Chapter 3 Fundamentals of Stormwater Management

Chapter 3 describes several fundamental concepts of stormwater management. Among these are the relationships between land use and water quantity and quality, sources of stormwater pollutants, watershed planning, and traditional stormwater management concerns. This chapter may be useful to better understand the basic concerns and causes of stormwater pollution and to help understand the interconnectedness of activities in a watershed to plan for protection and restoration of water quality.

3-1. Hydrologic Impacts

Development activities can alter the natural hydrologic cycle and the movement of water off of the land. Development removes natural vegetation and introduces impervious surfaces, such as roads, rooftops, driveways, and parking areas. Precipitation falling on these impervious areas can no longer soak into the ground, resulting in an increase in stormwater runoff. Vegetation no longer slows down the rate of flow. Because of this, developed areas generate a greater amount of stormwater, and this runoff reaches rivers and lakes in a shorter amount of time. This runoff picks up sediment and other pollutants in its flow path, and carries these pollutants to the receiving waterbodies. The increased runoff can also result in erosion of the land surface, conveying the resultant sediment load to the receiving waters as well.

Stormwater flows into a catch basin from a commercial parking lot during a rainstorm in Concord, New Hampshire.

Potential hydrologic impacts from development activities include the following[3]:

- Changes to Stream Flow
- Increased runoff volumes
- Increased peak runoff discharges
- Increased runoff velocities
- Increased frequency of bank-full & near bank-full events
- Increased flooding

3 Adapted from Minnesota Stormwater Manual, 2006.

- Lower baseflows (dry weather flows)

Changes to Stream Geomorphology

- Stream widening & bank erosion
- Changes in flow velocities
- Stream degradation (downcutting) or aggradation (rise in channel elevation due to sediment deposition), resulting from changes in flows or sediment load
- Other changes in stream bed due to sedimentation
- Loss of riparian vegetation & canopy
- Increased flood elevation
- Isolation of the primary channel from its natural flood plain, resulting in further changes in channel geometry

Changes to Aquatic Habitat

- Degrading of habitat structure - channel scour, streambank erosion, riparian vegetation loss, sediment deposition
- Loss of pool-riffle structure
- Reduced baseflows
- Increased stream temperatures
- Decline in abundance and biodiversity of fish and benthic organisms

3-2. Water Quality Impacts

In addition to the water quantity impacts from development activities, stormwater runoff also affects water quality. The pollutants affecting water quality come from changes in land use and associated activities as well as social behavior. As the population grows, many changes occur in the landscape. Forests and other undisturbed lands are converted to make room for homes and businesses. Transportation infrastructure is expanded including roads, highways, and parking lots, which are salted and sanded for safety. This decreases the amount of vegetated areas that are available to naturally treat stormwater and increases the impervious surfaces. Fertilizers and other household products, including pet waste, septic system leachate, trash, and a variety of other pollutants are introduced into the environment, all of which would not be present in the undeveloped landscape (CT DEP, 2004).

These pollutants are picked up and carried by stormwater runoff and discharged to receiving waters. Fortunately, there are ways to lessen the water quality impacts of these changes in the landscape through environmentally

sensitive site planning. Implementing better site design techniques and best management practices can not only reduce the volume and velocity of runoff leaving a site, but can also reduce pollutant runoff that can threaten water quality.

- Potential water quality impacts from development activities may result in:
- Shellfish bed closures due to bacterial contamination.
- Swimming beach closures due to bacterial contamination.
- Pathogenic bacteria/viruses from fecal material in combined sewer overflows (CSOs), pet and wildlife waste.
- Nuisance algal growth from excess nutrients in runoff.
- Toxicity from ammonia, metals, organic compounds, pesticides, and other contaminants.

Turbidity in Hodgson Brook, Portsmouth, New Hampshire.

- Depleted dissolved oxygen (DO) levels due to increased biochemical oxygen demand (BOD) of the water from biodegradable organic material – leading to oxygen deprivation of aquatic organisms.
- Increased temperatures due to warm impervious surfaces and loss of shade from decreased riparian canopy, leading to reduced DO levels as warm water can hold less oxygen than cold water.
- Contamination of groundwater with soluble organic chemicals, metals, nitrates, and salt.

3-3. Concerns with Conventional Stormwater Management

Conventional stormwater management has focused on removing stormwater from a site as quickly as possible to reduce on-site flooding. This has meant implementing management techniques, such as curb and gutter and piping systems, that discharge runoff to the nearest receiving water, or implementing detention type BMPs to reduce peak runoff discharge rates (CEI, 2003).

Although this is an efficient way to remove water quickly and prevent on-site flooding, it has proven to be devastating to downstream waters by increasing the frequency and magnitude of floods, altering stream channel morphology (alignment, cross-section geometry, streambed composition) and reducing groundwater recharge, all of which make less water available for drinking water withdrawal and stream base flows.

Flooding of New Hampshire's Exeter and Squamscott Rivers, April, 2007.

These shortcomings of traditional stormwater management are largely because the methods used rely on conveyance efficiency and end-of-pipe treatment. Although end-of-pipe practices still have their place in stormwater control and treatment, *the key to effective management of stormwater runoff is to reduce the amount of stormwater generated in the first place by maintaining and working with the hydrology of a site and managing stormwater at the source.*

Subsequent chapters of Volume 1 present alternative measures to this conventional approach to stormwater management. As will be seen in the discussion of the Antidegradation Provisions in Chapter 5, New Hampshire's approach to managing stormwater to meet water quality standards includes objectives to limit increased impervious surface and to retain natural undisturbed areas. Chapter 6 offers guidance to address site design, including low impact development techniques, to minimize the generation of stormwater, and to control quantity and quality impacts close to its source.

Chapter 3 References

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