Protecting Drinking Water Sources

The 1996 Amendments to the Safe Drinking Water Act (SDWA) took a major new step in drinking water protection by mandating that states perform a source water assessment for each public water system. States are responsible for completing assessments for public water systems in major metropolitan areas, small towns, schools, restaurants, and other public facilities that have a well or surface water supply. (Private wells are not included in this effort.)

After a state’s Source Water Assessment Program (SWAP) is approved by the United States Environmental Protection Agency (US EPA), the state has two years, with a possible 18 months extension, to conduct an assessment for each public water system and make these assessments available to the public. US EPA has approved 52 SWAP programs. States must complete all the assessments in the state no later than 3 years after US EPA approves the programs.

The source water assessment programs established by each state differ, depending on the nature and threats to the water resources and the drinking water program priorities in a particular state. However, each assessment program must include four major elements:

- delineate (or mapping) the source water protection areas
- conducting an inventory of potential sources of contamination in those areas
- determining the susceptibility of public water systems to those contamination sources
- releasing the results of the determinations to the public

Following successful completion of these elements for each assessment, communities can use the resulting information to identify priority actions for protecting their drinking water sources.

Source Water Assessments

The four assessment steps are described in more detail below.

Step 1: Delineate the source water assessment area

For ground water wells or surface water systems that supplies public drinking water, states must delineate and map the boundaries of each protection area.

For ground water systems, states commonly use available information about ground water flow and recharge to determine the source water protection area around a well or well field.

For surface water systems drawing water from a stream, river, lake, or reservoir, the land area in the watershed upstream of the intake is identified on a map. A topographic map is used to identify the perimeter of the area that provides water to the water system’s intake. Some states plan to divide the watershed area into segments—areas that are closest to the intake where most types of contamination sources may be found to be significant, and other more distant areas. The entire watershed area up to the state’s boundaries is required to be delineated and mapped, but the level of detail in the inventory of potential pollution sources and the susceptibility determination can vary in the different segments. Coordination across state boundaries is encouraged where appropriate.

Step 2: Conduct an inventory of potential sources of contamination

In the second step of an assessment, the state identifies the potential sources of pollutants that could contaminate the water supply. This inventory
usually results in a list and a map of facilities and activities within the delineated area that may release contaminants into the underground water supply (for wells) or the watershed of the river or lake (for surface water sources).

Some examples of the many different types of potential pollutant sources include landfills, underground or above-ground fuel storage tanks, residential or commercial septic systems, urban runoff from streets and lawns, farms and other entities that apply pesticides and fertilizers, and sludge disposal sites.

**Step 3: Determine the susceptibility of the water supply to contamination**

In the third step—the susceptibility determination—the state combines the inventory results with other relevant information to decide the likelihood of contamination of the water supply by the identified significant potential sources of contamination. This critical step makes the assessments useful for communities. It helps local decision-makers consider priority approaches for protecting the drinking water supply from contamination. Some states prioritize the potential for contamination from the specific potential contamination sources or to individual chemicals that could pollute the water. Other states assign a susceptibility ranking of high, medium, or low to the water sources.

**Step 4: Provide the assessment results to the public**

After the state completes the assessment for a particular water system, it will summarize the information for the public. Such summaries will help communities better understand the potential threats to their water supplies and identify priority needs for protecting the water from contamination. This summary information must be included in water systems’ Consumer Confidence Reports (annual water quality reports). Local communities, working in cooperation with local, regional, and state agencies, can use the information gathered through the assessment process to create a broader source water protection program to address current and future threats to the quality of their drinking water supplies.

**Source Water Protection**

While source water protection was not specifically mandated by SDWA, US EPA and its partners encourage states, tribes, and communities to use the information from source water assessments to protect the delineated source water protection areas from identified pollution sources of major concern. Using a partnership approach, community groups and local officials can plan how to best manage those identified potential sources and prevent new contaminant threats in the source water area.

Many source water protection areas will include multiple jurisdictions, i.e., the city or county where the source water intake or wellhead is located, and other towns, counties, or states upstream or upgradient from the public water system. Local political authorities may be able to adopt protection measures within their jurisdiction, but to achieve effective protection beyond their boundaries, they will usually have to work with neighboring jurisdictions or federal or state authorities.

Communities use a wide array of different source water protection methods to prevent contamination of their drinking water supplies. One management option involves regulations, such as prohibiting or restricting land uses that may release contaminants in critical source water protection areas. Along with regulations, many communities hold local events and distribute information to educate and encourage citizens and businesses to recycle used oil, limit their use of pesticides, participate in watershed cleanup activities, and a multitude of other prevention activities. Another aspect of a source water protection program can be the purchase of land or the creation of conservation easements to serve as a protection zone near the drinking water source. For an effective protection program, communities should consider using a variety of prevention measures.

To assist their efforts to protect areas which surround surface water sources of drinking water, local authorities can look to Section 303 of the Clean Water Act. This section requires each state to review its water quality standards every three years. The review must consider the “use and value” of the water as a drinking water supply. States that adopt water quality standards to protect all public water supplies and prospective supplies can enforce these standards under state and federal law to control pollution.

To augment local ground water protection efforts, some states use ground water quality standards that work much like the Section 303 program for surface water. Some states also use a permit program to regulate pollution that can contaminate ground water. The federal Underground Injection Control (UIC) program regulates the use of wells as a means to dispose of waste, and the Resource Conservation & Recovery Act (RCRA) regulates the management of hazardous and non-hazardous waste that can contaminate ground water.

**For More Information:**

For further information on your state’s source water assessment program and how to participate, contact the agency in your state that is managing the program. Call the Safe Drinking Water Hotline at 1-800-426-4791, or visit the safe water web site at www.epa.gov/safewater for more information, state contacts, and links to other organizations that may be active with source water protection in your area. Your local water supplier may also have more information about opportunities to become involved in the source water assessment process. You can call the phone number on your water bill or contact your local health department for information on your water supplier.
Managing Above Ground Storage Tanks to Prevent Contamination of Drinking Water

Above ground storage tanks (ASTs) are tanks or other containers that are above ground, partially buried, bunkered, or in a subterranean vault. These can include floating fuel systems. This fact sheet focuses on the management of facilities with ASTs to prevent contamination of drinking water sources (ground water and surface water used as public drinking water supplies).

Above Ground Storage Tank Use

The majority of storage tanks contain petroleum products (e.g., motor fuels, petroleum solvents, heating oil, lubricants, used oil). Oil storage facilities with ASTs are typically found in marketing terminals, refineries, and fuel distribution centers. Storage tanks may also be found in airports, school bus barns, hospitals, automotive repair shops, military bases, farms, and industrial plants. Discharges of chemicals, petroleum, or non-petroleum oils from storage tanks can contaminate source water. Product spilled, leaked, or lost from storage tanks may accumulate in soils or be carried away in storm runoff.

Some of the causes for storage tank releases are holes from corrosion, failure of piping systems, and spills and overfills, as well as equipment failure and human operational error. The Spill Prevention Control and Countermeasures (SPCC) regulations require owners or operators of certain above ground oil storage facilities to prepare and comply with written, site-specific, spill prevention plans (see 40 CFR Part 112):

- Facilities with a total above ground oil storage capacity of more than 1,320 gallons;
- Single above ground tanks with an oil storage capacity of more than 660 gallons; and
- Facilities with a combined underground oil storage capacity greater than 42,000 gallons.

Please note, however, that State AST regulations may be more stringent or differ in other ways from the Federal requirements. You must check with local regulatory authorities to make sure which ASTs are subject to what requirements. All AST facility owners or operators exempt from these regulations should still consider implementing the prevention measures described in this fact sheet to preclude future storage tank problems.

Basic AST Facts:
- Most storage tanks contain petroleum products.
- State AST regulations may be more stringent than Federal requirements.
- A spill of only one gallon of oil can contaminate a million gallons of water.
- ASTs should have a secondary containment area to contain spills.
- If a tank is not used for more than a year it is possible your State may require you to declare it as “Out of Service”.
- Inspect any accumulated water for chemicals prior to discharge from the AST area.
- Most States require AST inspections by Fire Marshalls.
Storage tank releases can contaminate soil and drinking water supplies. Petroleum products are composed of volatile organic compounds (VOCs). Any oil spill can pose a serious threat to human health and the environment, requires remediation that extends beyond your facility’s boundary, and results in substantial cleanup costs. Even a small spill can have a serious impact. A single pint of oil released into the water can cover one acre of water surface area and can seriously damage an aquatic habitat. A spill of only one gallon of oil can contaminate a million gallons of water. It may take years for an ecosystem to recover from the damage caused by an oil spill.

The location of the facility must be considered in relation to drinking water wells, streams, ponds and ditches (perennial or intermittent), storm or sanitary sewers, wetlands, mudflats, sandflats, farm drain tiles, or other navigable waters. Factors such as the distance to drinking water wells and surface water, volume of material stored, worst case weather conditions, drainage patterns, land contours, and soil conditions must also be taken into account.

Available Prevention Measures to Address Above Ground Storage Tanks

The following list of prevention measures is not all-encompassing; others can be found in the references provided at the end of the document. Furthermore, detailed explanations of each device mentioned below are found in the supporting documents. Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source water, the public’s acceptance of the measures, and the community’s desired degree of risk reduction.

Federal AST Requirements under 40 CFR Part 112

Follow standard tank filling practices when filling tanks to prevent spills and overfills. Furthermore, all ASTs should have a secondary containment area that contains spills and allows leaks to be more easily detected. The containment area surrounding the tank should hold 110 percent of the contents of the largest tank plus freeboard for precipitation. Secondary containment for ASTs must be impermeable to the materials being stored. Methods include berms, dikes, liners, vaults, and double-walled tanks. A manually controlled sump pump should be used to collect rain water that may accumulate in the secondary containment area. Any discharge should be inspected for petroleum or chemicals prior to being dispensed.

Routinely monitor ASTs to ensure they are not leaking. An audit of a newly installed tank system by a professional engineer can identify and correct problems such as loose fittings, poor welding, and poorly fit gaskets. After installation, inspect the tank system periodically to ensure it is in good condition. Depending on the permeability of the secondary containment area, more frequent containment area checks may be necessary. Areas to inspect include tank foundations, connections, coatings, tank walls, and the piping system. Integrity testing should be done periodically by a qualified professional and in accordance to applicable standards.

