



## Construction Site Management for Stormwater Quality

### *1.1.3 Erosion and Sediment Control Regulations*

Short-term stormwater quality management predominately focuses on erosion prevention and sedimentation control (EPSC) for construction sites. However, for some fully developed sites EPSC can also be a concern. Soil erosion is the process by which soil particles are removed from land surfaces by wind, water or gravity. Natural erosion generally occurs at slow rates. However, the rate of erosion increases when land is cleared or altered and left disturbed. Erosion rates will increase when flow rates and velocities discharged from a site exceed the erosive range.

Clearing and grubbing activities during construction remove vegetation and disrupt the structure of the soil surface, leaving the soil susceptible to rainfall erosion, stream and channel erosion, and wind erosion if left untreated. Ultimately, the material suspended by erosion settles during sedimentation in downstream reaches. This can lead to increased maintenance needs and flooding problems.

#### *1.1.3.1 Water Erosion*

The rainfall erosion process begins when raindrops impact the soil surface and dislodge minute soil particles. These soil particles then become suspended in the water droplet. The sediment laden water droplets accumulate on the soil surface until a sufficient quantity has developed to begin flowing under the forces of gravity.

The initial flow of sediment-laden water generally consists of a thin, slow-moving sheet, known as sheet flow. While sheet flow is generally not highly erosive on its own, it does begin the transport of previously suspended sediment. Due to irregularities in the soil surface and uneven topography, sheet flow will usually begin to concentrate into rivulets, where the flow picks up velocity, and erosive energy increases as a result of gravitational forces.

The increasing erosive energy of water flowing in rivulets will cut small grooves, or rills, in the soil surface. Rill erosion of the soil surface tends to concentrate more flows, which then flow faster and gain erosive energy as a result of gravitational forces. In turn, the rills become deeper and larger, and join adjacent rills. Typically, rills run parallel with the slope and each other, are small enough to be stepped across, and are generally enlarged by direct erosion of the rill's sides and bottom by the action of flowing water.

The communion of several adjacent rills, or sufficient enlargement of a single rill, begins gully erosion. Gully erosion of the soil surface tends to concentrate more flows, which then flow faster and gain erosive energy as a result of gravity. Typically, gullies run parallel with the slope, may have one or more lateral branches, and are enlarged by four key actions. First, gullies often have a "head cut" at the upstream end which progresses its way upstream as water flowing



into the gully erodes the lip of the head. This mechanism is similar to a waterfall working its way upstream. Second, the flow in a gully tends to under cut the banks. Once sufficiently under cut, the banks collapse into the gully where the loosened soil is then washed away. Third, when banks collapse into the gully, flowing water is diverted around the temporary blockage of soil. This temporary blockage increases velocities along one or both banks, which results in increased bank erosion. Fourth, the concentration of flows in the gully can result in scour of the gully floor until a stable slope is obtained.

#### *1.1.3.2 Stream and Channel Erosion*

One or more of the following factors that disrupt the delicate balance required for stable streams and channels generally precipitate erosion within streams and channels.

1. Disturbing the banks of streams and channels is often required during construction. Once vegetation or other bank protection measures are disturbed, flows may begin to erode the unprotected soil.
2. Disturbing the flow within a stream or channel is often necessary to facilitate construction activities. However, this should only be allowed when traversing banks such as temporary stream crossing, culvert installation, bridge construction, etc. By diverting flows within the channel, velocities are increased in some areas to compensate for decreases in other areas. The increases in velocity may exceed those normally experienced by the channel, resulting in bank erosion and bottom scour.
3. Increasing the quantity and rate of flow to streams and channels often results from construction activities and construction of facilities that increase the quantity and rate of runoff as well as how runoff is conveyed to the discharge point. The increased quantity and rate of flow can cause bank erosion and bottom scour.

#### *1.1.3.3 Wind Erosion*

Dust is defined as solid particles or particulate matter small enough to remain suspended in the air for a period of time and large enough to eventually settle out of the air. Dust from a construction site originates as inorganic particulate matter from rock and soil surfaces and material storage piles. The majority of dust generated and emitted into the air at a construction site is related to earth moving, demolition, construction traffic on unpaved surfaces, and wind over disturbed soil surfaces.

#### *1.1.3.4 Factors Influencing Erosion*

There are five primary factors that influence erosion: soil characteristics, vegetative cover, topography, climate, and rainfall.



1. Soil characteristics that determine the erodibility of the soil include particle size, particle gradation, organic content, soil structure, and soil permeability. Soil characteristics affect soil stability and infiltration capacity. The less permeable the soil, the higher the likelihood for increased runoff and erosion. Soils with a high percentage of silt and clays are generally the most erodible.

