Polluted Urban Runoff:

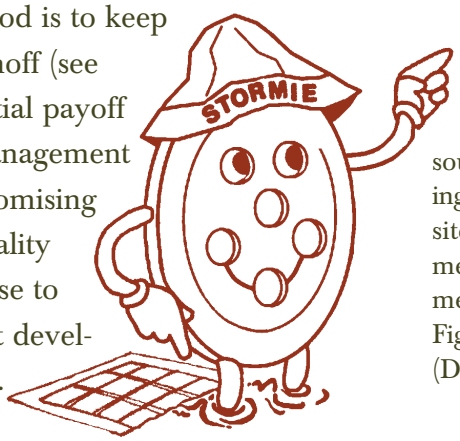
A Source of Concern

During the last twenty years, urban areas have invested billions of dollars in new wastewater treatment facilities to control water pollution. Despite this effort, many of our local lakes and streams are still plagued with pollution and cannot be used for fishing and swimming. Why? The answer lies in the ways we use our land and in the aftermath of a storm.

What we do on our land is reflected in our water

When rain falls or snow melts, the runoff washes pollutants off our streets, parking lots, construction sites, industrial storage yards, and lawns. Urban runoff carries a mixture of pollutants from our cars and trucks, outdoor storage piles, muddy construction sites and pesticide spills. Efficient systems of ditches, gutters and storm sewers carry the polluted runoff to nearby lakes and streams, bypassing wastewater treatment systems.

One way of cleaning up polluted urban runoff is to install stormwater treatment facilities. Another less expensive method is to keep pollutants out of runoff (see sidebar). The potential payoff from better land management practices is high, promising healthier waters, quality water recreation close to home and riverfront development possibilities.



From Streets to Streams

Urban runoff is a relatively recent concern, but it is not an insignificant issue. Although we have less urban area than rural area in Wisconsin, urban areas have more impervious surfaces. That means more water runs off instead of soaking in, and more enters lakes and streams unfiltered by soil or vegetation.

Some of the pollutants found in urban runoff are similar to pollutants found in rural runoff. These are the "conventional" pollutants – sediment, nutrients, oxygen-demanding materials, and bacteria. Urban areas on a per-acre basis deliver as much or more of these conventional pollutants as rural areas.

Sediment

Like rural runoff, urban runoff is loaded with sediment. Cities may have less soil erosion than rural areas, but urban areas produce their own distinctive mix of sediment – flakes of metal from rusting vehicles, particles from vehicle exhaust, bits of tires and brake linings, chunks of pavement, and soot from residential chimneys as well as industrial smokestacks.

As Figure 1 on the following page shows, the leading sources of sediment in existing urban areas are industrial sites, commercial development and freeways. But by far the highest loads of sediment come from areas under construction (not shown in Figure 1). The Wisconsin Department of Natural Resources (DNR) estimates that an average acre under construction

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Keeping It Clean

Keeping pollutants out of stormwater runoff is less expensive than installing stormwater treatment facilities. Here are some ways that you can help prevent stormwater pollution:

Individuals

- Recycle oil
- Direct downspouts to lawns
- Sweep paved areas to keep waste out of stormsewers
- Keep your car tuned, repair leaks
- Limit fertilizer and pesticide use, leave grass clippings on lawn
- Clean up pet waste
- Dispose of toxic wastes properly
- Wash your car on your lawn or at a car wash

Municipalities

- Enforce construction site erosion control laws
- Enact laws requiring stormwater management in new development
- Develop and implement a comprehensive stormwater management plan
- Sponsor household hazardous waste collections

delivers 60,000 pounds (30 tons) of sediment per year to downstream waterways, which is much more than any other land use.

Two factors account for the large amount of sediment coming from construction sites – high erosion rates and high delivery rates. Construction sites have high *erosion rates* because they are usually stripped of vegetation and topsoil for a year or more. Typical erosion rates for construction sites are 35 tons to 45 tons per acre per year as compared to 1 to 10 tons per acre per year for cropland.

