

## **CHAPTER 8 – LAND-DISTURBING ACTIVITIES AND WATER QUALITY IMPACTS**

Land-disturbing activities are often associated with road construction and maintenance, industrial, commercial and residential development and mining operations. All of these can be a major source of pollution because of the cumulative number of acres disturbed at any given time. Even though such activities are short-lived and considered temporary sources of pollution, the impacts to water quality and overall stream function can be severe and long lasting.

To avoid potential environmental and financial problems, it is essential to use the proper best management practices (BMPs) to control erosion and sedimentation. It is also imperative that the practices be maintained throughout the duration of the development or land-disturbing activity. This chapter provides an overview of land-disturbing activities and impacts to water quality. It includes definitions of erosion and sediment, reviews the role of state and local governments and provides a list of BMPs for controlling both sediment and erosion.

### **8.1 LAND-DISTURBING ACTIVITIES**

Because construction activities can dramatically increase sediment delivery to streams, construction activities are regulated under the North Carolina Sedimentation Pollution Control Act (SPCA) of 1973 ([http://www.dlr.enr.state.nc.us/images/Sedimentation Pollution Control Act of 1973, 2006 amendments.pdf](http://www.dlr.enr.state.nc.us/images/Sedimentation%20Pollution%20Control%20Act%20of%201973,%202006%20amendments.pdf)). The Act requires an approved Sedimentation and Erosion Control Plan for any activity that disturbs one or more acres of land. North Carolina defines a land-disturbing activity as any use of the land by any person in residential, industrial, educational, institutional or commercial development, highway and road construction and maintenance that results in a change in the natural cover or topography and that may cause or contribute to sedimentation (15A NCAC 04A .0105). The Sedimentation and Erosion Control Plan explains the erosion control measures (i.e., barriers, filters, sediment traps) that will be used to retain sediment on site. The Act exempts agriculture, forestry, mining and emergency land-disturbing activities; however, each of these activities has additional rules or requirements for controlling sediment and erosion. Chapter 6 contains information about agricultural activities and Chapter 7 contains information about forestry activities.

The North Carolina Mining Act of 1971 (<http://www.dlr.enr.state.nc.us/pages/miningprogram.html>) applies to all persons or firms involved in any activity or process that disturbs or removes surface soil for the purpose of removing minerals or other solid matter from the earth. The Act also applies to activities that prepare, wash, clean or in any way treat minerals or other solid materials in order to make them suitable for commercial, industrial or construction use. While mining operations range from large quarries to small borrow pits, the Act applies only to those operations that impact one acre or more.

## 8.2 IMPACTS TO WATER QUALITY

### 8.2.1 EROSION VS. SEDIMENTATION

Erosion is a natural process by which soil and rock material is loosened and removed. Natural erosion occurs primarily on a geologic time scale, but when human activities alter the landscape, the erosion process can be greatly accelerated. The amount of damage caused by erosion depends on many factors such as the amount of rainfall, type of land cover, slope length and gradient and soil particle size (Erosion and Sediment Control Planning and Design Manual, June 2006, <http://www.dlr.enr.state.nc.us/pages/manualsandvideos.html>).

Erosion starts with a single rain event. The rain will either infiltrate, or absorb, into the soil or begin to gather and flow down slope. As velocity increases, the water will begin to pick up soil particles. Stormwater, or runoff, velocity is dependent upon the slope gradient, rainfall amount and type of land cover. If there is dense vegetation, the roots will trap or hold the soil in place allowing for very little erosion to occur. If the land has been disturbed and there is little to no vegetation, stormwater will easily gather large amounts of soil. The sediment-laden stormwater becomes abrasive, cuts gullies into hillsides and flows into the nearest body of water. The amount of erosion that occurs upstream is directly related to the amount of sedimentation (sediment deposition) downstream.

Sedimentation occurs when the water in which the soil particles are carried is sufficiently slowed for a long enough period of time to allow particles to settle out. Heavier particles, such as gravel and sand, settle out sooner than finer particles, such as clay. The length of time a particle stays in suspension increases as the particle size decreases. Clay particles stay in suspension for days or even years and contribute significantly to water clarity and turbidity.

#### *Water Quality Impacts: Sedimentation*

- ❑ Habitat Degradation – Sediment damages aquatic life by destroying stream habitat, clogging fish gills and reducing water clarity.
- ❑ Polluted Water – Sediment often carries other pollutants including nutrients, bacteria and toxic/synthetic chemicals. Pollution can also threaten public health if it contaminates drinking water sources or fish tissue.
- ❑ Increased Costs for Treating Drinking Water – Water with large amounts of sediment requires costly filtration to make it suitable for drinking. Water supply reservoirs lose storage capacity when they become filled with sediment, necessitating expensive dredging efforts.

Sedimentation is important to the maintenance of diverse aquatic habitats. Streams naturally tend toward a state of equilibrium between erosion and sedimentation. As streams meander through floodplains, the outside of the stream cuts into the streambank eroding it away, while the inside of the stream deposits sediments to create sand bars further downstream.

