-1111
617/292-5500
CZM 617/626-1250
617/626-1700
617/626-1395
617/626-1000

This information on nonpoint source pollution is brought to you by the Department of Environmental Protection, the Executive Office of Environmental Affairs' Massachusetts Watershed Initiative, Coastal Zone Management, the Department of Environmental Management, the Department of Fisheries, Wildlife, and Law Enforcement, the Department of Food and Agriculture, and the Metropolitan District Commission working to reduce nonpoint source pollution through public education. This project was funded by the U.S. Environmental Protection Agency with a federal 104(b)(3) grant.

Figure 2: Educational Brochure on Fertilizer
Source: http://www.state.ma.us/dep/brp/wm/files/fertiliz.pdf

N-2	Neighborhood Source Area: Yard	
	REDUCED PESTICIDE USE	

Description

The ideal watershed behavior is to not apply any insecticides or herbicides to the lawn or garden. Many residents, however, still want to control pests and weeds, so the next best behavior is a natural approach that emphasizes limited use of safer chemicals, proper timing and targeted application methods. The negative residential behavior is over-use or improper application of insecticides and herbicides that are known to have an adverse impact on aquatic life.

How Pesticide Use Influences Subwatershed Quality

The leading source of pesticides to urban streams is homeowner applications in the lawn and garden to kill insects and weeds. The pesticides of greatest concern are insecticides, such as diazinon and chloropyrifos, and a large group of herbicides (CWP, 2003; USGS, 2001; Schueler, 1995; Figure 1). Very low levels of these pesticides can be harmful to aquatic life. According to a national monitoring study, one or more pesticides were detected in 99% of urban streams sampled (USGS, 2001). Pesticide levels in urban streams exceeded national water quality standards to protect aquatic life in one out of every five samples. Even more troubling was the finding that 100% of fish in urban streams had detectable levels of pesticide in their tissues, with 20% exceeding recommended guidelines for fish-eating wildlife (such as racoons, kingfishers, ospreys and eagles).

Figure 1: Bag of Pesticide Granules

Percentage of People Engaging in Pesticide Use

About half of Chesapeake Bay residents reported that they had applied pesticides to their lawn or garden (Swann, 1999). Surveys on residential pesticide use for other regions of the country indicate that home pesticide use varies greatly, ranging from a low of 17% to a high of 87% of households (Swann, 1999). According to EPA, the average acre of maintained suburban lawn receives five to seven pounds of pesticides each year.

Variation in Pesticide Use

Many regional and neighborhood factors influence the degree of local pesticide use. From a regional standpoint, climate is an extremely important factor. For example, insecticides are applied more widely in warmer climates where insect control is a year round problem (e.g., 50 to 90% of warm-weather residents report using them). This can be compared to 20 to 50% of insecticide use reported for colder regions where hard winters help keep insects in check (Schueler, 2000b). By contrast, herbicide application rates tend to be higher in colder climates in order to kill weeds that arrive with the onset of spring (e.g., 60 to 75% of cold weather residents report use).

Many neighborhood factors can play a strong role in the degree of pesticide use. These include lot or lawn size, presence of gardens, condition of turf, presence or absence of irrigation and neighborhood age. The average income and demographics within a neighborhood are also thought to play a strong role, particularly if residents rely on lawn care and landscaping companies to maintain their lawns.

Difficulty in Changing the Behavior

Pesticide use is a difficult behavior to change for several reasons. First, many residents want a quick and effective solution to their pest problems. Second, many residents lack awareness about the link between their pesticide use and stream quality. Lastly, many residents rely on commercial sources of information when choosing pesticides, and lack understanding of safer alternatives and practices. As with fertilizers, product labels are the primary source of information about pesticides. Nearly 90% of homeowners rely on them to guide their pesticide use (Swann, 1999). In addition, many residents are unaware of the pesticide application practices that their lawn care company applies to their yard and prefer to rely on professional know-how (Knox *et al*., 1995).

Confusion also stems from the recent growth of "weed and feed" lawn care products that combine weed control and fertilizer in a single bag. In one Minnesota study, 63% of residents reported that they used weed and feed lawn products, but only 24% understood that they were applying herbicides to their lawn (Morris and Traxler, 1996).

Techniques to Change the Behavior

Most communities rely on the same basic combination of carrots to change pesticide use as they do for fertilizer use, since they are so interrelated. The following are some of the most common techniques to change pesticide use:

- Seasonal media awareness campaigns
- Distribution of lawn care outreach materials (brochures, newsletters, posters, etc.)
- Direct homeowner assistance and training
- Master gardener program
- Exhibits and demonstration at point of sale at retail outlets
- Pest advice hotlines
- Training, certification and/or licensing of lawn care professionals and pesticide applicators
- Radio lawn and garden advice shows

Figure 2: Educational Pesticide Brochure
Source: http://www.lacity.org/SAN/wpd/index.htm

Good Examples

Perdue Pesticide Program - Web-based program to help comply with the State of Indiana regulations that help homeowners use pesticides effectively and safely. According to Indiana law and recently enacted regulations, all retail establishments in the state that sell gardening and pest control products and offer recommendations on their use must be licensed as consultants, while their sales associates must be trained to knowledgeably disseminate product information.
http://www.btny.purdue.edu/PPP/

Green Communities Association's Pesticide Free Naturally: A Campaign to Reduce the Cosmetic Use of Pesticides - The campaign includes an Action Kit that includes pesticide-free lawn signs, fact sheets on health impacts, tips on how to engage neighbors in discussions about pesticide use, a children's activity pack, and information on effective alternatives to pesticides, including home recipes.
http://www.gca.ca/indexcms/index.php?pfn

Top Resources

Tips for Homeowners on Hiring a Pesticide Applicator
http://www.epa.gov/oppfead1/Publications/Cit_Guide/citguide.pdf

Try Pesticide Alternatives
http://www.mda.state.md.us/pdf/Tip1.pdf

Washington State University - Pesticide Safety Programs
http://pep.wsu.edu/psp/

National Pesticide Information Center Site - Provides objective, science-based information about a variety of pesticide-related subjects, including pesticide products, toxicology, and environmental chemistry.
http://npic.orst.edu/

IPM Practitioners Association IPM ACCESS Webpage
http://www.efn.org/~ipmpa/

Our Water, Our World
http://sfwater.org/detail.cfm/MC_ID/4/MSC_ID/78/MTO_ID/NULL/C_ID/1402

Grow Green: Landscaping for Clean Water
http://www.ci.austin.tx.us/growgreen/default.htm

N-3	Neighborhood Source Area: Yard	
	XERISCAPING	

Description

The ideal watershed behavior is to maintain a lawn with native species that does not require watering or irrigation at all (Figure 1). The next best thing is to water the lawn sparingly so water does not run off to impervious areas or local waterways. The negative behavior is over-watering to the extent that water and its associated pollutants reach the storm drain conveyance system and enter the stream.

How Lawn Watering Influences Watershed and Subwatershed Quality

Lawn watering exerts different impacts at the watershed and subwatershed scale. At the watershed scale, over-watering cumulatively leads to sharp increases in river withdraws or groundwater pumping that can affect regional water supplies, as well as aquatic resources. Normal daily household water demands can double or even triple during really hot and dry summer days, which can put a great deal of stress on rivers, reservoirs and groundwater at a time when they are frequently at their lowest levels. According to Steiner *et al*. (2000), the average home in the Washington D.C. metropolitan area consumes about 22,700 gallons of water for outdoor use each year, mostly for lawn watering. Outdoor water use rates are often twice as high in arid and semi-arid regions of the country (Solley *et al.*, 1998).

Figure 1: Xeriscape Garden

Lawn watering has a different impact at the subwatershed level. Generally, most of the water supply delivered to a household originates from outside the watershed. When homeowners water their lawns, some fraction of this "imported" water may reach the street and eventually return to the stream itself. Thus, in arid and semi-arid subwatersheds, overwatering can actually increase dry weather flows in streams. The compacted nature of lawns can increase the runoff potential (Legg *et al.*, 1996).This may not necessarily be a negative impact, although it is likely that this nuisance water may carry nutrients and pesticides to the stream.

Percentage of Homeowners Engaging in Lawn Watering

Outdoor water use is nearly universal, but there are sharp differences from household to household in actual water use. Nationally, the average person uses 154 gallons of water per day, with 42% used indoors and 58% used outdoors (AWWARF, 1999). Curtailing outdoor water use is an important theme of urban water conservation (Figure 2).

Factors that Contribute to Variation in Lawn Watering

As might be expected, lawn watering and outdoor water use are greatest in arid and semi-arid regions, although high use is noted in nearly all urban areas during dry weather, and particularly during times of drought. Several neighborhood factors explain the variability in outdoor watering, the most notable of which is the proportion of homes that have permanent

irrigation systems installed (AWWARF, 1999). Other key factors include lawn size, income, the price of water, and the age of the lawn (younger lawns require more watering).

Difficulty in Changing Lawn Watering Behavior

Lawn watering is one behavior that residents show some willingness to change. Perhaps the best example is the widespread response to outdoor watering restrictions in times of drought or water emergency. Sharp reductions in lawn watering can be achieved even without a crisis.

Techniques to Change the Behavior

A range of both carrots and sticks can be used to influence watering behavior, including:

- Seasonal watershed conservation campaigns (e.g., radio, TV, newspaper and billboards)
- Distribution of xeriscaping and water conservation education materials (e.g. bill inserts, brochures, newsletters, posters, etc.)
- Demonstration gardens
- Discounts/rebates for efficient sprinklers and irrigation system
- Differential water rates to discourage excessive use during peak periods (pricing)
- Water bill credits for installing xeriscapes
- Voluntary or mandatory outdoor water restrictions

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

splash!

quick facts on...

Xeriscape:
How to Save Water Through Water-smart Landscaping

MARCH 12, 2001

The South Florida Water Management District is a regional, governmental agency that oversees the water resources in the southern half of the state. It is the oldest and largest of the state's five water management districts.

Our Mission is to manage and protect water resources of the region by balancing and improving water quality, flood control, natural systems, and water supply.

Sea grape

Did you know that half of residential water is used for outdoor irrigation? You can cut your outdoor water use substantially with water-conserving plants and use of Xeriscape principles.

Xeriscape is water conservation through creative landscaping. The term Xeriscaping means water-conserving, drought-tolerant landscaping, or simply the use of the right plant in the right place—with proper maintenance and water-wise watering.

Follow the seven fundamentals of Xeriscape systematically and you'll be well on your way to saving water!

1. Design your landscape. Careful planning is crucial to the long-term success of a Xeriscape landscape. You can minimize your initial investment by installing your Xeriscape in phases. First, make a simple site plan drawing of your property. Note slopes, drainage problems and existing plants and trees. Also note shaded and sunny areas. Determine the areas that will be irrigated when you select plants.

2. Select the right plant for the right area. Select and group plants according to their water needs to eliminate unnecessary watering. You should have three zones in your site plan:

Natural zones: Plants in this area can live on rainfall. They can be native plants or cultivated plants that have adapted to Florida.

Low water or "drought-tolerant" zones: Plants in these areas can survive mostly on rainfall.

Moderate or "oasis" water zones: These areas require regular watering and should be limited as accents in your Xeriscape. Keep these zones functional, such as entryways, turf areas and fruit or vegetable gardens.

3. Analyze the soil. Determine the acid and alkaline levels (pH) of your soil before planting. You can mix organic matter such as compost, peat, manure or topsoil into sandy soils for enrichment and to retain moisture.

4. Have limited turf areas. Turf is the single largest consumer of water in a landscape. Always look for drought tolerant turf varieties. Consider mulch as an alternative to turf. Avoid long, narrow turf areas because they are difficult to water efficiently.

5. Water wisely. Drought-tolerant plants can survive mostly on rainfall. If watering is necessary, do it only in the early morning, and in accordance with any water restrictions, to reduce evaporation. Remember, Florida Statutes require that all new automatic lawn sprinkler systems must have a rain sensor device or shut-off switch which overrides the system cycle following adequate rainfall. Water trees, shrubs, flowers and ground covers with low-volume drip or spray heads. These low-volume methods include "soaker hoses" in which water escapes through tiny holes in the hose. Apply the "soaker hose" to the root zone of the plant so that the water does not run off the root area.

6. Use mulches. Mulches limit weed growth and retain moisture. Two to three inches of mulch on garden beds and walkways also reduces weed growth and slows erosion. Avoid cypress mulch. Use other organic mulches such as recycled mulch, bark chips, wood shavings or pine straw/needles.

7. Properly maintain your landscape. Overwatering increases the risk of plant disease. To encourage deep rooting and more drought resistance, water plants thoroughly without over-watering.

Fertilize properly: excessive fertilizer promotes fast, but weak growth and actually increases a plant's water needs, as does over-pruning.

sfwmd.gov

Figure 2: Educational Xeriscaping Brochure
Source: http://www.sfwmd.gov/images/pdfs/splash/splxeris.pdf

Good Examples

Corpus Christi Texas, Xeriscape Learning Center and Design Garden. A demonstration garden at the entrance to the Corpus Christi Museum of Science and History demonstrates xeriscape principles to about 150,000 residents and tourists annually.
http://www.cctexas.com/?fuseaction=main.view&page=1182

Metropolitan Water District of Southern California- On-line Watering Calculator and Watering Index
This tool developed by the City of San Diego estimates the right amount of water for your landscape or garden every week and demonstrates how to adjust your watering schedule.
http://www.mwdh20.com/mwdh2o/pages/conserv/conserv01.html

Las Vegas Valley Groundwater Management Program -Conservation Incentive Program.
Southern Nevada Water Authority (SNWA) offers a Water Smart Landscapes Rebate Program that gives residential property owners a rebate of 40 cents per square foot when they upgrade some or all of their water-thirsty grass to xeriscape, a lush yet water-efficient landscape.
http://www.lasvegasgmp.com/html/gwupdate_summer2002.html

Top Resources

Colorado Springs Utilities Xeriscape Page
http://www.csu.org/xeri/

Xeriscape Gardening
This web page contains information about xeriscape planning and design, practical turf areas, appropriate plant selection, soil improvement, use of mulches, efficient irrigation, and appropriate maintenance.
http://www.xeriscape.org/

California Urban Water Conservation Council - H2ouse Water Saver Website
This website includes specific actions residents can take to conserve water indoors and outdoors.
www.h2ouse.org

American Water Work Association (AWWA) - WaterWiser Website
WaterWiser is an interactive web site that strives to meet the information needs of the water conservation community and the drinking water industry. The site provides news, information, research results, discussion forums, references, a calendar of events, searchable information databases, and other resources primarily targeted to water conservation professionals, but freely accessible to others in the water industry and the general public.
http://www.awwa.org/waterwiser

EPA's Water Efficiency Program
http://www.epa.gov/owm/water-efficiency/

N-4	Neighborhood Source Area: Yard **NATURAL LANDSCAPING**	

Description

The ideal watershed behavior is to replace existing turf cover with native species of annuals, perennials, shrub and forest cover in mulched beds that produce less runoff and create backyard habitat. The negative watershed behavior is exclusive reliance on turf cover in the yard and/or use of non-native invasive species that can spread from the yard into adjacent stream corridors or natural area remnants.

How Natural Landscaping Influences Subwatershed Quality

The cumulative effect of natural landscaping practices on subwatershed quality are hard to quantify, but can provide some clear benefits. First, reduced turf area produces more natural hydrologic conditions in the yard, since mulched beds intercept and adsorb rainfall and can produce less runoff (Figure 1). Natural landscaping also creates native habitats, increases forest cover, and creates a natural seed bank of native plant species in subwatersheds. Natural landscaping can also prevent the spread of invasive non-native plant species into the stream corridor, which is an increasing problem in many urban subwatersheds. English ivy, bamboo, and other fast-spreading non-native species can quickly dominate the plant community of the urban stream corridor.

Percentage of Homeowners Engaging in Natural Landscaping

The proportion of homeowners that engage in natural landscaping is poorly understood at both the national and neighborhood level. About half of Americans report that home gardening and landscaping is one of their major hobbies (Figure 1), but the proportion using native plants or landscape for wildlife or watershed appears to constitute a much smaller niche market.

Variation in Landscaping Behavior

Native plant species are adapted to local differences in soil, rainfall and temperature conditions. Neighborhood factors such as neighborhood age, lot size, income level and watershed awareness appear to influence the promotion of natural landscaping.

Figure 1: Before (a) and After (b) Natural Landscaping

Difficulty in Changing Landscaping Behavior

While natural landscaping practices have been growing in recent years, there are a number of barriers to more widespread implementation. The first barrier is that many homeowners are not aware of which plant species are native or non-native, and they do not know the benefits of natural landscaping. Second, native plant materials are not always widely available at garden centers and nurseries. Third, some communities still have weed and vegetation control ordinances that discourage natural landscaping.

Techniques to Promote Natural Landscaping

A range of carrots and sticks can help promote more widespread use of natural landscaping in a subwatershed, including:

- Conventional outreach on natural landscaping (brochures, newsletters, plant guides)
- Backyard habitat programs
- Free or reduced mulch
- Distribution of free or discounted native plant material
- Repeal of local weed ordinances with natural landscaping criteria
- Support of garden clubs and native plant societies
- Demonstration gardens (e.g. Bayscapes)
- Invasive species alerts
- Promotion of native plant nurseries
- Homeowner award/recognition programs
- Xeriscaping rebates

Good Examples

City of Austin, TX - WaterWise Program. Owners of new and existing homes may qualify for rebates up to $500 for Water Wise plantings of trees and shrubs. The goal of this program is to install a quality, low water use, low maintenance native landscape. http://www.ci.austin.tx.us/watercon/wwlandscape.htm

Village of Long Grove, IL - Village Code. Natural landscaping is encouraged in the city code, which states "impervious surfaces, shall not exceed forty percent (40%) of the total lot area. The remaining minimum sixty percent (60%) of the lot area shall be maintained as a 'green area' and shall consist of native wild areas, grass, trees, ponds or other natural vegetation." The code also does not limit residential vegetation height, which in other communities can limit use of natural plant species. http://www.longgrove.net/

Top Resources

National Wildlife Federation - Natural Back Yard Habitat Program. The Backyard Wildlife Habitat program educates people about the benefits and techniques of creating and restoring natural landscapes. Through a backyard wildlife "certification" process, guided efforts of homeowners and other community members to improve wildlife habitat where they live and work are formally acknowledged. http://www.nwf.org/backyardwildlifehabitat/

Alliance for the Chesapeake Bay - Bayscapes. This website provides practical guidance on how to design a "Bayscape," which is a watershed friendly form of natural landscaping. http://alliancechesbay.org/bayscapes.cfm

Wild-Ones- Native Plants, Natural Landscaping Publications and Model Ordinances. Website contains a wealth of information on natural landscaping, including the *Wild Ones Handbook* - a compendium of useful information for the native plant landscaper and wildflower gardener, appropriate for all bioregions. The site also provides vegetation and weed control model municipal ordinances that encourage the use of native plant communities as an alternative in urban landscape design. http://www.for-wild.org/

N-5	Neighborhood Source Area: Yard **TREE PLANTING**	

Description

The ideal watershed behavior is to ultimately achieve a mature tree canopy that covers more than 50% of residential lots within a neighborhood through tree planting and care (Figure 1a). The negative watershed behavior is tree clearing that reduces existing tree canopy on a residential lot and in neighborhoods (Figure 1b).

How Tree Planting Influences Subwatershed Quality

Forested neighborhoods have a distinctly different hydrological profile than non-forested neighborhoods. For operational purposes, American Forests defines forested neighborhoods as having at least 50% forest canopy covering the residential lot. The branches and leaves of the forest canopy help intercept and slowdown rainfall. For example, a large oak tree can intercept and retain more than 500 to 1,000 gallons of rainfall in a given year, which is roughly equivalent to a rain barrel in terms of runoff reduction (Cappiella, 2004). According to American Forests (1999), a healthy forest canopy can reduce storm water runoff by as much as 7% in a neighborhood.

Figure 1: Lots with Extensive Tree Cover (a) and Less Tree Cover (b)

A healthy residential forest canopy provides many additional environmental and economic benefits within a neighborhood. These include savings on home heating and cooling costs, higher property values, shading, removal of air pollutants, and noise reduction (Cappiella, 2004).

Percentage of Homeowners Engaging in Tree Planting

Regional GIS analyses of urban areas conducted by American Forests (2001) reveal that about 60% of neighborhoods have less than 50% forest canopy cover. The actual rate of tree planting is a poorly understood residential behavior. The actual rate of tree planting is a poorly understood residential behavior. A survey in the Chesapeake Bay watershed indicated that 71% of residents had planted a tree within the last five years (CBP, 2002). Tree planting rates by homeowners of around 50% were reported in urban metropolitan areas such as Baltimore, MD and Washington, D.C.; however, more research is needed to determine the frequency and impact of tree planting in urban subwatersheds.

Variation in Tree Planting Behavior

Trees may not be part of the native plant community in some regions of the country, and specific tree or prairie species will be determined by local climate and soils. Also, concerns about fire safety may make the 50% forest canopy goal impractical in regions that experience wildfires. At the neighborhood level, several factors influence the extent of forest canopy that can be attained. Probably the most important factor is the neighborhood age, as recently constructed neighborhoods generally lack established forest cover (Figure 2). Other factors include the existing forest canopy, lot subsidies or rebates for energy conservation plantings, size and soil depth.

Difficulty in Increasing Tree Planting Behavior

Generally, tree planting is a relatively easy behavior to encourage, although it may take decades to grow a mature canopy on a residential lot. Perhaps the biggest barrier to overcome is to find the best locations in the yard to plant trees that can grow to maturity (e.g., away from overhead powerlines, underground utilities, septic systems, etc.). The second concern is proper planting and care techniques to ensure that trees can survive and flourish in the critical first few years after they are planted. Third, some localities may discourage tree planting in the right-of-way due to maintenance concerns and pavement cracking.

Techniques for Increasing Residential Forest Canopy Cover

A series of techniques can promote tree planting and discourage tree clearing:

- Distribution of outreach materials on tree planting (brochures, newsletters, plant guides)
- Tree clearing ordinances and permits
- Direct forestry assistance
- Free seedlings or other native tree stocks
- Native tree planting guidebooks

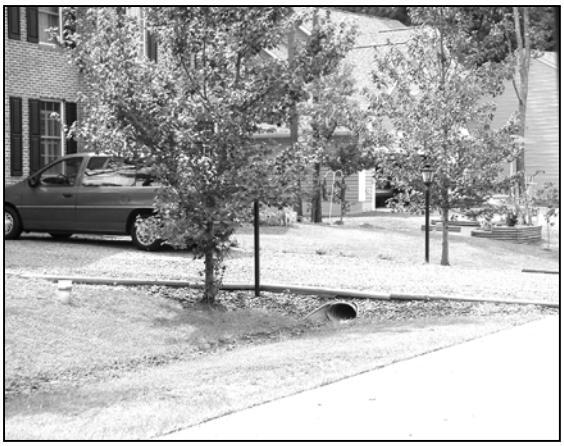


Figure 2: Newly Planted Trees in a New Neighborhood

Good Examples

Slinger, WI -Residential Tree Power Incentive Program. The electric utility in this community offers cash incentives for planting deciduous trees that conserve energy by providing significant shading of an air conditioning unit or the south or west exposure of a home upon tree maturity.
http://www.slinger-wi-usa.org/utilityprograms.htm

Tucson Electric Power (TEP) Tree Planting Incentives for Residents. TEP, working with the Trees for Tucson program, offers residents up to two five-gallon size trees at $3.00 per tree for planting on the west, east or south side of their homes. The program has distributed more than 22,000 trees since its inception, and also provides information to homeowners, neighborhood groups, and schools on low-water species appropriate to the local environment, and optimum placement of trees for energy and water conservation.
http://swenergy.org/programs/arizona/utility.htm

Banks and Buffers: A Guide to Selecting Native Plants for Streambanks and Shorelines. Produced by the Tennessee Valley Authority, this guide includes a software application to assist in plant selection. It also contains selected characteristics and environmental tolerances of 117 native plants and over 400 color photographs illustrating habitat and growth form.
http://www.tva.gov/river/landandshore/stabilization/index.htm

National Arbor Day Foundation Awards
This award recognition program honors the achievements of citizens, communities, the media, and schools whose work in the cause of tree planting, care, and conservation have set an example of excellence. Applications are submitted through the Department of Natural Resources to the National Arbor Day Foundation. Contact: DNR - Forest Service regional office or The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410. http://www.arborday.org/

Top Resources

American Forests - CityGreen GIS software
http://www.americanforests.org./

Center for Urban Forest Research
http://wcufre.ucdavis.edu/

Guidelines for Developing and Evaluating Tree Ordinances
http://www.isa-arbor.com/publications/ordinance.aspx

Treelink
http://www.treelink.org/

National Tree Trust
http://www.nationaltreetrust.org/

Treepeople
http://www.treepeople.org/

Society of Municipal Arborists
http://www.urban-forestry.com/

Urban Forest Ecosystems Institute
http://www.ufei.calpoly.edu/

USDA Forest Service, Northeastern Research Station
http://www.fs.fed.us/ne/

USDA Forest Service, Southern Region
http://www.urbanforestrysouth.org/

USDA Forest Service, Pacific Northwest Research Station
http://www.fs.fed.us/pnw/

USDA Forest Service, Pacific Southwest Research Station
http://www.fs.fed.us/psw/

N-6	Neighborhood Source Area: Yard **YARD WASTE COMPOSTING**	

Description

The ideal watershed behavior is to recycle or compost yard waste entirely within the yard, so that it stays out of the solid waste stream and the storm drain system. The next best behavior is curbside yard waste collection that keeps organic matter from the storm drain system (Figure 1). The negative behavior is to blow or rake yard waste into the gutter and storm drain system or dump it into the stream corridor or natural areas.

How Yard Waste Influences Watershed and Subwatershed Quality

The major benefit of managing yard waste is realized at the regional or watershed level, where it can preserve local landfill capacity by keeping organic waste out of the trash stream. Yard waste normally comprises about 10% of the annual waste stream during the year, but this rises to almost 70% during the fall. The impact of yard waste at the subwatershed level is poorly defined, but can be significant, at least on a seasonal basis. The major concern is the potential for nutrient and organic matter to wash off to the storm drain system, whether it consists of grass clippings, fallen leaves or organic debris accumulating on impervious surfaces and street gutters. The second concern is dumping yard wastes in the stream corridor itself.

Figure 1: Curbside Yard Waste Pick-up

Percentage of Residents Engaging in Yard Waste Composting

Based on municipal surveys, the average rate of backyard composting of yard waste ranges from one to 5% of households, although participation rates as high as 10% have been observed after intensive municipal education and subsidy programs. Much higher rates have been reported for recycling of grass clippings, whether by composting or use of grass-cycling mowers. Surveys indicate about 40 to 70% of households currently recycle grass clippings, with higher rates reported in communities that prohibit grass-clippings in regular trash pickup (Smith, 1996; DeYoung, 1997; Morris and Traxler, 1996; and Knox *et al*., 1995). The highest homeowner participation rates are noted for curbside leaf and yard waste collection (50 to 70%), which is not surprising given the convenient nature of this municipal service. It is worth noting that communities need to educate homeowners to keep leaves out of streets and gutters during seasonal curbside pick-up where they can easily reach the storm drain system.

Variation in Yard Waste Behavior

Regional factors influencing the generation and disposal of yard waste include the length of growing season, the presence of deciduous trees, and annual rainfall. Neighborhood factors contributing to the generation of yard waste are large lot size or turf area, high forest canopy, low usage of lawn care or landscaping companies, and older neighborhoods. The actual rate of participation in various yard waste

programs depends largely on their ease and convenience, as well as the degree of outreach, notification and education employed by the municipality.