The soil characteristics play a different role for channel flow. The tractive-force or shear stresses developed by flowing water over the channel banks and bottom can cause the soil particles to move and become suspended into the runoff. The “permissible shear” stress indicates the stress that the channel banks and bottom can sustain without compromising stability. Protecting the channel bottom and banks with a variety of “soft/green” or “hard” armoring increases the permissible shear stress in the channel.

2. Vegetative cover plays an important role in controlling erosion by shielding the soil surface from the impacts of falling rain, and slowing the velocity of runoff. This permits greater infiltration, maintains the soil’s capacity to absorb water, and holds soil particles in place. Vegetative root structures create a favorable soil structure, improving its stability and permeability.
3. Topography, including slope length and steepness are key elements in determining the volume and velocity of runoff. As slope length, and /or steepness increases, so do the rate of runoff and the erosion potential.
4. Climate is a key factor that influences erosion. High rainfall areas and areas with freeze/thaw cycles have significant effects on soil stability and structure.
5. Wet weather frequency, intensity, and duration are fundamental factors in determining the amounts of erosion produced. When storms are frequent, intense, or of long duration, erosion risks are high. In Indiana, the erosion risk period is typically highest in the wet season (typically December through May) which coincides with the period of minimal vegetative cover.

#### *1.1.4 Other Stormwater Pollutants and Impacts*

Sediment from erosion is the pollutant most frequently associated with construction activities. However, other pollutants of concern include nutrients, metals, pesticides, oil and grease, fuels, other toxic chemicals, and miscellaneous wastes. These pollutants originate from a variety of activities including paving operations, demolition, materials storage, equipment fueling, and other daily activities necessary for project construction or site (commercial or industrial) management. By taking an activities inventory, the contractor/operator can identify potential pollutant sources and then select appropriate BMPs to address these sources. Appropriate BMPs are usually specific to the construction activity or site (commercial or industrial) management activity.



#### *1.1.4.1 Nutrients*

Phosphorous and nitrogen from fertilizers, pesticides, construction chemicals, and solid waste are often generated by site activities. These nutrients can result in excessive or accelerated growth of vegetation or algae resulting in impaired use of water in lakes and other sources of water supply through taste and odor problems. Excess algae can also deplete dissolved oxygen levels resulting in fish kills. Collectively, the problems associated with excessive levels of nutrients in a receiving water are referred to as *eutrophication* impacts.

#### *1.1.4.2 Oxygen Demanding Substances*

Lower dissolved oxygen (DO) levels are often the cause of fish kills in streams and reservoirs. The degree of DO depletion is measured by the biochemical oxygen demand (BOD) test that expresses the amount of easily oxidized organic matter present in water. The chemical oxygen demand (COD) test measures all the oxidizable matter present in urban runoff. BOD is caused by the decomposition of organic matter in stormwater that depletes DO. Other non-organic materials in the water can intensify DO depletion.

#### *1.1.4.3 Metals*

Many artificial surfaces (e.g., galvanized metal, paint, or preserved wood) contain metals that can enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. However, significant portions of metals in urban runoff are from cars and trucks. Over half the trace metal load carried in stormwater is associated with sediments to which these eroded metals attach. Heavy metals are of concern because they are toxic to aquatic organisms, can be bioaccumulative, and have the potential to contaminate drinking water supplies.

#### *1.1.4.4 Pesticides*

Herbicides, insecticides and rodenticides (collectively termed *pesticides*), are commonly used on construction sites, lawns, parks, golf courses, etc. Unnecessary, excessive, or improper application of these pesticides may result in direct water contamination, indirect water pollution by aerosol drift, or erosion of treated soil and subsequent transport into surface waters.

#### *1.1.4.5 Oil, Grease and Fuels*

These products are widely used and can be spilled/leaked/dumped on the ground where they can wash into waterways. Sources include leakage during normal vehicle use, hydraulic line failure, spills during fueling, and inappropriate disposal of drained fluids. These products can cause harm to plant and animal life.



### *Other Toxic Chemicals*

Often synthetic organic compounds (adhesives, cleaners, sealants, solvents, etc.) are widely applied and may be improperly stored and disposed. Accidental spills and leakage or deliberate dumping of these chemicals onto the ground or into storm drains causes environmental harm in receiving waters.

#### *1.1.4.6 Miscellaneous Wastes*

Miscellaneous wastes include wash water from concrete mixers, paints and painting equipment cleaning activities, solid organic wastes resulting from trees and shrubs removed during land clearing, wood and paper materials derived from packaging of building products, food containers, such as paper, aluminum, and metal cans, industrial or heavy commercial process wash/cooling water, vehicle washing, other commercial or industrial wastes and sanitary wastes. The discharge of these wastes can lead to unsightly and polluted receiving waters.