New York NEMO Program

Impacts of Development on Waterways:

Linking Land Use to Water Quality

Land Use Impacts

The New York NEMO Program (Nonpoint Education for Municipal Officials) is an educational program for land use decision makers that strives to reduce nonpoint pollution by illustrating the connection between land use and water quality. Our goal is to provide communities with information that will assist them in protecting their natural resources while meeting land use needs.

Altering the Land: Disruption of the Water Cycle

When development occurs, the resultant alterations to the land can lead to dramatic changes in *hydrology,* or the way water is transported and stored. Impervious manmade surfaces (asphalt, concrete, rooftops) and compacted earth associated with development create a barrier to the percolation of rainfall into the soil, increasing surface runoff and decreasing groundwater infiltration. This disruption of the natural water cycle leads to a number of changes, including:

- Increased volume and velocity of runoff;
- Increased frequency and severity of flooding:
- Peak (storm) flows many times greater than in natural basins;
- Loss of natural runoff storage capacity in vegetation, wetlands and soil;
- Reduced groundwater recharge; and
- Decreased *base flow* or, the groundwater contribution to stream flow. This can result in streams becoming intermittent or dry, and also affects water temperature.

Impacts on Stream Form and Function

Impacts associated with development typically go well beyond flooding. The greater volume and intensity of runoff leads to increased erosion from construction sites, downstream areas and stream banks. Because a stream's shape evolves over time in response to the water and sediment loads that it receives, development-generated runoff and sediment cause significant changes in stream form. To facilitate increased flow, streams in urbanized areas tend to become deeper and straighter than wooded streams, and as they become clogged with eroded sediment, the ecologically important "pool and riffle" pattern of the streambed is usually destroyed.

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Impacts on Stream Form and Function

These readily apparent physical changes result in less easily discerned damage to the ecological function of the stream. Bank erosion and severe flooding destroy valuable streamside, or *riparian*, habitat. Loss of tree cover leads to greater water temperature fluctuations, making the water warmer in the summer and colder in the winter. Most importantly, there is substantial loss of aquatic habitat as a uniform blanket of eroded sand and silt covers the varied natural streambed of pebbles, rock ledges and deep pools.

All this, of course, assumes that the streams are left to adjust on their own. However, as urbanization increases, physical alterations like stream diversion, channelization, damming and piping become common. As these disturbances increase, so do the ecological impacts — the endpoint being a biologically sterile steam completely encased in underground concrete pipes. In addition, related habitats like ponds and wetlands may be damaged or eliminated by grading and filling activities.

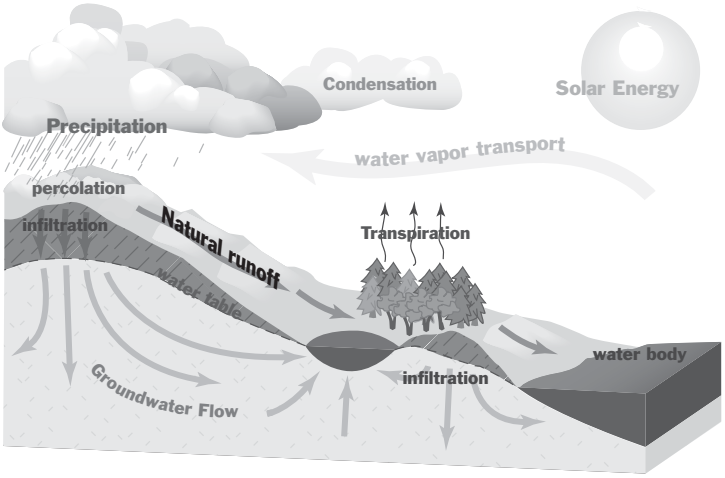

Figure A.

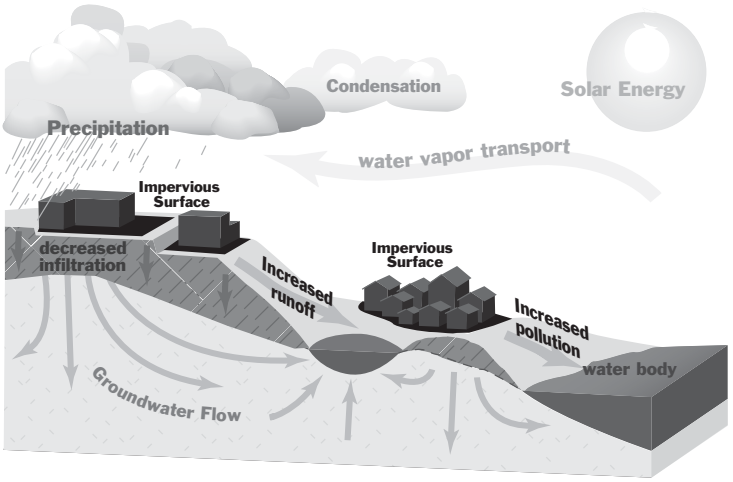

Figure B.