Techniques to Change the Behavior

To promote better management of yard wastes, communities can facilitate backyard composting and "grass-cycling" lawnmowers, arrange seasonal curbside yard waste collection, and/or prohibit yard waste from regularly scheduled trash pickup. Other techniques include:

- Conventional outreach methods (bill inserts, brochures, newsletters, neighborhood meetings)
- Regular yard waste collection
- Fall leaf collection
- Seasonal collection (e.g., Christmas trees)
- Distribution of free or discounted compost bins
- Ban on lawn clipping pickup
- Promotion of grass-cycling
- Notification about keeping leaves out of gutters during fall leaf pick-up

Good Examples

Fort Worth, TX. Division of Environmental Management -"Don't Bag it" Program
The City of Fort Worth requires that, if grass clippings are put out for pick-up, they be contained in paper yard bags to be sent to a composting facility instead of the landfill. Under the "Don't Bag It" program homeowners are encouraged to leave lawn clippings on the grass to allow them to work themselves back into the soil. Residents that have followed this lawn care plan report that they mow their lawns in 38% less time than when they bagged their grass clippings. They also found that their lawns are 30% better than they were before the "Don't Bag It" campaign.
http://www.fortworthgov.org/dem/dontbag.htm

The Village of Niles, IL - Yard Waste Collection
The Village of Niles offers an optional yard waste collection service to help residents comply with an Illinois law that requires the separation of yard waste from regular garbage. To participate in the curbside yard waste collection homeowners need to purchase stickers for a nominal fee to place on yard waste bags. Mulching is recommended as an alternative no-cost disposal method. Free leaf pick up is provided in the fall.
http://www.vniles.com/Pages/yard%20waste%20collection.asp

City of Gresham, OR Yard Debris Exemption Program - Residents can receive a $3.65 reduction on their garbage bill when they agree to compost yard waste instead of having it picked up by the curbside yard-debris collection program. The approval process requires an application and a site inspection by a Master Gardener and composting expert who inspects the homeowner composting system before granting the exemption.
http://www.ci.gresham.or.us/departments/cao/gresham_municipal_code/chapter_7/25/450.html

Top Resources

USEPA- Composting Materials - *Waste Prevention, Recycling, and Composting Options: Lessons from 30 Communities; Composting, Yard Trimmings, and Municipal Solid Waste; and Innovative Uses of Compost: Erosion Control, Turf Remediation, and Landscaping*
http://www.epa.gov/compost/

Master Composter
http://www.mastercomposter.com/

Compost Guide Web Page
http://www.compostguide.com/

Recycle Your Grass Clippings
http://ucce.ucdavis.edu/files/filelibrary/1808/3868.doc

"Don't Bag It" Lawn Care
http://muextension.missouri.edu/xplor/agguides/hort/g06959.htm

Washington County, Minnesota, Recycling & Yard Waste
http://www.co.washington.mn.us/info_for_residents/environment/yard_waste/

N-7	Neighborhood Source Area: Yard **SOIL RECLAMATION**	

Description

The ideal watershed behavior is to reduce soil compaction and restore hydrologic properties on residential lawns through soil amendments and conditioning. Many urban lawns have been highly compacted as a result of past construction, soil disturbance and ongoing human traffic (Figure 1). This behavior seeks to recover the porosity and bulk density of soils by incorporating soil amendments or conditioners into the lawn, such as compost (McDonald, 1999). Soil reclamation improves the hydrological properties of the lawn by promoting more storage and infiltration, and producing less runoff.

How Soil Reclamation Influences Subwatershed Quality

Lawns are not the sponge many people think. Most lawn soils are extremely compacted, and recent research indicates that about half of all rain storms produce at least some runoff from lawns (Schueler, 2000a). Therefore, widespread application of lawn reclamation practices may show promise to improve hydrological conditions in residential subwatersheds. In addition, reduced runoff from reclaimed lawn soils may also reduce nutrient and sediment loading to surface waters. It is worth noting that lawn reclamation is still experimental, and that no subwatershed has received widespread yard reclamation yet.

Figure 1: Soil Compaction During Remodeling

Percentage of Homeowners Engaging in Soil Reclamation

Since this is a new and costly behavior to practice, it is doubtful whether more than a small percentage of homeowners currently engage in lawn reclamation.

Variation in Lawn Reclamation

Given that lawn reclamation is so new, little is known about regional or neighborhood factors that might lead to greater application. Two factors, however, are likely to be important. The first is the degree of existing compaction through the soil profile and its effect on runoff generation. Much of the pioneering work on soil amendments has been done on glacial till soils that are close to the surface. Therefore, the porosity and hydrologic soil group of parent soils are worth investigating.

The second key factor involved in soil reclamation is its relatively high cost, which can run from $2,000 to $10,000 per acre, depending on the availability of discounted compost and homeowner labor (Chollak and Rosenfeld, 1998). Given that soil reclamation is expensive, time consuming, and essentially requires complete lawn replacement, this behavior will undoubtedly require significant subsidies, discounts or other incentives to achieve greater subwatershed implementation.

Techniques to Promote Lawn Reclamation

Several potential techniques can be used to promote lawn reclamation:

- Conventional outreach materials (brochures, guides, etc.)
- Free soil testing
- Subsidies
- Free or discounted compost
- Direct technical assistance (e.g., municipality or local cooperative extension office)
- Credits or rebates on storm water utility fees

Good Examples

City of Seattle. The City has prepared an excellent guide on lawn compost amendments. Entitled *How Soil Amendments and Compost can Aid in Salmon Recovery*, this detailed guide is available from http://depts.washington.edu/cuwrm/publictn/s4s.pdf

Top Resources

Low Impact Development Center: Soil Amendments
http://www.lid-stormwater.net/soilamend/soilamend_home.htm

USDA Natural Resources Conservation Service
http://www.il.nrcs.usda.gov/technical/engineer/urban/tech_notes/technote2.html

Improve the Health of Your Soil
http://www.ci.eugene.or.us/PW/storm/Publications/healthy soil.pdf

N-8	Neighborhood Source Area: Yard	
	EROSION REPAIR	

Description

While most yards have extensive vegetative cover, soil erosion can occur on steep slopes, in bare patches, and around driveways. The ideal watershed behavior is to survey the yard for any patches of exposed soils and establish a fast-growing grass or ground cover (Figure 1). The negative watershed behavior is to allow erosion to continue unchecked. In most cases, existing residential yards are exempt from local erosion and sediment control laws, which means that a voluntary approach to erosion control is needed.

Figure 1: Reseeded Areas on a Lawn

How Lawn Erosion Influences Subwatershed Quality

Source area monitoring has revealed that some of the highest sediment concentrations in residential neighborhoods are generated from the yard (CWP, 2003). In many cases, erosion occurs in areas of the yard that are close to driveways, sidewalks and roads, or are directly in the flow path of storm water runoff. Bare patches of exposed soils can be caused by vehicles, snowplows, plant dieback, foot traffic and many other disturbances.

Percentage of Homeowners Engaging Erosion Repair

Reliable percentages could not be developed to profile the proportion of homeowners that repair soil erosion.

Factors that Contribute to Variation in Lawn Erosion

Climate appears to play a major role in residential soil erosion problems. For example, it is extremely difficult to maintain a vigorous ground cover on yards in arid and semi-arid climates without supplemental irrigation. Consequently, yards in these regions tend to have higher sediment erosion rates. Also, yards in regions with heavy snowfall or hard winters often require spot re-seeding in the spring. Neighborhood factors also play a strong role. For example, exposed soils are considered a social anathema in neighborhoods where turf care is widely practiced. Other factors that contribute to the potential for yard erosion are small lot size, heavy foot or vehicular traffic, inadequate parking capacity, older neighborhoods, and the absence of a strong neighborhood or civic association.

Techniques to Address Soil Erosion

- Conventional outreach methods (bill inserts, brochures, newsletters, neighborhood meetings)
- Distribution of free or discounted mulch
- Distribution of free or discounted grass patch repair kits
- Technical assistance on solving severe erosion problems on steep slopes
- Non-regulatory erosion and sediment control (ESC) consultations
- Enforcement actions under existing ESC, water quality, or nuisance ordinances

Good Examples

Riparian Homeowner's Stewardship Project (Ingham County, MI). County staff developed and distributed the *Red Cedar River Riparian Homeowner's Handbook* to more than 300 individual homeowners, local government officials, and other interested groups, and conducted individual, on-site consultations with interested homeowners on buffer strip design and erosion control.
http://www.glc.org/basin/project?id=74

Top Resources

Erosion in Your Own Backyard (Virginia Cooperative Extension). This fact sheet emphasizes how a properly planted landscape is the best protection against erosion.
http://www.ext.vt.edu/departments/envirohort/articles/lawns_and_landscaping/erosion.html

*University of Rhode Island Cooperative Extension Home*A*Syst*
http://www.uri.edu/ce/wq/has/html/has.html

Reducing Erosion and Runoff Information Webpage (Master Gardeners). This website covers signs of erosion and runoff, reasons to control runoff and erosion, using plants to reduce erosion, handling steep slopes, ground cover selection, and building and protecting soil.
http://www.mastergardenproducts.com/sustainablelandscape/erosion.htm

N-9	Neighborhood Source Area: Yard	
	SEPTIC SYSTEM MAINTENANCE	

Description

While most urban subwatersheds are served by sewers, some still rely on septic systems for sewage disposal, particularly in less developed subwatersheds that may lie outside of the sewer service envelope. The ideal watershed behavior is to regularly inspect and maintain septic systems, make repairs as needed, and prevent disposal of household chemicals through the leach field. The accepted practice is to inspect the tank and leach field once every two years to make sure it is working properly, and to pump out the tank (Ohrel, 1995; Figure 1). The negative watershed behavior is to ignore regular inspections and pumpouts to the point that the septic system becomes a subwatershed pollution source.

How Septic Systems Influence Subwatershed Quality

Failing septic systems can be a major source of bacteria, nitrogen, and phosphorus, depending on the overall density of systems present in a subwatershed (Swann, 2001). Failure results in surface or subsurface movement of nutrients and bacteria into the stream. According to the U.S. EPA (2002), more than half of all existing septic systems are more than 30 years old, which is well past their design life. The same study estimates that about 10% of all septic systems are not functioning properly at any given time, with even higher failure rates in some regions and soil conditions. It is extremely important to understand resident behavior in regard to inspection, pump out and repair, particularly if septic system density in a subwatershed is high.

Figure 1: Septic System Inspection/Cleaning Truck

Percentage of Homeowners Engaging in Septic System Maintenance

Until recently, homeowner awareness about septic system maintenance was poorly understood. Swann (1999) conducted one of the first surveys to examine how frequently homeowners maintain their septic systems. Roughly half of the owners were classified as "septic slackers," since they indicated that they had not inspected or cleaned out their systems in the past three years. A small, but significant, fraction (12%) of septic system owners had no idea where their septic system was located on their property. In addition, only 42% of septic system owners had ever requested advice on how to maintain their septic system, and they relied primarily on the private sector for advice (e.g., pumping service, contractors, and plumbers).

Variation in Septic System Maintenance

Septic system failure rates appear to vary regionally, ranging from five to 40% (Swann, 2001). In most regions, failure rates are tied to current or past design, construction and maintenance regulations, which are set by local or state public health authorities. Failing systems are often clustered together. At the neighborhood level, many factors can influence septic system problems. Key factors linked to failure include small lot size, aging systems, poor soil or water table conditions, and close proximity to streams, lake fronts or ditches. In other cases, failure rates are tied to experimental septic system technologies, and seasonal use of properties.

Difficulty in Improving Septic System Maintenance

Septic systems are a classic case of "out of sight, out of mind." Many owners take their septic systems for granted, until they back up or break out on the surface of their lawn. Subsurface failures, which are the most common, go unnoticed. In addition, inspections, pump outs, and repair can be costly, so many homeowners tend to put off these expenditures until there is a real problem. Lastly, many septic system owners lack basic awareness about the link between septic systems and water quality at the subwatershed level.

Techniques to Increase Septic System Maintenance

Many carrots and sticks have been developed in recent years to improve resident behaviors in regard to septic system maintenance, including:

- Media campaigns to increase awareness about septic system and water quality (e.g., billboards, radio, newspaper)
- Conventional outreach materials on maintenance (e.g., brochures, bill inserts, newsletters)
- Free or mandatory inspections
- Discount coupons for septic system maintenance
- Low interest loans for septic system repairs
- Performance certification upon property transfer
- Creation of septic management districts
- Certification and training of operation/maintenance professionals
- Termination of public services for failing systems

Good Examples

Swann (2001) describes a series of case studies of effective local programs to improve septic system maintenance. Some additional examples are provided below:

Washtenaw County, Michigan Time-Of-Sale Program: The County's septic system regulation requires the inspection of all residential septic systems by private evaluators at the time of sale of a property. Evaluations must be done by a certified inspector who has received a license after training and an exam.
http://www.rougeriver.com/pdfs/illicit/OSS-02.pdf

Yarmouth, Maine Free Pumpouts (Septic Tank Pumping Ordinance) - The town offers free septic system pump-outs to residents once every three years.
http://www.yarmouth.me.us/vertical/Sites/%7B13958773-A779-4444-B6CF-0925DFE46122%7D/uploads/%7B363C4270-0879-43BC-8639-55BFA419AC12%7D.PDF

Cannon Township, MI Septic Inspections and Testing - The township used school children to conduct dye tests to identify failing septic systems. This program doubled as an education campaign to increase awareness of septic system owners.
http://peer.tamu.edu/curriculum_modules/Water_Quality/module_1/Kids%20Dye%20Project.htm

Top Resources

Many excellent resources are available to educate homeowners about septic systems and water quality. Some of the better reference websites are provided below, and many contain additional educational links.

On-site Wastewater Treatment Systems Manual
http://www.epa.gov/ord/NRMRL/Pubs/625R00008/html/625R00008.htm

A Homeowner's Guide to Septic Systems
http://www.epa.gov/npdes/pubs/homeowner_guide_long.pdf

National Small Flows Clearinghouse
http://www.nesc.wvu.edu/nsfc/nsfc_septicnews.htm

On-site Septic Systems: Educating the Homeowner
http://www.nesc.wvu.edu/nsfc/Articles/SFQ/SFQw02_web/SFQw02_Onsite Education.html

University of Minnesota Onsite Sewage Treatment Program
http://septic.coafes.umn.edu/

*North Carolina Coast*A*Syst*
http://www.soil.ncsu.edu/assist/cas/septic/index.htm

N-10	Neighborhood Source Area: Yard	
	SAFE POOL DISCHARGES	

Description

Routine and end-of-season pool maintenance can cause chlorinated water or filter back flush water to be discharged into the storm drain system or the stream. The ideal watershed behavior is to discharge chlorinated pool water to the sanitary sewer system, or hold it for a week or more before spreading over a suitable pervious surface. The negative watershed behavior is to drain pool water directly into the storm drain system or stream where it may be toxic to aquatic life (Figure 1). Public and community pools can also be a subwatershed hotspot; details on controlling these pollution sources can be found in Profile Sheet H-14.

How Swimming Pool Maintenance Influences Subwatershed Water Quality

Pool water typically contains two to four parts per million of chlorine, as well as other chemicals to reduce bacteria and algae, and control pH. Consequently, the direct discharge of pool water can be toxic to aquatic life in small streams. Not much research has been done to characterize the precise impact of pool discharges on aquatic systems, but there is anecdotal evidence of fish kills and other problems. Part of the problem is the size of pool discharges: the average in-ground pool is estimated to have a capacity of nearly 20,000 gallons.

Percentage of Homeowners Engaging in Pool Maintenance

The density of swimming pools in a subwatershed is extremely variable, but can be determined through inspection of low-altitude aerial photographs or the USSR survey (Figure 2). The number of in-ground or above-ground swimming pools in the United States is estimated at 7.5 million (Pool and Spa Marketing, 2003), or about 7% of all households. The actual operational and discharge behaviors of pool owners remains poorly understood, so it is difficult to characterize the magnitude of the pool discharge problem.

Figure 1: Swimming Pool Discharging to Street and into Storm Drain

Figure 2: Aerial Photo Showing High Density of Swimming Pools (~30%) in a Neighborhood

Variation in Pool Discharge

While the greatest pool density is found in warmer regions, the actual discharge problem may be more acute in northern regions where pools must be drained before the onset of winter. Key neighborhood factors include local plumbing codes that govern how discharge water is handled, the overall density of pools in the subwatershed, and their age.

Techniques to Change the Behavior

Most pool owners understand that regular maintenance is essential to keep a pool safe and clean, and they probably conduct more water quality monitoring as a group than any other segment of society. Therefore, they may be more receptive to changing discharge behaviors with proper education. Some techniques include:

- Conventional outreach techniques on proper discharge (pamphlets, water bill inserts, posters)
- Educational kiosks at the retail outlets where they purchase pool chemicals
- Changes in local plumbing codes to require discharge to sanitary sewer systems
- Adoption of water quality ordinances that allow for fines/enforcement for unsafe pool discharges
- Inspections (done in conjunction with regular local health and safety inspections)

Good Examples

State of Maryland Pool Permit. The State has developed a general permit to govern pool discharges. The general discharge permit, developed by the Maryland Department of the Environment, addresses discharges from both swimming pools and spas. It can be found at: http://www.mde.state.md.us/assets/document/permit/MDE-WMA-PER070-SI.pdf

Top Resources

Guidelines for Swimming Pool and Spa Owners and Operators
http://www.montgomerycountymd.gov/mc/services/dep/Enforcement/pools.htm

Oregon Department of Environmental Quality (ODEQ). 1997. Water Quality Permit Program: Guidance for Swimming Pool and Hot Tub Discharges.
http://www.deq.state.or.us/wq/wqpermit/swimpools.pdf

US EPA National Menu of Best Management Practices for Storm Water Phase II: Alternative Discharge Options for Chlorinated Water. Office of Wastewater Management
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/poll_1.cfm

N-11	Neighborhood Source Area: Driveway	
	SAFE CAR WASHING	

Description

The ideal watershed behavior is to wash cars less often, wash them on grassy areas, and use phosphorus-free detergents and non-toxic cleaning products. Alternatively, residents can use commercial car washes that treat or recycle wash water. The negative behavior is to wash cars in a manner where dirty wash water frequently flows into the street, storm drain system, or the stream. This behavior applies not only to individuals, but to community groups that organize outdoor car washes for charitable purposes (Figure 1).

How Car Washing Influences Subwatershed Quality

Outdoor car washing has the potential to generate high nutrient, sediment, metal, and hydrocarbon loads in many subwatersheds. Detergent-rich water used to wash the grime off cars can flow down the driveway and into the storm drain, where it can be an episodic pollution source during dry weather. Not much is currently known about the quality of car wash water, but local water quality sampling can easily characterize it. Car wash water can also be a significant flow source to streams during dry weather. As an example, a typical hose flowing at normal pressure produces between 630 and 1,020 gallons of water per hour, depending on its diameter. These flows can be sharply reduced if the hose is equipped with a shut-off nozzle.

Figure 1: Poor Practices at a Charity Car Wash Event at a Local Gas Station

Percentage of Residents Engaging in Car Washing

Car washing is one of the most common watershed behaviors in which residents engage. According to surveys, about 55 to 70% of homeowners wash their own cars, with the remainder utilizing commercial car washes (Schueler, 2000b). Of these, 60% of homeowners can be classified as "chronic car-washers," in that they wash their car at least once a month (Smith, 1996; PRG, 1998; and Hardwick, 1997). Between 70 and 90% of residents reported that their car wash-water drained directly to the street, and presumably, to the nearest stream.

Variation in Car Washing

Regional and climatic factors play a strong role in determining the frequency of residential car washing. In colder climates, many residents utilize commercial car washes during the winter months, and then wash their cars themselves during the summer. In warmer climates, residential car washing is often a year-round phenomenon. Neighborhood factors that influence car washing include the number of vehicles per household, lot size, driveway surfaces, income and demographics. Another key factor is the nature of the storm water conveyance system. If a neighborhood has open section roads with grass swales, the impact of car wash water will be less.

Difficulty in Changing Car Washing Behaviors

Residential car washing is a hard watershed behavior to change, since the alternative of using commercial car washes costs more money. In addition, many residents are not aware of the water quality consequences of car washing, nor do they understand the chemical content of the soaps and detergents they use. Lastly, many residents do not understand that their driveway is often directly connected to the storm drain system and the urban stream. Consequently, many communities will need to educate homeowners about the water quality implications of car washing.

Techniques to Change Car Washing Behavior

Several communities have developed effective techniques to promote safer car washing, including:

- Media campaigns to increase awareness about water quality impacts of car washing (billboards, posters, etc.)
- Conventional outreach materials (brochures, posters, water bill inserts)
- Promote use of nozzles with shut-off valves
- Provide information on environmentally safe car washing products at point of sale
- Provide storm drain plugs and wet vacs for charity carwash events
- Provide discounted tickets for use at commercial car washes
- Modify sewer bylaws or plumbing codes to prevent storm drain discharges
- Storm drain marking (see N-21)

Good Examples

Puget Sound Car Wash Association - This charity car wash program allows qualifying nonprofit organizations to raise money for their group by selling tickets that can be redeemed at participating commercial car wash facilities. http://www.charitycarwash.com/

Drain Plugs and Bubble Busters (Kitsap County) – This program provides drain plugs to contain car wash water from charitable car wash events, as well as "bubble busters" to pump out and safely dispose of wash water. http://www.kitsapgov.com/sswm/carwash.htm

Top Resources

RiverSafe Carwash Campaign
http://www.riversides.org/riversafe/

The Dirty Secret of Washing Your Car at Home
http://www.forester.net/sw_0106_trenches.html

Best Management Practices for Controlling Runoff from Commercial Outdoor Car Washing
http://environment.alachua-county.org/Natural_Resources/Water_Quality/Documents/Commercial Outdoor Car Wash.pdf

How to Run a Successful Carwash fundraiser
http://www.carwashguys.com/fundraisers/LAschools.html

Make Your Next Car Wash "Environmentally Smart"
http://www.ci.eugene.or.us/PW/storm/Publications/Carwash fundraiser.pdf

N-12	Neighborhood Source Area: Driveway	
	DRIVEWAY SWEEPING	

Description

The ideal watershed behavior is to regularly sweep driveways and sidewalks and dispose of sweepings in the trash. The negative behavior is to use hoses or leaf blowers to clean off driveways and sidewalks that direct dirt and organic matter into the street or storm drain system.

How Driveway Cleaning Influences Water Quality

Source area research has indicated that driveways are a significant source of sediment, nutrients and metals in urban neighborhoods (CWP, 2003). Broom sweeping and disposal can reduce wash-off of accumulated pollutants during subsequent storms. On the other hand, hosing and blowing tend to move pollutants to the street and gutters, where they have a greater chance of reaching the stream (Figure 1).

Figure 1: Power Washing of a Driveway

Percentage of Homeowners Engaging in Driveway Cleaning

Residential driveway and sidewalk cleaning behaviors are poorly understood. Rough estimates that show 15% of residents using hoses and an additional 10% using leaf blowers to clean driveways and sidewalks appear to be conservative. The recent growth in the use of motorized leaf blowers has been quite rapid. The Outdoor Power Equipment Institute (2003) reports annual sales of more than 1.5 million units and indicates that leaf blowers are the fastest growing segment of the industry. To date, most environmental concerns about leaf blowers have focused on noise and air quality emissions; their role in re-suspending pollutants is poorly understood.

Variation in Driveway Cleaning

Regional and climatic factors play a strong role in determining the frequency of driveway cleaning. Since storms occur more rarely in regions with arid and semi-arid climates, particles and organic matter accumulate longer on driveway and sidewalk surfaces, which often prompts more frequent cleaning. By contrast, frequent storms in more humid regions often clean off driveway and sidewalk surfaces themselves. A number of neighborhood factors also influence driveway cleaning behaviors, including driveway dimensions, the nature of driveway surfaces, forest canopy coverage, and the nature of the storm water conveyance system. If a neighborhood has open section roads with grass swales, the impact of driveway cleaning may be less.

Difficulty in Changing Driveway Cleaning Behavior

Driveway cleaning is also a hard behavior to change, since hosing and leaf blowing are often faster and more convenient ways to get the job done. Few residents understand that their driveway is often directly connected to street gutters, and eventually, the urban stream. Lastly, few communities have emphasized the importance of educating residents and landscape contractors about the water quality impacts of driveway cleaning behaviors. Consequently, greater effort is needed to increase residential awareness about the water quality consequence of hosing and leafblowing.

Techniques to Change Car Washing Behavior

Not many communities have targeted driveway cleaning as an important residential watershed behavior. As a result, only a few innovative techniques have been developed for driveway cleaning behavior so far, including:

- Media campaigns to increase awareness about water quality impacts of driveway cleaning (billboards, posters, etc.)
- Conventional outreach materials (brochures, posters, water bill inserts)
- Landscaping contractor training or certification programs that emphasize proper leaf blower use

Top Resources

Tips on Cleaning Driveways, Decks, Sidewalks and Patios
http://www.thinkbluesd.org/brochures/Impervious_Surfaces.pdf

Stormwater Management for Homeowners
http://www.soil.ncsu.edu/assist/homeassist/stormwater/

N-13	Neighborhood Source Area: Sidewalk/Driveway	
	SAFE DE-ICER USE	

Description

The ideal watershed behavior is to avoid using de-icing products on driveways and sidewalks by manually clearing and shoveling snow and ice. The next best behavior is to purchase environmentally friendly de-icing products, and apply them early but sparingly during snowfall events. The negative watershed behavior is the indiscriminate application of de-icing compounds.

How Use of Home De-icing Products Influences Water Quality

De-icing compounds, such as rock salt and urea fertilizers, can increase chloride and nutrient levels in a neighborhood. While the vast majority of de-icing chemicals applied in a subwatershed come from municipal road salting operations, homeowners often apply them at a much higher unit-area rate. During snowmelt events, chloride levels in street runoff can rise to as high as 2,000 to 4,000 parts per million, which can adversely affect aquatic life, turf, landscaping, wildlife and pets (Environment Canada, 2001). In addition, rock salt contains impurities such as phosphorus, nitrogen, copper and even cyanide. Homeowners can also make informed choices in the de-icing chemicals they use, and put their sidewalk and driveway on a low salt diet. In general, calcium chloride is preferred to sodium chloride (rock salt), and both are superior to urea, kitty litter and ashes.

Percentage of Homeowners Applying De-icing Compounds

No reliable data is available to characterize homeowner use of de-icing compounds.

Factors that Contribute to Variation in Behavior

The use of de-icing compounds is directly related to climatic factors, and actual use depends on the severity of winter conditions. Several neighborhood factors also influence the use of de-icing compounds, including lot size, driveway dimensions, the nature of driveway surfaces, and the storm water conveyance system.

Difficulty in Modifying De-icing Behaviors

Keeping ice and snow off driveways and sidewalks is important for safety. The biggest challenge is to make consumers aware of how to choose the best de-icing product for the home and the environment. The most important behavior is to read labels to compare the pros and cons of the main ingredients contained in common de-icing products. Table 1 provides some comparative data on the cost and environmental risk of de-icing compounds.

When it comes to snow removal, there is no substitute for muscle and elbow grease. De-icers work best when there is only a thin layer of snow or ice that must be melted, and they are applied at the recommended rate.