### 8.2.2 HABITAT DEGRADATION

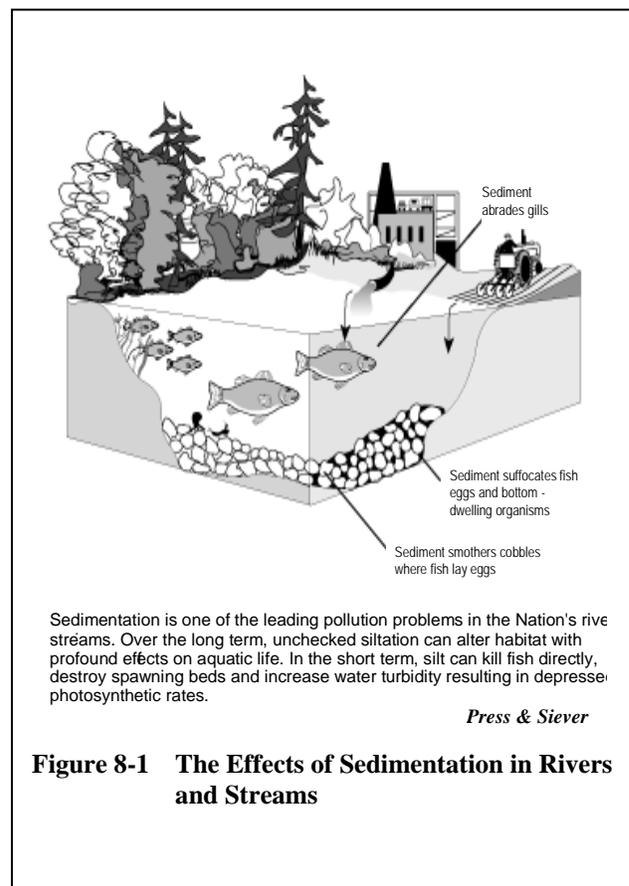
Habitat degradation in streams is identified as a notable reduction in habitat diversity or a negative change in habitat. It includes sedimentation, streambank erosion, channelization, lack of riparian vegetation, loss of pools and/or riffles, loss of organic (woody and leaf) habitat and streambed scour.

Land-disturbing activities are one of the main causes of habitat degradation. When land-disturbing activities are not managed properly it could result in frequent flooding, increased costs of treating municipal drinking water supplies and loss of biodiversity. In most cases, these activities involve the removal of native and riparian vegetation, which significantly loosens sediment. This can have severe impacts on nearby streams. Once washed into a stream by a rain event, overloading of sediment particles fills pools and covers or embeds riffles that are vital to aquatic, insect and fish habitats. Suspended sediment can decrease primary productivity (i.e., photosynthesis) by shading sunlight from aquatic plants, thereby affecting the overall productivity of a stream system. As the excess sediment in the water column settles out, the storage volume of the stream decreases thereby increasing the frequency of floods.

### 8.2.3 SEDIMENT

The impact of sediment on fish populations depends on both the concentration and degree of sediment. It also depends on the duration (or dose). For example, suspended sediments may be present at high concentrations for short periods of time, or at low concentrations for extended periods of time. The greatest impacts to fish populations occur when sediment is present in high concentrations for extended periods.

Suspended sediments can clog the gills of fish, reducing their respiratory abilities. Fish stressed by respiratory difficulties may, in turn, have a reduced tolerance level to disease, toxicants and chronic turbid conditions (Waters, 1995). The amount of sedimentation also impacts the quality and amount of fish spawning and rearing habitat, and aquatic macroinvertebrate community density, diversity and structure (Lenat *et al.*, 1979). The degree of sedimentation (also referred to as siltation) can be estimated by observing the amount of streambed covered, the depth of sedimentation and the percent of embeddedness (Figure 8-1).



**Figure 8-1 The Effects of Sedimentation in Rivers and Streams**

### 8.2.4 NUTRIENTS

Some land-disturbing activities, such as agriculture and forestry and residential/commercial fertilizer applications, can have a negative impact on the nutrient load in a waterbody. This can mainly be seen in large, slow-moving waters. Pesticides and fertilizers are heavily used in both farming and tree production. Nutrients that are not used by plants travel to nearby streams

during a rain event. Excessive nutrient concentrations stimulate algal blooms and plant growth in ponds, lakes, reservoirs and estuaries.

### 8.2.5 STREAMFLOW

Sediment transport within a stream is often divided into two categories: suspended load and bedload. Suspended load is composed of small particles that remain in suspension in the water influencing both water quality and aquatic habitat. Bedload is composed of larger particles that slide or roll along the stream bottom. The suspension of particles depends on water velocity and stream characteristics. When evaluating aquatic communities and habitat, biologists are primarily concerned with the concentration of the suspended sediments and the degree of sedimentation on the streambed (Waters, 1995).