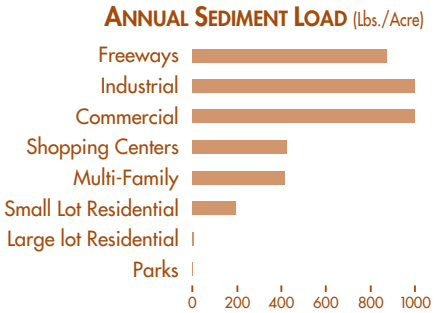
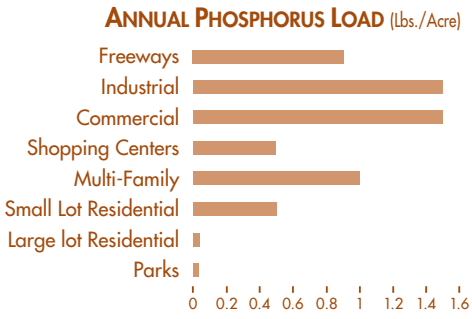


Figure 1



Even more importantly, construction sites have very high *delivery rates* compared to cropland. During the first phase of construction, the land is graded and ditches or storm sewers are installed to provide good drainage. This also provides an efficient delivery system for pollutants. Typically, 50% to 100% of the soil eroded from a construction site is delivered to a lake or stream, compared to only 3% to 10% of the soil from cropland delivered to lakes or streams.

Nutrients

Runoff from both urban and rural areas is loaded with nutrients such as phosphorus and nitrogen. **Phosphorus** is the nutrient of greatest concern because it promotes weed and algae growth in lakes and streams. Like sediment, phosphorus *concentrations* are lower in urban runoff than in rural runoff, but annual phosphorus *loads* per acre are at least comparable to rural areas.

Because phosphorus compounds attach to soil particles, areas with high sediment loads also produce high phosphorus loads (see Figure 1). This means that construction sites are significant sources of phosphorus as well as sediment. Other sources of phosphorus include fertilizer spills, leaves and grass left on paved areas, and orthophosphate in vehicle exhaust.

Oxygen Demanding Material

Urban runoff carries organic material such as pet waste, leaves, grass clippings and litter. As these materials decay, they use up oxygen needed by fish and other aquatic life. Shallow, slow-moving waterways are especially vulnerable to fish kills caused by oxygen demand from the organic materials in urban runoff. Indeed, the surge of oxygen demand after a storm dumps organic waste into an urban waterway can totally deplete its oxygen supply. Runoff from older residential areas (with more pavement, more pets, and combined storm and sanitary sewers) carries the highest load of oxygen demanding materials.

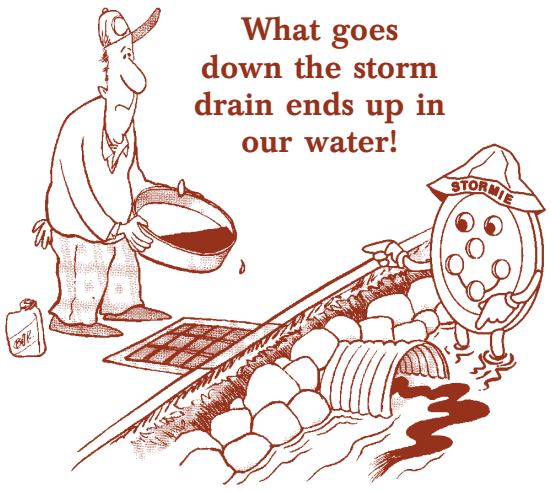
Bacteria

The levels of bacteria found in urban runoff almost always exceed public health standards for recreational swimming and wading. Generally, fecal coliform bacteria counts for urban runoff are 20 to 40 times higher than the health standard for swimming. Research shows these high levels of bacteria are typical of runoff from small as well as large cities in Wisconsin. Sources of bacteria in urban runoff include sanitary sewer overflows, pets, and populations of urban wildlife such as pigeons, geese and deer.

The DNR estimates that an average acre under construction delivers 60,000 pounds (30 tons) of sediment per year to downstream waterways, which is much more than any other land use.

Toxic Pollutants

One of the special challenges of urban watersheds is toxic pollution. Toxic pollutants are substances that may cause death, disease or birth defects or that may interfere with reproduction, child development or disease resistance. According to DNR studies, the toxic pollutants of most concern in urban runoff are metals, pesticides, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs).