Table 1: Comparison of De-icing Compounds			
Check the Label for	**Works Down to**	**Cost**	**Environmental Risks**
NaCl, Sodium Chloride (also known as rock salt)	15° F	About $5 for a 50 pound bag	Contain cyanide Chloride impacts
Calcium Magnesium Acetate (CMA)	22° to 25° F	20 times more than rock salt	Less toxic
CaCl, Calcium Chloride	-25° F	3 times more than rock salt	Uses lower doses No Cyanide Chloride impact
Urea	20° to 25° F	5 times more than rock salt	Needless nutrients Less Corrosion
Sand	No melting effect	About $3 for a 50 lb. bag	Accumulates in streets and streams

Techniques to Change De-icing Behavior

- Conventional outreach materials (seasonal newsletters, brochures, water bill inserts)
- Broadcast advice from local TV meteorologists during storms
- Brochures or advice at point of sale

Good Example

Montgomery County Maryland De-icer Use Press Release
http://www.montgomerycountymd.gov/apps/news/press/DisplayInfo.cfm?ItemID=157

Top Resources

Using De-icers Correctly
http://www.saltinstitute.org/kirchner-1.html

Melting Ice Safely
http://www.agnr.umd.edu/MCE/Publications/PDFs/FS707.pdf

Slip-Sliding, Away! A review of the available options, and their environmental, safety, and efficiency implications.
http://www.consciouschoice.com/environs/slipslidingaway1201.html

Ice Control for Roads and Walkways
http://www.swmcb.org/EPPG/9_3.asp

Protect Concrete and Vegetation with Proper Use of De-icers
http://snow.grounds-mag.com/ar/grounds_maintenance_january_3/

Winter De-icing Agents for the Homeowner
http://www.ianr.unl.edu/pubs/horticulture/g1121.htm

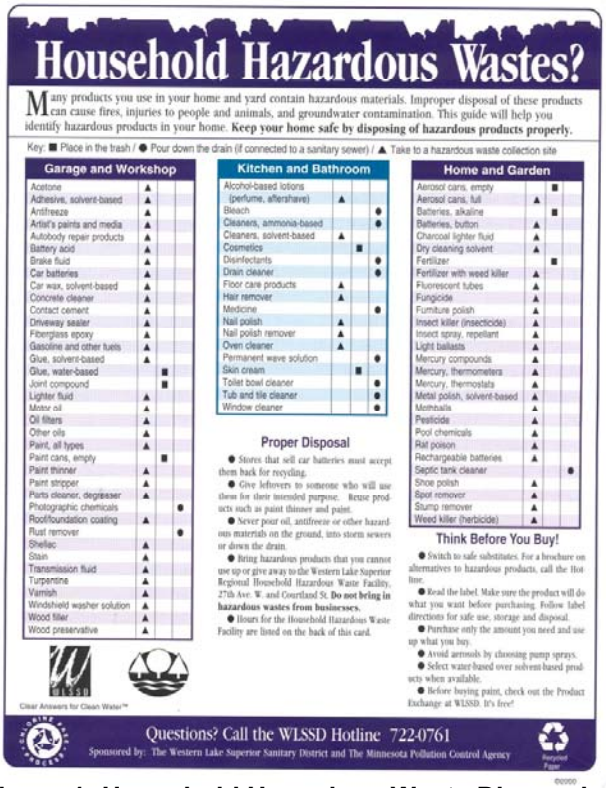
National Snow and Ice Data Center
http:// www.nsidc.org/

Salt Institute
http://www.saltinstitute.org/

N-14	Neighborhood Source Area: Garage **HOUSEHOLD HAZARDOUS WASTE COLLECTION**	

Description

The average garage contains many products that are classified as hazardous waste, including paints, stains, solvents, used motor oil, excess pesticides, and cleaning products. The ideal watershed behavior is to regularly participate in household hazardous waste (HHW) collection days, and to be careful when rinsing paintbrushes, cleaning pesticide applicators and fertilizer spreaders, and fueling outdoor power equipment (Figure 1). The negative watershed behavior is continued storage, improper disposal or illegal dumping of household hazardous wastes, and poor cleaning, refueling and rinsing practices.



Household Hazardous Wastes?

Many products you use in your home and yard contain hazardous materials. Improper disposal of these products can cause fires, injuries to people and animals, and groundwater contamination. This guide will help you identify hazardous products in your home. **Keep your home safe by disposing of hazardous products properly.**

Key: ■ Place in the trash / ● Pour down the drain (if connected to a sanitary sewer) / ▲ Take to a hazardous waste collection site

Garage and Workshop

Acetone	▲	
Adhesive, solvent-based	▲	
Antifreeze	▲	
Artist's paints and media	▲	
Autobody repair products	▲	
Battery acid	▲	
Brake fluid	▲	
Car batteries	▲	
Car wax, solvent-based	▲	
Concrete cleaner	▲	
Contact cement	▲	
Driveway sealer	▲	
Fiberglass epoxy	▲	
Gasoline and other fuels	▲	
Glue, solvent-based	▲	
Glue, water-based		■
Joint compound		■
Lighter fluid	▲	
Motor oil	▲	
Oil filters	▲	
Other oils	▲	
Paint, all types	▲	
Paint cans, empty		■
Paint thinner	▲	
Paint stripper	▲	
Paint cleaner, degreaser	▲	
Photographic chemicals		●
Roof/foundation coating	▲	
Rust remover		●
Shellac	▲	
Stain	▲	
Transmission fluid	▲	
Turpentine	▲	
Varnish	▲	
Windshield washer solution	▲	
Wood filler	▲	
Wood preservative	▲	

Kitchen and Bathroom

Alcohol-based lotions (perfume, aftershave)	▲		
Bleach			●
Cleaners, ammonia-based			●
Cleaners, solvent-based	▲		
Cosmetics		■	
Disinfectants			●
Drain cleaner			●
Floor care products	▲		
Hair remover	▲		
Medicine			●
Nail polish	▲		
Nail polish remover	▲		
Oven cleaner	▲		
Permanent wave solution			●
Skin cream		■	
Toilet bowl cleaner			●
Tub and tile cleaner			●
Window cleaner			●

Home and Garden

Aerosol cans, empty		■
Aerosol cans, full	▲	
Batteries, alkaline		■
Batteries, button	▲	
Charcoal lighter fluid	▲	
Dry cleaning solvent	▲	
Fertilizer		■
Fertilizer with weed killer	▲	
Fluorescent tubes	▲	
Fungicide	▲	
Furniture polish	▲	
Insect killer (insecticide)	▲	
Insect spray, repellant	▲	
Light ballasts	▲	
Mercury compounds	▲	
Mercury, thermometers	▲	
Mercury, thermostats	▲	
Metal polish, solvent-based	▲	
Mothballs	▲	
Pesticide	▲	
Pool chemicals	▲	
Rat poison	▲	
Rechargeable batteries	▲	
Septic tank cleaner		●
Shoe polish	▲	
Spot remover	▲	
Stump remover	▲	
Weed killer (herbicide)	▲	

Proper Disposal

● Stores that sell car batteries must accept them back for recycling.

● Give leftovers to someone who will use them for their intended purpose. Reuse products such as paint thinner and paint.

● Never pour oil, antifreeze or other hazardous materials on the ground, into storm sewers or down the drain.

● Bring hazardous products that you cannot use up or give away to the Western Lake Superior Regional Household Hazardous Waste Facility, 27th Ave. W. and Courtland St. **Do not bring in hazardous wastes from businesses.**

● Hours for the Household Hazardous Waste Facility are listed on the back of this card.

Think Before You Buy!

● Switch to safe substitutes. For a brochure on alternatives to hazardous products, call the Hot line.

● Read the label. Make sure the product will do what you want before purchasing. Follow label directions for safe use, storage and disposal.

● Purchase only the amount you need and use up what you buy.

● Avoid aerosols by choosing pump sprays.

● Select water-based over solvent-based products when available.

● Before buying paint, check out the Product Exchange at WLSSD. It's free!

WLSSD
Clear Answers for Clean Water™

Questions? Call the WLSSD Hotline 722-0761

Sponsored by: The Western Lake Superior Sanitary District and The Minnesota Pollution Control Agency

Recycled Paper

Figure 1: Household Hazardous Waste Disposal Guidelines

Source: http://www.duluthstreams.org/understanding/impact_oil.html

How It Influences Water Quality

According to EPA, the average home/garage accumulates as much as 100 pounds of household hazardous waste per year**.** Nationally, households are collectively estimated to generate more than 1.6 million tons of household hazardous wastes annually. The proportion of HHW that reaches the storm drain system is not well known. Most HHW appears to be stored indefinitely, thrown out with the trash, or flushed down the sink/toilet, which is not environmentally acceptable. The key unknown is what fraction of HHW is illegally dumped into the storm drain. It is probable that most HHW enters the storm drain system during outdoor rinsing of pesticide applicators and outdoor painting cleanup. HHW that reaches the storm drain system can potentially be toxic to downstream aquatic life.

Percentage of Residents Engaging in HHW Collection

Homeowner participation in HHW collection programs is usually quite low, with several studies indicating participation rates of one to 5% (HGAC, 2004).

Variation in Participation

Convenience and awareness appear to be critical factors influencing participation in household hazardous waste collection programs. Participation is inversely related to the distance homeowners must travel to recycle waste, restrictions on what can be accepted and the number of days each year that collection events are held.

Techniques to Increase Participation

Communities continue to experiment with improved techniques to make HHW collection more convenient for residents, including:

- Mass media campaigns to educate residents on proper outdoor cleaning/rinsing
- Conventional outreach to notify residents about HHW collection days
- More frequent HHW collection days
- Providing curbside disposal options for certain HHW
- Establishing permanent collection facilities at solid waste facilities
- Providing mobile HHW pickup
- Waiving disposal fees at landfills
- Storm drain marking (see N-21)

Good Examples

The City of Denver Pilot Door-to-Door HHW Collection Program. This unique program assists residents in proper disposal and recycling of household hazardous wastes. Residents are permitted one HHW collection annually and receive a collection date and an HHW Kit that can hold up to 75 pounds. The program not only provides a curbside pick-up program for household hazardous waste, but also educates citizens on how to prevent the accumulation of chemicals in the garage.
http://www.denvergov.org/admin/template3/forms/INSERT1.pdf

King County Wastemobile. The Wastemobile is a traveling collection program that goes to two sites in the county per month to accept HHW and provide information about alternatives to hazardous products. The Wastemobile is funded through a surcharge on solid waste disposal and wastewater discharge, and residents utilizing the Wastemobile are not charged a fee on site.
http://www.govlink.org/hazwaste/house/disposal/wastemobile/

Top Resources

EPA Household Hazardous Waste Website
http://www.epa.gov/epaoswer/non-hw/muncpl/hhw.htm

Guide to Household Hazardous Wastes
http://www.epa.gov/grtlakes/seahome/housewaste/house/products.htm

Household Hazardous Waste: Steps to Safe Management
A guide for residential homeowners that describes household hazardous waste and the dangers of improper disposal.
http://www.epa.gov/epaoswer/non-hw/househld/hhw.htm

Household Hazardous Waste (HHW) Management: A Manual for One Day Community Collection Programs
A manual that helps communities plan for one-day, drop-off HHW collection programs. Provides community leaders with guidance on all aspects of planning, organizing, and publicizing a HHW collection program.
http://www.epa.gov/epaoswer/non-hw/househld/hhw/cov_toc.pdf

Department of Defense - Household Hazardous Waste Topic Hub
http://wrrc.p2pays.org/p2rx/toc.cfm?hub=16&subsec=7&nav=7&CFID=23448&CFTOKEN=55325833

Household/Small Business Hazardous Waste: A Manual for Sponsoring a Collection Event
http://www.dep.state.pa.us/dep/deputate/airwaste/wm/Hhw/Documents/TechMan.pdf

N-15	Neighborhood Source Area: Driveway	
	CAR FLUID RECYCLING	

Description

The ideal watershed behavior is to have automotive fluids changed at a commercial operation where stringent pollution source controls and fluid recycling practices are in place. The next best alternative is to perform car maintenance under cover within the garage, and carefully dispose of all oil, antifreeze and other fluids at approved recycling facilities. The negative behavior is to improperly store, dump or otherwise dispose of car fluids into the storm drain system.

How Fluid Changing Influences Water Quality

Dumping automotive fluids down storm drains can be a major water quality problem, since only a few quarts of oil or a few gallons of antifreeze can have a major impact on small streams. Dumping can be a major source of hydrocarbons, oil/grease, metals, xylene and other pollutants to a stream, and are potentially toxic if dumped during dry-weather conditions when existing flow cannot dilute these discharges. The major culprit has been the backyard mechanic who changes his or her own automotive fluids (Figure 1). It has been estimated that do-it-yourself mechanics improperly dispose of 192 million gallons of used oil into the environment each year (University of Missouri, 1994). It remains unclear what fraction of the improper disposal of motor oil occurs within the storm drain system.

Figure 1: Fluid Changing on Driveway

Percentage of People Engaging in Improper Disposal

The number of backyard mechanics who change their own oil and antifreeze has been dropping steadily in recent decades. With the advent of the $20 oil change, only about 30% of car owners still change their own oil or antifreeze (Swann, 2001). Backyard mechanics have traditionally been the target of community oil recycling and storm drain marking programs. These programs appear to have been quite effective, since more than 80% of backyard mechanics claim to dispose of or recycle these fluids properly (Smith, 1996; PRG, 1998; Assing, 1994). Most backyard mechanics were more prone to recycle oil than antifreeze. Backyard mechanics that indicated they had improperly disposed of automotive fluids reported that they dumped it into trashcans rather than the storm drain system. Oil and antifreeze dumping is considered socially unacceptable in many communities, and, according to Swann (2001), less than 5% of backyard mechanics report that they illegally dump oil.

Variation in Car Fluid Disposal

Neighborhood demographic and income levels appear to be important factors governing the number of "do-it-yourselfers" in a given subwatershed. As with other residential behaviors, proper disposal of oil and anti-freeze is primarily influenced by the ease, convenience and costs for accepting these fluids at local service stations or municipal collection stations.

Techniques to Change Car Fluid Disposal

While used oil collection has been a common municipal service for many years, some communities are continuously refining their programs to increase participation (Figure 2). These techniques include:

- Conventional outreach materials provided at point of sale (e.g., auto parts stores, service stations)
- Multilingual outreach materials
- Community oil recycling
- Directories of used oil collection stations
- Free or discounted oil disposal containers
- Storm drain marking

Figure 2: Frisbee Advertising Oil Recycling

Good Examples

King County Kiosks (Washington). Thirty interactive kiosks on oil recycling were placed in King County licensing offices, county buildings and other locations. In addition, a direct mail campaign to 6,000 households and three newspaper ads were used to distribute coupons good for product or service discounts that could be used when dropping off oil at participating sites.

California's Used Oil Recycling Program Incentive Program. Residents can receive incentives from certified centers that recycle used oil. Certified centers must accept used oil from the public at no charge during business hours and offer a $0.16 per gallon recycling incentive. In turn, only certified used oil collection centers can file a claim for recovery of the $0.16 per gallon it pays out. Certified centers can also claim the recycling incentive for all used oil generated on site from their business as an inducement to take oil from the public. http://www.ciwmb.ca.gov/BoardInfo/ProgramResp/SpecialWaste/HHW.htm - Public%20Info

Top Resources

Car Care for Do-It-Yourselfers
http://www.monterey.org/publicworks/carcare.html

Car Care for Cleaner Water
http://clean-water.uwex.edu/pubs/stormie/carcare.pdf

Motor Vehicle Maintenance
http://www2.ctahr.hawaii.edu/oc/freepubs/pdf/HH-15.pdf

How To Set Up a Local Program to Recycle Used Oil - Explains the organization, design, implementation, and promotion of a used oil program, as well as administrative issues. Includes sample brochures and letters.
http://www.epa.gov/epaoswer/non-hw/recycle/89039a.pdf

N-16	Neighborhood Source Area: Rooftop	
	DOWNSPOUT DISCONNECTION	

Description

Downspout disconnection spreads rooftop runoff from individual downspouts across the lawn or yard where it filters or infiltrates into the ground. While some disconnections are simple, most require the installation of an on-site storm water retrofit practice. These simple practices capture, store and infiltrate storm water runoff from residential lots, and include rain barrels, rain gardens, French drains or dry wells. *Rain barrels* capture runoff from rooftops and are typically installed on individual roof leaders. Runoff captured in the barrel is stored for later use as supplemental irrigation. *Rain gardens* are shallow, landscaped depressions in the yard used to store and infiltrate runoff from rooftops and other impervious surfaces on the lot. *French drains and dry wells* are shallow small stone trenches used to infiltrate rooftop runoff into the ground, where soils are permeable. More details about on-site retrofit practices can be found in Profile Sheets 0S-15 through 0S-17 in Manual 3.

The ideal watershed behavior is to disconnect all downspouts so individual rooftops deliver no runoff to the storm drain system or stream. The negative watershed behavior is to pipe downspouts across the yard and into the curb or street in order to promote positive drainage (Figure 1).

How Downspout Disconnection Influences Subwatershed Quality

Downspout disconnection reduces the amount of impervious cover on a developed lot that can generate stormwater runoff. In addition to reducing the volume of runoff, downspout disconnection promotes groundwater recharge, reduces storm water runoff volumes, and filters out pollutants through the lawn soil. Since each individual retrofit for downspout disconnection treats only a few hundred or thousand square feet of impervious cover, dozens or hundreds are needed to make a measurable difference at the subwatershed level. Consequently, an intensive campaign to target education, technical assistance, and financial resources within a neighborhood or subwatershed to encourage widespread adoption of disconnection is needed.

Percentage of Residents Engaging in Downspout Disconnection

Data is not currently available to estimate the rate at which homeowners voluntarily disconnect downspouts. The frequency of this behavior is thought to be extremely low in most neighborhoods unless a community aggressively promotes and subsidizes disconnections. If this occurs, homeowner participation rates of 20 to 30% have been reported in pilot projects (Environment Canada, 2001).

Figure 1: Downspout Intentionally Bypassing Landscaped Area and Draining onto Driveway

Variation in Downspout Disconnection

The potential to disconnect downspouts is normally evaluated as part of the Neighborhood Source Assessment component of the USSR survey (see Manual 11). The most important neighborhood factor is the proportion of existing homes directly connected to the storm drain system. Negative neighborhood factors include the presence of basements, compacted soils, and poor neighborhood awareness or involvement. Positive factors are large rooftop areas that are directly connected to the storm drain system, lots with extensive tree canopy, and good neighborhood housekeeping. In general, large residential lots are most suitable for most disconnection retrofits (1/4 acre lots and larger), although rain barrels can be used on lots as small as 4,000 square feet (Figure 2).

To date, the impetus for most disconnection retrofit programs has been to separate residential storm water from sewer flows in older neighborhoods in order to minimize basement sewer backups or combined sewer overflows.

Figure 2: Rain Barrel Used on a Back, Second Floor Balcony

Techniques to Promote Downspout Disconnection

Communities are experimenting with many different carrots to promote disconnection retrofits, including:

- Conventional outreach materials (flyers, brochures, posters)
- Free or discounted rain barrel distribution
- Municipal or schoolyard demonstration projects
- Credits or subsidies for disconnection retrofits
- Direct technical assistance
- Provision of discounted mulch, piping or plant materials
- Modification of sewer and storm water ordinances to promote disconnection
- Mandatory disconnection for targeted subwatersheds

Good Examples

Downspout Disconnection Program (Portland, OR). The City offers residents a credit of $53 per disconnection in the form of a check or a one-time lump sum credit toward their sewer bill after inspection and approval of the work. In addition, neighborhood associations and other civic groups (churches, schools, etc.) can earn $13 for every downspout they disconnect. http://www.portlandonline.com/bes/index.cfm?c=32144

Rain Blocker Program (*City of Chicago)*. The Rain Blocker pilot program is specifically designed to eliminate or greatly reduce the amount of basement flooding caused by sewer surcharge. The program works by restricting the rate of storm water flow into the city sewer system, via installing vortex restrictors within the catch basins of city streets and through downspout disconnection from buildings. http://www.cityofchicago.org/WaterManagement/blocker.html

Neighborhood Rain Gardens (Minneapolis, MN). This program works with neighborhood associations to encourage landscaping for rainwater management. The Fulton Neighborhood Association has worked with eight homeowners to install rain gardens, rain barrels, gutter downspout redirection, and infiltration systems that reduce runoff delivered from individual properties to streets, alleys and sidewalks.
http://www.fultonneighborhood.org/lfrwm.htm

Top Resources

How to Disconnect Your Downspouts (Portland Oregon)
http://www.portlandonline.com/bes/index.cfm?c=32144

Milwaukee Downspout Disconnection Program
http://www.mmsd.com/projects/downspout.cfm

Boston Water and Sewer Commission's Downspout Disconnection Program
http://www.bwsc.org/Customer_Service/Programs/downspout.htm

RainGardens.org
http://www.raingardens.org/

Rain Gardens: A how-to manual for homeowners
http://www.dnr.state.wi.us/org/water/wm/dsfm/shore/documents/rgmanual.pdf

Rain Garden Applications and Simple Calculations
http://www.cwp.org/Community_Watersheds/Rain_Garden.htm

How to Build and Install a Rain Barrel
http://www.cwp.org/Community_Watersheds/brochure.pdf

Skills for Protecting Your Stream: Retrofitting Your Own Backyard
http://www.cwp.org/Community_Watersheds/Retrofitting_Backyard.pdf

N-17	Neighborhood Source Area: Rooftop	
	SINGLE LOT CONTROLS	

Description

The ideal watershed behavior is to gradually reduce impervious cover on residential lots by converting impervious cover to pervious cover. Examples include converting an impervious driveway to a more pervious design, or eliminating an old walkway, deck or outbuilding. In practice, however, most homeowners gradually add more impervious cover to their residential lots over time, in the form of decks, patios, walkways and home additions. Thus, the practical watershed behavior is to treat storm water runoff produced by new impervious cover, using downspout disconnection and other on-site retrofits to minimize storm water runoff (see Profile sheets N-16 and 0S-15 to 17 in Manual 3).

How Impervious Cover Influences Subwatershed Quality

Impervious cover plays a strong role in defining both subwatershed quality and stream health (CWP, 2003). The amount of impervious cover in a neighborhood or a subwatershed does not remain constant over time, but rather increases incrementally as individual residents remodel, redevelop or otherwise improve their lots. Collectively, the gradual "creep" in impervious cover may make it more difficult to achieve subwatershed restoration goals.

Percentage of Residents Adding Impervious Cover

More than 18 million households (20% of all households in the U.S.) completed projects over the last decade that added impervious cover to their residential lots (U.S. Census, 2001). This included three million home additions (e.g., expansions, decks, carports, attached garages, porches, and other remodeling), as well as 15 million detached structures (e.g., driveways, walkways, patios, terraces, swimming pools, tennis courts, detached decks, garages, sheds, and other outbuildings).

Factors that Contribute to Variation in Adding Impervious Cover

The precise reasons why impervious cover is added or reduced within a neighborhood are often unique, and reflect its age, housing stock, demographics, income levels, and average lot size. In many cases, the degree of redevelopment/remodeling activity can be ascertained during the neighborhood source assessment of the USSR survey (see Manual 11). If redevelopment activity level is high, serious consideration should be given to residential storm water management requirements such as those described in BASMAA (1997) and Winer (2003). In some communities, erosion control or storm water treatment requirements are triggered when areas as small as 100, 250, or 500 square feet are disturbed.

Techniques to Change the Behavior

Most communities have been reluctant to regulate small remodeling and redevelopment projects on individual residential lots, but a few have developed simplified techniques to address the storm water impacts single lots (Figure 1).

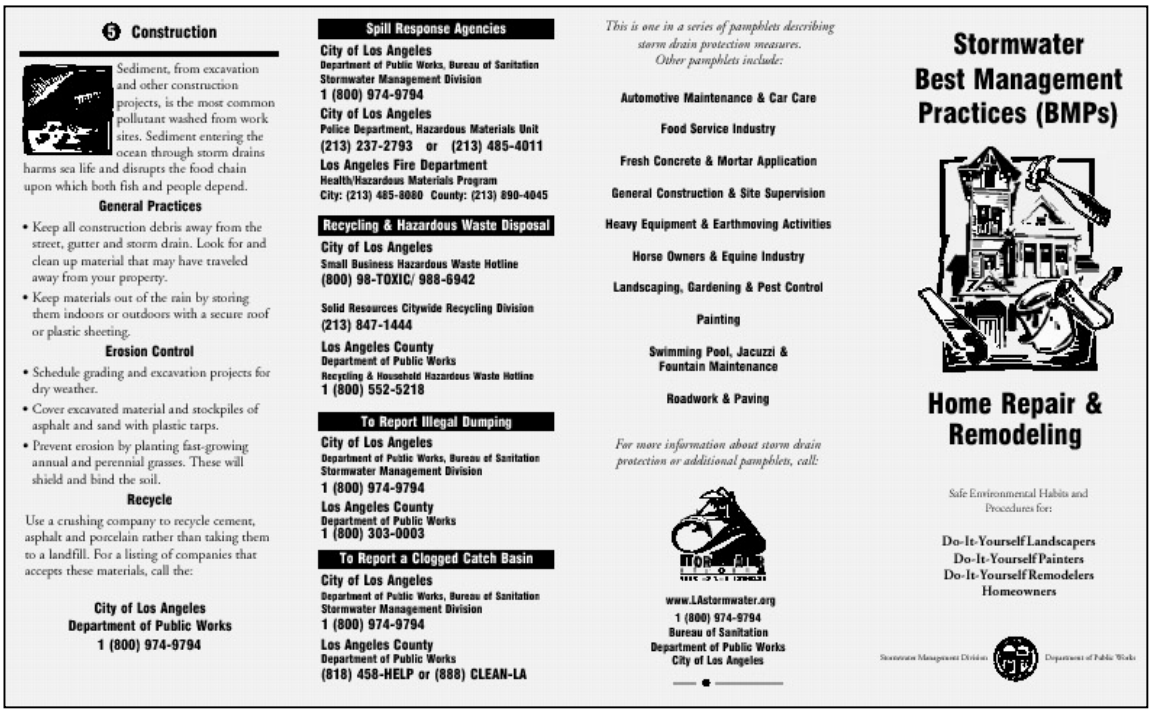
Other techniques include:

- Conventional outreach materials (brochures, water bill inserts)
- Contractor training and certification (see Hotspot Profile Sheet H-9)
- Setting storm water utility rates based on actual impervious cover
- Simplified residential storm water management plans

Good Examples

Simplified Residential Storm Water Management Plan (Maryland Critical Area) - The regulatory threshold to treat storm water runoff is triggered at only 250 square feet, which means that many decks, additions, and other residential projects must comply. To simplify compliance for individual residential lots, the Critical Area Commission allows non-engineered storm water plans such as compensatory tree planting, rooftop disconnection, and pervious driveways and walkways. http://www.dnr.state.md.us/criticalarea/10percent_rule.html

City of Charlotte and Mecklenberg County, NC Stormwater Credits - These communities created a credit system for storm water fees when property owners are able to show an effective reduction of the impact their property has on the drainage system. The fee credit applies to all properties, including single-family residential properties with practices that reduce storm water runoff from their site. http://www.charmeck.org/Living/Environment/Home.htm



5 Construction

Sediment, from excavation and other construction projects, is the most common pollutant washed from work sites. Sediment entering the ocean through storm drains harms sea life and disrupts the food chain upon which both fish and people depend.

General Practices

- Keep all construction debris away from the street, gutter and storm drain. Look for and clean up material that may have traveled away from your property.
- Keep materials out of the rain by storing them indoors or outdoors with a secure roof or plastic sheeting.

Erosion Control

- Schedule grading and excavation projects for dry weather.
- Cover excavated material and stockpiles of asphalt and sand with plastic tarps.
- Prevent erosion by planting fast-growing annual and perennial grasses. These will shield and bind the soil.

Recycle

Use a crushing company to recycle cement, asphalt and porcelain rather than taking them to a landfill. For a listing of companies that accepts these materials, call the:

City of Los Angeles
Department of Public Works
1 (800) 974-9794

Spill Response Agencies

City of Los Angeles
Department of Public Works, Bureau of Sanitation
Stormwater Management Division
1 (800) 974-9794

City of Los Angeles
Police Department, Hazardous Materials Unit
(213) 237-2793 or (213) 485-4011

Los Angeles Fire Department
Health/Hazardous Materials Program
City: (213) 485-8080 County: (213) 890-4045

Recycling & Hazardous Waste Disposal

City of Los Angeles
Small Business Hazardous Waste Hotline
(800) 98-TOXIC/ 988-6942

Solid Resources Citywide Recycling Division
(213) 847-1444

Los Angeles County
Department of Public Works
Recycling & Household Hazardous Waste Hotline
1 (800) 552-5218

To Report Illegal Dumping

City of Los Angeles
Department of Public Works, Bureau of Sanitation
Stormwater Management Division
1 (800) 974-9794

Los Angeles County
Department of Public Works
1 (800) 303-0003

To Report a Clogged Catch Basin

City of Los Angeles
Department of Public Works, Bureau of Sanitation
Stormwater Management Division
1 (800) 974-9794

Los Angeles County
Department of Public Works
(818) 458-HELP or (888) CLEAN-LA

This is one in a series of pamphlets describing storm drain protection measures. Other pamphlets include:

Automotive Maintenance & Car Care
Food Service Industry
Fresh Concrete & Mortar Application
General Construction & Site Supervision
Heavy Equipment & Earthmoving Activities
Horse Owners & Equine Industry
Landscaping, Gardening & Pest Control
Painting
Swimming Pool, Jacuzzi & Fountain Maintenance
Roadwork & Paving

For more information about storm drain protection or additional pamphlets, call:

www.LAstormwater.org
1 (800) 974-9794
Bureau of Sanitation
Department of Public Works
City of Los Angeles

Stormwater Best Management Practices (BMPs)

Home Repair & Remodeling

Safe Environmental Habits and Procedures for:

Do-It-Yourself Landscapers
Do-It-Yourself Painters
Do-It-Yourself Remodelers
Homeowners

Stormwater Management Division — Department of Public Works

Figure 1: Repair and Remodeling Brochure
Source: http://www.lacity.org/SAN/wpd/index.htm

N-18	Neighborhood Source Area: Common Areas	
	PET WASTE PICKUP	

Description

The ideal watershed behavior is to pick up and properly dispose of pet waste (Figure 1). The negative watershed behavior is to leave pet waste in common areas and the yard, where it can be washed off in storm water runoff.