The movement of sediment through a stream channel network is a function of past and present land activities. Under many conditions, the amount of sediment carried by a stream will increase as erosion in the watershed increases and decline as erosion decreases. A stream has a finite capacity for transporting sediment. Once the supply of sediment exceeds the stream's carrying capacity, any additional sediment will be deposited in channels and floodplains. These stored deposits can be remobilized into the stream system years, or even decades, later.

The vast majority of sediment transport in a stream occurs during periods of high flow. The relationship between sediment load and the ability of a stream to transport sediment directly affects habitat type, channel morphology and bedload particle size.

Stormflows are also important in determining the rate of streambank erosion and channel migration. Increased streambank erosion and channel migration can affect the riparian vegetation and increase the amount of active sediment in the stream channel.

#### *Activities that Increase Sediment Loads*

- Construction activities
- Unpaved private access roads
- Road construction and maintenance
- Golf courses
- Uncontrolled urban runoff
- Mining operations
- Timber harvesting
- Agriculture and livestock operations

### 8.3 STATE AND LOCAL ROLES

Controlling sediment that results from land-disturbing activities is the responsibility of many stakeholder groups including homeowners, developers/contractors, local governments and the NC Division of Land Resources (DLR). The mission of DLR's Land Quality Section (<http://www.dlr.enr.state.nc.us/pages/landqualitysection.html>) is to promote and allow development within our State while preventing pollution by sedimentation. The Sedimentation Pollution Control Act (SPCA) of 1973 sets basic performance standards adopted by the Sedimentation Control Commission (SCC). It is the responsibility of the land developer to prepare (when needed) a sedimentation and erosion control plan and employ appropriate measures (BMPs) to meet the performance standards.

### 8.3.1 MAIN SEDIMENTATION AND EROSION CONTROL LAWS

For activities that disturb more than one acre of land, there are five mandatory standards that a developer must adhere to per the SPCA. These five standards are:

- ❑ Buffer zones along streams or rivers must be sufficient to control visible siltation within the first 25 percent of the buffer zone closest to the land-disturbing activity. There must also be a 25-foot minimum width buffer along trout waters.
- ❑ Ground cover must be established on exposed slopes within 21 calendar days after completion of any phase of grading.
- ❑ Permanent ground cover must be established within 15 working days or 90 calendar days of completion of the project, whichever is shorter, and measures must be provided to keep sediment on site.
- ❑ Any land-disturbing activities of one acre or more must have an approved erosion and sediment control plan.
- ❑ The land-disturbing activity shall be conducted in accordance with the approved erosion and sedimentation control plan.

### 8.3.2 PROCESS FOR SEDIMENTATION AND EROSION CONTROL PLANS

An approved erosion and sediment control plan is required for any land-disturbing activity over one acre. LQS must approve a plan 30 days prior to the initial land-disturbing activity. An express permit allows for the land-disturbance to begin as soon as the plan is approved. If the activity involves the utilization of a ditch to de-water or lower the water table of the property, a copy of the plan is furnished to the NC Division of Water Quality (DWQ). Plans are reviewed by LQS or a local government that has been delegated that authority by the SCC. Local governments may also furnish a copy of the plan to the county Soil and Water Conservation District (SWCD) for comments. No land-disturbing activity may begin until the plan is approved. Violations of the SPCA are subject to civil penalties of up to \$5,000 per day.

### 8.3.3 LOCAL PROGRAMS

Because DLR's planning and inspection staff must oversee a wide variety of projects that stretch across a large geographic area, careful pre-construction planning may be overlooked due to a lack of staff time and resources. The Act, however, allows local governments to take responsibility for reviewing and enforcing the SPCA within their jurisdiction as long as the local program is as stringent as the State's regulations. The SCC has delegated 45 county and

#### *Sediment Control Related Programs*

##### **Construction and Urban Development**

- ❑ Sediment Pollution Control Act
- ❑ Federal Urban Stormwater Discharge Program
- ❑ Water Supply Protection Program
- ❑ HQW and ORW Stream Classification

##### **Agriculture**

- NC Agriculture Cost Share Program
- ❑ NC Cooperative Extension Service and Agricultural Research Service
- ❑ Watershed Protection and Flood Prevention Program (PL 83-566)
- ❑ Food Security Act (FSA) of 1985 and the Food, Agriculture, Conservation and Trade Act (FACTA) of 1990

##### **Forestry**

- ❑ Forest Practice Guidelines
- ❑ National Forest Management Act
- ❑ Forest Stewardship Program
- ❑ Forestry Best Management Practices
- ❑ Forest Management Program Services

##### **Mining**

- ❑ Mining Act of 1971

##### **Wetland Alterations**

- ❑ Section 10 of the Rives and Harbors Act of 1899
- ❑ Section 404 of the Clean Water Act
- ❑ Section 401 Water Quality Certification (from the Clean Water Act)
- ❑ NC Dredge and Fill Act (1969)

municipal governments the authority to administer their own sedimentation and erosion control program. Local programs provide advantages for both development and environmental protection. Local programs can:

- ❑ Unify the permitting process for approval of planning and zoning, streets, utilities and erosion control.
- ❑ Review plans more quickly than regional LQS staff.
- ❑ Be tailored to the needs of the community. Several programs in the mountains require plans on sites less than one acre because of the difficulty of controlling erosion on steep slopes.
- ❑ Inspect projects frequently, and identify problems before severe sediment damage has occurred.
- ❑ Suspend building inspections or issuance of a certificate of occupancy until violations have been corrected.