If an AST has remained out of service for more a year or more, many States require owners to maintain and monitor the tank, declare the tank inactive, or remove it. If the tank is declared inactive, remove all substances from the AST system (including pipes) and completely clean the inside. Secure tanks by bolting and locking all valves, as well as capping all gauge openings and fill lines. Clearly label tanks with the date and the words “Out of Service.” Samples may be required when removing tanks to determine if any contamination has occurred. Most States require out-of-service tanks to be inspected and meet leak detection requirements before they are put back into service.
Additional AST Prevention Measures

The following prevention measures go beyond the Federal regulations under 40 CFR Part 112, but are highly recommended:

Facility Location:
The location of the facility must be considered in relation to drinking water wells, streams, ponds and ditches (perennial or intermittent), storm or sanitary sewers, wetlands, mudflats, sandflats, farm drain tiles, or other navigable waters. The distance to drinking water wells and surface water, volume of material stored, worse case weather conditions, drainage patterns, land contours, and soil conditions must also be taken into account.

Corrosion Control:
ASTs should have corrosion protection for the tank. Options include elevating tanks, resting tanks on continuous concrete slabs, installing double-walled tanks, cathodically protecting the tanks, internally lining tanks, inspecting tanks according to American Petroleum Institute standard, or a combination of the options listed above. All underground piping to the tank should be double-walled or located above ground or cathodically protected so you can inspect it when it fails.

To maximize system safety, seal the floors, containment area, and sump pump pit with an appropriate coating (e.g., petroleum resistant coating). Any accumulated water should be inspected for petroleum or chemicals prior to discharge.

Periodic Cleanup:
Accumulated minor spillage, over time, may result in a film or sheen on collected rain water, making it unsuitable for discharge to the soil or drains. Periodic cleanup of the containment areas (e.g., sweeping with a broom and using limited absorbent) can prevent unnecessary dirt and contaminant buildup.

Registration Programs:
Local jurisdictions may want to implement registration programs for exempt tanks, in order to exercise some oversight of their construction and operation. Furthermore, most States also require inspections for ASTs by fire marshals. Inspection programs can be expanded to cover water contamination issues.

Preventing Evaporation:
While not a preventative measure for source water protection, preventing evaporation has economic and air quality benefits. To keep out rain and reduce evaporation losses and moisture condensation, paint tanks a reflective color, install them in an east-west direction, install a low-pressure valve on top of the tank, and cover the structure. A roof structure covering a 10,000 gallon tank will conserve 600 to 1,000 gallons of gasoline per year, which would have escaped by evaporation without the shade cover.
Additional Information

The following documents contain more detailed information on ASTs and are available for free on the Internet. You can contact your EPA Regional SPCC or Oil Coordinator for more information, as well. There are also State and local authorities that are often located in Oil, Environmental, or Pollution Control Divisions who can provide you with local regulations for ASTs.

Contact local government authorities in your area to see if there are ordinances in place to manage ASTs. Numerous examples of local source water protection-related ordinances for various potential contaminant sources can be found at: http://www.epa.gov/r5water/ordcom/http://www.epa.gov/owow/nps/ordinance/http://www.epa.gov/owow/nps/ordinance/links.htm

The following documents provide additional information on AST prevention measures and regulations:


Image Credits


7, 8 - From original AST document.


10 - AST Diagram.

11 - AST diagram.
Managing Above Ground Storage Tanks to Prevent Contamination of Drinking Water

The mission of EPA is to protect human health and to safeguard the natural environment -- air, water and land -- upon which life depends.

USEPA East (EPA East) [Old ICC Building]
1201 Constitution Avenue N.W.
Washington, DC 20004
Source Water Protection Practices Bulletin
Managing Underground Storage Tanks to Prevent Contamination of Drinking Water

This fact sheet focuses on the management of underground storage tanks (USTs) to prevent contamination of drinking water sources (ground water and surface water used as public drinking water supplies). USTs are tanks and any connected underground piping that have at least ten percent of their combined volume underground. USTs contain either petroleum or hazardous substances identified by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), except those substances listed as hazardous wastes. Over 95 percent of USTs contain petroleum.

UNDERGROUND STORAGE TANK USE

You are likely to find many USTs in the vicinity of the water sources you want to protect. Currently, the U.S. EPA regulates about 714,000 active USTs located at about 269,000 sites nationwide. Many USTs are located at filling stations that fuel vehicles. In addition to thousands of roadside filling stations, USTs can be found at airports, school bus barns, hospitals, automotive repair shops, military bases, industrial plants, residential areas and other facilities.

Some USTs, like the following, do not need to meet the Federal requirements:

- USTs not storing either petroleum or certain hazardous substances;
- Farm and residential tanks of 1,100 gallons or less capacity holding motor fuel used for noncommercial purposes;
- Tanks storing heating oil used on the premises where it is stored;
- Tanks on or above the floor of underground areas, such as basements; and
- Septic tanks and systems for collecting storm water and wastewater.
Please note, however, that State UST regulations may be more stringent or differ in other ways from the Federal requirements. You must check with local regulatory authorities to make sure which USTs are subject to what requirements. For example, some States regulate heating oil tanks and farm and residential tanks. Even if your UST does not need to meet Federal, State, or local requirements, you should strongly consider implementing some of the prevention measures mentioned in this fact sheet to preclude future releases.

WHY IS IT IMPORTANT TO MANAGE UNDERGROUND STORAGE TANKS NEAR THE SOURCES OF YOUR DRINKING WATER?

Most UST releases result from the corrosion of parts, improper installation, failure of piping systems, poorly conducted fuel deliveries (spills and overfills), and improper operation and maintenance of the UST system.

UST releases can contaminate soil and drinking water supplies. As of September 2000, almost 412,000 UST releases had been confirmed. Once in the soil, these releases can move rapidly and threaten drinking water supplies. EPA estimates that about half of UST releases reach ground water.

Petroleum includes carcinogenic compounds such as benzene. Even at very low levels, fuel contaminants in water may not be detected by smell or taste, yet they can affect human health. Petroleum can also contain the additive methyl tertiary butyl ether (MTBE), which can make water smell and taste bad enough to be undrinkable. And it does not take much pollution to create a drinking water problem. For example, an unrestricted gasoline leak of one drop per second releases about 400 gallons per year. Even a few quarts of gasoline in the ground water can pollute a drinking water well. Also, cleaning up contaminated soil and ground water involves expensive operations. Average cleanup costs at leaking UST sites are about $125,000, and ground water cleanup at some sites exceeds $1 million.

AVAILABLE PREVENTION MEASURES TO ADDRESS UNDERGROUND STORAGE TANKS

Federal UST regulations were promulgated in 1988 to prevent and detect UST releases (see 40 CFR Part 280). The following paragraphs briefly identify some basic UST requirements. Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source water, the public’s acceptance of the measures, and the community’s desired degree of risk reduction.

Federal UST Requirements

Proper installation. USTs must be installed according to industry standards with great care to maintain the integrity and the corrosion protection of the tank.
Tanks must also be properly sited away from wells, reservoirs, and floodplains. Ideally, all types of USTs should be located outside of source water protection areas.

**Corrosion protection.** UST systems must be made of noncorrodible material, such as fiberglass, or have corrosion protection provided in other ways, such as by being made of externally coated and cathodically protected metal, having double-walls, metal having a thick corrosion resistant cladding or jacket, or having an internal tank lining.

**Spill protection.** USTs must have catchment basins that can catch spills that may occur when the delivery hose is disconnected from the fill pipe. A catchment basin is basically a bucket sealed around the fill pipe.

**Overfill protection.** When an UST is overfilled, large volumes can be released at the fill pipe and through loose fittings on the top of the tank or a loose vent pipe. USTs must have overfill protection devices, such as automatic shutoff devices, overfill alarms, and ball float valves. In addition, proper filling procedures during fuel delivery must be followed to reduce the chance of spills or overfills.

**Leak detection.** Leak detection options include automatic tank gauging, interstitial monitoring, statistical inventory reconciliation, vapor monitoring, and ground water monitoring. All leaks must be detected in a timely manner, before they become big cleanup and liability problems.

**Proper closure.** The regulatory authority needs to be notified 30 days before UST closure, and a determination must be made if any contamination of the environment has occurred. The tank must be emptied and cleaned, after which it may be left underground or removed. Standard safety practices should always be followed when emptying, cleaning, or removing tanks.

Additionally, some large capacity UST owners — those who have more than 42,000 gallons of oil storage capacity at one site — may need to comply with Federal Spill Prevention Control and Countermeasures (SPCC) regulations. Refer to the above ground storage tank fact sheet or 40 CFR Part 112 for information.

**Additional Prevention Measures**

Local jurisdictions may want to implement registration programs for exempt tanks, in order to exercise some oversight of their construction and operation.

Local governments can use land use controls to address some of the potential risks from USTs. For example, zoning can restrict these activities to specific geographic areas that are away from drinking water sources. Prohibition of gas stations (which use USTs) or residential
heating oil tanks in source water protection areas can reduce the risk that harmful contaminants may enter source water. Local governments may also require permits that impose additional requirements such as setbacks, open spaces, buffers, walls and fences; street paving and control of site access points; and regulation of hours and methods of operation.

Work with your State and local UST regulatory authorities to ensure that adequate inspection of UST sites takes place regularly — inspections that verify whether USTs are properly equipped, operated, and maintained so they will not pose a threat to your water source. State UST program contacts are among the many resources found at the Web site described below.

FOR ADDITIONAL INFORMATION

Information and publications on UST regulations and best management practices can be obtained at no cost on the Internet at the following Web site address maintained by EPA’s Office of Underground Storage Tanks: http://www.epa.gov/OUST/. You can also call an EPA Hotline at 1-800-424-9346 for assistance and to order helpful publications about USTs. The most useful general publication is called “Musts For USTs,” a basic plain language description of UST types and Federal requirements. Also, see EPA’s Drinking Water Academy Web site at http://www.epa.gov/safewater/dwa.html for a listing of documents on management measures.

Contact local government authorities in your area to see if there are ordinances in place to manage USTs. Numerous examples of local source water protection-related ordinances for various potential contaminant sources can be found at:
http://www.epa.gov/r5water/ordcom/
http://www.epa.gov/owow/nps/ordinance/
http://www.epa.gov/owow/nps/ordinance/links.htm

The following documents provide additional information on UST prevention measures and regulations:


http://www.state.ia.us/dnr/organiza/wmad/lqbureau/ust/index.htm

http://www.pca.state.mn.us/cleanup/ust.html


Source Water Protection Practices Bulletin

Managing Livestock, Poultry, and Horse Waste to Prevent Contamination of Drinking Water

Animal waste or feces have long been isolated from people for public health reasons. Yet, animal waste is deposited daily into rivers, streams, and other water bodies. This waste poses a continuous threat to human health. Appropriate steps must be taken to lower this risk and prevent contamination of drinking water sources. This fact sheet addresses some source water contamination prevention measures related to livestock, poultry, and horses that can improve water quality and reduce the burden on drinking water treatment facilities. (Refer to the fact sheet on pet and wildlife waste for information on management measures related to these animals.)