How Pet Waste Influences Subwatershed Quality

Pet waste has been found to be a major source of fecal coliform bacteria and pathogens in many urban subwatersheds (Schueler, 1999). A typical dog poop contains more than three billion fecal coliform bacteria and as many as 10% of dogs are also infected with either *giardia* or salmonella, which is not surprising considering they drink urban creek water. Fecal coliform bacteria are frequently detected in urban streams and rivers after storms, with levels as high 5,000 fecal coliform per tablespoon. Thus, it is not uncommon for urban and suburban creeks to frequently violate bacteria standards for swimming and water contact recreation after larger rainstorms.

Percentage of Residents that Pick Up After Pets

Surveys indicate that about 40% of all households own one or more dogs (Swann, 1999). Not all dog owners, however, are dog walkers. Only about half of dogs are walked regularly. About 60% of dog walkers claim to pick up after their dog some or all of the time (Swann, 1999; HGIC, 1998; and Hardwick, 1997). The primary disposal method reported by residents for pet waste is the trash can, with toilets coming in distant second. Dog walkers that do not pick up after their dogs are highly resistant to change; nearly half would not pick up even if confronted with fines or complaints from neighbors (Swann, 1999). Men are also prone to pick up after their dogs less often than women (Swann, 1999).

Figure 1: Pet Waste Pickup Station

Techniques to Promote Pet Waste Pickup

The key technique is to educate residents on sanitary and convenient options for retrieving and disposing of pet waste. Several communities have used both carrots and sticks to get more owners to pick up after their pets, including:

- Mass media campaigns of the water quality impacts of pet waste
- Conventional outreach materials (brochures, flyers, posters)
- Pooper bag stations in parks, greenways and common areas
- Educational signs in same areas
- "Pooper scooper" ordinances and enforcement
- Banning dogs from beaches and waterfront areas
- Providing designated "dog parks"

Good Examples

Water Quality Consortium Nonpoint Source Education Materials
The Water Quality Consortium implemented an ad campaign focused on four themes: a man pushing a fertilizer spreader, a car driving on water leaking oil, a man washing his car, and man walking his dog. Each ad explains how the behavior leads to water pollution and provides specific tips outlining what residents can do to protect water quality.
http://www.psat.wa.gov/Programs/Pie_Ed/Water_Ed_Materials.htm

Pick It Up - It's Your Doodie Campaign (Gwinnett County Parks & Recreation Department) - The county park agency provides plastic grocery bags for pet owners to use to clean up after their pets as part of a pilot program. The baggies are attached to a wooden post at a local park. Underneath a sign explains their purpose. Pet owners are also encouraged to bring replacement bags when they visit the park.
http://www.gwinnettcitizen.com/0203/doodie.html

Top Resources

Public Open Space and Dogs: A Design and Management Guide for Open Space Professionals and Government
http://www.petnet.com.au/openspace/frontis.html

Considerations for the Selection and Use of Pet Waste Collection Systems in Public Areas
http://www.ecy.wa.gov/programs/wq/nonpoint/pet_waste/petwaste_station.pdf

Properly Disposing of Pet Waste
http://www.cleanwatercampaign.com/what_can_i_do/pet_waste_home.html

Managing Pet and Wildlife Waste to Prevent Contamination of Drinking Water
U.S. EPA Source Water Protection Practices Bulletin.
http://www.epa.gov/safewater/protect/pdfs/petwaste.pdf

N-19	Neighborhood Source Area: Common Areas **STORM WATER PRACTICE MAINTENANCE**	

Description

The ideal watershed behavior is to regularly maintain storm water treatment practices, which are normally located in common space managed by a homeowner's association. The negative behavior is to ignore routine and non-routine maintenance tasks to the extent that the ability of the practice to remove pollutants and protect streams is impaired. Storm water maintenance consists of routine and non-routine tasks. Routine tasks include on-going inspections, mowing, vegetation management, trash and debris pickup, and removal of any obstructions within pipes and riser structures. Non-routine tasks include sediment clean-outs, structural repairs, tree removal, fence repair, and other major tasks performed every five to 10 years.

How Storm Water Maintenance Influences Subwatershed Quality

Storm water detention or treatment practices have been constructed in many subwatersheds over the last few decades. The vast majority of these practices have been dry or wet storm water ponds. These ponds were designed to detain flood waters and, in some cases, remove pollutants as well. Ongoing pond maintenance is needed to maintain pollutant removal rates, keep the pond safe, and to enhance its habitat, wetland or landscaping value (Figure 1).

Percentage of People Engaging in Storm Water Practice Maintenance

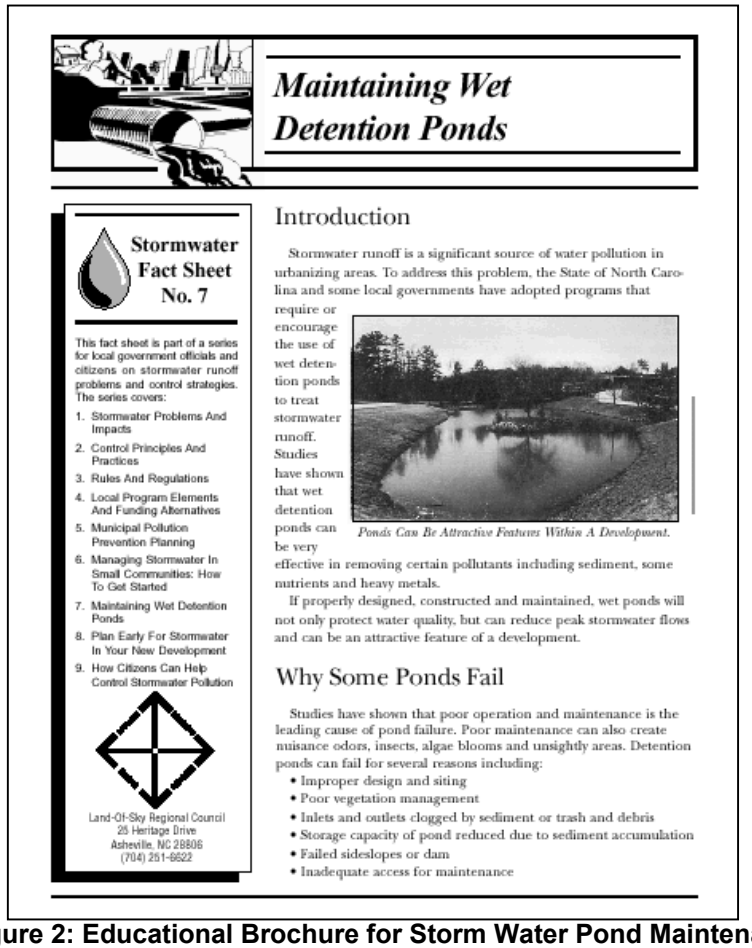
Little data is available to characterize this watershed behavior, although anecdotal evidence indicates that maintenance is the exception rather than the rule at many ponds.

Figure 1: Wet Storm Water Pond

Variation in Storm Water Practice Maintenance

Each state or locality has its own storm water history, which begins when storm water detention or treatment practices were first required on new development projects. Thus, some communities may have hundreds or even thousands of storm water practices built over decades, while others may have few practices and no real history of managing storm water.

If a community has a history of managing storm water, several neighborhood factors play a role in defining maintenance behaviors. The most critical factor is the age of the neighborhood, since most storm water practices have only been built in the last 10 to 15 years. The second key neighborhood factor is the design objective of the past storm water management practices (e.g., provide flood control, peak shaving, water quality or recharge). The last important factor is the size, sophistication and financial health of the homeowners association that has maintenance responsibility for the pond.



Maintaining Wet Detention Ponds

Stormwater Fact Sheet No. 7

This fact sheet is part of a series for local government officials and citizens on stormwater runoff problems and control strategies. The series covers:

1. Stormwater Problems And Impacts
2. Control Principles And Practices
3. Rules And Regulations
4. Local Program Elements And Funding Alternatives
5. Municipal Pollution Prevention Planning
6. Managing Stormwater In Small Communities: How To Get Started
7. Maintaining Wet Detention Ponds
8. Plan Early For Stormwater In Your New Development
9. How Citizens Can Help Control Stormwater Pollution

Land-Of-Sky Regional Council
25 Heritage Drive
Asheville, NC 28806
(704) 251-6622

Introduction

Stormwater runoff is a significant source of water pollution in urbanizing areas. To address this problem, the State of North Carolina and some local governments have adopted programs that require or encourage the use of wet detention ponds to treat stormwater runoff. Studies have shown that wet detention ponds can be very effective in removing certain pollutants including sediment, some nutrients and heavy metals.

Ponds Can Be Attractive Features Within A Development.

If properly designed, constructed and maintained, wet ponds will not only protect water quality, but can reduce peak stormwater flows and can be an attractive feature of a development.

Why Some Ponds Fail

Studies have shown that poor operation and maintenance is the leading cause of pond failure. Poor maintenance can also create nuisance odors, insects, algae blooms and unsightly areas. Detention ponds can fail for several reasons including:

- Improper design and siting
- Poor vegetation management
- Inlets and outlets clogged by sediment or trash and debris
- Storage capacity of pond reduced due to sediment accumulation
- Failed sideslopes or dam
- Inadequate access for maintenance

Figure 2: Educational Brochure for Storm Water Pond Maintenance
Source: http://h2o.enr.state.nc.us/su/PDF_Files/Land_of_Sky_factsheets/FactSheet_7.pdf

Difficulty in Improving Maintenance of Storm Water Practices

Improving routine and non-routine maintenance can be difficult, since many homeowner or civic associations lack adequate maintenance budgets. They may also be ignorant of the purpose and functions of storm water practices, and not understand basic maintenance operations. Consequently, targeted education and direct technical assistance to homeowner associations is important to improve maintenance behaviors.

Techniques to Improve Maintenance Behavior

Some communities have adopted innovative techniques to improve the frequency of maintenance of storm water practices, including the following:

- Conventional outreach materials (maintenance guidebooks)
- Liaison w/homeowner and civic associations
- Free inspections and contractor referral
- Pondscaping assistance (e.g., technical assistance, free plant material)
- Adopt-a-pond programs
- Storm water maintenance classes and work parties
- Pond beautification awards
- Annual maintenance reminder letters

Good Examples

Adopt- a-Pond Program (Baltimore County, MD). The County developed a pilot pond adoption program that features four different levels of participation. The basic level includes inspections and trash pickup, while the most advanced involves pondscaping, wildlife enhancements, and simple retrofits. Another interesting feature of this pond adoption program is the fact that the training and administration of the program are subcontracted to a local watershed organization. Contact the Center for Watershed protection for information on how to access.

Adopt-a-Pond Program (Hillsborough County, FL). This Florida county has the largest and longest running "adopt a pond" program in the nation. Nearly 200 ponds have been adopted by neighborhood groups and service clubs. The program features signs, volunteer recognition, newsletters and work parties to actively engage, train and retain volunteers. For more details: http://www.swfwmd.state.fl.us/documents/publications/files/adopt.htm

Pond Maintenance Training and Work Parties (Lacey, WA). This version of an adopt-a-pond program uses a series of night-time training classes on the basics of storm water maintenance, followed by weekend work parties to spruce up and landscape storm water ponds.

Top Resources

Thurston County, Washington, "How to Care for Your Stormwater Pond." This web document is an excerpt from the publication *Maintaining Your Stormwater Pond: A Step-by-Step Guide to Keeping Your Stormwater Pond Happy and Healthy.* Geared toward private landowners and homeowner associations, this document answers basic questions on storm water pond maintenance.
http://www.co.thurston.wa.us/wwm/stormwaterpages/maintainpond.pdf

Northern Virginia Planning District Commission, Maintaining Your BMP - A Guidebook for Private Owners and Operators in Northern Virginia. This document is designed for individual property owners, homeowner association leaders, and residential/commercial property managers. The guidebook outlines the basic maintenance and planning tasks to help keep practices functioning properly, and includes information on general maintenance needs, who should carry out maintenance, inspections, and basic planning. The document also includes a simple inspection checklist and a maintenance cost planning sheet.
http://www.novaregion.org/pdf/Maintaining_BMPs.pdf

Montgomery County, MD "Maintaining Urban Storm water Facilities: A Guidebook for Common Ownership Communities." This guidebook describes the four primary types of storm water practices found in the County and outline some basic maintenance tasks to keep them functioning properly.
http://www.montgomerycountymd.gov/mcgtmpl.asp?url=/content/dep/stormwater/maintain.asp

City of Eugene, Oregon - Storm Water Drain Maintenance on Private Property. This short guide discusses the maintenance of storm water drains, street gutters, underground pipes, roadside ditches, and open drainage channels. Proper storm water drain maintenance is crucial for flood control and water quality protection. This guide explains the private property owner's responsibility to maintain storm water drains on his or her property and some simple maintenance procedures to meet this responsibility.
http://www.stormwatercenter.net/

South Carolina Department of Health and Environmental Control, Ocean and Coastal Resource Management's A Citizen's Guide to Storm Water Pond Maintenance. This booklet is a guide for individuals and homeowner associations on the proper function and maintenance of storm water ponds. Instructions are provided on inspections, dredging, weed control, herbicides, pollutants and pesticides. Photos and descriptions of nuisance aquatic plant species are provided to aid in the identification and removal of these species from storm water ponds.
http://www.scdhec.net/ocrm/pubs/ponds.pdf

Howard County, MD – Maintaining Your Stormwater Management Structure. This manual is directed at commercial property managers who own storm water management structures. The purpose of this manual is to describe the four types of stormwater management structures and their maintenance requirements.
http://www.co.ho.md.us/DPW/DOCS/stormwatermanual.pdf

Stormwater Manager's Resource Center. This website offers information on maintenance arrangements, agreements, costs, frequencies, and educational materials.
http://www.stormwatercenter.net
(Click on "Program Resources" then "STP Maintenance")

N-20	Neighborhood Source Area: Common Areas	
	BUFFERSCAPING	

Description

Many neighborhoods built in the last few decades still have a decent stream corridor protected by buffers, flood plain setbacks or wetland protection requirements. The stream corridor that remains is often in common or private ownership. The ideal watershed behavior is to respect the boundaries of the stream corridor and expand it where possible through "bufferscaping" and backyard planting of native plants and trees. The negative watershed behavior is stream corridor encroachment, through clearing, dumping, allowing invasive plant species to spread from private yards, and erecting structures (Figure 1).

How Bufferscaping Influences Subwatershed Quality

A forested stream corridor is an essential ingredient of a healthy stream, except in certain arid and semi-arid regions. Bufferscaping can add to the total area of the stream corridor, provide wildlife habitat and enhance the structure and function of the buffer. By contrast, encroachment activities diminish the quality, function and attractiveness of the stream buffer.

Percentage of People Encroaching on/Expanding the Stream Corridor

Data is not currently available to estimate the rate at which homeowners add to the stream corridor, but several troubling studies have examined the degree of residential buffer encroachment. Many residents perceive buffers as an extension of their backyard, and think little of removing trees, dumping yard wastes or erecting structures on their land. A major reason is that nearly 60% of residents are ignorant of the boundaries and intended purpose of stream buffers (Heraty, 1993). Studies of wetland buffer encroachment in Washington residential areas found that 95% of buffers were visibly altered, 40% to such a degree that their functional value was eliminated (Cooke, 1991). Other studies of Maryland buffers indicate encroachment rates of as much as 1% of area buffer per year. Clearly, residential awareness and behaviors in regard to the stream corridor need to be improved in many subwatersheds.

Neighborhood Factors that Contribute to Buffer Stewardship

Several factors play a role in how buffers are managed within a neighborhood: the age of the development, lot size, activism of homeowner association, boundary signs, and the prior existence of stream buffer or flood plain regulations.

Figure 1: A New Subdivision Encroaching on the Stream Buffer

Techniques to Encourage Buffer Stewardship

Protecting or expanding stream buffers requires direct education and interaction with individual property owners that back up to the buffer. Some useful techniques include:

- Bufferscaping assistance and guides
- Community buffer walks
- Buffer boundary inspections
- Boundary signs (Figure 2)
- Defining unallowed uses in local stream buffer ordinances
- Presentations to community associations
- Adopt-a-stream program
- Financial incentives for bufferscaping

Figure 2: Sign Identifying a Buffer Boundary

Good Examples

Burnett County, WI Natural Shoreline Incentives. The county pays homeowners to enroll in a program to maintain shorelines in their natural state. The program asks for a voluntary commitment by placing a covenant on a homeowner's property stating that the shoreline will remain natural. Program members receive a payment of $250 after an initial inspection that certifies the property meets program standards, and the shoreline covenant is recorded. Participants also receive an annual deduction from their tax statement as a thank you.
http://www.burnettcounty.com/burnett/lwcd/preserve.html

Tennessee Valley Authority Banks and Buffers Software: A Guide to Selecting Native Plants for Streambanks and Shorelines includes software application to help homeowners select plants for bufferscaping. It also contains selected characteristics and environmental tolerances of 117 plants and more than 400 color photographs illustrating habitat and growth form.
http://www.tva.gov/river/landandshore/stabilization/websites.htm

Top Resources

The Architecture of Urban Stream Buffers
http://www.stormwatercenter.net/Library/Practice/39.pdf

Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers
http://www.chesapeakebay.net/pubs/subcommittee/nsc/forest/riphbk.pdf

Riparian Forest Buffer Design, Establishment, and Maintenance
http://www.agnr.umd.edu/MCE/Publications/Publication.cfm?ID=13

Riparian Area Management: A Citizen's Guide
http://www.co.lake.il.us/elibrary/publications/smc/riparian.pdf

Backyard Buffers for the South Carolina Lowcountry
http://www.scdhec.net/ocrm/pubs/backyard.pdf

Alliance for the Chesapeake Bay – Backyard Buffers
http://www.acb-online.org/pubs/projects/deliverables-158-1-2003.pdf

Cayuga County, NY – Green Thumbs for Blue Water Workshops
http://www.co.cayuga.ny.us/wqma/greenthumbs

Tree-mendous Maryland
http://www.dnr.state.md.us/forests/treemendous/

N-21	Neighborhood Source Area: Common Areas	
	STORM DRAIN MARKING	

Description

The ideal watershed behavior is to get residents to fully understand the connection between storm drains and downstream waters and avoid any activity that discharges pollutants. This awareness is most often created by marking or stenciling storm drain inlets with a "Don't dump, drains to..." message (Figure 1). The negative watershed behavior is to use storm drains as a means of disposal for trash, yard waste and household products.

How Storm Drain Marking Influences Water Quality

Storm drain marking sends a clear message to keep trash and debris, leaf litter and organic matter out of the storm drain system. Stencils may also reduce residential spills and illicit discharges. Marking is also a direct and local way to increase watershed awareness and practice neighborhood stewardship. The actual water quality benefits of storm drain marking have yet to be demonstrated through field research or monitoring. Still, marking is always a sign of good neighborhood housekeeping. Santa Monica, CA also marks the hotline phone number on storm drains to report water quality problems and illegal dumping.

Percentage of Residents Engaging in Storm Drain Marking

This behavior does not require extensive resident participation; only a few trained volunteers are needed to thoroughly mark storm drains within a neighborhood. Volunteers can include scouts, service groups, high school students, neighborhood associations, and other volunteers. Normally, marking is "sanctioned" by the local public works authority or environmental agency, so it is important to coordinate closely with them (Figure 2). Table 1 provides guidance for marking storm drains.

Factors to Consider in Storm Drain Marking

The only significant impediment to storm drain marking is when a neighborhood is primarily served by open channels or grassed channels, rather than enclosed storm drains.

Figure 1: Storm Drain Marking

PROTECT *the* ENVIRONMENT

STORMWATER POLLUTION —WHAT IS IT?

Runoff from rainstorms is called stormwater. Stormwater becomes polluted by flowing over dirty surfaces, like parking lots, or when someone dumps materials, like oil or paint, directly into the storm drain. Polluted stormwater flows without treatment directly to creeks and rivers, where it can be harmful to aquatic life.

IT'S ILLEGAL TO DISCHARGE POLLUTANTS

Intentionally or unintentionally causing materials to enter the storm drain system is illegal and can result in corrective penalties. The following is a partial list of materials that are prohibited for discharge into the storm drain:

Paint	Concrete mix
Motor oil	Antifreeze
Yard waste	Chlorinated pool water

Rinse water from clothes washers

CURB WHAT FLOWS TO THE CREEKS

HOW TO GET A FREE STENCILING KIT

To obtain a stenciling kit, or for more information about controlling stormwater pollution, contact your local stormwater agency or check out their website:

County of Sacramento www.sactostormwater.org	(916) 874-6851
City of Sacramento www.sacstormwater.org	(916) 433-6369
City of Elk Grove	(916) 478-2232
City of Citrus Heights	(916) 727-4769
City of Folsom	(916) 355-7272
City of Elk Grove	(916) 478-2232
City of Galt	(209) 366-7260

To report illegal discharge to the storm drain or creeks in your area, call:

NON-EMERGENCY	
County of Sacramento	(916) 875-RAIN (7246)
City of Sacramento	(916) 264-5011
City of Citrus Heights	(916) 875-RAIN (7246)
City of Elk Grove	(916) 875-RAIN (7246)
City of Folsom	(916) 355-7230
City of Galt	(209) 366-7260

EMERGENCY ONLY	911

PAINT-A-DRAIN CAMPAIGN

Storm drain stenciling sends a clear "No Dumping" message

SACRAMENTO STORMWATER MANAGEMENT PROGRAM

Figure 2: Educational Brochure on Storm Drain Marking/Stenciling
Source: http://www.sactostormwater.org/documents/stencil_brochure_03.pdf

Table 1: Storm Drain Marking Guidance

- Enlist one person to serve as the team leader, and make sure he/she knows all marking rules and safety procedures.
- Review all safety procedures before marking.
- Marking should be performed by at least two people, so one can be on the lookout for oncoming vehicles. Safety vests and traffic cones can be used to alert vehicles.
- Remember to wear old cloths and shoes.
- Bring paper towels or a rag to wipe up and two trash bags – one for the wet stencil (when necessary), which is not garbage, and one to pick-up garbage along the way.
- Keep track of all storm drain stencils and turn this information over to the team leader or the appropriate local government agency.
- Do not mark any storm drains with vehicles parked nearby.
- Record the locations of any storm drains that have leaves, grass clippings, oil, or other pollutants.
- Properly dispose of all trash at the end of the day, and return all empty paint cans and supplies to the team leader.

Information adapted from the following sources:
http://www.deq.state.la.us/assistance/litter/stormdrain.htm
Storm Drain Stenciling: A Manual for Communities (GI-212) *developed by the Texas Natural Resource Conservation Commission*

Top Resources

Texas Natural Resource Conservation Commission's Storm Drain Stenciling: A Guide for Communities. This extensive guide includes information on how to get volunteers involved, guidelines and materials for marking, reviews of five marking programs, and sample recognition certificates, press releases, door hangers, and public service announcements.
http://www.tnrcc.state.tx.us/exec/sbea/education.html

The Urban Dweller's Guide To Watersheds
http://www.museumca.org/creeks/umbrella.html

University of Wisconsin-Extension Water Resources Program Storm Drain Stenciling Web Page
http://clean-water.uwex.edu/wav/stormdrain/index.htm

Earthwater Stencils Home Page
http://www.earthwater-stencils.com/

Storm Drain Stenciling Project Guidelines
http://www.epa.gov/adopt/patch/html/guidelines.html

The Ocean Conservancy's Storm Drain Sentries
http://www.oceanconservancy.org/site/PageServer?pagename=op_sentries

South Carolina Department of Health and Environmental Control's Water Watch Campaign: Conducting a Storm Drain Tagging Project
http://www.scdhec.net/water/pubs/wwtag2.pdf

Multilingual Storm Drain Stenciling GreenSpace Partners worked with local watershed groups and volunteers to stencil storm drains with messages in English, Somali and Spanish.
http://www.greeninstitute.org/GSP/programs/stormwater/stencils/stencils.html

North Carolina's Storm Drain Stenciling Project This project was piloted in 1994 along coastal NC watersheds and has received support from many state and national organizations and has received the "Take Pride in North Carolina" Award.
http://www.bae.ncsu.edu/bae/programs/extension/wqg/smp-18/stormdrain/

Chapter 6: Hotspot Pollution Prevention Practice Profile Sheets

This chapter presents profile sheets that describe 15 different pollution prevention practices that can be applied to storm water hotspots. The sheets are organized by the six common hotspot operations, and explain basic pollution prevention practices, along with key feasibility, implementation, and cost factors to consider. Extensive resources, references and websites are also listed where you can get more information on each pollution prevention practice. The pollution prevention practices profiled in this chapter include:

H-1	Hotspot Source Area: Vehicles **VEHICLE MAINTENANCE AND REPAIR**	

Description

Vehicle maintenance and repair operations can exert a significant impact on water quality by generating toxins such as solvents, waste oil, antifreeze, and other fluids. Often, vehicles that are wrecked or awaiting repair can be a storm water hotspot if leaking fluids are exposed to storm water runoff (Figure 1). Vehicle maintenance and repair can generate oil and grease, trace metals, hydrocarbons, and other toxic organic compounds. Table 1 summarizes a series of simple pollution prevention techniques for vehicle maintenance and repair operations that can prevent storm water contamination. You are encouraged to consult the Resources section of this sheet to get a more comprehensive review of pollution prevention practices for vehicle maintenance and repair operations.

Figure 1: Junkyard and Potential Source of Storm Water Pollution

Application

Pollution prevention practices should be applied to any facility that maintains or repairs vehicles in a subwatershed. Examples include car dealerships, body shops, service stations, quick lubes, school bus depots, trucking companies, and fleet maintenance operations at larger industrial, institutional, municipal or transport-related operations. Repair facilities are often clustered together, and are a major priority for subwatershed pollution prevention.

Table 1: Pollution Prevention Practices for Vehicle Maintenance and Repair Activities

- Avoid hosing down work or fueling areas
- Clean all spills immediately using dry cleaning techniques
- Collect used antifreeze, oil, grease, oil filters, cleaning solutions, solvents, batteries, hydraulic and transmission fluids and recycle with appropriate agencies
- Conduct all vehicle and equipment repairs indoors or under a cover (if done outdoors)
- Connect outdoor vehicle storage areas to a separate storm water collection system with an oil/grit separator that discharges to a dead holding tank, the sanitary sewer or a storm water treatment practice
- Designate a specific location for outdoor maintenance activities that is designed to prevent storm water pollution (paved, away from storm drains, and with storm water containment measures)
- Inspect the condition of all vehicles and equipment stored outdoors frequently
- Use a tarp, ground cloth, or drip pans beneath vehicles or equipment being repaired outdoors to capture all spills and drips
- Seal service bay concrete floors with an impervious material so cleanup can be done without using solvents. Do not wash service bays to outdoor storm drains
- Store cracked batteries in a covered secondary containment area until they can be disposed of properly
- Wash parts in a self-contained solvent sink rather than outdoors

Primary Training Targets

Owners, fleet operation managers, service managers, maintenance supervisors, mechanics and other employees are key targets for training.

Feasibility

Pollution prevention techniques for vehicle repair facilities broadly apply to all regions and climates. These techniques generally rely on changes to basic operating procedures, after an initial inspection of facility operations. The inspection relies on a standard operations checklist that can be completed in a few hours.

Implementation Considerations

Employee training is essential to successfully implement vehicle repair pollution prevention practices. The connection between the storm drain system and local streams should be emphasized so that employees understand why any fluids need to be properly disposed of. It is also important to understand the demographics of the work force; in some communities, it may require a multilingual education program.