### **8.3.4 PERMITS – SECTION 401 AND 404**

Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States, unless the activity is exempt from regulation (e.g. certain farming and forestry activities). The basic premise of the program is that no discharge of dredged or fill material may be permitted if: (1) a practicable alternative exists that is less damaging to the aquatic environment or (2) the nation's waters would be significantly degraded. In other words, when a contractor applies for a permit, he/she must show that he/she has, to the extent practicable, taken steps to avoid wetland impacts, minimized potential impacts to wetlands and can provide compensation for any remaining unavoidable impacts.

Proposed activities are regulated through a permit review process. An *individual permit* is required for potentially significant impacts. Individual permits are reviewed by the U.S. Army Corps of Engineers (USACE), which evaluates applications under a public interest review, as well as the environmental criteria set forth in the CWA Section 404(b)(1) Guidelines. However, for most discharges that will have only minimal adverse effects, a *general permit* may be suitable. General permits are issued on a nationwide, regional or State basis for particular categories of activities. The general permit process eliminates individual review and allows certain activities to proceed with little or no delay, provided that the general or specific conditions for the general permit are met (EPA, *Wetland Regulatory Authority*).

Section 401 of the Clean Water Act delegates authority to the states to issue a 401 Water Quality Certification (<http://h2o.enr.state.nc.us/nwetlands/>) for all projects that require a Federal Permit (such as a Section 404 Permit). The "401" is essentially a verification by the state that a given project will not degrade waters of the State or otherwise violate water quality standards. If the USACE determines that a 404 Permit is required then a 401 Water Quality Certification is also required. The USACE also determines which type of permit is applicable to the project, a Nationwide, Regional, General or Individual Permit. For each of the Nationwide, Regional or General Permit, a matching General Certification must be issued by DWQ in order for the Permit to be valid. An Individual 401 Water Quality Certification is necessary if an Individual 404

Permit is required. To learn more about the permitting process, visit the USACE Web site ([http://www.saw.usace.army.mil/wetlands/permit\\_primer.html](http://www.saw.usace.army.mil/wetlands/permit_primer.html)).

## 8.4 REDUCING IMPACTS TO WATER QUALITY

To accommodate the rapidly growing population throughout the State of North Carolina, thousands of acres of land are exposed each year. Without proper planning and protective measures, these exposed areas are vulnerable to accelerated erosion and sedimentation that have a lasting, damaging effect on the State's waterways. Federal, State and local government agencies have implemented various programs designed to minimize soil loss from land-disturbing activities, and even though North Carolina does not have a numeric water quality standard for suspended sediment, there is a numeric standard for point source dischargers. Point source dischargers must meet minimum federal effluent guidelines of 30 mg/l for total suspended solids (TSS). In addition, a TSS limit of 10 mg/l applies to discharges to High Quality Waters (HQW) that are trout waters or primary nursery areas, and a 20 mg/l limit applies to discharges to other HQWs. Many point source dischargers also have limits for biochemical oxygen demand (BOD). BOD limits usually dictate a degree of treatment that assures the removal of solids below federal requirements.

There are also numerical instream turbidity standards to measure water clarity. Instream turbidity standards are measured using Nephelometric Turbidity Units (NTU) and must be:

- ❑ 50 NTU in streams not designated as trout (Tr) waters.
- ❑ 25 NTU in lakes and reservoirs not designated as Tr waters.
- ❑ 10 NTU in Tr waters.

Land-disturbing activities that implement approved BMPs are considered to be in compliance with these standards.

### 8.4.1 BEST MANAGEMENT PRACTICES (BMPs)

The BMPs listed below are some of the most commonly used measures to reduce erosion and sedimentation. A full explanation of these and the measures listed in Table 8-1 can be found in Chapter 6 of the *Erosion and Sediment Control Planning and Design Manual* written by the LQS. It is available online (<http://www.dlr.enr.state.nc.us/pages/manualsandvideos.html>).

*Rolled Erosion Controlled Products (RECP)* are intended to protect soil and hold seed and mulch in place on slopes and in channels so that vegetation can become well established. Turf reinforcement mats can be used to permanently reinforce grass in drainage ways during high flows. Nets are made of high tensile material woven into an open net which overlays mulch materials. Blankets are made of interlocking fibers, typically held together by biodegradable or photodegradable netting. They generally have lower tensile strength than nets, but cover the ground more completely. RECPs should be used to aid permanent vegetation stabilization of slopes 2:1 or greater and with more than 10 feet of vertical relief.

Temporary Slope Drains are a flexible tubing or conduit extending temporarily from the top of a cut or fill slope to the bottom. They are used to convey concentrated runoff down the face of a cut or fill slope without causing erosion. This practice applies to construction areas where stormwater runoff above a cut or fill slope will cause erosion if allowed to flow over the slope.