SOURCES OF ANIMAL WASTE

Livestock and poultry are major sources of waste. Estimates indicate that the amount of livestock waste is 13 times greater than the amount of human sanitary waste generated in the United States. Livestock and poultry waste can be introduced to the environment through direct discharges, through land application of manure, and from open feedlots, barns and housing, and pastures.

Companion animals, such as horses used for showing and recreation, also produce waste that should be accounted for in pollution prevention. Horses raised on hobby farms, while similar to livestock, are managed differently, allowing for alternative prevention measures. The average horse produces about 45 pounds of waste each day, an amount that can be overwhelming to those operating small, suburban horse farms. Horses are rarely kept in a single facility of more than 50 animals. Although this lower density eliminates some of the concerns that pertain to livestock, horse waste can be managed using many of the same prevention measures used for livestock.

WHY IS IT IMPORTANT TO MANAGE ANIMAL WASTE NEAR THE SOURCES OF YOUR DRINKING WATER?

Animal waste contains many pollutants that can contaminate surface and ground waters used as drinking water sources. Probably the greatest health concern associated with livestock, poultry, and horse wastes is pathogens. Many pathogens found in animal waste can infect humans if ingested. Organisms like Cryptosporidium, Giardia lamblia, and Salmonella can induce symptoms ranging from skin sores to chest pain. E. coli, which causes diarrhea and
abdominal gas, has been the source of disease outbreaks in several States. Particularly virulent strains of *E. coli* can cause serious illness and even death. *Cryptosporidium* is of particular concern because it is highly resistant to disinfection with chlorine. This protozoan causes gastrointestinal illness that lasts 2 to 10 days in healthy individuals but can be fatal in people with weakened immune systems. *Cryptosporidium* was responsible for more than 50 deaths and an estimated 403,000 illnesses after contaminating a Milwaukee drinking water supply. Runoff from cow manure application sites was a suspected source of the *Cryptosporidium*.

Animal wastes can contribute to nitrates in drinking water. Consumption of nitrates can cause methemoglobinemia (blue baby syndrome) in infants, which reduces the ability of the blood to carry oxygen. If left untreated, methemoglobinemia can be fatal. Because of this health risk, EPA set a drinking water maximum contaminant level (MCL) of 10 milligrams per liter or parts per million for nitrate measured as nitrogen.

Animal waste contains many other pollutants of concern that affect humans and water quality. Such pollutants include oxygen-demanding substances that can lead to fish kills and degraded water quality. Solids from animal waste can increase turbidity and adversely affect the taste and odor of waters. In addition, metals such as arsenic, copper, selenium, and zinc, which are often added to animal feed, can be toxic to humans. Antibiotics, pesticides, and hormones, also used in animal feeding operations, can become harmful pollutants as well.

### AVAILABLE PREVENTION MEASURES TO ADDRESS ANIMAL WASTE

Many prevention measures can significantly reduce the impact of waste from livestock, poultry, and horses on water supplies. These measures vary greatly in complexity and cost. It should be noted that individual prevention measures might not be adequate to prevent contamination of source waters. Measures should be combined in an overall pollution prevention approach that considers the nature of the animal waste, the vulnerability of the drinking water sources, and the cost and operation and maintenance requirements of the measures.

Proper management of livestock waste includes preventing animals and their waste from coming into contact with runoff and water sources, properly applying waste as fertilizer on crop or pastures, and appropriately managing pastures.

**Feedlot Management Measures**

Several options are available to reduce contact between manure and precipitation or runoff through proper storage and treatment of the manure from animal operations. Among them are waste storage lagoons, litter storage structures, clean water diversions, composting, and runoff treatment.

**CAFO Permits**

Under the National Pollutant Discharge Elimination System (NPDES) regulations, concentrated animal feeding operations (CAFOs) are defined as point sources and are subject to permitting where they discharge or have the potential to discharge pollutants (40 CFR 122.23). EPA regulations define a CAFO based on the size of the animal feeding operation or its size in combination with the manner of discharge. An animal feeding operation can also be designated a CAFO when the permit authority determines it is a significant source of pollution. A NPDES permit authorizes, and imposes conditions on, the discharge of pollutants. The permit must include technology-based limitations and, if necessary, more stringent water quality-based limitations. EPA has published technology-based limitations (e.g., effluent guidelines) for feedlots at 40 CFR Part 412. The guidelines include numeric limits, non-numeric effluent limitations, and requirements for facilities to use specific BMPs. EPA published a proposed rule in the *Federal Register* on January 12, 2001 (66 FR 2960), that would revise and update both the definition of a CAFO and the effluent guidelines for feedlots. These revisions seek to address water quality issues posed by changes in the animal production industry as well as to more effectively address the land application of CAFO-generated manure and process wastewater. Additional information on this proposed rule can be obtained at [http://www.epa.gov/npdes/afo](http://www.epa.gov/npdes/afo).
A lagoon, or waste storage pond, is made by excavating earth fill to provide temporary storage of animal waste. This practice can reduce the amount of organics, pathogens, and nutrients entering surface waters; however, lagoons can contaminate ground water if they are not constructed and maintained properly. Lagoons have three distinct zones containing liquids, sludge, and solids. These wastes can later be pumped out and applied to cropland as fertilizer.

Because of the risk to ground water, good planning, design, and maintenance are critical when using a lagoon for animal waste storage. Two important components are the location and the liner of the lagoon. A lagoon should be placed in accordance with State and local requirements for separation distances from nearby drinking water wells. Lagoons should be located downslope from wells and never sited on floodplains. Lagoons should be designed to contain at least a 25-year, 24-hour storm plus process wastewater. (A 25-year storm is one that has a one-in-25 chance of occurrence in a given year).

A lagoon should be constructed with a low-permeability liner made of synthetic material or geotextiles or formed by compacted clay or other soil material. Once the liner is established, it is imperative to maintain its integrity during the waste removal process. Any erosion can lead to seepage and subsequent contamination of ground water. Two practices to protect the liner are building a concrete access ramp for waste removal equipment, and operating equipment under dry conditions by first removing all the liquids and letting the solids dry.

Poultry litter storage facilities are designed to keep rainwater and runoff away from poultry house waste being stored for later application to crops. Litter storage can ensure that poultry waste is applied under the proper conditions to protect the environment and to coincide with soil and crop needs. Types of litter storage buildings (ranging from the least to the most protective of water sources) include open stockpiles, covered stockpiles, bunker-type storage, and roofed storage structures. The appropriate size of the storage structure depends on the amount of litter removed and how often the poultry houses are cleaned out.

Clean water diversion is an effective measure that prevents contamination of precipitation or surface flow as it makes its way to drinking water sources. Proper storm water management in and around feedlots and livestock yards, including proper protection (or isolation) of agricultural drainage well inlets, is essential to guarding against ground water contamination. Rain gutters and downspouts on animal shelter roofs keep runoff clean by directing precipitation away from manure. Another tactic to prevent runoff contamination is to construct superficial diversions, such as earthen ridges or diversion terraces built above the feedlot or barnyard, to direct surface flow away from waste.
Composting can help eliminate pathogens and reduce the volume of manure. Composting is the controlled biological decomposition of organic materials; it can be aerobic (occurring with oxygen) or anaerobic (occurring with little or no oxygen). It is perhaps the most common and least costly method of handling livestock waste. Compost sites should be located away from drinking water wells and water sources to avoid leaching during heavy rain. Also, piles should be situated on fairly flat sites where water does not collect or run off. Once manure has fully broken down into usable compost, it can be spread as fertilizer, using proper application methods. Composting should take place at the correct temperature and for an appropriate length of time to kill the pathogens in the manure.

Once runoff becomes contaminated, vegetative filter strips and other means can be used to control overland flow. Such measures treat the runoff from feedlots or grazing areas by absorbing nutrients, bacteria, and chemicals. More detailed descriptions of these types of prevention measures can be found in the fact sheet on managing storm water runoff.

Proper Land Application of Manure

Effective nutrient management minimizes the quantity of nutrients available for loss. This is achieved by developing a comprehensive nutrient management plan and using only the types and amounts of nutrients necessary to produce the crop, applying nutrients at the proper times and with appropriate methods, implementing additional farming practices to reduce nutrient losses, and following proper procedures for fertilizer storage and handling.

Correct placement of manure in the root zone can greatly enhance plant nutrient uptake and minimize losses. Manure should be incorporated into the subsurface, rather than simply applied to the surface to reduce runoff and production of vapors. Waste should never be applied to frozen, snow-covered, or saturated ground. Good management of irrigation water can help maximize efficiency and minimize runoff or leaching.

Proper manure application rates are also important. Applying waste at the time of maximum crop uptake can minimize loss to surface runoff and decrease the amount of manure needed to fertilize crops. Calculating the optimal rate of application also includes crediting other sources that contribute nitrogen and phosphorus to the soil. Furthermore, appropriate manure application is based on yield goals established by the crop producers. Yield expectations are established for each crop and field based on soil properties, available moisture, yield history, and management level. Soil sampling is necessary to determine plant nutrient needs and to make accurate fertilizer recommendations.

Conservation tillage and buffers can reduce runoff over feeding and grazing lands and transport of livestock wastes to water sources. In conservation tillage, crops are grown with minimal cultivation of the soil. Plant residues are not completely incorporated into the soil; instead they remain to provide cover and reduce runoff. Buffer strips and filter strips are created by planting dense vegetation near surface water bodies. The vegetation reduces runoff and filters sediments and chemicals. For more information on buffer strips and filter strips, see the fact sheet on storm water runoff.

In some areas of the country, the amount of animal waste produced is more than can be used by all the crops in the area. In these cases, programs to move the excess manure out of the
watershed or source water protection area or to develop an alternative use for the manure (other than land application) might be necessary.

**Crop rotation** can often yield crop improvement and economic benefits by minimizing fertilizer and pesticide needs. Planting legumes as part of a crop rotation plan provides nitrogen for subsequent crops. Deep-rooted crops can be used to scavenge nitrogen left in the soil by shallow-rooted crops. See the fact sheet on agricultural application of fertilizer for additional information on measures such as laser-controlled land leveling, conservation tillage, and buffer strips.

**Pasture Management**

Several methods are available to keep livestock away from water bodies. In addition to preventing damage to stream banks, *fencing* can be used to keep livestock from defecating in or near streams or wells. Fencing designs include standard or conventional (barbed or smooth wire), suspension, woven wire, and electric fences. The height, size, spacing, and number of wires and posts are a function of the landscape topography as well as the animals of concern. Optimum design criteria depend on the specific situation and should be developed through consultation with biologists. Providing *alternative water sources* and *hardened stream crossings* for use by livestock lessens their impact on water quality.