Cost - Employee training is generally inexpensive, since training can be done using posters, pamphlets, or videos. Structural practices can vary based on what equipment is required. For instance, solvent sinks to clean parts can cost from $1,500 to $15,000, while spray cabinets may cost more than $50,000. In addition, proper recycling/disposal of used or spilled fluids usually requires outside contractors that may increase costs.

Resources

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs.
http://www.ecy.wa.gov/biblio/9914.html

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial.
http://www.cabmphandbooks.com/

Coordinating Committee For Automotive Repair (CCAR) Source: US EPA CCAR-*Green*Link®, the National Automotive Environmental Compliance Assistance Center CCAR-*Green*Link® Virtual Shop http://www.ccar-greenlink.org/

Auto Body Shops Pollution Prevention Guide. Peaks to Prairies Pollution Prevention Information Center.
http://peakstoprairies.org/p2bande/autobody/abguide/index.cfm

Massachusetts Office of Technical Assistance for Toxics Use Reduction (OTA). Crash Course for Compliance and Pollution Prevention Toolbox
http://www.state.ma.us/ota/pubs/toolfull.pdf

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities.
http://www.swrcb.ca.gov/stormwtr/murp.html

US EPA. Virtual Facility Regulatory Tour: Vehicle Maintenance. FedSite Federal Facilities Compliance Assistance Center.
http://permanent.access.gpo.gov/websites/epagov/www.epa.gov/fedsite/virtual.html

City of Santa Cruz. Best Management Practices for Vehicle Service Facilities (in English and Spanish).
http://www.ci.santa-cruz.ca.us/pw/pdf/vehiclebmp.pdf

City of Los Angeles Bilingual Poster of BMPs for Auto Repair Industry
http://www.lastormwater.org/downloads/PDFs/autopstr.pdf

H-2	Hotspot Source Area: Vehicles	
	VEHICLE FUELING	

Description

Spills at vehicle fueling operations have the potential to directly contribute oil, grease, and gasoline to storm water, and can be a significant source of lead, copper and zinc, and petroleum hydrocarbons. Delivery of pollutants to the storm drain can be sharply reduced by well-designed fueling areas and improved operational procedures. The risk of spills depends on whether the fueling area is covered and has secondary containment. The type, condition, and exposure of the fueling surface can also be important. Table 1 describes common pollution prevention practices for fueling operations.

Application

These practices can be applied to any facility that dispenses fuel. Examples include retail gas stations, bus depots, marinas, and fleet maintenance operations (Figure 1). In addition, these practices also apply to temporary above-ground fueling areas for construction and earthmoving equipment. Many fueling areas are usually present in urban subwatersheds, and they tend to be clustered along commercial and highway corridors. These hotspots are often a priority for subwatershed source control.

Figure 1: Covered Retail Gas Operation Without Containment for Potential Spills

Table 1: Pollution Prevention Practices For Fueling Operation Areas

- Maintain an updated spill prevention and response plan on premises of all fueling facilities (see Profile Sheet H-7)
- Cover fueling stations with a canopy or roof to prevent direct contact with rainfall
- Design fueling pads for large mobile equipment to prevent the run-on of storm water and collect any runoff in a dead-end sump
- Retrofit underground storage tanks with spill containment and overfill prevention systems
- Keep suitable cleanup materials on the premises to promptly clean up spills
- Install slotted inlets along the perimeter of the “downhill” side of fueling stations to collect fluids and connect the drain to a waste tank or storm water treatment practice. The collection system should have a shutoff valve to contain a large fuel spill event
- Locate storm drain inlets away from the immediate vicinity of the fueling area
- Clean fuel-dispensing areas with dry cleanup methods. Never wash down areas before dry clean up has been done. Ensure that wash water is collected and disposed of in the sanitary sewer system or approved storm water treatment practice
- Pave fueling stations with concrete rather than asphalt
- Protect above ground fuel tanks using a containment berm with an impervious floor of Portland cement. The containment berm should have enough capacity to contain 110% of the total tank volume
- Use fuel-dispensing nozzles with automatic shutoffs, if allowed
- Consider installing a perimeter sand filter to capture and treat any runoff produced by the station

Primary Training Targets

Training efforts should be targeted to owners, operators, attendants, and petroleum wholesalers.

Feasibility

Vehicle fueling pollution prevention practices apply to all geographic and climatic regions. The practices are relatively low-cost, except for structural measures that are installed during new construction or station remodeling.

Implementation Considerations

Fueling Area Covers - Fueling areas can be covered by installing an overhanging roof or canopy. Covers prevent exposure to rainfall and are a desirable amenity for retail fueling station customers. The area of the fueling cover should exceed the area where fuel is dispensed. All downspouts draining the cover or roof should be routed to prevent discharge across the fueling area. If large equipment makes it difficult to install covers or roofs, fueling islands should be designed to prevent storm water run-on through grading, and any runoff from the fueling area should be directed to a dead-end sump.

Surfaces - Fuel dispensing areas should be paved with concrete; the use of asphalt should be avoided, unless the surface is sealed with an impervious sealant. Concrete pads used in fuel dispensing areas should extend to the full length that the hose and nozzle assembly can be pulled, plus an additional foot.

Grading - Fuel dispensing areas should be graded with a slope that prevents ponding, and separated from the rest of the site by berms, dikes or other grade breaks that prevent run-on of urban runoff. The recommended grade for fuel dispensing areas is 2 - 4% (CSWQTF, 1997).

Cost - Costs to implement pollution prevention practices at fueling stations will vary, with many of the costs coming upfront during the design of a new fueling facility. Once a facility has implemented the recommended source control measures, ongoing maintenance costs should be low.

Resources

Best Management Practice Guide – Retail Gasoline Outlets. Prepared by Retail Gasoline Outlet Work Group.
http://www.swrcb.ca.gov/rwqcb4/html/programs/stormwater/la_ms4_tentative/RGO BMP Guide_03-97_.pdf

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs.
http://www.ecy.wa.gov/biblio/9914.html

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: New Development and Redevelopment.
http://www.cabmphandbooks.com/

City of Los Angeles, CA Best Management Practices for Gas Stations
http://www.lacity.org/SAN/wpd/downloads/PDFs/gasstation.pdf

City of Dana Point Stormwater Best Management Practices (BMPs) For Automotive Maintenance And Car Care
http://www.danapoint.org/water/WC-AUTOMOTIVE.pdf

Alachua County, FL Best Management Practices for Controlling Runoff from Gas Stations
http://environment.alachua-county.org/Natural_Resources/Water_Quality/Documents/Gas%20Stations.pdf

California Stormwater Regional Control Board Retail Gasoline Outlets: New Development Design Standards For Mitigation Of Storm Water Impacts
http://www.swrcb.ca.gov/rwqcb4/html/programs/stormwater/la_ms4_tentative/RGOpaper.pdf
http://www.swrcb.ca.gov/rwqcb4/html/programs/stormwater/la_ms4_tentative/RGOPaperSupplement_12-01_.pdf

Canadian Petroleum Products Institute Best Management Practices Stormwater Runoff from Petroleum Facilities
http://www.cppi.ca/tech/BMPstormwater.pdf

City of Monterey (CA). Posters of Gas Station BMPs.
http://www.monterey.org/publicworks/stormeduc.html

Pinole County, CA Typical Stormwater Violations Observed in Auto Facilities and Recommended Best Management Practices (BMPs)
http://www.ci.pinole.ca.us/publicworks/downloads/AutoStormwater.pdf

H-3	Hotspot Source Area: Vehicles	
	VEHICLE WASHING	

Description

Vehicle washing pollution prevention practices apply to many commercial, industrial, institutional, municipal and transport-related operations. Vehicle wash water may contain sediments, phosphorus, metals, oil and grease, and other pollutants that can degrade water quality. When vehicles are washed on impervious surfaces such as parking lots or industrial areas, dirty wash water can contaminate storm water that ends up in streams.

Application

Improved washing practices can be used at any facility that routinely washes vehicles. Examples include commercial car washes, bus depots, car dealerships, rental car companies, trucking companies, and fleet operations. In addition, washing dump trucks and other construction equipment can be a problem. Washing operations tend to be unevenly distributed within urban subwatersheds. Vehicle washing also occurs in neighborhoods, and techniques to keep wash water out of the storm drain system are discussed in the car washing profile sheet (N-11). Table 1 reviews some of the pollution prevention techniques available for hotspot vehicle washing operations.

Primary Training Targets

Owners, fleet managers, and employees of operations that include car washes are the primary training target.

Feasibility

Vehicle washing practices can be applied to all regions and climates. Vehicle washing tends to occur more frequently in summer months and in drier regions of the country. Sound vehicle washing practices are not always used at many sites because operators are reluctant to change traditional cleaning methods. In addition, the cost of specialized equipment to manage high volumes of wash water can be too expensive for small businesses.

Improved vehicle washing practices are relatively simple to implement and are very effective at preventing storm water contamination. Training is essential to get owners and employees to adopt these practices, and should be designed to overcome cultural and social barriers to improved washing practices.

Table 1: Pollution Prevention Practices for Vehicle Washing

- Wash vehicles at indoor car washes that recycle, treat or convey wash water to the sanitary sewer system
- Use biodegradable, phosphate-free, water-based soaps
- Use flow-restricted hose nozzles that automatically turn off when left unattended
- Wash vehicles on a permeable surface or a washpad that has a containment system
- Prohibit discharge of wash water into the storm drain system or ground by using temporary berms, storm drain covers, drain plugs or other containment system
- Label storm drains with “No Dumping” signs to deter disposal of wash water in the storm drain system
- Pressure and steam clean off-site to avoid runoff with high pollutant concentrations
- Obtain permission from sewage treatment facilities to discharge to the sanitary sewer

Implementation Considerations

The ideal practice is to wash all vehicles at commercial car washes or indoor facilities that are specially designed for washing operations. Table 2 offers some tips for indoor car wash sites. When washing operations are conducted outside, a designated wash area should having the following characteristics:

- Paved with an impervious surface, such as Portland cement concrete
- Bermed to contain wash water
- Sloped so that wash water is collected and discharged to the sanitary sewer system, holding tank or dead-end sump
- Operated by trained workers to confine washing operations to the designated wash area

Outdoor vehicle washing facilities should use pressurized hoses without detergents to remove most dirt and grime. If detergents are used, they should be phosphate-free to reduce nutrient loading. If acids, bases, metal brighteners, or degreasing agents are used, wash water should be discharged to a treatment facility, sanitary sewer, or a sump. In addition, waters from the pressure washing of engines and vehicle undercarriages must be disposed of using the same options.

Table 2: Tips for Indoor Car Wash Sites
(Adapted from U.S. EPA, 2003)

- Facilities should have designated areas for indoor vehicle washing where no other activities are performed (e.g. fluid changes or repair services)
- Indoor vehicle wash areas should have floor drains that receive only vehicle washing wastewater (not floor washdown or spill removal wash waters) and be connected to a holding tank with a gravity discharge pipe, to a sump that pumps to a holding tank, or to an oil/grit separator that discharges to a municipal sanitary sewer
- The floor of indoor vehicle wash bays should be completely bermed to collect wash water
- Aromatic and chlorinated hydrocarbon solvents should be eliminated from vehicle-washing operations
- Vehicle-washing operations should use vehicle rinsewater to create new wash water through the use of recycling systems that filter and remove grit.

Discharge to pervious areas may be an option for washing operations that generate small amounts of relatively clean wash water (water only - no soaps, no steam cleaning). The clean wash water should be directed as sheet flow across a vegetated area to infiltrate or evaporate before it enters the storm drain system. This option should be exercised with caution, especially in environmentally sensitive areas or protected groundwater recharge areas.

The best way to avoid stormwater contamination during washing operations is to drain the wash water to the sanitary sewer system. Operations that produce high volumes of wash water should consider installing systems that connect to the sewer. Other options for large and small operations include containment units to capture the wash water prior to transport away for proper disposal (Figure 1). If vehicles must be washed on an impervious surface, a storm drain filter should be used to capture solid contaminants.

Cost - The cost of using vehicle-washing practices can vary greatly and depends on the size of the operation (Table 3). The cost of constructing a commercial grade system connected to the sanitary sewer can exceed $100,000. Disposal fees and frequency of washing can also influence the cost. Training costs can be minimized by using educational

Figure 1: Containment System Preventing Wash Water from Entering the Storm Drain

materials available from local governments, professional associations or EPA's National Compliance Assistance Centers (http://www.assistancecenters.net/). Temporary, portable containment systems can be shared by several companies that cannot afford specialized equipment independently.

Table 3: Sample Equipment Costs for Vehicle Washing Practices

Item	Cost
Bubble Buster	$2,000 –2,500*
Catch basin insert	$65*
Containment mat	$480-5,840**
Storm drain cover (24" drain)	$120.00 **
Water dike/ berm (20 ft)	$100.00 **
Pump	$75-3,000**
Wastewater storage container	$50-1,000+**

*Source: *U.S. EPA, 1992 **Robinson, 2003*

Resources

EPA FedSite Virtual Facility Regulatory Tour, Vehicle Maintenance Facility Tour. Vehicle Washing - P2 Opportunities http://permanent.access.gpo.gov/websites/epagov/www.epa.gov/fedsite/virtual.html

Alachua County Pollution Prevention Fact Sheet: Best Management Practices for Controlling Runoff from Commercial Outdoor Car Washing. http://environment.alachua-county.org/Natural_Resources/Water_Quality/Documents/Commercial Outdoor Car Wash.pdf.

Kitsap County Sound Car Wash Program. http://www.kitsapgov.com/sswm/carwash.htm.

Washington Department of Ecology. 1995. Vehicle and Equipment Wash Water Discharges: Best Management Practices Manual. Olympia, Washington. http://www.ecy.wa.gov/pubs/95056.pdf

U.S. Environmental Protection Agency. Pollution Prevention/Good Housekeeping for Municipal Operations. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/poll_18.cfm

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial. http://www.cabmphandbooks.com/

H-4	Hotspot Source Area: Vehicles	
	VEHICLE STORAGE	

Description

Parking lots and vehicle storage areas can introduce sediment, metals, oil and grease, and trash into storm water runoff. Simple pavement sweeping, litter control, and storm water treatment practices can minimize pollutant export from these hotspots. Table 1 provides a list of simple pollution prevention practices intended to prevent or reduce the discharge of pollutants from parking and vehicle storage areas.

Application

Pollution prevention practices can be used at larger parking lots located within a subwatershed. Examples include regional malls, stadium lots, big box retail, airport parking, car dealerships, rental car companies, trucking companies, and fleet operations (Figure 1). The largest, most heavily used parking lots with vehicles in the poorest condition (e.g., older cars or wrecked vehicles) should be targeted first. This practice is also closely related to parking lot maintenance source controls, which are discussed in greater detail in profile sheet H-11.

Primary Training Targets

Owners, fleet operation managers, and property managers that maintain parking lots are key training targets.

Figure 1: Retail Parking Lot

Table 1: Pollution Prevention Practices for Parking Lot and Vehicle Storage Areas

Parking Lots

- Post signs to control litter and prevent patrons from changing automobile fluids in the parking lot (e.g., changing oil, adding transmission fluid, etc.)
- Pick up litter daily and provide trash receptacles to discourage littering
- Stencil or mark storm drain inlets with "No Dumping, Drains to _____" message
- Direct runoff to bioretention areas, vegetated swales, or sand filters
- Design landscape islands in parking areas to function as bioretention areas
- Disconnect rooftop drains that discharge to paved surfaces
- Use permeable pavement options for spillover parking (Profile sheet OS-11 in Manual 3)
- Inspect catch basins twice a year and remove accumulated sediments, as needed
- Vacuum or sweep large parking lots on a monthly basis, or more frequently
- Install parking lot retrofits such as bioretention, swales, infiltration trenches, and storm water filters (Profile sheets OS-7 through OS-10 in Manual 3)

Vehicle Storage Areas

- Do not store wrecked vehicles on lots unless runoff containment and treatment are provided
- Use drip pans or other spill containment measures for vehicles that will be parked for extended periods of time
- Use absorbent material to clean up automotive fluids from parking lots

Feasibility

Sweeping can be employed for parking lots that empty out on a regular basis. Mechanical sweepers can be used to remove small quantities of solids. Vacuum sweepers should be used on larger parking lot storage areas, since they are superior in picking up deposited pollutants (See Manual 9). Constraints for sweeping large parking lots include high annual costs, difficulty in controlling parking, and the inability of current sweeper technology to remove oil and grease. Proper disposal of swept materials might also represent a limitation.

Implementation Considerations

The design of parking lots and vehicle storage areas can greatly influence the ability to treat storm water runoff. Many parking areas are landscaped with small vegetative areas between parking rows for aesthetic reasons or to create a visual pattern for traffic flow. These landscaped areas can be modified to provide storm water treatment in the form of bioretention (Figure 2).

Figure 2: Parking Lot Island Turned Bioretention Area

Catch basin cleanouts are also an important practice in parking areas. Catch basins within the parking lot should be inspected at least twice a year and cleaned as necessary. Cleanouts can be done manually or by vacuum truck. The cleanout method selected depends on the number and size of the inlets present (see Manual 9).

Most communities have contractors that can be hired to clean out catch basins and vacuum sweep lots. Mechanical sweeping services are available, although the cost to purchase a new sweeper can exceed $200,000. Employee training regarding spill prevention for parking areas is generally low-cost and requires limited staff time.

Resources

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial
http://www.cabmphandbooks.com/

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs. WA Dept. of Ecology
http://www.ecy.wa.gov/biblio/9914.html

H-5	Hotspot Source Area: Outdoor Materials	
	LOADING AND UNLOADING	

Description

Outdoor loading and unloading normally takes place on docks or terminals at many commercial, industrial, institutional, and municipal operations. Materials spilled or leaked during this process can either be carried away in storm water runoff or washed off when the area is cleaned. As a result, many different pollutants can be introduced into the storm drain system, including sediment, nutrients, trash, organic material, trace metals, and an assortment of other pollutants. A number of simple and effective pollution prevention practices can be used at loading/unloading areas to prevent runoff contamination, as shown in Table 1.

Application

While nearly every commercial, industrial, institutional, municipal and transport-related site has a location where materials or products are shipped or received, the risk of storm water pollution is greatest for operations that transfer high volumes of material or liquids, or unload potentially hazardous materials. Some notable examples to look for in a subwatershed include distribution centers, grocery stores, building supply outlets, lawn and garden centers, petroleum wholesalers, warehouses, landfills, ports, solid waste facilities, and maintenance depots (Figure 1). Attention should also be paid to industrial operations that process bulk materials, and any operations regulated under industrial storm water NPDES permits.

Primary Training Targets

Owners, site managers, facility engineers, supervisors, and employees of operations with loading/unloading facilities are the primary training target.

Feasibility

Loading/unloading pollution prevention practices can be applied in all geographic and climatic regions, and work most effectively at preventing sediment, nutrients, toxic materials, and oil from coming into contact with storm water runoff or runon. Few impediments exist to using this practice, except for the cost to retrofit existing loading and unloading areas with covers or secondary containment.

Figure 1: Loading/Unloading Area of Warehouse

Table 1: Pollution Prevention Practices for Loading and Unloading Areas
• Avoid loading/unloading materials in the rain • Close adjacent storm drains during loading/unloading operations • Surround the loading/unloading area with berms or grading to prevent run-on or pooling of storm water. If possible, cover the area with a canopy or roof • Ensure that a trained employee is always present to handle and cleanup spills • Inspect the integrity of all containers before loading/unloading • Inspect equipment such as valves, pumps, flanges, and connections regularly for leaks, and repair as needed • Install an automatic shutoff valve to interrupt flow in the event of a catastrophic liquid spill • Install a high-level alarm on storage tanks to prevent overfilling • Pave the loading/unloading area with concrete rather than asphalt • Place drip pans or other temporary containment devices at locations where leaks or spills may occur, and always use pans when making and breaking connections • Position roof downspouts to direct storm water away from loading/unloading areas and into bioretention areas • Prepare and implement an Emergency Spill Cleanup Plan for the facility (see Profile Sheet H-7) • Sweep loading/unloading area surfaces frequently to remove material that could otherwise be washed off by storm water • Train all employees, especially fork lift operators, on basic pollution prevention practices and post signs • Use seals, overhangs, or door skirts on docks and terminals to prevent contact with rainwater

Implementation Considerations

Loading/unloading pollution prevention practices should be integrated into the overall storm water pollution prevention plan for a facility. Employee training should focus on proper techniques to transfer materials, using informational signs at loading docks and material handling sites and during routine safety meetings.

Cost - Costs to implement loading/unloading pollution prevention practices consist of one-time construction costs to retrofit new or existing loading areas, but annual maintenance costs are relatively low thereafter. Exceptions include industries that elect to use expensive air pressure or vacuum systems for loading/unloading facilities, which can also be expensive to maintain (U.S. EPA, 1992). Ongoing costs include employee training and periodic monitoring of loading/unloading activities.

Resources

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial.
http://www.cabmphandbooks.com/

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs. WA Dept. of Ecology 99-14
http://www.ecy.wa.gov/biblio/9914.html

Ventura County Flood Control District Clean Business Program Fact Sheet
http://www.vcstormwater.org/sheet-materials.htm

Business Best Management Practices Stormwater Bmp #3 - Shipping/Receiving/Loading Docks
http://www.cleancharles.org/stormwater_bmp3.shtml

City of Los Angeles, CA Reference Guide For Stormwater Best Management Practices
http://www.lastormwater.org/downloads/PDFs/bmp_refguide.pdf

H-6	Hotspot Source Area: Outdoor Materials	
	OUTDOOR STORAGE	

Description

Protecting outdoor storage areas is a simple and effective pollution prevention practice for many commercial, industrial, institutional, municipal, and transport-related operations. The underlying concept is to prevent runoff contamination by avoiding contact between outdoor materials and rainfall (or runoff). Unprotected outdoor storage areas can generate a wide range of storm water pollutants, such as sediment, nutrients, toxic materials, and oil and grease (Figure 1).

Materials can be protected by installing covers, secondary containment, and other structures to prevent accidental release. Outdoor storage areas can be protected on a temporary basis (tarps or plastic sheeting) or permanently through structural containment measures (such as roofs, buildings, or concrete berms). Table 1 summarizes pollution prevention practices available for outdoor storage areas.

Figure 1: Mulch Stored Outdoors at a Garden Center

Application

Many businesses store materials or products outdoors. The risk of storm water pollution is greatest for operations that store large quantities of liquids or bulk materials at sites that are connected to the storm drain system. Several notable operations include nurseries and garden centers, boat building/repair, auto recyclers/body shops, building supply outlets, landfills, ports, recycling centers, solid waste and composting facilities, highway maintenance depots, and power plants. Attention should also be paid to industrial operations that process bulk materials, which are often regulated under industrial storm water NPDES permits.

Primary Training Targets

Owners, site managers, facility engineers, supervisors, and employees of operations with loading/unloading facilities are the primary training target.

Feasibility

Outdoor storage protection can be widely applied in all regions and climate zones, and requires routine monitoring by employees. Most operations have used covering as the major practice to handle outdoor storage protection (U.S. EPA, 1999). The strategy is to design and maintain outdoor material storage areas so that they:

- Reduce exposure to storm water and prevent runon
- Use secondary containment to capture spills
- Can be regularly inspected
- Have an adequate spill response plan and cleanup equipment

Table 1: Pollution Prevention Practices for Protecting Outdoor Storage Areas
• Emphasize employee education regarding storage area maintenance • Keep an up-to-date inventory of materials stored outdoors, and try to minimize them • Store liquids in designated areas on an impervious surface with secondary containment • Inspect outdoor storage containers regularly to ensure that they are in good condition • Minimize storm water run-on by enclosing storage areas or building a berm around them • Slope containment areas to a drain with a positive control (lock, valve, or plug) that leads to the sanitary sewer (if permitted) or to a holding tank • Schedule regular pumping of holding tanks containing storm water collected from secondary containment areas

Implementation Considerations

Covers - The use of impermeable covers is an effective pollution prevention practice for non-hazardous materials. Covers can be as simple as plastic sheeting or tarps, or more elaborate roofs and canopies. Site layout, available space, affordability, and compatibility with the covered material all dictate the type of cover needed for a site. In addition, the cover should be compatible with local fire and building codes and OSHA workplace safety standards. Care should be taken to ensure that the cover fully protects the storage site and is firmly anchored into place.

Secondary Containment - Secondary containment is designed to contain possible spills of liquids and prevent storm water run-on from entering outdoor storage areas. Secondary containment structures vary in design, ranging from berms and drum holding areas to specially-designed solvent storage rooms (Figure 2).

Figure 2: Secondary Containment of Storage Drums Behind a Car Repair Shop

Secondary containment can be constructed from a variety of materials, such as concrete curbs, earthen berms, plastic tubs, or fiberglass or metal containers. The type of material used depends on the substance contained and its resistance to weathering. In general, secondary containment areas should be sized to hold 110% of the volume of the storage tank or container unless other containment sizing regulations apply (e.g., fire codes).

If secondary containment areas are uncovered, any water that accumulates must be collected in a sanitary sewer, a storm water treatment system, or a licensed disposal facility. Water quality monitoring may be needed to determine whether the water is contaminated and dictate the method of disposal. If the storm water is clean, or an on-site storm water treatment practice is used, a valve should be installed in the containment dike so that excess storm water can be drained out of the storage area and directed either to the storm drain (if clean) or into the storm water treatment system (if contaminated). The valve should always be kept closed except when storm water is drained, so that any spills that occur can be effectively contained. Local sewer authorities may not allow discharges from a large containment area into the sewer system, and permission must be obtained prior to discharge. If discharges to the sanitary sewer system are prohibited, containment should be provided, such as a holding tank that is regularly pumped out.

Employee training on outdoor storage pollution prevention should focus on the activities and site areas with the potential to pollute storm water and the proper techniques to manage material storage areas to prevent runoff contamination.

Training can be conducted through safety meetings and the posting of on-site informational signs. Employees should also know the on-site person who is trained in spill response.

Cost - Many storage protection practices are relatively inexpensive to install (Table 2). Actual costs depend on the size of the storage area and the nature of the pollution prevention practices. Other factors are whether practices are temporary or permanent and the type of materials used for covers and containment. Employee training can be done in connection with other safety training to reduce program costs. Training costs can also be reduced by using existing educational materials from local governments, professional associations or from EPA's National Compliance Assistance Centers (http://www.assistancecenters.net).

Table 2: Sample Equipment Costs for Outdoor Storage Protection

Storage Protection Device	Cost
Concrete Slab (6")	$3.50 to $5.00 per ft^2
Containment Pallets	$50 to $350 based on size and # of barrels to be stored
Storage buildings	$6 to $11 per ft^2
Tarps & Canopies	$25 to $500 depending on size of area to cover

Sources: Costs were derived from a review of Ferguson et al.*, 1997 and numerous websites that handle proprietary spill control or hazardous material control products*

Resources

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial. http://www.cabmphandbooks.com/

Rouge River National Wet Weather Demonstration Project. Wayne County, MI. http://www.rougeriver.com/geninfo/rougeproj.html

Storm Water Management Fact Sheet: Coverings. USEPA, Office of Water, http://www.epa.gov/owm/mtb/covs.pdf.

EPA Office of Wastewater Management Storm Water Management Fact Sheet: Coverings http://www.epa.gov/owm/mtb/covs.pdf

California Stormwater Quality Association Factsheet: Outdoor Storage of Raw Materials http://www.cabmphandbooks.com/Documents/Municipal/SC-33.pdf

Alameda Countywide Clean Water Program Outdoor Storage of Liquid Materials http://www.cleanwaterprogram.com/outdoor_stor_liquid_fact_sht.pdf

Washtenaw County, MI Community Partners for Clean Streams Fact Sheet Series #1: Housekeeping Practices http://www.ewashtenaw.org/content/dc_drnbmp1.pdf

H-7	Hotspot Source Area: Spills and Accidents	ATTENTION
	SPILL PREVENTION AND RESPONSE	Spill Clean-up Kit Located Here

Description

Spill prevention and response plans describe operational procedures to reduce spill risks and ensure that proper controls are in place when they do occur. Spill prevention plans standardize everyday procedures and rely heavily on employee training and education. The investment is a good one for most operations, since spill prevention plans reduce potential liability, fines and costs associated with spill cleanup. Table 1 provides some simple tips to prevent and respond to spills.