Outlet Stabilization Structure is a structure designed to control erosion at the outlet of a channel or conduit. This practice applies where the discharge velocity of a pipe, box culvert, diversion, open channel, or other water conveyance structure exceeds the permissible velocity of the receiving channel or disposal area.

Hardware Cloth and Gravel is a temporary measure of wire-mesh hardware cloth around steel posts supporting washed stone placed around the opening of a drop inlet. It is used to prevent sediment from entering yard inlets, grated storm drains or drop inlets during construction. Use this practice around a catch basin or a drop inlet where the flow is light to moderate.

Rock Pipe Inlet Protection is a horseshoe shape rock dam structure at a pipe inlet with a sediment storage area around the outside perimeter of the structure. This structure is used to prevent sediment from entering, accumulating in and being transferred by a culvert or storm drainage system prior to stabilization of the disturbed drainage area. It may be used at pipes with a maximum diameter of 36 inches.

Temporary Sediment Trap is a small, temporary ponding basin formed by an embankment or excavation. These traps are used to detain sediment-laden runoff and trap the sediment to protect receiving streams, lakes, drainage systems, and protect adjacent property. Traps maybe installed at the outlets of diversions, channels, slope drains, or other runoff conveyances that discharge sediment-laden water. Because the sediment must be removed and properly disposed of, an access must be maintained. The maximum drainage area is 5 acres. A temporary sediment trap should not be located in an intermittent or perennial stream.

Sediment Basin is an earthen embankment suitably located to capture sediment. The purpose of a sediment basin is to retain sediment on a construction site, and prevent sedimentation in streams, lakes, and drainage ways. Installation requires a drainage area of less than 100 acres, the location provides a convenient concentration point for sediment-laden flows from the area served, access for sediment removal and proper disposal under all weather conditions, and a maximum life of three years unless designed as a permanent structure. A sediment basin should not be located in an intermittent or perennial stream.

Sediment Fence is a temporary sediment control measure consisting of fabric buried at the bottom, stretched, and supported by posts. The fence is used to retain sediment from small-disturbed areas by reducing the velocity of sheet flow to allow sediment deposition. They should be placed below small-disturbed areas that are less than ¼ acre per 100 feet of fence. Do not install sediment fences across streams, ditches, waterways or other areas of concentrated flow.

Rock Dam is a rock embankment located to capture sediment in a naturally formed drainage feature. The rock dam maybe used in drainage areas too large for the use of a temporary sediment trap, but must not exceed 10 acres. They are preferred where a stable, earthen

embankment would be difficult to construct, and riprap and gravel are readily available. The site must be accessible for periodic sediment removal. A rock dam should not be located in an intermittent or perennial stream.

Skimmer Sediment Basin is an earthen embankment suitably located to capture runoff, with a trapezoidal spillway lined with an impermeable geotextile or laminated plastic membrane, and equipped with a floating skimmer for dewatering. Sediment basins are designed to provide an area for runoff to pool and settle out a portion of the sediment carried down gradient. The basic concept is that the skimmer does not dewater the basin as fast as runoff enters it, but instead allows the basin to fill and then slowly drain over hours or days. This allows sediment more time to settle out prior to discharge. Do not locate the skimmer sediment basin in an intermittent or perennial stream.

Porous Baffles are installed inside a temporary sediment trap, rock dam, skimmer basin, or sediment basin to reduce the velocity and turbulence of the water flowing through the measure, and facilitate the settling of sediment from the water before discharge. Sediment traps and basins are designed to temporarily pool runoff water to allow sediment to settle before the water is discharged. Unfortunately, they are usually not very efficient due to high turbulence and short-circuiting which takes the runoff quickly to the outlet with little interaction with most of the basin. Baffles improve the rate of sediment retention by distributing the flow and reducing turbulence. This process can improve sediment retention.

Temporary Stream Crossing is a bridge, ford or temporary structure installed across a stream or watercourse for short-term use by construction vehicles or heavy equipment. They provide a means for construction vehicles to cross streams or watercourses without moving sediment into streams, damaging the streambed or channel, or causing flooding.

Check Dam is a small temporary stone dam constructed across a drainage way. Check dams reduce erosion in a drainage channel by reducing the velocity of flow. Do not use check dams in intermittent or perennial streams.