**FOR ADDITIONAL INFORMATION**

These sources contain information on animal waste pollution prevention measures. All of the documents listed are available free of charge on the Internet.

Contact the Natural Resources Conservation Service (NRCS), Conservation District, and Agricultural Extension Service representatives in your area. They can provide more information on nutrient management and cost-share programs, such as the Environmental Quality Incentives Program (EQIP), the Conservation Reserve Program (CRP), and the Conservation Reserve Enhancement Program (CREP), to assist in financing source water protection measures.


The following sites provide publications and information on livestock management and related prevention measures:

Idaho One Plan (http://www.oneplan.org) provides a catalog of best management practices.

Iowa State University Extension. http://www.exnet.iastate.edu/Pages/pubs/fm1.htm

Michigan Department of Agriculture. Right to Farm Program. http://www.mda.state.mi.us/right2farm/farm.htm

Texas Agricultural Extension Service. http://agextension.tamu.edu

U.S. EPA, Office of Wastewater Management, has a site dedicated to animal feeding operations. http://www.epa.gov/owmitnet/afo.htm

Source Water Protection Practices Bulletin
Managing Pet and Wildlife Waste to Prevent Contamination of Drinking Water

Animal waste or feces have long been isolated from people for public health reasons. However, droppings from pets, such as dogs, cats, exotic birds and rabbits, are deposited into rivers, streams, and other water bodies and can threaten human health. This fact sheet addresses some of the measures pet owners can take to improve water quality and reduce the burden on drinking water treatment. (See the fact sheet on livestock, poultry, and horse wastes for information on management measures related to these animals.)

SOURCES OF PET AND WILDLIFE WASTE

While livestock are the greatest contributor of animal waste, perhaps the least suspected source of animal waste is man’s very own best friend. Pets, particularly dogs, are significant contributors to source water contamination. Studies performed on watersheds in the Seattle, Washington, area found that nearly 20 percent of the bacteria found in water samples were matched with dogs as the host animals.

Wild birds and small mammals can introduce microorganisms into a water supply through direct contact or from watershed runoff. Wildlife commonly associated with microbial contamination of drinking water supplies include deer, beavers, muskrats, rodents, gulls, and geese. Birds are widely reported to be one of the most common and significant sources of contamination of open reservoirs. Areas that are suitable for pets can attract wildlife as well, so tips pet owners can use to deter wildlife are presented in this fact sheet.
WHY IS IT IMPORTANT TO MANAGE PET AND WILDLIFE WASTE NEAR THE SOURCES OF YOUR DRINKING WATER?

Probably the greatest health concern associated with animal wastes is pathogens. Many pathogens found in animal waste can infect humans if ingested. Organisms such as Cryptosporidium, Giardia lamblia, and Salmonella can induce symptoms ranging from skin sores to chest pain. E. coli, which causes diarrhea and abdominal gas, has been the source of disease outbreaks in several States. Particularly virulent strains of E. coli can cause serious illness and fatalities. Cryptosporidium is of particular concern because it is highly resistant to disinfection with chlorine. This protozoan causes gastrointestinal illness lasting two to ten days in healthy individuals but can be fatal in people with weakened immune systems.

Dog and cat droppings often contain roundworms and other parasitic nematodes. Infection by just a few roundworms usually causes no problems, but more severe infections may cause fevers, bronchitis, asthma, or vision problems. Cat feces may contain toxoplasmosis, a parasite that infects humans and other animals. Cats are the only animals known to excrete toxoplasmosis oocysts, which are resistant to most disinfectants. Toxoplasmosis is a serious health concern for pregnant women and immuno-compromised individuals.

AVAILABLE PREVENTION MEASURES TO ADDRESS PET AND WILDLIFE WASTE

The most effective way for pet owners to limit their pet’s contribution to source water contamination is to simply clean up and dispose of pet waste. As long as the droppings are not mixed with other materials, pet waste should be flushed down the toilet. This allows waste to be properly treated by a community sewage plant or septic system. Also, pet waste can be buried or sealed in a plastic bag and put into the garbage if local law allows it (check with the local health department to be sure).

To bury pet wastes, dig a hole at least one foot deep, and place three to four inches of pet waste at the bottom. Use a shovel to chop and mix the wastes into the soil at the bottom, then cover the wastes with at least eight inches of soil to keep rodents and pets from digging them up. Pet wastes should only be buried around ornamental plants, and never in vegetable gardens or food-growing locations.

Pet wastes are not recommended for back yard compost piles. While animal manures can make useful fertilizer, parasites carried in dog and cat feces can cause diseases in humans and should not be incorporated into compost piles. Dogs and cats should be kept away from gardens as well.

Pets should not be walked near streams, ponds, or lakes. Stream banks should not be part of the normal territory of animals. Instead, walk pets in grassy areas, parks, or undeveloped areas. Pet wastes left on sidewalks, streets, or other paved and hard surfaces are readily carried by storm water into streams. Pet wastes should be kept out of street gutters and storm drains.

Some more advanced practices that can be adopted in public parks are doggy loos and pooch patches. Doggy loos are disposal units installed in the ground where decomposition can occur. If pets are allowed off-leash, they can be trained to defecate on pooch patches, which are sandy areas designated for that purpose. Special bins can also be provided for the disposal of pet waste. Wherever pets defecate, whether in public parks or backyards, the “Long Grass Principle” can be used to prevent source water contamination. Not only are dogs readily attracted to long grass, but long grass helps to filter pollutants and the feces can decompose.
naturally while minimally polluting runoff. A height of around ten centimeters (10 cm) is appropriate for such long grass. These long grass areas, however, should be placed away from overland flow paths, stream channels, lakes, drinking water wells, and storm water drainage inlets.

** Managing Wildlife **

Although there are a variety of ways to decrease the risk posed by non-domestic animals by removing attractants or harassing nuisance species, any such plans should be implemented only with a good understanding of the nuisance wildlife population in question. For example, Federal or State permits might be required for wildlife control harassment programs; in addition, some nuisance species, such as Canada geese, are protected by Federal law, and harming the birds or their eggs can result in stiff penalties. Consult fish and wildlife agencies regarding the handling of protected species.

** Harassment ** programs can be implemented to repel birds and wildlife from valuable surface waters. Available methods include habitat modification, decoys, eagle kites, noisemakers, and scarecrows or plastic owls. A daily human presence can keep birds and other wild species away.

** Reducing the attractiveness of yards ** to wildlife might encourage these species to live elsewhere. Species can be diverted from sensitive areas by using fencing, mowing, landscaping changes, tree pruning (to reduce bird roosting), or drainage devices (to keep beavers and muskrats from building dams and dens). Food sources can be kept to a minimum by prohibiting feeding by the public, removing trash, securing pet feed, and reducing palatable plant species.

** FOR ADDITIONAL INFORMATION **

These sources contain information on pet waste pollution prevention measures. All of the documents listed are available free of charge on the Internet.

If your community does not regulate pet waste, e.g., with a “pooper-scooper” ordinance, try to make it a priority of your local governing body. Contact the local animal control officer or local or State department of health. Encourage the parks and recreation department to place pet waste collection and disposal stations in public parks.

Home*A*Syst (www.uwex.edu/homeasyst) provides valuable information on environmental and health issues in and around the home.

Managing Septic Systems to Prevent Contamination of Drinking Water

Septic systems (also known as onsite wastewater disposal systems) are used to treat and dispose of sanitary waste. When properly sited, designed, constructed, and operated, they pose a relatively minor threat to drinking water sources. On the other hand, improperly used or operated septic systems can be a significant source of ground water contamination that can lead to waterborne disease outbreaks and other adverse health effects.

This fact sheet discusses ways to prevent septic systems from contaminating sources of drinking water. Septic systems that receive non-sanitary wastes (e.g., industrial process wastewater) are considered industrial injection wells, and are not the primary focus of this fact sheet. Other fact sheets in this series address prevention measures for contamination sources such as fertilizers, pesticides, animal feeding operations, and vehicle washing.

**SOURCES OF SEPTIC SYSTEM EFFLUENT**

About 25 percent of U.S. households rely on septic systems to treat and dispose of sanitary waste that includes wastewater from kitchens, clothes washing machines, and bathrooms. Septic systems are primarily located in rural areas not served by sanitary sewers.

A typical household septic system consists of a septic tank, a distribution box, and a drain field. The septic tank is a rectangular or cylindrical container made of concrete, fiberglass, or polyethylene. Wastewater flows into the tank, where it is held for a period of time to allow suspended solids to separate out. The heavier solids collect in the bottom of the tank and are partially decomposed by microbial activity. Grease, oil, and fat, along with some digested solids, float to the surface to form a scum layer. (Note: Some septic tanks have a second compartment for additional effluent clarification.)

The partially clarified wastewater that remains between the layers of scum and sludge flows to the distribution box, which distributes it evenly through the drain field. The drain field is a network of perforated pipes laid in gravel-filled trenches or beds. Wastewater flows out of the pipes, through the gravel, and into the surrounding soil. As the wastewater effluent percolates down through the soil, chemical and biological processes remove some of the contaminants before they reach ground water.
Large capacity septic systems are essentially larger versions (with larger capacities and flow rates) of single family residential septic systems, but they may have more than one septic tank or drain field for additional treatment capacity. In some cases, an effluent filter may be added at the outlet of the large capacity septic tank to achieve further removal of solids. Many large systems rely on pumps rather than gravity to provide an even flow distribution into the drain field.

WHY IS IT IMPORTANT TO MANAGE SEPTIC SYSTEMS NEAR THE SOURCES OF YOUR DRINKING WATER?

Septic systems are a significant source of ground water contamination leading to waterborne disease outbreaks and other adverse health effects. The bacteria, protozoa, and viruses found in sanitary wastewater can cause numerous diseases, including gastrointestinal illness, cholera, hepatitis A, and typhoid.

Nitrogen, primarily from urine, feces, food waste, and cleaning compounds, is present in sanitary wastewater. Consumption of nitrates can cause methemoglobinemia (blue baby syndrome) in infants, which reduces the ability of the blood to carry oxygen. If left untreated, methemoglobinemia can be fatal for affected infants. Due to this health risk, a drinking water maximum contaminant level (MCL) of 10 milligrams per liter (mg/l) or parts per million (ppm) has been set for nitrate measured as nitrogen. Even properly functioning conventional septic systems, however, may not remove enough nitrogen to attain this standard in their effluent.