Metals

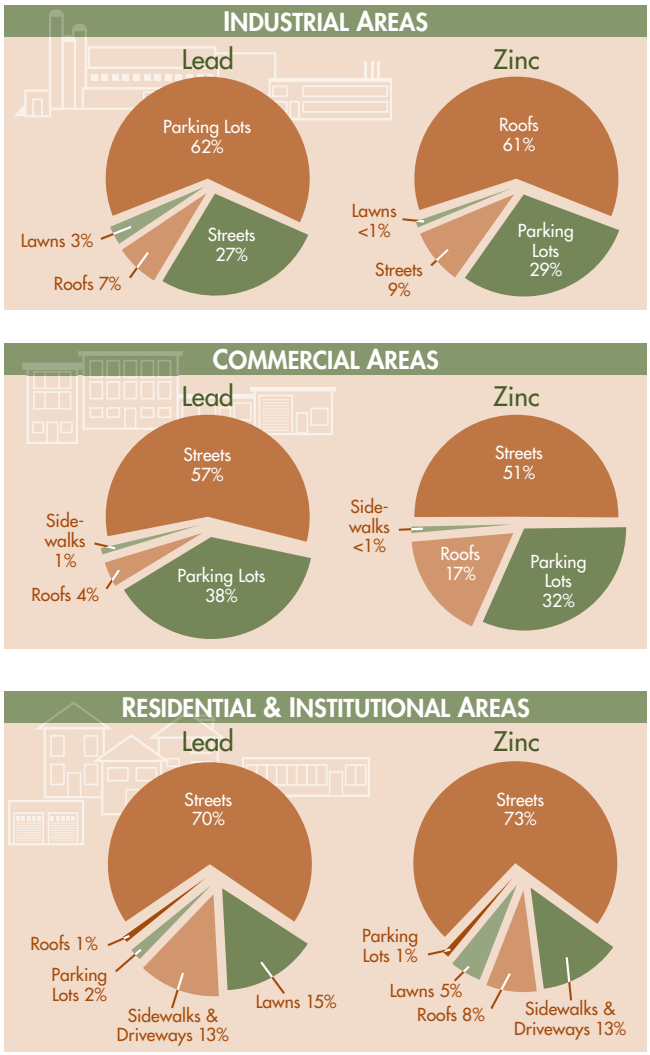
Metals are the best understood toxic pollutants in urban runoff. They were extensively monitored as part of the National Urban Runoff Program during the early 1980s. Recent data from Wisconsin cities confirms that runoff from small as well as large cities is contaminated with metals such as lead and zinc.

Lead has historically been used as an "indicator" for other toxic pollutants in urban stormwater because it is relatively easy to monitor and its dangers are well documented. Lead is a problem for both humans and aquatic life. Its human health effects include damage to the nervous system and kidneys, high blood pressure and digestive disorders.

Lead can also be toxic to aquatic life. Wisconsin monitoring shows that about 40% of the samples from

Figure 2

Sources of Total Lead and Zinc in Urban Runoff



storm sewer discharges in a primarily residential area and 70% of the samples from a commercial area had lead levels high enough to kill aquatic life. Although lead levels still exceed water quality standards, they are much lower today than they were before the shift to unleaded gasoline.

Zinc is another metal in urban runoff which commonly violates water quality standards. While zinc does not create human health problems, it can be toxic to aquatic life. In fact, zinc is even more likely than lead to exceed levels that kill aquatic life.

The primary source of many metals in urban runoff is vehicle traffic. Concentrations of zinc, cadmium, chromium and lead appear to be directly correlated with the volume of traffic on streets that drain into a storm sewer system. As Figure 2 shows, streets and parking lots are the primary sources of lead in urban areas.

Roofs can also be a significant source of metals. Galvanized metal rooftops, gutters and downspouts are the primary source of zinc (61%) in industrial areas where downspouts discharge onto pavement or directly into storm sewers. Roofs are a less significant source of zinc (8%) in residential areas where downspouts discharge onto lawns. On some roofs, copper flashing contaminates runoff with copper and lead.

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In some cities, a significant source of metals is outdoor storage of scrap metal, coal, and salt. According to U.S. Geological Survey monitoring, scrap metal piles are the primary source of mercury in the area surrounding the Milwaukee harbor. Other metals found in runoff from outdoor storage include chromium and lead from road salt piles and arsenic from scrap metal and coal piles.

The list of other sources of metals is long, ranging from combustion to deteriorating metal and paint. Airborne emissions from burning coal, oil or municipal waste may carry cadmium, copper, lead or mercury. In fact, this is the primary source of mercury for many Wisconsin lakes. Other sources of metals include paints and plated metals which commonly contain cadmium or chromium. Bullets, fishing weights, and paint sold before 1977 may contain lead. Wood used in outdoor construction may contain arsenic, chromium, copper or zinc to prevent rotting.

Pesticides

Wisconsin stormwater monitoring documents the presence of many pesticides in urban runoff. However, how they got there is currently the subject of some debate. Tests indicate that most properly applied pesticides are bound up in plants and soil; therefore, little runs off. Nevertheless, the pesticides listed above are frequently found in urban runoff at levels that violate surface and/or ground water quality standards.

PESTICIDES IN STORMWATER

Regulated Insecticides:
Aldrin, Chlordane, DDT, Endrin, Heptachlor, Lindane, Toxaphene.

Lawn & Garden Insecticides:
Diazinon, Malathion

Agricultural Herbicides:
Alachlor, Atrazine, Cyanazine.