#### 8.4.2 HEADWATER STREAM PROTECTION

Many streams in a given river basin are only small trickles of water that emerge from the ground. A larger stream is formed at the confluence of these trickles. This constant merging eventually forms a large stream or river. Most monitoring of fresh surface waters evaluates these larger streams. The many miles of small trickles, collectively known as headwaters, are not directly monitored and in many instances are not even indicated on maps. These streams account for approximately 80 percent of the stream network and provide many valuable services for quality and quantity of water delivered downstream (Meyer *et al.*, 2003). However,

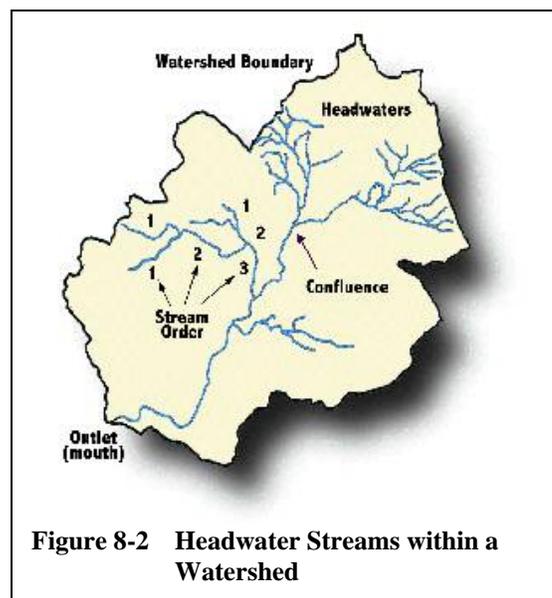


Figure 8-2 Headwater Streams within a Watershed

degradation of headwater streams can (and does) impact the larger stream or river. There are three types of headwater streams – perennial (flow year-round), intermittent (flow during wet seasons) and ephemeral (flow only after precipitation events). All types of headwater streams provide benefits to larger streams and rivers. Headwater streams control flooding, recharge groundwater, maintain water quality, reduce downstream sedimentation, recycle nutrients, and create habitat for plants and animals (Meyer *et al.*, 2003) (Figure 8-2).

**Table 8-1 Best Management Practices (BMPs) for Land Disturbing Activities**

<p><b>Site Preparation</b></p> <ul style="list-style-type: none"> <li>Land Grading</li> <li>Surface Roughening</li> <li>Topsoiling</li> <li>Tree Preservation and Protection</li> <li>Temporary Gravel Construction Entrance/Exit</li> </ul>	<p><b>Inlet Protection</b></p> <ul style="list-style-type: none"> <li>Hardware Cloth and Gravel (Temporary)</li> <li>Block and Gravel Inlet Protection (Temporary)</li> <li>Sod Drop Inlet Protection</li> <li>Rock Doughnut Inlet Protection</li> <li>Rock Pipe Inlet Protection</li> </ul>
<p><b>Surface Stabilization</b></p> <ul style="list-style-type: none"> <li>Temporary Seeding</li> <li>Permanent Seeding</li> <li>Sodding</li> <li>Tree, Shrubs, Vines, and Ground Covers</li> <li>Mulching</li> <li>Riprap</li> <li>Vegetative Dune Stabilization</li> <li>Rolled Erosion Controlled Product</li> </ul>	<p><b>Runoff Control Measures</b></p> <ul style="list-style-type: none"> <li>Temporary Diversions</li> <li>Permanent Diversions</li> <li>Diversion Dike (Perimeter Protection)</li> <li>Right-of-Way Diversion (Water Bars)</li> <li>Grass-Lined Channels</li> <li>Riprap and Raved Channels</li> <li>Temporary Slope Drains</li> <li>Paved Flumes (Chutes)</li> </ul>
<p><b>Sediment Traps and Barriers</b></p> <ul style="list-style-type: none"> <li>Temporary Sediment Trap</li> <li>Sediment Basin</li> <li>Sediment Fence</li> <li>Rock Dam</li> <li>Skimmer Sediment Basin</li> <li>Porous Baffles</li> </ul>	<p><b>Stream Protection</b></p> <ul style="list-style-type: none"> <li>Temporary Stream Crossing</li> <li>Permanent Stream Crossing</li> <li>Vegetative Streambank Stabilization</li> <li>Structural Streambank Stabilization</li> <li>Buffer Zones</li> </ul>
<p><b>Outlet Protection</b></p> <ul style="list-style-type: none"> <li>Level Spreader</li> <li>Outlet Stabilization Structure</li> </ul>	<p><b>Other Related Practices</b></p> <ul style="list-style-type: none"> <li>Construction Road Stabilization</li> <li>Subsurface Structure</li> <li>Check Dam with/out Weir</li> <li>Dust Control</li> <li>Sand Fence</li> <li>Flocculants</li> </ul>

In smaller headwater streams, fish communities are not well developed and benthic macroinvertebrates dominate aquatic life. Benthic macroinvertebrates are often thought of as "fish food" and, in mid-sized streams and rivers, they are critical to a healthy fish community. However, these insects, both in larval and adult stages, are also food for small mammals, such as river otter and raccoons, birds and amphibians (Erman, 1996). Benthic macroinvertebrates in headwater streams also perform the important function of breaking down coarse organic matter, such as leaves and twigs, and releasing fine organic matter. In larger rivers, where coarse organic matter is not as abundant, this fine organic matter is a primary food source for benthic macroinvertebrates and other organisms in the system (CALFED, 1999). When the benthic macroinvertebrate community is changed or extinguished in an area, even temporarily, as occurs

during land use changes, it can have repercussions in many parts of both the terrestrial and aquatic food web.