AVAILABLE PREVENTION MEASURES TO ADDRESS SEPTIC SYSTEMS

Septic systems can contribute to source water contamination for various reasons, including improper siting, poor design, faulty construction, and incorrect operation and maintenance. Most States and localities regulate siting, design, and construction of septic systems and only regulate operation and maintenance for large capacity septic systems. Some of the more widely used prevention measures are described below. Your local health department should be able to advise you on specific requirements for your community.

Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source water, the public’s acceptance of the measures, and the community’s desired degree of risk reduction.

Siting

Most jurisdictions have adopted, for septic systems, minimum horizontal setback distances from features such as buildings and drinking water wells and minimum vertical setback distances from impermeable soil layers and the water table. Septic systems should be located a safe distance from drinking water sources to avoid potential contamination. Areas with high water tables and shallow impermeable layers should be avoided because there is insufficient unsaturated soil thickness to ensure sufficient treatment. Soil permeability must be adequate to ensure proper treatment of septic system effluent. If permeability is too low, the drain field may not be able to handle wastewater flows, and surface ponding (thus contributing to the contamination of surface water through runoff) or plumbing back-ups may result. If permeability is too high, the effluent may reach ground water before it is adequately treated. As a result, alternative systems may be necessary in karst areas. Well-drained loamy soils are generally the most desirable for proper septic system operation. In making siting decisions, local health officials should also evaluate whether soils and receiving waters can absorb the combined effluent loadings from all of the septic systems in the area.
Design and Construction

Septic tanks and **drain fields should be of adequate size** to handle anticipated wastewater flows. In addition, soil characteristics and topography should be taken into account in designing the drain field. Generally speaking, the lower the soil permeability, the larger the drain field required for adequate treatment. Drain fields should be located in relatively flat areas to ensure uniform effluent flow.

Effluent containing excessive amounts of grease, fats, and oils may clog the septic tank or drain field and lead to premature failure. The installation of **grease interceptors** is recommended for restaurants and other facilities with similar wastewater characteristics.

Construction should be performed by a **licensed septic system installer** to ensure compliance with applicable regulations. The infiltration capacity of the soil may be reduced if the soil is overly compacted. Care should be taken not to drive heavy vehicles over the drain field area during construction or afterward. Construction equipment should operate from upslope of the drain field area. Construction should not be performed when the soil is wet, or excessive soil smearing and soil compaction may result.

Operation and Maintenance

Proper operation and maintenance of septic systems is perhaps the most crucial prevention measure to preventing contamination. Inadequate septic system operation and maintenance can lead to failure even when systems are designed and constructed according to regulation. Homeowners associations and tenant associations can play an important role in educating their members about their septic systems. In commercial establishments such as strip malls, management companies can serve a similar role. Septic system owners should continuously monitor the drain field area for signs of failure, including odors, surfacing sewage, and lush vegetation. The septic tank should be **inspected annually** to ensure that the internal structures are in good working order and to monitor the scum level.

Many septic systems fail due to hydraulic overloading that leads to surface ponding. Reducing wastewater volumes through **water conservation** is important to extend the life of the drain field. Conservation measures include using water-saving devices, repairing leaky plumbing fixtures, taking shorter showers, and washing only full loads of dishes and laundry. Wastewater from basement sump pumps and water softeners should not be discharged into the septic system to minimize hydraulic load. In addition, surface runoff from driveways, roofs, and patios should be directed away from the drain field.

If an excessive amount of sludge is allowed to collect in the bottom of the septic tank, wastewater will not spend a sufficient time in the tank before flowing into the drain field. The increased concentration of solids entering the drain field can reduce soil permeability and cause the drain field to fail. Septic tanks should be pumped out every two to five years, depending on the tank size, wastewater volume, and types of solids entering the system. Garbage disposals increase the volume of solids entering the septic tank, requiring them to be pumped more often.
Household chemicals such as solvents, drain cleaners, oils, paint, pharmaceuticals, and pesticides can interfere with the proper operation of the septic system and cause ground water contamination. Homeowners should take advantage of local hazardous waste collection programs to dispose of these wastes whenever possible. Grease, cooking fats, coffee grounds, sanitary napkins, and cigarettes do not easily decompose, and contribute to the build-up of solids in the tank. The use of additives containing yeast, bacteria, enzymes, and solvents has not been proven to improve the performance of septic systems, and may interfere with their normal operation. Bacterial “starters” are not necessary because a wide range of bacteria are normally present in sewage entering the tank. Additives containing solvents or petrochemicals can cause ground water contamination.

Vehicles and heavy equipment should be kept off the drain field area to prevent soil compaction and damage to pipes. Trees should not be planted over the drain field because the roots can enter the perforated piping and lead to back-ups. Last, any type of construction over the drain field should be avoided. Impervious cover can reduce soil evaporation from the drain field, reducing its capacity to handle wastewater.

FOR ADDITIONAL INFORMATION

For information on septic system regulations in your community, contact your state or local health department. The information sources below contain information on measures to prevent septic system failures. All of the documents listed are available free of charge on the Internet.

Numerous documents on septic systems are available for download from U.S. Department of Agriculture Cooperative State Research, Education, and Extension Service State Partners. Links to the various State Partners can be found at http://www.reeusda.gov/1700/statepartners/usa.htm. Several examples of these documents are presented below:


Many small businesses, government agencies, and academic institutions use chemicals to carry out their business functions. Although varying greatly in purpose, these small quantity chemical users share in their ability to potentially contribute to the pollution of drinking water. Many small businesses understand their day-to-day business operations but may lack familiarity with procedures for proper use and management of chemicals. This fact sheet provides an overview of prevention measures and demonstrates how precaution must be taken in all areas regarding chemical use. Businesses that generate hazardous waste, as it is defined under the Resource Conservation and Recovery Act, should consult with their State hazardous waste agency regarding proper handling and disposal.

**Places Where Small Quantity Chemical Use Occurs**

Small quantity chemical users include dry cleaners, beauty shops, photo finishers, vehicle repair shops, printers, laboratories, water supply facilities, academic institutions, nursing homes, medical facilities, and many others. It is the daily practices of these businesses that use chemicals and produce chemical waste. Degreasing, cleaning, polishing, paint preparation, rust removal, and photo processing are just a fraction of the activities in which small businesses are engaged.

Improper disposal of chemicals from these users can reach ground or surface water through a number of pathways. If substances from these businesses are accidentally or intentionally discharged into sewers, contamination of ground and surface waters can occur. Improper disposal into sewers can also endanger the ability of publicly-owned treatment works (POTWs) to properly treat wastewater. Chemicals poured into septic systems or dry wells can leach into ground water or contribute to treatment system failure. Chemical users should always ensure that haulers they hire to carry their waste off-site are properly licensed and that they deliver the waste to appropriate disposal sites.
Many ordinary businesses use chemicals and produce chemical waste that can be harmful to humans if ingested. Types of chemicals used by these businesses include solvents, corrosives, dry cleaning agents, heavy metals and inorganics, inks and paint, lead-acid batteries, plating chemicals, cyanide, and wood preserving agents. Each set of contaminants has its own environmental and health hazards. For example, a dry cleaning filtration residue, perchloroethylene, causes kidney and liver damage in both humans and animals. It is among the most common contaminants in ground water and a very small amount can contaminate many thousands of gallons of water.

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**Why is it Important to Manage Small Quantity Chemical Use Near Sources of Drinking Water?**

Due to the large number and variety of businesses that use chemicals, there are a vast number of prevention measures, many of which are specific to the facility of interest. This fact sheet discusses some prevention measures that are common to most chemical using facilities. Before a facility can implement any pollution prevention practice, it must first assess what kinds of chemicals are used and how they are used. Monitoring chemical use can help operators decide which option will be the most beneficial. Businesses should start with easy and inexpensive practices before considering more costly measures such as equipment and process modifications. Some of the easiest and least expensive practices can produce the most effective pollution prevention results.

Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source waters, the public’s acceptance of the measures, and the community’s desired degree of risk reduction.

**Available Prevention Measures to Address Small Quantity Chemical Use**

Due to the large number and variety of businesses that use chemicals, there are a vast number of prevention measures, many of which are specific to the facility of interest. This fact sheet discusses some prevention measures that are common to most chemical using facilities. Before a facility can implement any pollution prevention practice, it must first assess what kinds of chemicals are used and how they are used. Monitoring chemical use can help operators decide which option will be the most beneficial. Businesses should start with easy and inexpensive practices before considering more costly measures such as equipment and process modifications. Some of the easiest and least expensive practices can produce the most effective pollution prevention results.

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**Ways to Avoid Excess Chemical Use:**

5 - Measure carefully to avoid producing large quantities of useless material.

Waste exchanges reduce disposal costs and quantities, reduce the demand for natural resources and increase the value of waste.

6 - Order materials on an as-needed basis.

**Waste Reduction and Management -**

Good waste reduction and management strategies can significantly reduce the threat of hazardous materials to drinking water sources. Make sure employees carefully follow the manufacturer’s directions when mixing or using chemicals to prevent producing large quantities of useless material that must be disposed of as waste. The toxicity of waste can be reduced by using the least hazardous or least concentrated products available to accomplish their processes. Such substitutions include the use of water based paints, or high solids solvent based paints when water based paints are not available. Cleaning products and solvents, which can contain highly toxic or harsh chemicals, can be replaced with less hazardous counterparts. Printing businesses can use non-toxic inks that are free of heavy metal pigments.

**Responsible Purchasing -**

Responsible purchasing can also drastically decrease the amount of waste for disposal. This includes ordering materials on an as-needed basis and returning unused portions back to vendors. A facility may unwittingly create excess harmful materials by mixing hazardous with nonhazardous waste. Avoiding this practice can significantly reduce the toxicity of waste disposed and increase the possibility of recycling materials. Another method of waste reduction is trading waste with other businesses. Waste exchanges reduce disposal costs and quantities, reduce the demand for natural resources, and increase the value of waste.
Proper Use and Handling of Chemicals:

**Reading the Labels -**
Reading the label on chemical containers is one of the simplest and most important prevention measures. The label provides information on proper use, storage, and disposal and may provide emergency information in the event the product is accidentally spilled or ingested. In cases where the chemical is highly dangerous, the label will contain special warnings or use restrictions.

7 - Labels provide information on proper use, storage and disposal.

8 - All staff should be trained on proper storage and spill protocols.

**Employee Training -**
Employee training is critical in preventing source water pollution by chemical using facilities. While many preventive measures seem simple and straightforward, if they are not followed or employees are unaware of them, significant consequences can result. All staff should be trained to store materials properly and be aware of spill control and response protocols. Employees can be encouraged to learn and retain proper procedures through periodic drills, pollution prevention training workshops, and company incentive or reward programs.