Application

A spill prevention and response plan is useful at any storm water hotspot operation, and is mandatory for any operation that uses, generates, produces, or transports hazardous materials, petroleum products or fertilizers. These operations are known as SARA 312 sites and are regulated by state environmental agencies. A list of SARA 312 sites within a subwatershed helps locate these potential storm water hotspots. In addition, all industrial sites regulated by individual or group NPDES storm water permits must have an updated spill prevention and response plan on-site. Lastly, spill containment and response plans should be prepared for major highways that cross the subwatershed, since truck and tanker accidents often represent the greatest potential spill risk in many communities (Figure 1).

Figure 1: Overturned, Leaking Tractor Trailer

Table 1: Pollution Prevention Practices for Spill Prevention and Response

- Develop a Spill Prevention Plan and ensure that employees are familiar with it and proper spill cleanup procedures
- Store and contain liquid materials to prevent the contents from entering the storm drain system, surface waters, or groundwater (see Profile Sheet H-7 on outdoor material storage)
- Store and maintain appropriate spill cleanup materials in a readily accessible location and strategically deploy them based on the type and quantities of chemicals present
- Schedule regular inspections for leaks and spills and replace storage containers as needed
- Label all containers according to their contents and potential hazards (e.g., solvent, gasoline)
- Clean up spills promptly and with as little water as possible; dispose of used cleanup materials properly
- Always treat cleanup materials used for hazardous substances as a hazardous waste
- Use absorbents, gels, and foams to cleanup chemical materials
- Report spills that pose an immediate threat to human health or the environment to the appropriate local agencies, such as the fire department

Primary Training Targets

The owner or operator, facility engineer, safety supervisor, and employees should receive annual training on spill prevention and response.

Feasibility

Spill prevention and response plans are recommended for storm water hotspots in every region and climate zone.

Implementation Considerations

Cleanup costs for a single 55-gallon drum that spills and reaches the storm drain have been estimated at 10 to 100 times its raw material value. A spill reponse and prevention plan is used to assess how pollutants are handled at the site and the pattern of storm water movement. The plan seeks to minimize the chance of accidental spills and ensure that proper safety and response measures are understood and applied (U.S. EPA, 1992). A good spill prevention and response plan includes five major components:

1. A Site Map and Evaluation of Past Spills and Leaks

A site map should provide the following information:

- A general description of the facility
- Owner's name and address
- Nature of the activities at the facility
- Types of chemicals used
- Location of chemical storage areas
- Location of the storm drains and water bodies
- Direction of the drainage away from the site
- Location of any structures or devices used to prevent spills leaving the site

2. An Inventory of Materials at the Site

A material inventory list should be created including the type of material, the location where it is stored, the type of container, its estimated volume, and whether a material safety data sheet is required. The inventory should also indicate what safeguards are currently in place to reduce the exposure of chemicals to storm water, provide insight as to spill risks, and help local authorities in the event of an emergency response (such as a fire).

3. Locations of Possible Spill Areas

It is important to identify potential spill areas, project potential spill volume, and determine the drainage paths in order to choose the most appropriate prevention, containment, and spill response practices. Areas at the site that can be most vulnerable to spills include the following:

- Areas for outdoor processing (H-4)
- Loading and unloading sites (H-5)
- Outdoor storage locations (H-6)
- Waste storage disposal (H-8)

Also, the spill potential should be assessed for stationary facilities, including manufacturing operations, warehouses, and service stations.

4. A List of Required Spill Response Equipment

The plan should document what kind of spill response equipment will be stored at the site, and contain clear and concise step-by-step instructions for their use.

5. Employee Training Needs

Effective and repeated employee training is essential to effectively implement this practice. Lack of employee motivation or training is considered the biggest weakness of most spill prevention plans. Employee training programs should be held annually to educate all personnel on the spill prevention plan. Spill prevention messages can be reinforced through signage and periodic inspections. The spill response training program should include detailed information on the following:

- The specific individuals responsible for implementing the plan
- Safety procedures for handling each kind of waste

- Current emergency contact numbers to notify appropriate authorities
- Step-by-step procedures to contain, divert, isolate, and clean up a spill
- Training in the use of spill response equipment, including safety procedures

Cost - Spill prevention and response plans are a good investment since they reduce the liability, cleanup costs and penalties. The costs to implement plans depend on the amount of employee training and cleanup equipment needed (which vary depending on the size of the facility); the containment needed; and the types of materials handled at the facility. The costs to inspect the site and write a plan range from $5,000 to as high as $20,000 for petroleum industries (IPAA, 2001). Costs to prepare plans at most other hotspots are much lower – about $4,000 to $7,000 (SWRCB, 1999). Annual costs to implement the plan are estimated to be less than $2,500, mostly for on-going training and spill response equipment. Table 2 shows some of the equipment costs related to spill response.

Table 2: Sample Equipment Costs for Spill Prevention and Response

Storage Protection Device	Cost
Absorbents	$2 to $35 for 25 lb. bag
Containment Pallets	$50 to $350, based on size and number of barrels to be stored
Industrial Spill Kits	$280 to $450, based on # of pads, booms, goggles, gloves, etc.

Sources: Costs were derived from a review of numerous websites that handle proprietary spill control or hazardous material control products

Resources

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial. www.cabmphandbooks.com

Setting Administrative Civil Liability. State Of California Regional Water Quality Control Board, San Francisco Bay Region. www.swrcb.ca.gov/rwqcb2/OrderNum/99-038.doc

Pollution Prevention Fact Sheet Sector: Printers/Lithographer: Spill Prevention. http://dep.state.ct.us/wst/p2/p2printer/spillpre.htm

EPA Office of Wastewater Management Storm Water Management Fact Sheet: Spill Prevention Planning http://www.epa.gov/owm/mtb/spillprv.pdf

Developing A Spill Prevention Response Plan http://www.dep.state.pa.us/dep/subject/pubs/water/wc/FS1471.doc

City of Rancho Santa Margarita Spill Prevention and Cleanup http://www.cityofrsm.org/civica/filebank/blobdload.asp?BlobID=1697

Land of Sky Regional Council Municipal Pollution Prevention Planning http://h2o.enr.state.nc.us/su/PDF_Files/Land_of_Sky_factsheets/FactSheet_5.pdf

Environmentally Responsible Best Management Practices Emergency Response and Spill Cleanup Plans http://www.cleanrivers-pdx.org/pdf/bmp04.pdf

City of Mitcham, Australia Emergency Spill Response Factsheet http://www.mitchamcouncil.sa.gov.au/webdata/resources/files/Emergency_Spil_Response_Plan1.pdf

H-8	Hotspot Source Area: Waste Management	
	DUMPSTER MANAGEMENT	

Description

Dumpsters provide temporary storage of solid wastes at many businesses. Most dumpsters are unregulated hotspots that can be a significant pollution source in many subwatersheds. Many dumpsters are open, which allows rainfall to mix with the wastes, creating a potent brew affectionately known as "dumpster juice." When combined with the inevitable spillage, dumpsters can be a source of trash, oil and grease, metals, bacteria, organic material, nutrients, and sediments. Poor dumpster management can make a site unsightly, create unpleasant odors, and attract rodents (Figure 1). Table 1 lists some common pollution prevention practices for dumpsters.

Application

Every business generates waste as a part of its daily operations and temporarily stores it pending disposal by an independent contractor. Nearly every hotspot site has a ubiquitous dumpster located somewhere behind the building. Several factors should be evaluated to determine whether an individual dumpster could be a pollution source. The first is whether the dumpster pad is directly connected to the storm drain system. The second factor is how frequently the dumpster is emptied. Frequently emptied dumpsters usually have more spillage and are open more often and exposed to rainfall. The last factor is the type and moisture content of wastes thrown in the dumpster, which can include trash, yard waste, building rubble, food, or other waste products.

Figure 1: Dumpster Site with Typical Signs of Poor Management (trash accumulation, dumpster without lid, dumpster near storm drain)

Good dumpster management is particularly important to reduce trash loadings to a stream. Several kinds of hotspots deserve scrutiny if they exist in a subwatershed, including dumpsters serving convenience stores, fast food restaurants, shopping centers, recycling centers, solid waste collection areas and hospitals. It may useful to target waste haulers as well, since the placement of temporary open dumpsters for demolition, remodeling and other construction purposes can be a problem in some subwatersheds.

Primary Training Targets

Key education targets are the managers and employees that use the dumpster.

Feasibility

Dumpster pollution prevention practices can be applied in all regions and climate zones.

Table 1: Pollution Prevention Practices for Dumpsters
• Locate dumpsters on a flat concrete surface that does not slope or drain to the storm drain system • Install a secondary containment system such as a berm or curb around the dumpster if it is connected to the storm drain • Install protective covers or lids to keep rainfall from accumulating in the dumpster or secondary containment area • Close lids at dumpsters located at vehicle service areas, fast food restaurants, and convenience stores • Install an oil and grease separator or sump pit for dumpsters that receive waste with a high moisture content • Place clear and visible signs on dumpsters indicating what kind of waste can be accepted • Never throw oil and grease or other liquids into a dumpster - provide alternative disposal locations for impermissible substances • Close and secure lids properly when the dumpster is not being loaded or unloaded • Empty dumpsters on a frequent basis to prevent overfilling or storage outside the dumpster • Repair leaking or damaged dumpsters immediately • Never use bleach and soap to clean the container unless the wash water is sent to the sanitary sewer system • Pick up and sweep trash and litter from around the dumpster regularly

Implementation Considerations

Dumpster pollution prevention practices can be hard to implement. Perhaps the greatest challenge is changing the mindset of employees about proper disposal techniques. Since dumpster practices require additional effort, owners need to train staff and inspect dumpsters more frequently. Lastly, dumpster practices that require liquids/oil and grease separation or secondary containment may be costly for many small businesses.

Target Areas for Education and Enforcement- Education and enforcement should be targeted to specific types of dumpsters that are known hotspots and/or have high potential for environmental contamination. These include:

- Foodservice dumpsters that produce waste with high moisture content and oil and grease that can be easily carried by storm water runoff (Figure 2)
- Automobile service dumpsters that can potentially produce a high volume of wastes, such as oil and grease, cleaning fluids, used parts, filters, and rags
- Industrial dumpsters that produce a high volume and variety of wastes
- Dumpsters with multiple contributors, such as multi-family units, and institutional facilities
- Temporary dumpster locations at small construction sites, demolition projects, and redevelopment projects

Figure 2: Restaurant Waste Barrels Without Secondary Containment

Routine Inspection - Dumpsters should be routinely inspected for the following problems:

- Cracks or dents in the dumpster that may permit storm water run-on
- Poorly functioning lids that cannot be closed or secured
- Hydraulic hoses with cracks or leaks (if applicable)
- Presence of impermissible substances in the container
- Liquid leaking from the container and/or signs of previous leakage, which are often indicated by stains or deposits on ground or storm drain inlets

Working with Solid Waste Disposal Contractor - Choosing a reliable and environmentally-conscious waste disposal contractor is important to prevent storm water contamination. Routine maintenance and emptying of the dumpster by the solid waste disposal contractor should be performed on a regular basis. If concerns about the condition of the dumpster or collection process arise (e.g. dumpster put in wrong location, dented corners, infrequent dumping, etc.), the service should be contacted immediately.

Cost - Proper dumpster management is a relatively inexpensive storm water pollution prevention practice and avoids the liability for spills and/or containment. Operational costs depend on the volume and type of waste, frequency of maintenance (e.g., replacing damaged containers), and whether additional protective measures need to be installed, such as secondary containment systems, canopies, and signs.

Operational costs are primarily related to training workers on proper dumpster management. Frequent training is needed to maintain compliance by workers, particularly in high turnover businesses.

Resources

California Stormwater BMP Handbook: Industrial and Commercial
http://www.cabmphandbooks.com/

Storm Water BMP #4. Solid Waste Containers (Dumpsters/Compactors)
http://www.cleancharles.org/stormwater_bmp4.shtml

North Central Texas Council of Governments (NCTCOG) Building Maintenance BMP Fact Sheet
http://www.dfwstormwater.com/P2/PDF/p2bldg_bmps.pdf

San Mateo Countywide Storm Water Pollution Prevention Program: Storm Water Best Management Practices for Supermarkets and Grocery Stores
http://www.flowstobay.org/pdfs/bmp/Food/grocery.pdf

Harvard University Stormwater Bmp: Solid Waste Container
http://www.uos.harvard.edu/ehs/env_sbmp4.shtml

California Stormwater Quality Association Factsheet: Waste Handling and Disposal
http://www.cabmphandbooks.com/Documents/Municipal/SC-75.pdf

City of Rancho Santa Margarita Waste Handling and Disposal
http://www.cityofrsm.org/civica/filebank/blobdload.asp?BlobID=1772

Stanford University SLAC Stormwater BMP Factsheet: Waste Handling and Disposal
http://www.slac.stanford.edu/esh/epr/Stormwater/BMP9.html

H-9	Hotspot Source Area: Physical Plant	
	BUILDING REPAIR AND REMODELING	

Description

Many building repair and remodeling operations are too small to be covered under local or state erosion and sediment control permits, but they can still generate pollution in the absence of good pollution prevention practices. Excavation, demolition, construction and finishing operations at a site can generate a range of pollutants that can be carried away by storm water runoff, including sediment, trash, metals, hydrocarbons and many other pollutants. Small construction sites are always somewhat messy, particularly during wet weather. Table 1 summarizes a series of simple pollution prevention practices that construction supervisors, contractors and workers can apply to reduce erosion at small building and remodeling sites.

Application

Over many decades, much of the building stock within a subwatershed is redeveloped, remodeled or demolished. The actual distribution of these small construction operations in a subwatershed is very hard to predict and even harder to control (Figure 1).

Primary Training Targets

The primary targets for training in this practice are general contractors, facility operators, construction supervisors, construction workers, and local erosion and sediment control inspectors.

Feasibility

Small construction sites are a challenge because they are temporary, mostly unregulated, and involve many different contractors and workers that may be resistant to change. Pollution prevention practices are required if the disturbed area exceeds one acre under the NPDES storm water permit program. (Note: Some states and municipalities have an even lower area threshold to trigger erosion and sediment control plans.)

Figure 1: Restaurant Remodeling

Table 1: Pollution Prevention Practices for Building Repair and Remodeling
• Store construction materials under cover where they are protected from rainfall and runoff • Temporarily block off any adjacent storm water inlets with sandbags • Lay tarps on outside of buildings to collect fallen debris and splatters • Police the site at the end of each day to pick up litter and make sure construction materials are properly stored • Make sure adequate dumpster capacity is available on-site to store rubble and construction debris and practice good dumpster management (see Profile Sheet H-8) • Segregate hazardous materials (e.g., lights, HVAC equipment, electrical equipment, asbestos) from construction debris and dispose of these properly • Never clean brushes or rinse paint or drywall containers into a street, gutter, storm drain or a stream • Secure bags of cement after they are opened, and keep windblown cement powder away from gutters and storm drains • Dispose of small amounts of dry concrete, grout and mortar in the dumpster • Remember that liquid residues of oil-based paints, thinners, solvents, glues and cleaning fluids are considered hazardous wastes, and must be disposed of properly • Contain, collect, and filter wash water from concrete operations. Dispose of wash water in the sanitary system, and dispose of filtered particles in the trash • Wash concrete mixers out in designated wash-out areas in the company yard, where wash water can flow to containment ponds or over dirt. At construction sites, recycle washout water by pumping it back into mixers for re-use. Recycle or properly dispose of concrete remaining in the chute. Never dispose of washout into streets, storm drains or ditches. • Recycle and reuse products such as paints, solvents, and building materials • Properly dispose of hazardous waste and other material that cannot be recycled • Train construction workers on the proper handling, storage, and disposal of construction material • Routinely inspect site for potential sources of storm water contamination • Protect storm drains with barriers such as berms when runoff cannot be prevented. Label storm drains with “No Dumping” signs to deter disposal of waste and washwater in the drain

Implementation Considerations

Outdoor Storage Area Protection – Construction materials and rubble/debris are often stored outside during building repair, remodeling or demolition. Since construction is temporary, outdoor storage practices (H-6) are often not practical. Consequently, this practice relies on temporary housekeeping and covering techniques to prevent runoff.

Hazardous Waste Handling and Disposal – Small construction and demolition sites can generate or accumulate a considerable volume of hazardous waste materials, including paints, pressure-treated wood, cleaning/refinishing chemicals, thermostats, lights, light switches, and other products with toxic components. The location of all hazardous material should be identified prior to demolition to reduce worker health risks and prevent storm water contamination. All construction workers should be trained on proper handling, storage and disposal procedures.

Contractor Accountability – Contractor and sub-contractor agreements should specifically stipulate who will be responsible for implementing and maintaining pollution prevention practices. On-site preconstruction meetings and spot inspections are often needed to ensure that the agreements are being followed.

Cost - Building repair and remodeling practices are relatively inexpensive to implement compared to other pollution prevention practices. Actual costs will vary depending on the size, type, and duration of the construction project. Least predictable are hazardous waste disposal fees, which can vary greatly by region and type of waste material. Local program costs

for training and site inspections are generally low if they are done through existing erosion and sediment control or safety training programs.

Resources

Alameda Countywide Clean Water Program: Building Maintenance and Remodeling
http://www.ci.alameda.ca.us/publicworks/pdf/bldgmaint.pdf

King County Storm Water Pollution Control Manual
http://dnr.metrokc.gov/wlr/dss/spcm.htm

Santa Clara Valley Urban Runoff Pollution Prevention Program
http://www.scvurppp.org

California Stormwater Quality Association. California Stormwater BMP Handbook: Industrial and Commercial
http://www.cabmphandbooks.com/

North Central Texas Council of Governments Building Maintenance BMP Fact Sheet
http://www.dfwstormwater.com/P2/PDF/p2bldg_bmps.pdf

California Stormwater Quality Association Factsheet: Building Repair and Construction
http://www.cabmphandbooks.com/Documents/Industrial/SC-42.pdf

Stanford University SLAC Stormwater BMP factsheet: Building Repair, Remodeling, and Construction
http://www.slac.stanford.edu/esh/epr/Stormwater/BMP12.html

Pierce County, WA Construction And Demolition Activities
http://www.co.pierce.wa.us/pc/services/home/environ/water/swm/sppman/a5.htm

H-10	Hotspot Source Area: Physical Plant	
	BUILDING MAINTENANCE	

Description

Many routine practices used to maintain the walls and rooftops of buildings can cause storm water pollution such as washing, power washing, sanding, sandblasting, painting, graffiti removal, and roof maintenance (Figure 1). Some building maintenance practices produce polluted wash water that can directly enter the storm drain system during dry weather, whereas others deposit fine particles or liquids that can wash off during wet weather (e.g., cleaners, paint, solvents or sealers). In either case, maintenance practices can cause sediment, metals, hydrocarbons, or other potentially toxic pollutants to enter the storm drain system. Table 1 summarizes simple pollution prevention practices that can be used by maintenance contractors to minimize the risk of storm water pollution during routine building maintenance.

Figure 1: Roof Maintenance

Application

Routine maintenance occurs at most buildings, but is performed most frequently at high-visibility retail, institutional, and industrial sites. Since maintenance is often conducted by small contractors that use specialized mobile equipment, the best approach is to directly educate and train contractors rather than individual property owners.

Primary Training Targets

The training targets for this practice are facility operators; maintenance crews; and washing, power-washing, sandblasting, and painting contractors.

Feasibility

Since most maintenance contractors are small businesses, it can be hard to assemble them for pollution prevention training.

Implementation Considerations

While these pollution prevention practices primarily rely on simple good housekeeping, they can be hard to implement if either the property manager or contractor lacks awareness about the environmental consequences of building maintenance operations. Municipalities and industries can help promote broader use by specifying precise pollution prevention practices when they negotiate maintenance contracts or work orders.

Cost - Presumed to be minimal, with the exception of storm drain covers or containment devices.

Table 1: Pollution Prevention Practices for Building Maintenance
• Enclose painting and sanding operations, where possible or required by air quality regulations • Lay tarps below outside work areas to collect fine particles and splatters • Sweep up paved surfaces immediately after scraping, stripping, sanding or sandblasting operations are completed. Do not use blowers or hoses • Block adjacent storm drains when stripping or cleaning buildings with high-pressure water (Figure 2), and contain and collect wash water for disposal in the sanitary sewer or other appropriate disposal method. Filtering wash water at the storm drain inlet may be acceptable if no soaps are used • Direct runoff from pressure washing operations over grassy areas or to a bermed area where it can be collected for disposal in the sanitary sewer • Never clean paintbrushes, sprayers or containers in a manner where rinse water can reach a curb, gutter, storm drain or stream • When cleaning up after using water-based paints, first paint out the brushes as much as possible, then rinse in a sink. Empty cans, brushes and rags should be disposed in the trash • When cleaning up after using oil-based paints, paint out the brushes as much as possible, then filter and reuse thinners and solvents. Treat excess liquids as a hazardous waste and dispose of accordingly • Purchase paints, sealants and finishes that have low environmental risk • Prevent discharge of wash water to the storm drain system or ground • Label storm drains with “No Dumping” signs to deter disposal of waste and washwater

Resources

California Stormwater BMP Handbook: Industrial and Commercial
http://www.cabmphandbooks.com

North Central Texas Council of Governments. Building Maintenance Pollution Prevention BMPs
http://www.dfwstormwater.com/P2/PDF/p2bldg_bmps.pdf

Ventura Countywide Stormwater Quality Management Program. Clean Business Program Fact Sheet: Building Maintenance and Grounds Maintenance
http://www.vcstormwater.org/

Washtenaw County, MI Community Partners for Clean Streams Fact Sheet SERIES #4: Maintaining Buildings and Pavement
http://www.ewashtenaw.org

Figure 2: Storm Drain Cover Used when Washing with Soaps

Pierce County, WA Cleaning And Washing Activities
http://www.co.pierce.wa.us/pc/services/home/environ/water/swm/sppman/a1.htm#a15

City of Rancho Santa Margarita Building Maintenance
http://www.cityofrsm.org/civica/filebank/blobdload.asp?BlobID=1684

H-11	Hotspot Source Area: Physical Plant	
	PARKING LOT MAINTENANCE	

Description

Parking lots are associated with nearly every commercial, industrial, institutional, municipal and transport-related operation in a subwatershed. Each lot requires annual maintenance, including litter pickup, sweeping, pothole repair, power-washing, steam cleaning, de-greasing, re-striping, and re-surfacing. Several maintenance operations have the potential to pollute storm water runoff if sensible pollution prevention practices are not employed. This is particularly true for power washing, which can deliver sediment, nutrients, hydrocarbons, and other pollutants to the storm drain system. Less is known about the storm water impacts of parking lot re-sealing and re-surfacing operations, but anecdotal data suggests that they could be a significant source of polycyclic aromatic hydrocarbons under certain conditions.

Application

In general, power washing and steam cleaning are conducted more frequently at commercial and retail parking lots in high visibility locations, airport runways and some industrial parking lots. When evaluating these operations, it is helpful to interview mobile vendors about the kinds of parking lots they maintain most often. Several factors help determine whether this pollution prevention practice should be applied to a parking lot, including the size and usage of the lot, the pavement condition, and whether it is directly connected to the storm drain system.

Primary Training Targets

Training targets include property managers; facility engineers; and sweeping, steam cleaning, power-washing, asphalt re-surfacing, and sealing contractors.

Table 1: Pollution Prevention Practices for Parking Lot Maintenance

- Use dry methods such as absorbents, brooms, or wire brushes to clean pavement surfaces where possible
- Mechanically remove loose debris before washing or power washing the lot
- Pressure wash pavement only when needed, and avoid using acids, soaps, solvents and other cleaning agents. Also, block adjacent storm drains, contain and collect wash water for disposal in the sanitary sewer or other appropriate disposal method
- Filtering of wash water at the storm drain inlet may be acceptable if no soaps are used. Direct runoff from pressure washing operations over a grassy area or to a bermed area where it can be collected for disposal in the sanitary sewer system
- Cover and seal nearby storm drain inlets and manholes before applying sealant to parking lot surfaces, and only apply sealants when no precipitation is forecast
- Conduct surface repair work during dry weather, where possible
- Post signs in parking areas to control litter and prohibit automobile maintenance or washing in the parking lot
- Inspect and cleanout catch basins and storm water treatment practices routinely to remove sediment and pollutants (see Manual 9)

Feasibility

Parking lot maintenance practices can be applied in all regions of the country, and sweeping and power washing are commonly used for aesthetic reasons in many large parking areas. Many facilities contract out their parking lot maintenance work to small businesses, such as mobile washers and sweeping companies. These contractors should be the primary target of training and education on parking lot pollution prevention practices.

Changing the mindset of contractual maintenance employees and facility managers can be a challenge to implementing this practice, so some communities have included specific language in their storm water ordinances regulating pavement cleaning to prevent discharges to the storm drain.

Implementation Considerations

Parking lot pollution prevention focuses mainly on two maintenance practices: power washing and sweeping. Dry cleanup of parking lots is preferred to any wash down activity, since washing can introduce oils and heavy metals into the storm drain system (Figure 1). For small and medium-sized lots, dry cleanup can be done using a broom, or a mop and a bucket of warm water (which is disposed of in the sanitary sewer). Larger lots can be cleaned using sweeper technologies (see Manual 9). The frequency of parking lot sweeping should be based on usage and field observations of waste accumulation.

Figure 1: Parking Lot Power Washing

Cost - Parking lot pollution prevention is generally a low-cost practice, focused on simple operational changes to reduce discharges to the storm drain system. The main cost associated with this practice is employee training.

Resources

Alameda Countywide, CA Clean Water Program: Parking Lots
http://www.cleanwaterprogram.com/parking_lots_fact_sht.pdf

Fort Worth, TX Mobile Commercial Cosmetic Cleaning Fact Sheet for Power Washers
http://www.fortworthgov.org/DEM/factsheet.htm

City of Carlsbad, CA Best Management Practices for Power Washing
http://www.ci.carlsbad.ca.us/stormwater/comstormpdf/mobilewashing.pdf

North Central Texas Council of Governments Building Maintenance BMP Fact Sheet
http://www.dfwstormwater.com/P2/PDF/p2bldg_bmps.pdf

H-12	Hotspot Source Area: Turf and Landscaping	
	TURF MANAGEMENT	

Description

Many non-residential areas in a subwatershed have significant areas of intensively managed turf. Examples include road and utility rights-of-way, schools, ball fields, parks, corporate office parks and the grounds of large institutions, each of which has a different turf management regime (Figure 1). Turf management involves mowing, fertilization, pesticide application, and supplemental irrigation, where needed. These services are generally performed by a lawn care/landscaping contractor or an in-house maintenance crew. Poor turf management practices have the potential to create storm water pollution, particularly in urban areas where soils are compacted. Potential pollutants generated by poor turf management include nutrients, herbicides, organic carbon and sediment. In addition, poor irrigation practices can produce nuisance water in some subwatersheds.

Table 1 summarizes a series of simple pollution prevention practices for turf management to reduce this potential pollution source. Turf management practices are implemented by educating, training and certifying workers in the lawn care industry.

Figure 1: Extensive Turf Areas Commonly Found in Schoolyards

Application

The typical distribution of turf cover in three Mid-Atlantic states is shown in Table 2. As can be seen, home lawns constitute 67% of the total turf cover. Pollution prevention practices for residential lawns are described in profile sheets N-1 through N-8. Non-residential turf comprises about a third of the total turf cover (although the exact percentage will vary from subwatershed to subwatershed).

Municipal turf accounts for about two-thirds of non-residential turf, and includes roadside rights-of-way, public open space, parks and schools. Institutional turf, commercial turf and golf courses each represent about 10% of non-residential turf. With the exception of airports and sod farms, turf cover is generally rare at most industrial sites.

In terms of the intensity of turf management, golf courses, institutions, and corporate office parks usually receive the highest inputs of water, fertilizer, and pesticides. Turf management on municipal lands tends to be fairly modest, with the exception of athletic fields at schools and some park settings. Highway and power line rights-of-way are seldom fertilized or irrigated, although they are increasingly sprayed with herbicides to limit vegetative growth in places that cannot be safely or conveniently mowed. Recent research has linked roadway and utility herbicide use to the presence of atrazine and simazine in urban streams. These herbicides were detected in streams where they were used to control vegetation in rights-of-way, but were not available to residential homeowners for retail sale (USGS, 1999).