Headwater streams also provide a source of insects for repopulating downstream waters where benthic macroinvertebrate communities have been eliminated due to human alterations and pollution. Adult insects have short life spans and generally live in the riparian areas surrounding the streams from which they emerge (Erman, 1996). Because there is little upstream or stream-to-stream migration of benthic macroinvertebrates, once headwater populations are eliminated, there is little hope for restoring a functioning aquatic community. In addition to macroinvertebrates, these streams support diverse populations of plants and animals that face similar problems if streams are disturbed. Headwater streams are able to provide these important ecosystem services due to their unique locations, distinctive flow patterns, and small drainage areas.

Because of the small size of headwater streams, they are often overlooked during land use activities that impact water quality. All landowners can participate in the protection of headwaters by keeping small tributaries in mind when making land use management decisions on the areas they control. This includes activities such as retaining vegetated stream buffers, minimizing stream channel alterations, and excluding cattle from streams. Local rural and urban planning initiatives should also consider impacts to headwater streams when land is being developed. For a more detailed description of watershed hydrology and watershed management, refer to EPA's Watershed Academy website at <http://www.epa.gov/OWOW/watershed/wacademy/acad2000/watershedmgt/principle1.html>.

### **8.4.3 RIPARIAN ZONE PROTECTION**

Riparian zones are one of the most important defenses against pollutants for a river. The vegetated area acts as a buffer to reduce the amount of pollutants that reach the water. As runoff works its way down slope pollutants such as fertilizers, pesticides, sediment, debris and nutrients get pulled into the stormwater. Once the runoff reaches the riparian zone it is given a chance to be cleansed before entering the receiving river.

The ground cover of the zone reduces the velocity of the runoff that will then be able to percolate into the soil. The roots filter out certain pollutants such as fertilizers, pesticides and nutrients, which will be beneficial to the growth of the plant. Soil traps other pollutants that were not captured by the plants such as sediment, trash and debris. The runoff then reaches the river in a cleaner state. Without being processed through this zone, the runoff and its pollutants would flow straight into the river.

Studies done by the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) have shown that if properly installed and maintained, riparian zones have the capacity to remove up to 50 percent or more of nutrients and pesticides, 60 percent or more of certain pathogens and 75 percent or more of sediment. The zones show endless benefits to the environment and the community such as lower costs for treatment plants, a more aesthetically pleasing natural area for residents and/or tourists, a protective habitat for juvenile animals to find food, reduces flooding and conserves biodiversity.

The SPCA states “no land-disturbing activity during periods of construction or improvement to land shall be permitted in proximity to a lake or natural watercourse unless a buffer zone (i.e. riparian zone) is provided along the margin of the watercourse of sufficient width to confine visible siltation within the twenty-five percent of the buffer zone nearest the land-disturbing activity. Waters that have been classified as trout waters by the Environmental Management Commission (EMC) shall have an undisturbed buffer zone 25-feet wide or of sufficient width to confine visible siltation within the 25 percent of the buffer zone nearest the land-disturbing activity, whichever is greater.” More information on this Act and width calculations for buffer zones can be found in the *Erosion and Sediment Control Planning and Design Manual* written by the LQS. It is available online at [www.dlr.enr.state.nc.us/pages/manualsandvideos.html](http://www.dlr.enr.state.nc.us/pages/manualsandvideos.html).

#### **8.4.4 LIMIT STEEP SLOPE DEVELOPMENT**

Dramatic elevation changes and steep slopes define mountain topography. Building sites perched along mountainsides provide access to unparalleled vistas and are a major incentive for development. However, construction on steep slopes presents a variety of risks to the environment and human safety.

Poorly controlled erosion and sediment from steep slope disturbance negatively impact water quality, hydrology, aquatic habitat, and can threaten human safety and welfare. Soil types, geology, weather patterns, natural slope, surrounding uses, historic uses, and other factors all contribute to unstable slopes. Steep slope disturbance usually involves some form of grading. Grading is the mechanical excavation and filling of natural slopes to produce a level working surface. Improper grading practices disrupt natural stormwater runoff patterns and result in poor drainage, high runoff velocities, and increased peak flows during storm events. There is an inherent element of instability in all slopes and those who choose to undertake grading and/or construction activities should be responsible for adequate site assessment, planning, designing, and construction of reasonably safe and stable artificial slopes.

In cases where construction activities occur on steep slopes, slope stabilization should be mandated through a Site Grading Plan and/or Site Fingerprinting. Site Grading Plans identify areas intended for grading and address impacts to existing drainage patterns. They identify practices to stabilize, maintain and protect slopes from runoff and include a schedule for grading disturbance as well as methods for disposal of borrow and fill materials. Site Fingerprinting is a low-impact development (LID) BMP that minimizes land disturbances. Fingerprinting involves clearing and grading only those onsite areas necessary for access and construction activities. Extensive clearing and grading accelerates sediment and pollutant transport off-site. Fingerprinting and maintenance of vegetated buffers during grading operations provide sediment control that reduces runoff and off-site sedimentation (Yaggi and Wegner, 2002).