Proper Storage and Disposal of Chemicals:

**Proper On-Site Storage -**
Proper on-site storage of hazardous substances helps to prevent accidental leaks and applies to both storage areas and containers. Designated storage areas should have paved or impervious surfaces, a protective cover, and secondary containment around all containers to catch spills. Containers should have clear and visible labels which include purchase date and all information presented on the distributor’s original label. Dating materials allows facilities to use older materials first. When not in use, storage containers must be sealed to prevent spills and evaporation. Storage areas and containers should be thoroughly inspected on a weekly basis and secured against unauthorized entry. Care should be taken that chemical storage and handling areas do not allow for contamination of storm water flows. EPA has developed extensive guidance providing BMPs for storm water management in industrial settings.

9 - Compare the chemical needs of a facility to the supply on-hand. Excess chemicals should be removed.

**Chemical Audits -**
Chemical audits are a good starting point. It is important to understand chemical needs for the facility and compare these to the chemical supply on hand. Where appropriate, excess chemicals should be removed (and properly disposed), or future purchasing adjusted to reduce stored inventories. A chemical management plan that includes a list of chemicals used, the method of disposal such as reclamation or contract hauling, and procedures for assuring that toxic chemicals are not discharged into source water should be implemented.

10 - Storage areas should have impervious surfaces, a protective cover, and secondary containment around all containers to catch spills.
Proper Disposal Decisions and the MSDS

Hazardous waste should never be discharged into floor drains, storm drains, toilets, sinks, other improper disposal areas, or other routes leading to public sewers, septic systems, or dry wells. Chemical waste should be disposed of according to the manufacturer’s directions and State and local requirements. Many local communities sponsor household hazardous waste events to collect and properly dispose of small quantities of chemicals.

A useful tool for making disposal decisions is the Material Safety Data Sheet (MSDS). These sheets provide important information regarding contents of commercial products and enable a facility to determine whether materials will produce hazardous waste. MSDS data (i.e., chemical name, ingredients, possible carcinogens, and other known hazards) are also important for chemical use, storage and spill control. MSDS documents can be obtained from manufacturers and should be kept readily accessible.
**Additional Information**

These sources contain information on small quantity chemical use pollution prevention practices. All of the documents listed are available free of charge on the Internet.

Assistance is available to communities wishing to enact ordinances to protect water supplies from contamination due to small quantity chemical use or to small businesses seeking to improve their operations with management measures. Local fire departments or departments of health have the authority to pass ordinances or regulations covering chemical use and safety. Contact local government authorities in your area to see if there are ordinances in place to manage small quantity chemical use. Numerous examples of local source water protection-related ordinances for various potential contaminant sources can be found at: http://www.epa.gov/r5water/ordcom/
http://www.epa.gov/owow/nps/ordinance/

The Small Business Environmental Home Page (http://www.smallbiz-enviroweb.org/fundstat.html) provides links to financial assistance programs and other available assistance in all 50 States.

The following resources provide information on selection and design of specific management measures:


The following sites provide information on preventive measures for small quantity chemical use:
downdthedrain.org is a site dedicated to reducing the threat of hazardous materials to our drinking water supply. http://www.downdthedrain.org

The Miami-Dade Department of Environmental Resource Management provides several best management practices fact sheets for various types of facilities. http://www.co.miami-dade.fl.us/derm/

The Small Business Environmental Home Page (http://www.smallbiz-enviroweb.org) helps small business access environmental compliance and pollution prevention information. Its publication section provides documents and web sites for various small quantity chemical users.


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**Image Credits**

1 - 5 - Previous Small Quantity Chemical Use Bulletin from 2001.

6 - Shopping bags. Composite image of shopping bags.

7 - Previous Small Quantity Chemical Use Bulletin from 2001.

8 - Flickr Creative Commons: Attribute only search. Serene Computer Lab at Seward Montessori School, uploaded by “izzymuncheht” on September 21, 2007.

9 - Supply and Demand Curve: http://sworlandoblog.com/2008/04/01/orlando-has-the-most-number-of-vacant-homes/

10 - Image taken from the original 2001 Above Ground Storage Tank Bulletin.


12 - Spill Response Sample Plan taken from: http://www.northshorecity.govt.nz/OurCommunity/EnvironmentalEducation/PollutionPrevention/Pages/PollutionPreventionAtWork.aspx


Back Cover - Flickr Creative Commons: Attribute only search. Graduated cylinders and beaker filled with chemical compounds, uploaded by “Horia Varlan” on January 14, 2010.
14 - Sample of spill response supplies.
Source Water Protection Practices Bulletin

Managing Small Quantity Chemical Use to Prevent Contamination of Drinking Water

The mission of EPA is to protect human health and to safeguard the natural environment -- air, water and land -- upon which life depends.

USEPA East (EPA East) [Old ICC Building]
1201 Constitution Avenue N.W.
Washington, DC 20004
Source Water Protection Practices Bulletin
Managing Turfgrass and Garden Fertilizer Application to Prevent Contamination of Drinking Water

Fertilizers are made up of organic and inorganic materials that are added to soil to supply nutrients required for plant growth. If improperly managed, fertilizer elements, specifically phosphorus (P) and nitrogen (N), can run off into surface water or leach into ground water. This fact sheet focuses on the management of small-scale fertilizer applications to prevent contamination of drinking water sources (ground water and surface water used as public drinking water supplies); see the fact sheets on pesticide application and storm water for other preventative measures related to lawn and garden care.

FERTILIZER USE IN TURFGRASS AND GARDENS

The care of landscaped areas can contribute to the pollution of surface water and ground water. Heavily landscaped areas include residential yards, commercial lawns, golf courses, ball fields, and parks. The soils in many of these areas require frequent fertilization to maintain their turf grass. Because excess fertilizer use and poor application methods can cause fertilizer movement into sources of drinking water, the increased application of lawn and garden fertilizers in recent years has raised concern over the pollution of surface water and ground water.

The two main components of fertilizer that are of the greatest concern to source water quality are nitrogen and phosphorus. Nitrogen is used to promote green, leafy, vegetative growth in plants. Plants with nitrogen deficiency show stunted growth. Phosphorus promotes root growth, root branching, stem growth, flowering, fruiting, seed formation, and maturation.

A recent nonpoint source loading analysis from a New Jersey study indicated that ten percent of the nitrogen and four percent of the phosphorus applied annually in a 193-square-mile area of landscaped residential development ended up in surface waters as a result of over-application. Another study (South Jersey Resource Conservation and Development Council, Inc.) found that more than 50 percent of the nitrogen in fertilizer leaches from lawns when improperly applied. This kind of nutrient loss can be reduced by following the prevention measures given in this fact sheet.
WHY IS IT IMPORTANT TO MANAGE FERTILIZER USE NEAR THE SOURCES OF YOUR DRINKING WATER?

Improper or excessive use of fertilizer can lead to nitrate pollution of ground or surface water. Nitrogen fertilizer, whether organic or inorganic, is biologically transformed to nitrate that is highly soluble in water.

Use of nitrogen-containing fertilizers can contribute to nitrates in drinking water. Consumption of nitrates can cause methemoglobinemia (blue baby syndrome) in infants, which reduces the ability of the blood to carry oxygen. If left untreated, methemoglobinemia can be fatal for affected infants. Due to this health risk, EPA set a drinking water maximum contaminant level (MCL) of 10 milligrams per liter (mg/l) or parts per million (ppm) has been set for nitrate measured as nitrogen.

Phosphorus is the other element of concern in fertilizer. Under certain conditions phosphorus can be readily transported with the soil. In fact, 60 to 90 percent of phosphorus moves with the soil. Phosphorus is the major source of water quality impairments in lakes nationwide. Even though regulations that affect the taste and odor of water are not Federally enforceable under the Safe Drinking Water Act, municipalities often must treat their drinking water supplies for these aesthetic reasons.

AVAILABLE PREVENTION MEASURES TO ADDRESS TURFGRASS AND GARDEN APPLICATIONS OF FERTILIZER

This section discusses some of the most often used prevention measures, but is not an exhaustive list of all known measures. For information on additional prevention measures, see the documents referenced in the last section of this fact sheet. Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source water, the public’s acceptance of the measures, and the community’s desired degree of risk reduction.

Ways to Eliminate Excess Fertilizer Use

Fertilizer applications should be based on soil tests to avoid the economic and environmental costs that can be incurred with excess fertilizer use. A soil test will show the levels of phosphorus and potassium present in the lawn; however, soil tests for nitrogen are rare. Nitrogen is highly mobile in the soil and tests generally provide little useful information relative to lawns. Most newly planted areas should be tested during initial planting and every one or two years following that. A minimum of three to four weeks after the last fertilization should pass before sampling. For sampling, 15 to 20 cores should be taken at about three to four inches in depth and mixed in a plastic container. Samples can be tested using readily available field kits or submitted to a private laboratory or extension office for testing and interpretation.

Selecting the appropriate fertilizer is the next crucial step after receiving soil testing results. Most homeowners use blended fertilizers that list percentages of nitrogen, phosphorus, and potassium in the fertilizer. For example, a 100-pound bag of 10-5-10 would contain ten pounds of nitrogen, five pounds of phosphorus, and ten pounds of potassium. The remainder of the bag contains micronutrients and filler materials that allow for an even application of nutrients. If the soil test shows phosphorus is high, then a fertilizer with a low percentage of phosphorus should be chosen (such as 20-0-10 or 24-3-8). Most lawns contain adequate phosphorus, and continuous use of fertilizers high in phosphorus can result in excessive buildups. These lawns are more likely to contribute high levels of phosphorus to surface water during storm runoff events. The use of organic nutrient sources, such as manure, can supply all or part of the
nitrogen, phosphorus, and potassium needs for turfgrass and gardens. However, organic fertilizers can also cause excessive nutrient loads if improperly applied.

Nitrogen should be applied as recommended for the type of grass being grown. It is often recommended that 1,000 square feet of lawn requires 0.5 pounds of nitrogen per month of active growth. A good rule is never to apply more than one pound of nitrogen fertilizer per 1,000 square feet of lawn in any one application. For vegetable and flower gardens only 0.1 to 0.2 pounds of nitrogen per 100 square feet should be applied per year, although corn, tomatoes, and cole crops may require more.

To help maintain a healthy lawn it is best to mow frequently at a height of 2.5 to 3 inches. Grass clippings should remain on the lawn to decompose and recycle nutrients back to the lawn. By leaving grass clippings on the lawn, nitrogen applications can be reduced by 30 to 40 percent.