Impervious manmade surfaces associated with development create a barrier to the percolation of rainfall into the soil, increasing surface runoff and decreasing groundwater infiltration.

Then There's Water Quality...

With development comes more intensive land use and a related increase in the generation of pollutants (see Figures A and B). Increased runoff serves to transport these pollutants directly into waterways, creating *nonpoint source pollution*, or *polluted runoff*. Polluted runoff is now recognized as the single largest threat to water quality in the United States. The major pollutants of concern are pathogens (disease-causing microorganisms), nutrients, toxic contaminants and debris. Sediment is also a major nonpoint source pollutant; both for its effects on aquatic ecology and because of the fact that many of the other pollutants tend to adhere to eroded soil particles.

The Total Picture: A System Changed for the Worse

The hydrologic, physical and ecological changes caused by development can have a dramatic impact on the natural function of our waterways. When increased pollution is added, the combination can be devastating. In fact, many studies are finding a direct relationship between the intensity of development in an area — as indicated by the amount of impervious surfaces — and the degree of degradation of its streams. These studies suggest that aquatic systems begin to degrade at impervious levels of 12% to 15%, or at even lower levels for particularly sensitive steams. As the percentage of imperviousness climbs above these levels, degradation tends to increase accordingly. The end result is a system changed for the worse.

Impacts

Properly working natural water systems provide drainage, aquatic habitat, and a degree of pollutant removal through plant and biologic processes. Let's look at how those natural functions are affected by development in an urbanized watershed where no remedial action has been taken:

Drainage

Increased runoff leads to flooding. Drainage systems that pipe water offsite often improve that particular locale at the expense of moving flooding (and erosion) problems downstream. Overall system-wide water drainage and storage capacity is impaired.

Habitat

Outright destruction, physical alteration, pollution and wide fluctuations in water conditions (levels, clarity, temperature) all combine to degrade habitat and reduce the diversity and abundance of aquatic and riparian organisms. In addition, waterway obstructions like bridge abutments, pipes and dams create barriers to fish migration.

Pollutant Removal

Greater pollutant loads in the urban environment serve to decrease the effectiveness of natural processing. Damage to bank, stream and wetland vegetation further reduces their ability to naturally process pollutants. Finally, the greater volume and irregular, and intense flash pulses of water caused by stormwater runoff impair natural processing by decreasing the time that water is in the system.

Terms to Know

Hydrology
A science dealing with the properties, distribution and circulation of water.

Riparian
Habitat, plants and wildlife associated with the bank of a watercourse.

Habitat
The place where a plant or animal species naturally lives and grows.

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What Towns Can Do

Local officials interested in protecting town waters must go beyond standard flood and erosion control practices to address the issue of polluted runoff. Flood and erosion control have long been part of the municipal land use regulatory process, and are usually addressed with engineered systems designed to pipe drainage offsite as quickly and efficiently as possible. Flooding and erosion, however, are only two of the more easily recognized components of the overall impact of development on waterways. Standard drainage "solutions" address neither the root cause of these symptoms — increased runoff due to the way we develop land — nor the resultant environmental effects.

To begin to truly address the impacts of development, town officials need to look at their waterways as an interconnected system and recognize the fundamental changes that development brings to the water cycle, stream form and function, aquatic ecology, and water quality. Incorporating this understanding into local land use decisions can help to guide appropriate development. There are a number of options that can be employed to reduce the impacts of development on water quantity and quality. Preventing such impacts in the first place is the most effective (and cost effective) approach and should always be emphasized. To this end, town officials should consider a watershed management approach, which incorporates planning, site design, best management practices and public education and involvement.

Related Fact Sheets

- The New York NEMO Program
- Nonpoint Source Pollution
- Impacts of Development on Waterways: Linking Land Use to Water Quality
- The Nissequogue River: A River of Special Significance

LONG ISLAND SOUND STUDY
A Partnership To Restore And Protect The Sound

The New York NEMO Program is funded by the New York State Department of Environmental Conservation and the Long Island Sound Study

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