Regulated insecticides may no longer be widely used, but they are persistent chemicals which do not degrade rapidly in the environment. Except for lindane, these insecticides are banned in Wisconsin. Lindane is still sold at garden centers for home use in controlling woody plant pests. It is also available for some commercial uses including treatment of seeds, Christmas trees, and farm animals.

Common **lawn and garden insecticides** such as diazinon and malathion may not be persistent in the environment, but they are toxic to bees, fish, aquatic insects, and other wildlife. Diazinon is especially toxic to birds. It has been banned from golf courses because there are documented cases of waterfowl dying while feeding on areas treated with diazinon.

Finding **agricultural herbicides** like alachlor, atrazine and cyanazine in urban stormwater may seem surprising

since these herbicides are not used in lawn and garden compounds. However, Midwest studies suggest that concentrations of atrazine in urban stormwater are consistent with concentrations found in rainfall. Both atrazine and alachlor easily evaporate from treated farm fields and later end up in rainfall or snow. Atrazine contamination of rainfall is more widespread than alachlor contamination because atrazine is more widely used and more persistent in the environment.

Some regulations now apply to the use of alachlor, atrazine and cyanazine. Only certified applicators may apply these chemicals. Furthermore, atrazine use is restricted in many Wisconsin counties due to groundwater contamination.

Other Chemicals

Other potentially toxic chemicals found in urban runoff have such long names that we commonly refer to them by their initials. Some of these chemicals are hazardous even in very small doses and require water quality standards set to parts per *billion*. Because sampling for these chemicals can be difficult and costly, information on them is very limited. Monitoring of urban runoff in Wisconsin suggests that two groups of chemicals are present in large enough concentrations to be of concern – PAHs and PCBs.

Polycyclic aromatic hydrocarbons (also called polynuclear aromatic hydrocarbons) are a large group of about 10,000 compounds. They are common by-products of incomplete combustion from vehicles, wood and oil burning furnaces, and incinerators. Some PAHs are used as ingredients in gasoline, asphalt and wood preservatives. According to monitoring data of storm sewer discharges in Wisconsin cities, the PAHs that most frequently exceed surface or ground water standards include:

- Benzo-a-pyrene
- Benzo-ghi-perylene
- Chrysene
- Fluoranthene
- Phenanthrene
- Pyrene

PAHs affect human health in a variety of ways but they are of particular concern because several of these compounds are among the most potent carcinogens. Laboratory tests on animals indicate that benzo-a-pyrene causes cancer and reproductive and fetal development problems. Other tests indicate that some PAHs damage the lungs, liver, skin and kidneys. Some studies also suggest that PAHs are responsible for tumors and lesions in fish, especially those that feed on river bottoms.

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According to Wisconsin monitoring, more than 95% of the samples from storm sewer discharges violate human cancer criteria for benzo-a-pyrene and benzo-ghi-perylene. (Human cancer criteria are set at levels to keep the incremental risk of cancer below 1 in 100,000 for people who eat fish from lakes and streams in Wisconsin.) More than 60% of the samples violate human cancer criteria for chrysene, phenanthrene and pyrene. PAHs accumulate in bottom sediments in urban streams and are taken up by aquatic organisms such as crayfish. Unlike PCBs, they do not accumulate in living tissue or build up in the food chain.

Polychlorinated biphenyls (PCBs) are a group of over 200 compounds. They are very stable compounds which do not easily degrade, burn, dissolve in water, or conduct electricity. Therefore, PCBs have been used for many purposes including insulation in transformers and in electrical capacitors for old fluorescent light fixtures and appliances. They have also been used as coolants or lubricants.

PCBs are of special concern because they remain in the environment for a long time, build up in the food chain, accumulate in human fatty tissue, and may eventually cause health problems. Short term effects of PCB exposure include skin sores and liver problems. Longer term effects may include cancer as well as problems with reproduction, fetal development, immunity to disease, and liver functions.

PCB production stopped in 1977, but virtually all of the storm sewer discharge samples from Madison and Milwaukee still violate the human cancer criteria for PCBs. Sources of PCBs include sediment contaminated by past industrial waste discharges, landfill leachate, spills, and waste incineration.

Steps for Clean Water

Knowing what's in urban runoff is the first step in developing an effective stormwater strategy. Many communities in Wisconsin are already working on cleaning up urban runoff. Cities are sweeping streets more frequently and industries are covering outdoor storage piles. Youth groups are stenciling *Dump No Waste* beside storm drains. And many new developments have stormwater ponds or infiltration basins designed to filter pollutants from stormwater. What is your community doing?

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