Wherever possible, low maintenance, native plants and grasses should be planted to minimize the use of fertilizer. Plants that are adapted to the local soils require less fertilization and watering (for example, xeriscaping is a landscaping method to minimize the use of water in dry climates). In fact, these practices can reduce required lawn maintenance up to 50 percent. Local planting suggestions may be obtained from State and county extension offices and Web sites.

Proper Fertilizer Application

The use of an appropriate form of nitrogen fertilizer can reduce the potential for leaching and runoff problems. Quick-release fertilizers should be used on heavy clay or compacted soils, because the longer a fertilizer granule remains intact, the greater the chances it will be washed away into surface water. On sandy soils, however, nitrogen can leach through the soil quickly. On these soils, slow-release nitrogen sources provide soluble nitrogen over a period of time so a large concentration of nitrogen is not made available for leaching. Fertilizer bags are generally labeled as a ratio of water-insoluble nitrogen (WIN) slow-release fraction, to water-soluble nitrogen (WSN) quick-release fraction. A large WIN/WSN ratio indicates a high percentage of slow-release nitrogen is contained in the product.

While the proper time of year to fertilize varies by location, applying a smaller amount of fertilizer at a higher frequency is often best. Eliminating excess nutrients in soil reduces the chances of polluting surface runoff and ground water. Ideally, fertilizer application should be timed to coincide as closely as possible to the period of maximum uptake and growth. The most active growth periods are spring and fall in cool climates and early and late summer in warm climates. Avoid fertilizer applications before heavy rains.

Core compacted soils before applying fertilizer to insure incorporation. In all types of soil, it is always best to incorporate organic fertilizers into the lawn. When the phosphorus in organic fertilizer remains on top of the soil it has an increased chance of washing away during heavy
rains. Fertilizer should never be applied to frozen ground, and also should be limited on slopes and areas with high runoff or overland flow.

It is important to **irrigate** with ¼ to ½ inch of water immediately after application of phosphorus or water-soluble nitrogen fertilizer. Afterwards, the key is to add only enough water to compensate for that removed by plant uptake and evaporation; this will minimize potential pollution problems from runoff and leaching. Over-watering can increase nitrogen loss five to 11 times the amount lost when proper watering strategies are used. Soaker hoses and trickle or drip irrigation systems are preferred alternatives to sprinkler systems. These systems deliver water at lower rates, which can conserve water, increase the volume infiltrated, and reduce surface runoff.

To ensure the proper amount of fertilizer is applied, *spreaders should be properly calibrated*. As spreaders get older, settings gradually change because of wear and tear. Regular cleaning and lubrication of the spreader will help it perform properly. Labels on fertilizer bags often list the proper spreader settings for different types of spreaders. In general, drop spreaders are slower and more precise than rotary spreaders. Drop spreaders should be used near bodies of water because rotary spreaders can easily cast granules into the water bodies.

**Buffer strips or filter strips** can be created to slow runoff and help filter nitrogen and phosphorus from runoff. Buffers to runoff can be created simply by avoiding consistent mowing near water bodies. Additionally, natural deep-rooted vegetation can be planted to enhance nutrient filtering. Soil is held in place by the root systems of these plants. This decreases the velocity of runoff and helps prevent erosion near sources of surface water. The vegetation and soil strain and filter sediments, nutrients, and chemicals. For more information on buffer strips and filter strips see the fact sheet on storm water runoff.

**Fertilizer Storage and Handling**

Closely follow label directions when storing and handling fertilizer and when disposing empty containers. Stored dry fertilizer poses little threat to ground water as long as it is kept dry. Therefore, stored fertilizer should be kept covered to keep precipitation off. Keep bags on pallets to reduce the possibility of water damage.

Fill spreaders on hard or paved surfaces where spills can be cleaned up easily by sweeping or scooping up the spilled granules.

**Additional Prevention Measures for Golf Courses**

Golf course fairways, tees, and greens should be located where the seasonal water table is not excessively high. Fertilizer movement will be lowest on these sites.

State or local governments can produce guidelines for the design and maintenance of golf courses. These guidelines can require golf course developers and managers to submit plans for approval that show how they intend to lessen the impact of the site on the natural resources of the area. Plan requirements could include ground water and surface water monitoring, and design specifications, such as vegetative buffers or erosion controls.
FOR ADDITIONAL INFORMATION

These documents contain information on fertilizer use and best management practices. All sources are available for free on the Internet. See EPA’s Guide to Source Water Information at www.epa.gov/safewater/protect/sources.html for a listing of resources on management measures. You can also contact your local Extension Service for more information.

Contact local government authorities in your area to see if there are ordinances in place to manage fertilizer use. Numerous examples of local source water protection-related ordinances for various potential contaminant sources can be found at:
http://www.epa.gov/r5water/ordcom/
http://www.epa.gov/owow/nps/ordinance/
http://www.epa.gov/owow/nps/ordinance/links.htm

The following documents provide more detailed information on prevention measures for fertilizer use in lawns and gardens.


The following documents are examples of local guidelines for the design and maintenance of golf courses:


The following University of Florida website details their outreach program to reduce non-point source pollution, which includes proper nutrient management techniques: http://hort.ufl.edu/fyn/
Pesticides (including insecticides, herbicides, and fungicides) contain a variety of chemicals used to control pests, insects, and weeds. They are used in many applications to reduce the damage to plants by insects and other pests, and to control overgrowth of undesirable plant species. This fact sheet describes measures to prevent contamination of drinking water sources from small-scale pesticide application (i.e., on lawns, golf courses, cemeteries, parks, and roadways); see also the fact sheet on prevention measures for large-scale pesticide application for agricultural or farm conditions.

**SOURCES OF PESTICIDES**

Pesticides are used in a variety of applications in areas with green spaces. They are used by homeowners, in commercial establishments such as golf courses and cemeteries, and along roadways. Homeowners use pesticides in lawn care and gardening activities. Many homeowners plant non-native plant species, which require pesticides, fertilizers, and watering to keep them healthy.

Golf courses and recreational areas such as parks and other open spaces use pesticides for similar purposes. Shorter grasses typical of golf courses are less resistant to insects and require application of pesticides to keep them healthy. Pesticides are also used to maintain lawns in cemeteries and commercial areas. Herbicides are used along roadways and transportation and utility corridors to limit vegetation growth and increase visibility for drivers or access to power lines.

Excess rain can wash pesticides from plants and soil. This can, in turn, run off into streams. Pesticides can leach into the soil if plants are watered or rainfall occurs soon after application. Some pesticides resist degradation by microbes in the soil and will eventually leach into the ground water. Pesticides can reach ground water through drains, sink holes, and other conduits as well.

**WHY IS IT IMPORTANT TO MANAGE SMALL SCALE APPLICATION OF PESTICIDES NEAR THE SOURCES OF YOUR DRINKING WATER?**

Pesticides contain a variety of organic and inorganic compounds. By nature, they are poisonous, and while they can be safely used if manufacturers’ usage directions are followed, they can, if
mismanaged, seep into surface water and ground water supplies. They can be difficult and expensive to remove, and, if inhaled or consumed, be hazardous to human health. The synthetic organic chemicals in pesticides have been linked to serious health problems, including cancer, liver and kidney damage, reproductive difficulties, and nervous system effects.

Once a water supply becomes contaminated with a pesticide, it can be very difficult and costly to treat. Treating the water supply is a lengthy process and is not always successful. Using an alternative water source may also be costly and impractical. For example, it would be very expensive to connect to another public water system, and drilling new wells does not necessarily guarantee that the new ground water source will not be contaminated.

**AVAILABLE PREVENTION MEASURES TO ADDRESS SMALL-SCALE PESTICIDE APPLICATION**

Prevention measures are available to protect source water from pesticide contamination. They range from simple, common-sense activities (e.g., reading the label) to more complex activities such as properly storing and disposing pesticides. Most prevention measures for small-scale application of pesticides tend to be easy, low cost activities. The most effective pesticide contamination prevention measures encompass both simple and complex practices to reduce the potential for pesticides to move into source water. Prevention measures can be divided into those that protect surface water from pesticide runoff and those that protect ground water from leaching or percolation.

Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source waters, the public’s acceptance of the measures, and the community’s desired degree of risk reduction. The following are the more conventional prevention measures used to avoid contamination from small-scale application.

There are many options available to minimize the need for pesticides. **Integrated Pest Management (IPM)** is the use of all means of pest control (chemical and non-chemical) in a compatible fashion to reduce pesticide use. Pesticides are the last line of defense and are used only when pest levels are causing sufficient damage to offset the expense of the application. IPM includes **regular monitoring** to check levels of pest populations and their damage to determine management needs, be it pesticide application or other management actions. Monitoring can be accomplished by a trained employee such as a facility manager. IPM also includes **non-chemical control measures** such as mechanical, cultural and biological controls, sanitation, and pesticide-resistant plants are highly recommended. Where possible **alternate plants**, select **pest-resistant plant varieties**, and mulch the gardens or flower beds to reduce weeds. Maximize the benefits of naturally occurring **biological controls** by using pesticides only when necessary. Many insecticides are broad spectrum materials and affect beneficial insects and other arthropods as well as pests. If pesticides must be used, select those that are designed specifically for the pests you wish to control, and are **low-persistent** in the environment.
Proper Pesticide Application

**Reading the label** on the pesticide container is one of the simplest and most important prevention measures. The label indicates the proper use, rate of application, whether the pesticide is broad spectrum or selective (i.e., kills everything or only a certain type of insect), and proper handling of the pesticide. The label also provides information on proper storage and disposal, and emergency contact numbers, if accidentally ingested. In cases where the pesticide is highly toxic, the label will contain special warnings and use restrictions, such as **setbacks** for mixing and application away from wells or drinking water sources. Reading the label and following the directions will ensure that pesticides are *not over-used* and are used in a way that is **consistent** with the pest problem.

**Proper application** of pesticides reduces the amount of chemicals applied to the ground and saves landowners money by reducing the amount of pesticides purchased. Calibrate application equipment to allow correct application, follow pesticide manufacturers’ directions, and select leaching-resistant or “slow release” pesticides. Apply in large droplets to resist carrying away by the wind. Mix and load pesticides only over impervious surfaces, such as cement, that do not contain floor drains or storm water drain inlets; these drains may convey spills to ground water sources. Check the pesticide label for pesticide application procedures; do not over-apply the pesticide.

Pesticides should not be applied immediately before or after rainfall, as this may cause soil runoff at the application site and the need to reapply the pesticide. The soil in the runoff can carry the pesticide to the local storm water drain, and contaminate local source waters.

