BCD NEMO PROGRAM

NEMO Program Brief

Key Finding

Standard land development can drastically alter waterways. Increased stormwater runoff associated with development often begins a chain of events that includes flooding, erosion, stream channel alteration, and ecological damage. Combined with an increase in man-made pollutants, these changes in waterway form and function result in degraded systems no longer capable of providing good drainage, healthy habitat, or natural pollutant processing. Truly addressing the issue of polluted runoff at the local level means implementing a multilevel strategy of planning, site design, and stormwater best management practices.

Disruption of the Water Cycle

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

1. Increased volume and velocity of runoff
2. Increased frequency and severity of flooding
3. Peak (storm) flows many times greater than in natural basins
4. Loss of natural runoff storage capacity in vegetation, wetlands and soil
5. Reduced groundwater recharge
6. Decreased base flow, the groundwater contribution to stream flow

Water Quality

Development results in more intensive land uses and related increases in the generation of pollutants. Increased runoff serves to transport these pollutants directly into waterways, creating nonpoint source pollution, or polluted runoff. Polluted runoff is now widely recognized by environmental scientists and regulators as the single largest threat to water quality in the United States. The major pollutants of concern are pathogens, sediment, nutrients, toxic contaminants, and debris. BCD NEMO Fact Sheet #2 provides more detail on polluted runoff and its effects.

Impacts on Stream Form and Function

Impacts associated with development often go well beyond flooding. The greater volume and intensity of runoff leads to increased erosion from construction sites, downstream areas, and stream banks. Development-generated runoff and sediment cause significant changes in stream form. Increased flow causes streams in urbanized areas to take on a more linear shape, while destroying the ecologically important “pool and riffle” pattern of the streambed.

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 stream completely encased in underground concrete pipes. In addition, related habitats like ponds and wetlands may be damaged or eliminated by grading and filling activities.

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. 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 waterways. These studies suggest that water quality begins to degrade at impervious levels of 10% to 15%. As the percentage of imperviousness climbs above these levels, water quality degradation tends to increase accordingly.

The end result is a system changed for the worse. Properly working water systems provide drainage, aquatic habitat, and a degree of pollutant removal through natural processing. Let's look at those functions in an urbanized watershed where no remedial action has been taken:

Drainage: Increased runoff leads to flooding. Drainage systems that pipe water off-site 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 migration.

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

What Local Officials Can Do

To begin to truly address the impacts of development, waterways need to be seen as an interconnected system. The fundamental changes that development brings to the water cycle, stream form and function, aquatic ecology, and water quality also needs to be recognized. Incorporating this understanding into local land use decisions can help to guide appropriate development (see BCD NEMO Fact Sheet #5).

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, local officials can consider a three-tiered strategy of natural resource based planning, appropriate site design, and stormwater best management practices. BCD NEMO Fact Sheet #4 goes into this strategy in more detail.