Local communities also have a role in reducing impacts from steep slope development. These impacts can also be addressed through the implementation of city and/or county land use and sediment and erosion control plans. Land use plans are a non-regulatory approach to protect water quality, natural resources and sensitive areas. In the planning process, a community gathers data and public input to guide future development by establishing long-range goals for the local community over a ten- to twenty-year period. They can also help control the rate of

development, growth patterns and conserve open space throughout the community. Land use plans examine the relationship between land uses and other areas of interest including quality-of-life, transportation, recreation, infrastructure and natural resource protection (Jolley, 2003).

Sediment and Erosion Control Plans are a regulatory approach to reducing the impacts of steep slope development and ensure that land disturbing activities do not result in water quality degradation, soil erosion, flooding, or harm to human health (i.e., landslides). The DLR LQS has the primary responsibility for assuring that erosion is minimized and sedimentation is reduced during construction activities. Under the SPCA, cities and counties are given the option to adopt local ordinances that meet or exceed the minimum requirements established by the State. Local programs must be reviewed and approved by the SCC. Once approved, local staff performs plan reviews and enforces compliance. If for some reason the local program is not being enforced, the SCC can assume administrative control of the local program until the local government assures the State that it can administer and enforce sediment and erosion control rules. The SPCA as well as an example of a local ordinance can be found on the DLR Web site (<http://www.dlr.enr.state.nc.us/pages/sedimentation.html>).

The requirements outlined in the SPCA were designed to be implemented statewide and may not fully capture the needs of mountain communities. For example, only projects disturbing more than one-acre of land are required to produce a sediment and erosion control plan. Many small construction projects fall below this threshold. In steep mountainous terrain, even these small disturbances can produce an astounding volume of sediment runoff. DWQ strongly encourages local governments to adopt Sediment and Erosion Control ordinances that exceed the State's minimum requirements.

#### **8.4.5 LIMIT PRIVATE ACCESS ROAD CONSTRUCTION**

Improperly designed, constructed and maintained private access roads are a significant source of sediment because landowners often do not realize the importance of building driveways for long-term service.

While some landowners rely entirely on a contractor to design a private road, others will attempt to design the road themselves without ever consulting a reputable, knowledgeable source. The consequences of an improperly designed and constructed private access road may be significant and can include the loss of the road as well as adjacent property. Water quality problems can also arise, especially if a road is washed-out.

While the responsibility for designing, building and maintaining a private access road rests with the landowner, local governments, citizens and state/federal agencies can all help overcome many of the problems associated with private access roads.

## References

- CALFED Bay-Delta Program. 1999. *Monitoring, Research, and Assessment Components for Benthic Macroinvertebrate Communities*. Sacramento, CA. <http://calfed.ca.gov/programs/cmarp/a7a13.html>
- Erman, N.A. 1996. *Status of Aquatic Invertebrates in: Sierra Nevada Ecosystem Project: Final Report to Congress, Vol II, Assessments and Scientific Basis for Management Options*. University of California. Davis Centers for Water and Wildland Resources.
- Lenat, D.R., D.L. Penrose and K.W. Eagleson. 1979. *Biological Evaluation of Nonpoint Source Pollutants in North Carolina Streams and Rivers*. North Carolina Department of Natural Resources and Community Development. Biological Series 102. Raleigh, NC.
- Meyer, J.M., L.A. Kaplan, D. Newbold, D.L. Strayer, C.J. Woltemade, J.B. Zedler, R. Beilfuss, Q. Carpenter, R. Semlitsch, M.C. Watzin and P.H. Zedler. September 2003. *Where Rivers are Born: The Scientific Imperative for Defending Small Streams and Wetlands*. American Rivers and Sierra Club. Washington, D.C.
- North Carolina Department of Environment and Natural Resources (NCDENR). Division of Land Resources (DLR). Land Quality Section. June 2006. *Erosion and Sediment Control Planning and Design Manual*. Raleigh, NC. <http://www.dlr.enr.state.nc.us/>.
- NRCS, USGS, October 2006. *Buffer Strips: Common Sense Conservation*. <http://www.nrcs.usgs.gov/feature/buffers/>.
- US EPA. Worksheet: *Wetland Regulatory Authority*. [http://www.epa.gov/owow/wetlands/pdf/reg\\_authority\\_pr.pdf](http://www.epa.gov/owow/wetlands/pdf/reg_authority_pr.pdf)
- Watershed Education for Communities and Local Officials (WECO). 2003. */Nonpoint Source Pollution Prevention and Control Through Land Use Planning and Management: An Introduction & Resource Guide for Protection Coastal North Carolina Waters/*. Prepared by Jason Jolley. North Carolina State University (NCSU): Raleigh, NC.
- Yaggi, M.A. and W. Wegner. 2002. */Steep Slope Development and How It Effects the Environment/*. Concerned Citizens of Southeast; Brewster, NY.