**Ways to Reduce Pesticide Use**

**Select healthy seeds** and seedlings that are known to resist diseases and are suited to the climate. Strong seeds are likely to produce mature plants with little need for pesticides. Planting pest-resistant plant varieties and local plant species will also reduce pesticide needs.

**Alternate your plants** each year; plants will not be vulnerable to the pests that survive the winter. Insects will move to another location where they can find nutrients, and weeds will remain dormant until their nutrient source is replenished.

**Manual activities** such as spading, hoeing, hand-picking weeds and pests, setting traps, and mulching are all good ways to get rid of pests without using pesticides. Homeowners have a tendency to over-use pesticides, and should take care to use only what they need.

**Proper plant management** can improve plant health, reduce the need for pesticides, and reduce runoff and infiltration. Use mowing and watering techniques that maintain a healthy lawn and minimize the need for chemical treatment. Maintain proper drainage and aeration to encourage the growth of microbes that can degrade pesticides. Reduce watering to control seepage of pesticides to the ground water; this conserves water and reduces runoff.
Use of biological controls reduces the need for chemical pesticides. Plants that attract predatory species, such as birds and bats, can enhance landscaping and naturally reduce pests.

**Proper Pesticide Storage and Handling**

*Proper storage* is important in preventing both surface water and ground water contamination. Store pesticides in intact containers in a shed or covered structure on an impermeable surface such as concrete. You must follow directions for storage on pesticide labels, although the directions are usually general, such as “Do not contaminate water, food, or feed by storage or disposal.” Do not store pesticides in areas prone to flooding. Keep pesticides in their original containers; if the label is unreadable, properly dispose of the product.

*Spill clean up* is another important prevention measure. Promptly sweep up dry spills and reuse the pesticides as intended; dry spills are usually easier to clean. For liquid spills, recover as much of the spill as possible and reuse it as intended. It may be necessary to remove some contaminated soil. Have cat litter or other absorptive materials available to absorb unrecovered liquid from the floor. Be sure to have an emergency contact number to call for help, if necessary. Be sure to check the label for proper handling of the chemicals.

*Disposal of pesticide containers* can lead to ground water contamination if the containers are not stored or cleaned properly. Chemical residues from these containers can leak onto the ground. Homeowners and other users may have smaller quantities of pesticides and empty containers and different disposal options than farmers.

Homeowners usually use nonreturnable containers, and have the option of participating in their local community household hazardous waste collection events. Partially-full and empty containers may be given to household hazardous waste collection. Homeowners should only triple rinse pesticide containers if they are able to use the rinse water immediately, e.g., on plants that require pesticides. Rinse water should never be disposed down a drain or into a sewer system. Recycle plastic and metal containers whenever possible, keeping in mind that non-hazardous container recycling programs may refuse to take pesticide containers. Empty containers may be disposed in regular trash. Shake out bags, bind or wrap them to minimize dust, and put them in regular trash. Do not bury or burn pesticide containers or bags on private property. Homeowners may give unused pesticides to a neighbor rather than throw them away.

Farmers and users of larger quantities of pesticides (e.g., golf course managers) may have larger quantities of pesticides to store and dispose, and are often prohibited from participating in community household hazardous waste collection events. To prevent ground water contamination, use returnable containers as often as possible and take them back to the dealer. For non-returnable containers, pressure-rinse or triple-rinse containers immediately after they are empty, since residue can be difficult to remove after it dries, and apply the rinse water appropriately (i.e., on plants that require pesticides). Most States have collection programs for farmers and other pesticide users with unwanted pesticides, often referred to as Clean Sweep programs. Many States also have pesticide container and recycling programs. Puncture nonreturnable containers and store them in a covered area until they can be disposed according to your State’s guidelines. Shake out bags, bind or wrap them to minimize dust, and take them to a permitted landfill. Do not bury or burn pesticide containers or bags on private property. Contact your State Department of Agriculture or Department of Environmental Quality for information. If containers are full or partially full and the pesticide is in good condition, it may be given to another pesticide user. However, if the pesticide is labeled a restricted use pesticide, it can only be distributed and used by certified applicators.
These sources contain information on pesticide management measures. All of the documents listed are available for free on the Internet. Contact local government authorities in your area to see if there are ordinances in place to manage pesticides.


In urban and suburban areas, much of the land surface is covered by buildings and pavement, which do not allow rain and snowmelt to soak into the ground. Instead, most developed areas rely on storm drains to carry large amounts of runoff from roofs and paved areas to nearby waterways. The stormwater runoff carries pollutants such as oil, dirt, chemicals, and lawn fertilizers directly to streams and rivers, where they seriously harm water quality. To protect surface water quality and groundwater resources, development should be designed and built to minimize increases in runoff.

How Urbanized Areas Affect Water Quality

Increased Runoff

The porous and varied terrain of natural landscapes like forests, wetlands, and grasslands traps rainwater and snowmelt and allows them to filter slowly into the ground. In contrast, impervious (nonporous) surfaces like roads, parking lots, and rooftops prevent rain and snowmelt from infiltrating, or soaking, into the ground. Most of the rainfall and snowmelt remains above the surface, where it runs off rapidly in unnaturally large amounts.

Storm sewer systems concentrate runoff into smooth, straight conduits. This runoff gathers speed and erosional power as it travels underground. When this runoff leaves the storm drains and empties into a stream, its excessive volume and power blast out streambanks, damaging streamside vegetation and wiping out aquatic habitat. These increased storm flows carry sediment loads from construction sites and other denuded surfaces and eroded streambanks. They often carry higher water temperatures from streets, roof tops, and parking lots, which are harmful to the health and reproduction of aquatic life.

The most recent National Water Quality Inventory reports that runoff from urbanized areas is the leading source of water quality impairments to surveyed estuaries and the third-largest source of impairments to surveyed lakes.

Did you know that because of impervious surfaces like pavement and rooftops, a typical city block generates more than 5 times more runoff than a woodland area of the same size?

The loss of infiltration from urbanization may also cause profound groundwater changes. Although urbanization leads to great increases in flooding during and immediately after wet weather, in many instances it results in lower stream flows during dry weather. Many native fish and other aquatic life cannot survive when these conditions prevail.

Increased Pollutant Loads

Urbanization increases the variety and amount of pollutants carried into streams, rivers, and lakes. The pollutants include:

- Sediment
- Oil, grease, and toxic chemicals from motor vehicles
- Pesticides and nutrients from lawns and gardens
- Viruses, bacteria, and nutrients from pet waste and failing septic systems
- Road salts
- Heavy metals from roof shingles, motor vehicles, and other sources
- Thermal pollution from dark impervious surfaces such as streets and rooftops

These pollutants can harm fish and wildlife populations, kill native vegetation, foul drinking water supplies, and make recreational areas unsafe and unpleasant.

Clean Water Is Everybody's Business

Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.
Managing Urban Runoff
What Homeowners Can Do
To decrease polluted runoff from paved surfaces, households can develop alternatives to areas traditionally covered by impervious surfaces. Porous pavement materials are available for driveways and sidewalks, and native vegetation and mulch can replace high maintenance grass lawns. Homeowners can use fertilizers sparingly and sweep driveways, sidewalks, and roads instead of using a hose. Instead of disposing of yard waste, they can use the materials to start a compost pile. And homeowners can learn to use Integrated Pest Management (IPM) to reduce dependence on harmful pesticides.

In addition, households can prevent polluted runoff by picking up after pets and using, storing, and disposing of chemicals properly. Drivers should check their cars for leaks and recycle their motor oil and antifreeze when these fluids are changed. Drivers can also avoid impacts from car wash runoff (e.g., detergents, grime, etc.) by using car wash facilities that do not generate runoff. Households served by septic systems should have them professionally inspected and pumped every 3 to 5 years. They should also practice water conservation measures to extend the life of their septic systems.

Controlling Impacts from New Development
Developers and city planners should attempt to control the volume of runoff from new development by using low impact development, structural controls, and pollution prevention strategies. Low impact development includes measures that conserve natural areas (particularly sensitive hydrologic areas like riparian buffers and infiltrable soils); reduce development impacts; and reduce site runoff rates by maximizing surface roughness, infiltration opportunities, and flow paths.

Controlling Impacts from Existing Development
Controlling runoff from existing urban areas is often more costly than controlling runoff from new developments. Economic efficiencies are often realized through approaches that target “hot spots” of runoff pollution or have multiple benefits, such as high-efficiency street sweeping (which addresses aesthetics, road safety, and water quality). Urban planners and others responsible for managing urban and suburban areas can first identify and implement pollution prevention strategies and examine source control opportunities. They should seek out priority pollutant reduction opportunities, then protect natural areas that help control runoff, and finally begin ecological restoration and retrofit activities to clean up degraded water bodies. Local governments are encouraged to take lead roles in public education efforts through public signage, storm drain marking, pollution prevention outreach campaigns, and partnerships with citizen groups and businesses. Citizens can help prioritize the clean-up strategies, volunteer to become involved in restoration efforts, and mark storm drains with approved “don’t dump” messages.

Related Publications

Turn Your Home into a Stormwater Pollution Solution!
www.epa.gov/nps
This web site links to an EPA homeowner’s guide to healthy habits for clean water that provides tips for better vehicle and garage care, lawn and garden techniques, home improvement, pet care, and more.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas
www.epa.gov/owow/nps/urbanmm
This technical guidance and reference document is useful to local, state, and tribal managers in implementing management programs for polluted runoff. Contains information on the best available, economically achievable means of reducing pollution of surface waters and groundwater from urban areas.

Onsite Wastewater Treatment System Resources
www.epa.gov/owm/onsite
This web site contains the latest brochures and other resources from EPA for managing onsite wastewater treatment systems (OWTS) such as conventional septic systems and alternative decentralized systems. These resources provide basic information to help individual homeowners, as well as detailed, up-to-date technical guidance of interest to local and state health departments.

Low Impact Development Center
www.lowimpactdevelopment.org
This center provides information on protecting the environment and water resources through integrated site design techniques that are intended to replicate preexisting hydrologic site conditions.

Stormwater Manager’s Resource Center (SMRC)
www.stormwatercenter.net
Created and maintained by the Center for Watershed Protection, this resource center is designed specifically for stormwater practitioners, local government officials, and others that need technical assistance on stormwater management issues.

Strategies: Community Responses to Runoff Pollution
www.nrdc.org/water/pollution/storm/stoinx.asp
The Natural Resources Defense Council developed this interactive web document to explore some of the most effective strategies that communities are using around the nation to control urban runoff pollution. The document is also available in print form and as an interactive CD-ROM.

For More Information
U.S. Environmental Protection Agency
Nonpoint Source Control Branch (4503T)
1200 Pennsylvania Avenue, NW
Washington, DC 20460
www.epa.gov/nps