Table 1: Pollution Prevention for Turf Management
• Evaluate whether some or all of the turf area can be managed as meadow or forest. If so, consider watershed reforestation techniques (see Manual 7) • Sweep any grass clippings away from paved surfaces after mowing • Use mulching type mowers to return grass clippings to the lawn • Never apply fertilizers or pesticides within five feet of pavement, 25 feet of a storm drain inlet, or 50 feet of a stream or water body • Consider a low or no fertilizer approach to maintain turf • Select a reputable lawn care or landscape service that uses organic fertilizers and natural pest management techniques • Perform a soil test to determine actual fertilization need and set application rates • Calibrate fertilizer spreaders to avoid excessive application. Do not apply fertilizer just prior to predicted rainfall events or on wet turf • Do not prepare herbicides or pesticides for application near storm drains • Minimize off-target application of fertilizers, and leave a no-application zone for fertilizer and pesticides around streams and lakes • Work fertilizers into the soil rather than just applying onto the surface • Reduce water needs during the hot summer months by adjusting grass to an increased height • Consider turf alternatives, such as native or low-water, cool-season turf grasses • Select grass species that will best meet the requirements and purposes of the lawn area • Use synthetic turf for small, lightly used and inaccessible areas that require no watering, chemicals, or mowing

Primary Training Targets

The training targets for this practice include property managers; landscaping contractors; golf course managers; and road, park, and utility maintenance crews and supervisors.

Table 2: Distribution of Turf Cover by Sector in Three Mid-Atlantic States

Sector	% of Total Turf Cover
Home Lawns	67
Roadside Rights-of-Way	10
Municipal Open Space	7
Parks	3.5
Schools	3
Commercial/Corporate	3
Institutions	3
Golf Courses	2.5
Airports/Sod Farms	1
Source: Schueler, 2003	

Feasibility

Turf grass management practices vary regionally, in response to different growing seasons, rainfall amounts and soil types. As Swann (1999) notes, arid and semi-arid areas rely heavily on supplemental irrigation, whereas the practice is less common in humid regions. Herbicide use tends to be greater in northern regions, while outdoor insecticide use is greatest in southern regions. To reduce the quantity of products used to manage turf, consult the local cooperative extension service for advice on the most appropriate grass species depending on its intended use.

A second key feasibility factor is the nature of the local lawn care industry. In many regions, it tends to be a low-wage, seasonal industry that employs young workers. These workers often have limited education, may not speak English, and have high turnover rates. As a result, education programs targeted toward the industry need to be simple, multi-lingual, and frequently repeated.

Implementation Considerations

In general, healthy and attractive turf is produced by good pollution prevention practices. A number of factors influence turf health, which can be stressed by mowing activity. Mowing grass too short causes turf to become less tolerant of environmental stresses, more disease-prone and more reliant on pesticides, fertilizers and irrigation. Mowing only a third of the grass blade height during cooler times of the day can minimize turf stress. Areas where soil is compacted may require aeration or soil amendments in order to increase permeability.

Equipment modifications may also be necessary to reduce environmental impacts. Fertilizer application equipment should be calibrated frequently (see the Resources section for more tips). Granular spreaders need to be calibrated for each product, since each fertilizer requires a different spreader setting to provide the desired rate of fertilizer. Liquid fertilizers should be applied using coarse droplet nozzles with a close/tight spray pattern at the lowest pumping pressure to avoid drift onto non-turf areas.

Professional training is extremely important to successfully implement turf management practices. Lawn care company employees can be trained on the proper calibration, use, and application techniques for the equipment they will use. Local governments have found that certification classes and promotional tie-ins can promote changes in the practice of professional landscape and lawn care companies. Examples include training, certification, and recognition programs for environmentally sensitive golf course management (See Profile Sheet H-15 for resources designed specifically for golf course managers).

Educating lawn care professionals on turf pollution prevention practices is an excellent way to improve local water quality. Messages to highlight in any education program include:

- Local information on proper timing and application rates for fertilizers and pesticides
- Registration and permit requirements for professional landscaping and lawn care service companies
- Recommended management practices and guidelines for reducing maintained turf area

Cost - Costs consist largely of program efforts for training and education, with only small operational costs to implement turf management practices. It is often reasonable to assume that operational savings from reduced fertilizer and herbicide inputs will offset any increased costs for more intensive practices, such as manual weed removal. Replacement of turf areas should also reduce mowing costs. A study in North Marin County, CA compared traditionally landscaped projects to projects that met specific design criteria for water conservation. The study found that when costs for water, labor, fertilizer, fuel, and herbicide were considered, annual savings of $75 per dwelling unit were realized for the water-conserving projects (Iwata, 1994). Water-conserving landscapes averaged 55% less turf area; used 54% less water; and saved 25% in labor costs, 61% in fertilizer, 44% in fuel, and 22% in herbicides, with a overall total of 10% less landscaped area.

Resources

California Stormwater BMP Handbook: Industrial and Commercial.
http://www.cabmphandbooks.com/

Xeriscape: Winning the Turf War Over Water
http://hem.dis.anl.gov/eehem/94/940711.html

University of Florida Cooperative Extension How to Calibrate a Fertilizer Spreader
http://turf.ufl.edu/residential/fertspreader.htm

Turf and Landscape Irrigation Best Management Practices. Prepared by the Water Management Committee of The Irrigation Association
http://www.irrigation.org/gov/default.aspx?r=1&pg=bmps.htm

Health Dangers of Urban Use of Pesticides Working Group. Sustainable Municipal Turf Management. Region of Ottawa-Carleton, Ontario Canada
http://www.sankey.ws/ipm.html

US EPA. Integrated Pest Management (IPM) in Schools
http://www.epa.gov/pesticides/ipm/

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities.
http://www.swrcb.ca.gov/stormwtr/murp.html

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs. WA Dept. of Ecology, Olympia, WA.
http://www.ecy.wa.gov/biblio/9914.html

Landscaping for Stormwater Management
http://www.dep.state.fl.us/law/Documents/Grants/CMP/pdf/stormwatermems.pdf

St. Johns River Water Management District Florida Landscaping to Promote Water Conservation Using the Principles of Xeriscape
http://sjr.state.fl.us/programs/outreach/conservation/landscape/toc.html

H-13	Hotspot Source Area: Turf and Landscaping	
	LANDSCAPING/GROUNDS CARE	

Description

Landscaping is a common feature in commercial, industrial and municipal settings, and typically involves maintaining beds of trees, shrubs, ground covers and/or flowers that are intended to meet unique landscaping objectives for a site (Figure 1). Once installed, landscaping beds are maintained seasonally to renovate, mulch, weed, and prune; pick up leaves and trash; inspect and repair irrigation systems; and apply fertilizers and pesticides, as needed. A well-designed and maintained landscaping bed absorbs rainfall, produces little runoff and discharges few pollutants. In some cases, landscaping can serve as an attractive on-site storm water retrofit.

However, landscaping can be a source of storm water pollutants at many sites, particularly if it drains to adjacent impervious areas. Poor landscaping practices can generate organic wastes; excess irrigation water, nutrients, and pesticides; organic carbon; and sediment loads to the storm drain system.

Figure 1: Landscaped Area at a Commercial Development

A series of simple pollution prevention practices, profiled in Table 1, can greatly reduce the potential for storm water pollution during routine landscape maintenance operations. Most landscaping maintenance is performed by contractors or in-house maintenance crews. Improved practices are generally adopted by educating, training, and certifying workers and supervisors within the landscaping and lawn care industry.

Application

Landscaping is a significant component of commercial land use, particularly in communities that have ordinances requiring landscaping on as much as 5-10% of commercial sites. Institutional lands such as colleges, private schools, and churches may also have a high percentage of landscaping. The best pollution prevention opportunities will be found at larger commercial and institutional sites in most subwatersheds.

Primary Training Targets

Property managers, lawn care and landscaping contractors, and municipal landscaping crews are the major training targets for this practice. These groups can be targeted for business recognition, certification or training programs. Since they are often responsible for turf management (H-12), outreach efforts should be integrated.

Table 1: Pollution Prevention for Landscaping and Grounds Care

Landscape Management

- Collect landscape waste and dispose at a local municipal yard waste recycling/composting facility
- Cover exposed beds and soils with mulch to minimize erosion and runoff
- Use manual and/or mechanical methods to remove weeds rather than herbicides
- Select a reputable landscaping company that uses native plants, organic fertilizers and natural pest management techniques
- Never apply fertilizers or pesticides within five feet of pavement, 25 feet of a storm drain inlet or 50 feet of a stream or water body
- Do not use leaf blowers to blow waste into streets, storm drains, or ditches
- Sweep up any organic matter from paved surfaces after landscaping operations
- Evaluate whether storm water can be directed into the landscaping bed to obtain further treatment. If installing a new landscaping bed, consider designing as a bioretention area or rain garden (see Manual 3)

Pesticides

- Develop and implement an integrated pest management plan that uses pesticides only as a last resort
- Apply pesticides when rain is **not** expected and when wind speeds are low
- Use the minimum amount needed for the job, employ techniques to curtail spray drift of pesticides and never mix or prepare pesticides within 25 feet of storm drains
- Consider a low or no pesticide approach to maintain landscaping areas

Irrigation

- Employ shutoff devices to prevent irrigation after precipitation or if a pressure drop occurs due to broken sprinkler heads or lines
- Design irrigation systems specific to each landscaped area's water requirements and make irrigation plans consistent with local water conservation resolutions
- Select native plant species whenever possible and group together plants with similar water requirements in order to reduce excess irrigation

Feasibility

Landscaping practices vary regionally, in response to different growing seasons, winter temperatures, rainfall depths and soil types. This, in turn, influences the type and availability of native plant species that can be used. The local cooperative extension service should be consulted on effective local practices for your region.

A second key feasibility factor is the nature of the local landscaping industry, which tends to employ younger, low-wage, seasonal workers. Landscaping workers often have limited education, may not speak English and change jobs frequently. As a result, education programs targeted toward landscaping contractors need to be simple, multilingual, and repeated every year.

Implementation Considerations

Landscape Management - Landscape management starts with the right soil conditions for planting. An adequate topsoil layer contains at least 8 - 10% organic matter to provide a growing medium. Soil amendments may be needed to reduce soil compaction and improve permeability. Plant material that is adapted to the local climate and soil type should be selected, and native plants should be the first choice.

Integrated Pest Management (IPM) - This approach uses environmentally-friendly measures to control pests at an acceptable level. IPM plans follow five basic steps to identify pest controls with minimal environmental impacts that maintain healthy landscaping.

The basic steps are to:

1. Identify problem pests and their life cycles. Any pest control used should be conducted at the life stage when the pest is most vulnerable
2. Establish tolerance thresholds for pests
3. Monitor pest problems and modify current landscaping practices to discourage pests
4. Use non-chemical (cultural, physical, mechanical, or biological) controls first; if pests exceed the tolerance thresholds, select the least toxic chemical pesticides available
5. Evaluate and record the effectiveness of pest controls and modify as needed to prevent recurrence

Irrigation – Over-watering can produce runoff that contains a variety of pollutants. An efficiently watered landscape avoids unwanted runoff, conserves water and saves money. The amount of irrigation needed depends on the rooting depth of the plant species, the available water-holding capacity of the soil, and the efficiency of the irrigation system. One method to reduce over-watering is to conduct a water audit to monitor water usage in landscaping, and design the most efficient use of irrigation water. A water audit evaluates three types of site data:

- Water-use history
- Information on the landscaped area (size, plant species, etc.)
- Evapotranspiration data from a local weather station to get a reasonable estimate of the amount of water a site *should* be using

Next, the existing irrigation system is inspected to check valve performance, pressure, flow rates, and coverage patterns. This information helps design a more efficient irrigation system and watering schedule for the landscaping area.

Automated irrigation technology can also improve irrigation efficiency and conserve water. For example, automated irrigation controllers are available, which communicate directly with weather stations to get local weather data to optimize irrigation scheduling. A study in California found that using an automated controller saved 37 gallons of water per day per 1,200 ft^2 of landscaped area (Meeks, 2002).

Delivery Mechanism(s) to Make Projects Happen

A wide range of educational materials is available to promote better pollution prevention practices in the landscaping industry. Materials can include brochures, posters, training courses, and online homestudy courses. In addition, several communities have designed programs to train and certify landscape maintenance contractors. In order to be certified, landscape contractors typically attend training classes on efficient landscaping practices, including non-point source pollution reduction, water efficiency, integrated pest management, and green waste reduction. Commercial contractors use the certification as a marketing tool to attract customers that want an environmental approach to landscape maintenance.

Cost – The costs to implement landscaping pollution prevention practices primarily involve training and education. Operational costs for changing current landscaping practices are generally quite low.

Resources

California Stormwater BMP Handbook: Industrial and Commercial
http://www.cabmphandbooks.com/

Turf and Landscape Irrigation Best Management Practices. Prepared by the Water Management Committee of The Irrigation Association
http://www.irrigation.org/gov/default.aspx?r=1&pg=bmps.htm

Integrated Pest Management (IPM) in Schools
http://www.epa.gov/pesticides/ipm/

Florida Yards and Neighborhoods Program
http://hort.ifas.ufl.edu/fyn

Washington State Department of Ecology Water Quality Program. Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs. WA Dept. of Ecology
http://www.ecy.wa.gov/biblio/9914.html

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities
http://www.swrcb.ca.gov/stormwtr/murp.html

H-14	Hotspot Source Area: Miscellaneous Sources	
	SWIMMING POOL DISCHARGES	

Description

Routine swimming pool maintenance can cause chlorinated water or filter backflush water to be discharged to the storm drain or stream, which can be toxic to aquatic life. Municipal and commercially-owned pools can be a major source of chlorinated water, as they hold as much as 100,000 gallons of water with an initial chlorine concentration of two to four parts per million (Figure 1). When exposed to sunlight, chlorine levels break down over several days. Consequently, holding water in the pool for several days prior to proper discharge is the core of this pollution prevention practice. Most states and localities require that larger pools discharge to the sanitary sewer system, and have appropriate pre-treatment and NPDES permits. Table 1 describes other pollution prevention practices for swimming pool discharges.

Application

The density of swimming pools can be ascertained by inspecting low-altitude aerial photographs or consulting local health department databases. If pool density appears to be high in the subwatershed, then it may be worth checking out local plumbing codes and practices that relate to public and private swimming pool discharges.

Primary Training Target

The primary training targets are pool managers that operate municipal and commercially-owned pools and local pool inspectors.

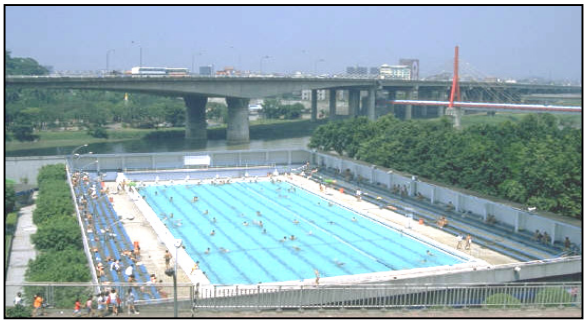


Figure 1: Large Municipal Pool

Table 1: Pollution Prevention Practices for Swimming Pool Discharges

The best option for discharging chlorinated water drained from pools is the sanitary sewer (i.e., sewage treatment plant). If discharge to a sanitary sewer is not possible, chlorinated water from pools and hot tubs may be discharged over lawns or pervious areas when the following provisions are met:

- Shut off the chlorination system or stop adding chlorine one week before disposing of pool water
- Make sure the pH of pool discharge is between 6.5 and 8.5
- Chlorine levels should not exceed 0.01 ppm for pool water discharges
- Discharge or spread pool water where it will not flow into a stream, storm sewer, or someone else's property
- Pool discharges should be handled in a manner that will prevent nuisance conditions (e.g., odors and mosquito-breeding conditions). Avoid ponding water for prolonged periods

Extra care must be taken when disposing of water resulting from backflushing of pool filters. It should be discharged to the sanitary sewer, septic tank system, or a seepage pit.

Feasibility

This practice applies to all pool owners and operators. Outdoor pool density tends to be greater in warmer regions, although the discharge problem may be more severe in cooler climates where swimming pools are drained at the end of the season to prevent damage from freezing. While this pollution prevention practice is easily implemented at municipally-owned pools, proper discharge of chlorinated pool water may be harder to control at privately-owned pools.

Implementation Considerations

This pollution prevention practice is implemented through a combination of education, enforcement, and inspection. Education can be achieved through pamphlets and posters targeted to pool managers that operate municipal, neighborhood and commercially-owned pools. End-of-season inspections are also helpful, and may be done in conjunction with routine safety and health inspections required by local authorities. The educational message to pool owners and commercial pool cleaners should clearly emphasize the impact of chlorinated pool water on aquatic life.

Cost – Swimming pool discharge pollution prevention practices are generally low cost and primarily involve staff time for inspections and education of pool managers and employees.

Resources

2003 California Stormwater BMP Handbook: Municipal
http://www.cabmphandbooks.com

Water Quality Permit Program: Guidance for Swimming Pool and Hot Tub Discharges
http://www.deq.state.or.us/wq/wqpermit/swimpools.pdf

National Menu of Best Management Practices for Storm Water Phase II: Alternative Discharge Options for Chlorinated Water
http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/menu.cfm

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs. WA Dept. of Ecology, Olympia, WA.
http://www.ecy.wa.gov/biblio/9914.html

H-15	Hotspot Source Area: Miscellaneous Sources
	UNIQUE HOTSPOT OPERATIONS

Certain unique hotspot operations require customized pollution prevention practices. Examples of unique hotspot operations include construction sites, marinas, hobby farms, golf courses, fairgrounds, racetracks, and restaurants. Each type of hotspot has its own mix of pollution prevention practices, which are described in the Resources sections of this sheet.

CONSTRUCTION

Construction sites have long been recognized as pollution hotspots, and pollution prevention and erosion control practices are required for sites that disturb more than one acre. While erosion and sedimentation are the greatest concerns at construction sites, practices used to store and handle construction materials and maintain heavy equipment can be a source of many pollutants including nutrients, soil additives, pesticides, trash, heavy metals, and oil and grease. The magnitude of storm water pollutants depends on the size of the construction site and climatic conditions.

Resources

How to Inspect Construction Sites for Compliance With NPDES Permit
www.epa.gov/region6/water/npdes/sw/ms4/c3/coninsp.ppt

Best Management Practices Manual For Construction Sites In Honolulu
http://www.cleanwaterhonolulu.com/reports/BMP_manual.pdf

City of Dana Point Stormwater Best Management Practices (BMPs) For General Construction and Site Supervision
http://www.danapoint.org/water/WC-CONSTRUCTION.pdf

EPA NPDES Storm Water Pollution Prevention Plans for Construction Activities
http://cfpub1.epa.gov/npdes/stormwater/swppp.cfm

EPA NPDES Construction Site Storm Water Runoff Controls
http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

California Dept. of Transportation Construction Site Best Management Practices (BMPs) Manual
http://www.dot.ca.gov/hq/construc/stormwater/CSBMPM_303_Final.pdf

MARINAS

The proximity of marinas to surface waters makes them a noteworthy hotspot. Many maintenance activities at marinas require pollution prevention practices because they are conducted directly over waterbodies. Marinas can generate nutrients, bacteria, lead, arsenic, zinc, copper and tin, sediment, and hydrocarbons. Key marina maintenance operations that can produce pollutants include the following:

- Boat and ship painting, cleaning, and repair
- Boat fueling, maintenance
- Fish handling
- Discharge of bilge water
- Discharge of marine sanitation devices

Resources

Stormwater Runoff Best Management Practices For Marinas: A Guide for Operators
http://www.seagrant.sunysb.edu/pages/BMPsForMarinas.htm

Best Management Practices for Marinas and Boatyards
http://www.state.me.us/dep/blwq/docwatershed/marina/bmp.htm

National Management Measures to Control Nonpoint Source Pollution from Marinas and Recreational Boating
http://www.epa.gov/owow/nps/mmsp/index.html

Maryland Clean Marina Guidebook
http://www.dnr.state.md.us/boating/cleanmarina/cmprogram.html

HOBBY FARMS

Small farms and boarding facilities are considered hotspots since livestock can generate pollutants such as bacteria, nutrients, and sediment. Many hobby farms are typically located with direct access to streams to provide a watering source. Proper handling of animal wastes and maintenance of sediment controls are important pollution prevention practices at hobby farms, which are often too small to be regulated by local or state authorities.

Resources

Horse Keeping Manual and Fact Sheets on Environmentally-sound Horse Keeping Practices
http://www.baysavers.org/

Stormwater Best Management Practices (BMPs), Horse Owners & Equine Industry
http://www.ci.la.ca.us/SAN/wpd/downloads/pdfs/horse.pdf

Safe Environmental Habits and Procedures for: Boarding Stables, Equestrian Centers, Small Farms, and Urban Horse Owners
http://www.lacity.org/SAN/wpd/pages/horsebmp.htm

Horse Keeping: A Guide To Land Management for Clean Water
http://mcstoppp.org/horses.htm

Guidelines & Best Management Practices for Horsekeeping
http://www.nhhorsecouncil.com/bestpractice.htm

GOLF COURSES

Golf courses can potentially generate pollutants during routine maintenance activities, such as irrigation, mowing, fertilization, and pesticide application. From a pollution prevention standpoint, the greatest concern about golf courses is large inputs of fertilizer, pesticides, and fungicides used to maintain trees and greens. Chemical application rates at golf courses can rival and even exceed those used in intensive agriculture. The actual rate of fertilizer and pesticide inputs at a particular golf course often varies considerably, depending on the soil, climate, and management program. The golf course industry has developed a series of pollution prevention practices to sharply reduce their pollution potential.

Resources

Florida Department of Environmental Protection Best Management Practice for Golf Course Maintenance Departments
http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/golfbmp.pdf

Golf Course Construction and Operation in New Jersey
http://www.state.nj.us/dep/watershedmgt/draft_golf_bmp_manual.htm

Green Industries of Colorado Fact Sheet on Park, Golf Course and Other Large Landscape Design and Management
http://www.greenco.org/downloadables/Parks%20and%20Large%20Landscapes.pdf

US EPA Golf and the Environment Bibliography
http://www.epa.gov/owow/wetlands/initiative/golfbib.html

FAIRGROUNDS AND HORSE TRACKS

Fairgrounds and horse tracks can become hotspot operations when large numbers of animals are boarded and manure is not properly handled. Animal operations can generate pollutants, such as bacteria, nutrients, and sediment. Proper pollution prevention practices emphasize manure handling and containment, as well as continuous erosion control.

Resources

Horse Keeping Manual and Fact Sheets on Environmentally-sound Horse Keeping Practices
http://www.baysavers.org/projects/equine/factsheets.html

Stormwater Best Management Practices (BMPs), Horse Owners & Equine Industry
http://www.ci.la.ca.us/SAN/wpd/downloads/pdfs/horse.pdf

Safe Environmental Habits and Procedures for: Boarding Stables, Equestrian Centers, Small Farms, and Urban Horse Owners
http://www.cityofreno.com/pub_works/stormwater/bmp/horse/

Horse Keeping: A Guide To Land Management for Clean Water
http://mcstoppp.org/horses.htm

Guidelines & Best Management Practices for Horsekeeping
http://www.nhhorsecouncil.com/bestpractice.htm

RESTAURANTS

Restaurants produce grease and other wastes as a byproduct of normal food preparation. If grease is dumped or washed into sewers or storm drains, it can cause sanitary sewer overflows or storm water runoff pollution. Nationally, pipe blockages cause 43% of sewer overflows and grease is a major factor in most blockages (U.S. EPA, 1996). Restaurants can implement simple and low-cost pollution prevention practices to prevent grease discharges. Also restaurants can train workers to properly dispose of used wastes and maintain dumpsters.

Resources

Bay Area Pollution Prevention Group: "Avoid Fines and Health Risks from Grease Overflows"
http://www.casaweb.org/committee/tritac/grease/bappgfs.pdf

Michigan Department of Environmental Protection: "Restaurant Industry Pollution Prevention and Waste Reduction"
http://www.michigan.gov/deq

City of Longmont Colorado Pollution Prevention Tips for the Food Service Industry
http://www.ci.longmont.co.us/water_waste/ipp/food_industry.htm

City of Los Angeles (CA): "BMP Poster for the Food and Restaurant Industry
http://www.lastormwater.org/

References

Advanced Marketing Research (AMR). 1997. *Stormwater Tracking Study*. City of Eugene, Oregon. Unpublished marketing survey.

American Forests. 2001. *Urban Ecosystem Analysis for the Washington D.C. Metro Area: An Assessment of Existing Conditions and A Resource for Local Action*. Washington, D.C.

American Forests. 1999. *Regional Ecosystem Analysis: Chesapeake Bay Region and the Baltimore Washington Corridor: Calculating the Value of Nature.* Washington, D.C.

American Water Works Association Research Foundation (AWWARF). 1999. *Residential End Uses of Water*. Denver, CO.

Assing, J. 1994. *Survey of Public Attitudes -- February and July, 1994.* Russian Hill Associates. Alameda County Urban Runoff Clean Water Program. San Francisco CA.

Bannerman, R., D. Owens and N. Hornewer. 1993. "Sources of Pollutants in Wisconsin Stormwater." *Water Science Technology*. 28(3-5): 241-259.

Barth, C. 1995a. "Toward a Low Input Lawn." in *Watershed Protection Techniques* 2(1): 254-264. Center for Watershed Protection. Ellicott City, MD.

Barth, C. 1995b. "Nutrient Movement from the Lawn to the Stream?" *Watershed Protection Techniques*. 2(1): 239-246. Center for Watershed Protection. Ellicott City, MD.

Bay Area Stormwater Management Agencies Association (BASMAA). 1997. *Start At the Source: Residential Site Planning and Design Guidance Manual for Stormwater Quality Protection*. San Francisco, CA.

Big Honking Ideas, Inc (BHI). 1997. *Final Report: Spring Regional Advertising Campaign.* Prepared for BASMAA. Oakland, CA.

Brown, E., D. Caraco, and R. Pitt. 2004. *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessment.* Center for Watershed Protection. Ellicott City, MD.

California Storm Water Quality Task Force (CSWQTF). 1997. *Best Management Practices Guide: Retail Gasoline Outlets*. Prepared by Retail Gasoline Outlet Work Group. Sacramento, CA.

Cappiella, K. 2004. *Urban Watershed Forestry Manual* (draft). Prepared for USDA Northeastern Area State and Private Forestry. Center for Watershed Protection, Ellicott City, MD

Center for Watershed Protection (CWP). 2003. *the Impacts of Impervious Cover On Aquatic Systems*. Ellicott City, MD.

CWP. 1998. *Rapid Watershed Planning Handbook: A Comprehensive Guide for Managing Urbanizing Watersheds*. Ellicott City, MD.

Chesapeake Bay Program (CBP). 2002. *A Survey of Chesapeake Bay Watershed Residents: Knowledge, Attitudes and Behaviors Towards Chesapeake Bay Watershed Water Quality Issues*. available online: http://www.chesapeakebay.net

Chollak, T. and R. Rosenfeld. 1998. *Guide for Landscaping With Compost Amended Soils.* City of Redmond (WA) Dept of Public Works.

Cooke, S. 1991. *Wetland Buffers: A Field Evaluation of Buffer Effectiveness in Puget Sound*. Washington Department of Ecology.

Council of State Governments. 1998. *Getting in Step: A Guide to Effective Outreach in Your Community*. Lexington, KY.

De Young, R. 1997. *Healthy Lawn and Garden Survey: Data Analysis Report.* Rouge River National Wet Weather Demonstration Project. Oakland County, MI.

Duke, D. and K. Shaver. 1999. "*Widespread Failure to Comply With U.S. Stormwater Regulations for Industry: Parts I and II*" in *Environmental Engineering Science*. 16(4)

Environment Canada. 2001. *Priority Substance List Assessment Report: Road Salt*. Ministry of the Environment. Toronto, Canada.

Ferguson, T., R. Gigac, M. Stoffan, A. Ibrahim, and H. Aldrich. 1997. *Rouge River National Wet Weather Demonstration Project*. Wayne County, MI.

Garn, H. 2002. *Effects of Lawn Fertilizer On Nutrient Concentrations in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin.* USGS. Water Resources Investigations Report 02-4130

Hardwick, N. 1997. *Lake Sammamish Watershed Water Quality Survey.* King County Water and Land Resources Division, Seattle, WA.

Heraty, M. 1993. *Riparian Buffer Programs: A Guide to Developing and Implementing A Riparian Buffer Program As An Urban Best Management Practice.* Metropolitan Washington Council of Governments. Washington, DC.

Home and Garden Information Center (HGIC). 1998. *Residential Fertilizer Use Survey.* University of Maryland Cooperative Extension. College Park, MD. Unpublished surveys. http://www.agnr.umd.edu/MCE/

Houston Galveston Area Council (HGAC). 2004. *Household Hazardous Waste*. Available online: http://www.h-gac.com

Independent Petroleum Association of America (IPAA). 2001. *Spill Prevention, Control, and Countermeasure (SPCC) Plan Comments*. http://www.ipaa.org/govtrelations/comments/SPCC_Comments.asp

Israel, G., S. Pinheiro and G. Knox. 1995. *Environmental Landscape Management -- Assessing Practices Among Commercial Groups.* University of Florida. Cooperative Extension Service. Bulletin 307. Monticello, FL.

Iwata, L. 1994. *Xeriscape: Winning the Turf War Over Water*. Home Energy Magazine. July/August.

Jenkins, V. 1994. *The Lawn: The History of An American Obsession*. Smithsonian Institute Press.

Knox, G., A. Fugate and G. Israel. 1995. *Environmental Landscape Management -- Use of Practices By Florida Consumers*. University of Florida Cooperative Extension Service. Bulletin 307. Monticello, FL.

Law, N.,L, Band and J. Grove. 2004. "Nitrogen Input from Residential Lawn Care Practices in Suburban Watersheds in Baltimore,County, MD." *Journal of Environmental Management and Planning*. in press

Legg, A., R. Bannerman and J. Panuska. 1996. *Variation in the Relation of Rainfall to Runoff from Residential Lawns in Madison, Wisconsin*. U.S. Geological Survey Water Resources Investigation Report 96-4194.

MacPherson, C. and B. Tonning. 2003. *Getting in Step: A Guide to Conducting Watershed Outreach Campaigns*. Prepared for the US EPA Office of Wetland, Oceans and Watersheds. EPA 841-B-03-002.

McDonald, F. 1999. *Ecologically Sound Lawn Care for the Pacific Northwest: Findings from the Scientific Literature and Recommendations from Turf Professionals.* City of Seattle Public Works.

Meeks, P. 2002. "Finding Solutions to Landscape Irrigation Runoff." in *Stormwater*. 3:6.

Morris, W. and D. Traxler. 1996. *Dakota County Subwatersheds: Residential Survey On Lawn Care and Water Quality*. Dakota County, Minnesota, Decision Resources, Ltd.

National Environmental Education Training Foundation (NEETF). 2003. *Weather Reporting and Public Awareness of Smart Growth Issues: Designing Smart Growth Training for Weathercasters*. Washington, D.C.

National Oceanic and Atmospheric Administration (NOAA). 1988. *Dealing With Annex V – A Guide for Ports*. U.S. Department of Commerce, NOAA, National Marine Fisheries Service, Seattle, WA. NOAA Technical Memorandum NMFS F/NWR-23. as cited in *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA 840-B-92-002.

Ohrel, R. 1995. "Dealing with Septic System Impacts." *Watershed Protection Techniques.* 2(1): 265-272. Center for Watershed Protection. Ellicott City, MD.

Outdoor Power Equipment Institute (OPEI). 2003. *Profile of the Outdoor Power Equipment Industry: 2002*. www.opei.org. Alexandria, VA.

Pellegrin Research Group. (PRG). 1998. *Stormwater/Urban Runoff Public Education Program: Interim Evaluation, Resident Population.* Los Angeles County Department of Public Works.

Pool and Spa Marketing. 2003. "Market Report: United States Swimming Pool Market" in *2003 Reference and Directory.* http://www.poolspamarketing.com/

Pronold, M. 2000. "Administering the NPDES Industrial Storm Water Program." in *Proceedings: National Conference on Tools for Urban Water Resource Management and Protection*. U.S. EPA Office of Research and Development. EPA/625-R-00-001

Robinson, C., Proprietor, "Latimat" portable wastewater containment system. Personal Communication June 2, 2003. http://www.latimat.com

Schueler, T. 2003. "The Grass Crop of the Chesapeake Bay Watershed." *Envirocast*. May 2003. National Environmental Education and Training Foundation.

Schueler, T. 2000a. "The Compaction of Urban Soils." *Watershed Protection Techniques*. 3(2): 661-665. Center for Watershed Protection. Ellicott City, MD.

Schueler, T. 2000b. "Understanding Watershed Behavior." *Watershed Protection Techniques*. 3(3): 671-679. Center for Watershed Protection

Schueler, T. 1999. "Microbes in Urban Watersheds." *Watershed Protection Techniques.* 3(1): 551-600. Center for Watershed Protection. Ellicott City, MD.

Schueler, T. 1995. "Urban Pesticides: From the Lawn to the Stream." *Watershed Protection Techniques*. 2(1):247-253. Center for Watershed Protection. Ellicott City, MD.

Scott, K.I., J.R. Simpson, E.G. McPherson. 1999. "Effects of Tree Cover On Parking Lot Microclimate and Vehicle Emissions." *Journal of Arboriculture*. 25(3): 129-141.

Smith, J. 1996. "Public Survey Used to Estimate Pollutant Loads in Maryland." in *Watershed Protection Techniques*. 2(2): 361-363. Center for Watershed Protection. Ellicott City, MD.

Solley, W., R. Pierce and H. Perlman. 1998. *Estimated Water Use in the United States in 1995.* United States Geological Survey. USGS Circular 1200.

State of California Regional Water Quality Control Board (SWRCB). 1999. Order No. 99-038 Setting Administrative Civil Liability. www.swrcb.ca.gov/rwqcb2/OrderNum/99-038.doc

Steiner, R., E. Hagen and J. Ducnuigeen. 2000. *Water Supply Demands and Resources of the Potomac River Basin*. Interstate Commission of the Potomac River Basin. Rockville, MD.

Steuer, J., W. Selbig, N. Hornewer and J. Prey. 1997. *Sources of Contamination in An Urban Basin in Marquette, MI and An Analysis of Concentrations, Loads and Data Quality.* U.S. Geological Survey Water Resources Investigation Report 97-4242.

Swammikanu, X. 1994. "Pollution Prevention for Auto Recyclers." Ph. D. Diss. University of California, Los Angeles in *the Practice of Watershed Protection*. T. Schueler and H. Holland, eds. Center for Watershed Protection. Ellicott City, MD.

Swann, C. 2001. "The Influence of Septic Systems At the Subwatershed Level." in *Watershed Protection Techniques*. 3(4): 821-834. Center for Watershed Protection. Ellicott City, MD.

Swann, C. 2000. "Understanding Watershed Behavior." Watershed Protection Techniques. 3(3): 671-678. Center for Watershed Protection. Ellicott City, MD.

Swann, C. 1999. *A Survey of Residential Nutrient Behaviors in the Chesapeake Bay Watershed.* Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD.

Teyssot, G. 1999. "The American Lawn: Surface of Everyday Life." in *The American Lawn*, G. Teyssot (ed.). Princeton Architectural Press, NY.

United States Census. 2001. *Profile of National Housing Conditions.* 2000 Census Data. Washington, D.C.

United States Environmental Protection Agency (U.S. EPA). 2003. FedSite, Virtual Facility Regulatory Tour, Vehicle Maintenance Facility Tour. *Vehicle Washing - P2 Opportunities*. Available online: http://permanent.access.gpo.gov/websites/epagov/www.epa.gov/fedsite/virtual.html

U.S. EPA 2002. *Onsite Wastewater Treatment Systems Manual.* U.S. EPA Office of Water, Oceans, and Wetlands. EPA 625/R-00/008.

U.S. EPA. 1999. Storm Water Management Fact Sheet: *"Coverings."* Office of Wastewater Management. Washington, D.C. EPA 832-R-99-009.

U.S. EPA. 1996. *Overview of the Storm Water Program*. EPA833-R-96-008. Office of Water. http://www.epa.gov/npdes/pubs/owm0195.pdf

U.S. EPA. 1992. *Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices.* US EPA Office of Wastewater Management. Washington, D.C. EPA 832-R-92-006.

United States Geological Survey (USGS). 2001. *the Quality of Our Nations Waters: Nutrients and Pesticides*. United States Geological Survey. FS-047-01

USGS. 1999. *Pesticides Detected in Urban Streams During Rainstorms and Relations to Retail Sales of Pesticides in King County, Washington*. United States Geological Survey FS-007-98

University of Missouri. 1994. *Storm Drains and Water Quality*. Waste Management Article WM6011. Available online: http://muextension.missouri.edu/xplor/wasteman/wm6011.htm.

Waschbusch, R., W. Selbig and R, Bannerman. 2000. "Sources of Phosphorus in Stormwater and Street Dirt from Two Residential Basins in Madison, Wisconsin" in *National Conference on Tools for Urban Water Resource Management and Protection*. US EPA February 2000.

Water Environment Research Federation. 2000. *Tools to measure Source Control Program Effectiveness.* Alexandria, VA.

Winer, R. 2003. *Maryland Chesapeake and Atlantic Coastal Bays Critical Area 10% Rule Guidance Manual*. Prepared for Maryland Critical Area Commission. Prepared by Center for Watershed Protection. Ellicott City, MD.

Wright, T., C. Swann, K. Cappiella, and T. Schueler. 2004. *Unified Subwatershed and Site Reconnaissance: A User's Manual*. Center for Watershed Protection. Ellicott City, MD.

Appendix A: Storm Water Hotspots and Potential Discharge Generators

Overview

Identifying land uses that may impact water quality in local streams can be a difficult and time-consuming task. Research suggests that program managers might wish to preferentially investigate certain land uses when looking for the sources of possible pollutant loads. These land uses are all considered to be hotspot sites where routine operations can produce higher levels of storm water pollutants, and/or present a higher potential risk for spills, leaks or illicit discharges. The two basic types of hotspots are *regulated hotspots* that are known sources of pollution and are subject to federal or state regulations, and *unregulated hotspots,* which are operations suspected to be potential pollution sources and are not currently regulated.

Identifying Potential Generating Sites

The number and type of hotspot sites present in a subwatershed may vary greatly, and currently there is no public database available to identify all the regulated sites in a subwatershed. Instead, multiple databases need to be queried to identify generating sites that may be targets for source control or illicit discharge investigations. A three-phase approach is useful for gathering as much information as possible on suspect sites within a subwatershed that may qualify for more intensive scrutiny.

Phase 1. Consult Publicly-Available Databases

The federal government has a number of databases that may help identify locations for investigation. The Environmental Protection Agency (EPA) operates two such databases. The first is the Enforcement and Compliance History Online (ECHO) database. With this system, you can look up facility compliance history and find facilities based on geographic location (county level) or zip code: (http://www.epa.gov/echo/index.html). The other database is Envirofacts (http://www.epa.gov/enviro/). This website provides access to multiple EPA databases that provide information about environmental activities (including RCRA and Toxic Release Inventory [TRI] facilities) that may affect air, water, and land anywhere in the United States. The website also provides access to Enviromapper, which will display the location of regulated facilities.

Several commercial databases can provide information on regulated industries based on manufacturing or industrial Standard Industrial Classification (SIC) codes. These databases are not free, and have limitations since they are designed primarily for marketing.

Phase 2. Consult State and Local Agencies

Most states have NPDES permit programs, and track permit application to some extent. You can consult state or local regulatory agencies to obtain lists of industries that have filed a Notice of Intent (NOI) to obtain storm water permits, as well as those that have filed under TRI requirements. Other agencies that may have information on local generating sites include fire departments (for hazardous waste), and sanitation or wastewater treatment agencies.

Phase 3. Permit Review

The final source for information is a review of local permits. Most permit databases have SIC codes as one of the fields. These codes can be matched against the SIC codes in Table B1, which list common generating sites under major land use headings. If a local permit database does not exist, it may be worthwhile to simply get the local phone book and do a quick look for businesses that are similar to those listed in Table B1.

Compiling the findings from the various databases will provide an initial list of potential generating sites for future investigation. However, research has found that most of these databases can miss many of the industries that are subject to regulation (Duke *et al*., 1999 and Duke and Shaver, 1999), and further identification may be necessary. Field investigation with techniques such as the USSR (Wright *et al.*, 2004) can assist in identifying

many of these generating sites that should probably be regulated by communities.

Reference Tables

This appendix is designed to help identify the land uses and associated generating sites in a subwatershed where routine activities may result in pollution being discharged to the storm drain system. There are two tables provided, each of which is described below.

Table A1 presents a listing of common land uses that may qualify as hotspots based on regular activities or practices. Column one describes the general industry type. Column two lists their associated SIC codes, if known. Column three identifies whether an industry type is subject to NPDES industrial storm water permit requirements (designated by "X"). Facilities where only certain activities or facilities at the site are subject to regulation are noted (this pertains mostly to the transport-related industries). In addition, storm water permits are required for many "light" industrial facilities only if material handling equipment or activities, raw materials, immediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. Industries where this applies are noted with an asterisk.

If only specific SIC codes within a major group qualify for this exception, they are noted in parentheses. Municipal facilities that are subject to NPDES MS4 permit requirements are designated by "MS4." Column four identifies businesses that can be considered unregulated storm water hotspots (also designated by "X"). Column five looks at the illicit discharge potential of each of the businesses listed. The potential for a business to produce an illicit discharge is rated as either high (H) medium (M) or low (L). This rating is based on the likelihood that it has a direct connection to the storm drain system (direct), or that it can produce a transitory discharge (indirect).

Table A2 provides a list of the SIC codes that are regulated by the Industrial Multi Sector General Permit (MGSP). The list includes the four-digit SIC codes along with the official description. This table is provided for those who wish to know the full description of each SIC code regulated by NPDES industrial storm water permits.

Table A1: Common Storm Water Hotspots and their Pollution Potential					
Industry Type/ General Description	**Associated SIC Code(s)**	**Regulated Storm Water Hotspot**	**Unregulated Storm Water Hotspot**	**Illicit Discharge Potential**	
				Direct	**Indirect**
Commercial					
Animal Care Services	0742,0752		X	L	L
Auto Repair	7532-7539, 7549		X	M	M
Automobile Parking	7521			L	M
Building Materials	5211-5251		X	L	L
Campgrounds/RV parks	7033		X	L	M
Car Dealers	5511-5599,		X	M	M
Car Washes	7542		X	L	L
Commercial Laundry/Dry Cleaning	7211-7219		X	L	L
Convenience Stores	5399		X	L	L
Food Stores and Wholesale Food and Beverage	5141-5149 5411-5499		X	L	M
Equipment Repair	7622-7699		X	L	L
Gasoline Stations	5541		X	M	M
Heavy Construction Equipment Rental and Leasing	7353		X	L	H
Building and Heavy Construction	1521-1542 1611-1629	X (For land disturbing activities)	X	L	H
Marinas	4493	X		L	M
Nurseries and garden centers	5261		X	L	M
Oil Change Shops	7549		X		M
Restaurants	5812,5813,7011		X	M	L
Swimming Pools	7997, 7999		X	L	L
Warehouses	4221-4226	X* (4221-4225)		L	L
Wholesalers of Chemical and Petroleum	5162-5169,5172		X	L	L
Industrial					
Apparel and Other Fabrics	2311–2399 3131–3199	X*		2300 L 3100 H	L M
Auto Recyclers and Scrap Yards	5015, 5093	X		L	H
Beverages and Brewing	2082-2087	X*		L	L
Boat Building and Repair	3731,3732	X		L	H
Chemical Products	2812-2899	X* (2830, 2850)		2810 H 2820 H 2840 H 2860 M 2830 L 2850 L 2870 L 2890 L	2810 L 2820 L 2840 L 2860 L 2830 L 2850 L 2870 L 2890 L

Table A1: Common Storm Water Hotspots and their Pollution Potential					
Industry Type/ General Description	**Associated SIC Code(s)**	**Regulated Storm Water Hotspot**	**Unregulated Storm Water Hotspot**	**Illicit Discharge Potential**	
				Direct	**Indirect**
Industrial (continued)					
Food Processing	2011–2141	X*		2010 H 2020 H 2030 H 2040 H 2050 L. 2060 L 2070 M 2090 L 2110 M	2010 L 2020 L 2030 L 2040 L 2050 L. 2060 L 2070 L 2090 L 2110 L
Garbage Truck Washout Activities	4212		X	L	H
Industrial or Commercial Machinery, Electronic Equipment	3511–3599 3612–3699	X*		L	L
Instruments; Photographic and Optical Goods, Watches and Clocks and other Miscellaneous Manufacturing	3812–3873 3933-3999	X*		L	L
Leather Tanners	3411	X		H	M
Metal Production, Plating and Engraving Operations	2514, 2522, 2542, 3312-3399, 3411-3499, 3590	X* (2514,2522, 2542, 3411-3433, 3442-3499, 3590)		H	L
Paper and Wood Products	2411-2499, 2511, 2512, 2517, 2519, 2521, 2541, 2611–2679	X* (2434, 2652–2657, 2671–2679)		2400 L 2500 L 2600 H	2400 H 2500 L 2600 H
Petroleum Storage and Refining	2911	X		2911 H	H
Printing	2711–2796	X*		L	L
Rubber and Plastics	3011-3089	X*		M	L
Stone, Glass, Clay, Cement, Concrete, and Gypsum Product	3211-3299	X* (3233)		L	L
Textile Mills	2211–2299	X*		H	L
Transportation Equipment	3711–3728, 3743-3799	X*		H	M
Institutional					
Cemeteries	6553		X	L	L
Churches	8661		X	L	L
Colleges and Universities	8221-8222		X	L	M
Corporate Office Parks			X	L	L
Hospitals	8062-8069 8071-8072		X	L	L
Private Golf Courses	7997		X	L	L
Private Schools	8211		X	L	L

Table A1: Common Storm Water Hotspots and their Pollution Potential					
Industry Type/ General Description	**Associated SIC Code(s)**	**Regulated Storm Water Hotspot**	**Unregulated Storm Water Hotspot**	**Illicit Discharge Potential**	
				Direct	**Indirect**
Municipal					
Composting Facilities	2875	X		L	L
Public Golf Courses	7992		X	L	L
Landfills and Hazardous Waste Material Disposal	4953, HZ, LF	X		L	H
Local Streets		MS4	X	L	H
Maintenance Depots	4173	MS4		M	H
Municipal Fleet Washing	4100	MS4		L	M
Public Works Yards		MS4		M	H
Steam Electric Plants	SE	X		L	L
Treatment Works	TW	X		L	L
Transport-Related (NPDES regulation is for the portion of the facility dedicated to vehicle maintenance shops, equipment-cleaning operations, and airport deicing operations)					
Airports	4581	X		L	M
Streets and Highways Construction	1611, 1622		X	L	H
Ports	4449, 4499	X		L	H
Railroads	4011, 4013	X		L	H
Rental Car Lots	7513-7519	X		L	M
US Postal Service	4311	X		L	M
Trucking Companies and Distribution Centers	4212-4215, 4231	X		L	M
Petroleum Bulk Stations or Terminals	5171	X		L	H

Table A2: SIC Codes for NPDES Industrial Storm Water Regulated Facilities	
A. Timber Products	
2411	Log Storage and Handling
2421	General Sawmills and Planning Mills
2426	Hardwood Dimension and Flooring Mills
2429	Special Product Sawmills, Not Elsewhere Classified
2431–2439	Millwork, Veneer, Plywood, and Structural Wood (except 2434)
2448, 2449	Wood Containers
2451, 2452	Wood Buildings and Mobile Homes
2491	Wood Preserving
2493	Reconstituted Wood Products
2499	Wood Products, Not Elsewhere Classified
B. Paper and Allied Products Manufacturing	
2611	Pulp Mills
2621	Paper Mills
2631	Paperboard Mills
2652–2657	Paperboard Containers and Boxes
2671–2679	Converted Paper and Paperboard Products, Except Containers and Boxes
C. Chemical and Allied Products Manufacturing	
2812–2819	Industrial Inorganic Chemicals
2821–2824	Plastics Materials and Synthetic Resins, Synthetic Rubber, Cellulosic and Other Manmade Fibers Except Glass
2833–2836	Medicinal chemicals and botanical products; pharmaceutical preparations; in-vitro and in-vivo diagnostic substances; biological products, except diagnostic substances
2841–2844	Soaps, Detergents, Cleaning Preparations; Perfumes, Cosmetics, Other Toilet Preparations
2851	Paints, Varnishes, Lacquers, Enamels, and Allied Products
2861–2869	Industrial Organic Chemicals
2873–2879	Agricultural Chemicals, Including Facilities that Make Fertilizer Solely from Leather Scraps and Leather Dust
2891–2899	Miscellaneous Chemical Products
3952 (limited to list)	Inks and Paints, Including China Painting Enamels, India Ink, Drawing Ink, Platinum Paints for Burnt Wood or Leather Work, Paints for China Painting, Artist's Paints and Watercolors
D. Asphalt Paving and Roofing Materials Manufacturers and Lubricant Manufacturers.	
2951, 2952	Asphalt Paving and Roofing Materials
2992, 2999	Miscellaneous Products of Petroleum and Coal
E. Glass, Clay, Cement, Concrete, and Gypsum Product Manufacturing	
3211	Flat Glass
3221, 3229	Glass and Glassware, Pressed or Blown
3231	Glass Products Made of Purchased Glass
3241	Hydraulic Cement
3251-3259	Structural Clay Products
3261-3269	Pottery and Related Products
3271-3275	Concrete, Gypsum and Plaster Products
3281	Cut Stone and Stone Products
3291–3292	Abrasive and Asbestos Products
3295	Minerals and Earth's, Ground, or Otherwise Treated
3296	Mineral Wool
3297	Non-Clay Refractories
3299	Nonmetallic Mineral Products, Not Elsewhere Classified

Table A2: SIC Codes for NPDES Industrial Storm Water Regulated Facilities	
F. Primary Metals	
3312–3317	Steel Works, Blast Furnaces, and Rolling and Finishing Mills
3321–3325	Iron and Steel Foundries
3331–3339	Primary Smelting and Refining of Nonferrous Metals
3341	Secondary Smelting and Refining of Nonferrous Metals
3351–3357	Rolling, Drawing, and Extruding of Nonferrous Metals
3363–3369	Nonferrous Foundries (Castings)
3398, 3399	Miscellaneous Primary Metal Products
G. Metal Mining (Ore Mining and Dressing)	
1011	Iron Ores
1021	Copper Ores
1031	Lead and Zinc Ores
1041, 1044	Gold and Silver Ores
1061	Ferroalloy Ores, Except Vanadium
1081	Metal Mining Services
1094, 1099	Miscellaneous Metal Ores
H. Coal Mines and Coal Mining-Related Facilities	
1221–1241	Coal Mines and Coal Mining-Related Facilities Sector
I. Oil and Gas Extraction and Refining	
1311	Crude Petroleum and Natural Gas
1321	Natural Gas Liquids
1381–1389	Oil and Gas Field Services
2911	Petroleum refining
J. Mineral Mining and Dressing	
1411	Dimension Stone
1422–1429.	Crushed and Broken Stone, Including Rip Rap
1481	Nonmetallic Minerals, Except Fuels
1442, 1446.	Sand and Gravel
1455, 1459	Clay, Ceramic, and Refractory Materials
1474–1479	Chemical and Fertilizer Mineral Mining
1499	Miscellaneous Nonmetallic Minerals, Except Fuels
K. Hazardous Waste Treatment Storage or Disposal Facilities	
HZ	Hazardous Waste Treatment, Storage or Disposal
L. Landfills and Land Application Sites	
LF	Landfills, Land Application Sites and Open Dumps
M. Automobile Salvage Yards	
5015	Automobile Salvage Yards
N. Scrap Recycling Facilities	
5093	Scrap Recycling Facilities
O. Steam Electric Generating Facilities	
SE	Steam Electric Generating Facilities
P. Land Transportation	
4011, 4013	Railroad Transportation
4111–4173	Local and Highway Passenger Transportation
4212–4231	Motor Freight Transportation and Warehousing
4311	United States Postal Service
5171	Petroleum Bulk Stations and Terminals
Q. Water Transportation	
4412–4499	Water Transportation
R. Ship and Boat Building or Repairing Yards	
3731, 3732	Ship and Boat Building or Repairing Yards
S. Air Transportation Facilities	
4512–4581	Air Transportation Facilities

Table A2: SIC Codes for NPDES Industrial Storm Water Regulated Facilities	
T. Treatment Works	
TW	Treatment Works
U. Food and Kindred Products	
2011–2015	Meat Products
2021–2026	Dairy Products
2032	Canned, Frozen and Preserved Fruits, Vegetables and Food Specialties.
2041–2048	Grain Mill Products
2051–2053	Bakery Products
2061–2068	Sugar and Confectionery Products
2074–2079	Fats and Oils
2082–2087	Beverages
2091–2099	Miscellaneous Food Preparations and Kindred Products
2111–2141	Tobacco Products
V. Textile Mills, Apparel, and Other Fabric Product Manufacturing	
2211–2299	Textile Mill Products
2311–2399	Apparel and Other Finished Products Made From Fabrics and Similar Materials
3131–3199	Leather Products (except 3111)
W. Furniture and Fixtures	
2511–2599	Furniture and Fixtures
2434	Wood Kitchen Cabinets
X. Printing and Publishing	
2711–2796	Printing, Publishing and Allied Industries
Y. Rubber, Miscellaneous Plastic Products, and Miscellaneous Manufacturing Industries	
3011	Tires and Inner Tubes
3021	Rubber and Plastics Footwear
3052, 3053	Gaskets, Packing, and Sealing Devices and Rubber and Plastics Hose and Belting.
3061, 3069	Fabricated Rubber Products, Not Elsewhere Classified
3081–3089	Miscellaneous Plastics Products
3931	Musical Instruments
3942–3949	Dolls, Toys, Games and Sporting and Athletic Goods
3951–3955	Pens, Pencils, and Other Artists' Materials. (except 3952)
3961, 3965	Costume Jewelry and Novelties, Buttons, and Miscellaneous Notions, Except Precious Metal
3991–3999	Miscellaneous Manufacturing Industries.
Z. Leather Tanning and Finishing	
3111	Leather Tanning and Finishing.
AA. Fabricated Metal Products	
3411–3499	Fabricated Metal Products, Except Machinery and Transportation Equipment and Cutting, Engraving and Allied Services
3911–3915	Jewelry, Silverware, and Plated Ware
3479	Coating, Engraving, and Allied Services
BB. Transportation Equipment, Industrial or Commercial Machinery	
3511–3599	Industrial and Commercial Machinery (except 3571–3579)
3711–3799	Transportation Equipment (except 3731, 3732)
CC. Electronic, Electrical, Photographic and Optical Goods	
3612–3699	Electronic, Electrical Equipment and Components, Except Computer Equipment
3812–3873	Measuring, Analyzing and Controlling Instrument, Photographic/Optical Goods, Watches/Clocks
3571–3579	Computer and Office Equipment
DD. Construction (based on land disturbing activities)	
1521-1542	Building Construction General Contractors And Operative Builders
1611-1629	Heavy Construction Other Than Building Construction Contractors

References

Duke, D., K Patel, and B. Masek. 1999. "Widespread Failure to Comply with U.S. Storm Water Regulations for Industry-Part I: Publicly Available Data to Estimate Number of Potentially Regulated Facilities." *Environmental Engineering Science*, 16(4).

Duke, D and K. Shaver. 1999. "Widespread Failure to Comply with U.S. Storm Water Regulations for Industry-Part II: Facility-Level Evaluations to Estimate Number of Regulated Facilities." *Environmental Engineering Science*. 16(4).

Pitt, R. 1993. Investigation of Inappropriate Pollutant Entries Into Storm Drain Systems. EPA, Office of Research and Development, Washington, DC. EPA/600/R-92/238.

Wright, T., C. Swann, K. Cappiella, and T. Schueler. 2004. *Unified Subwatershed and Site Reconnaissance: A User's Manual*. Center for Watershed Protection. Ellicott City, MD.