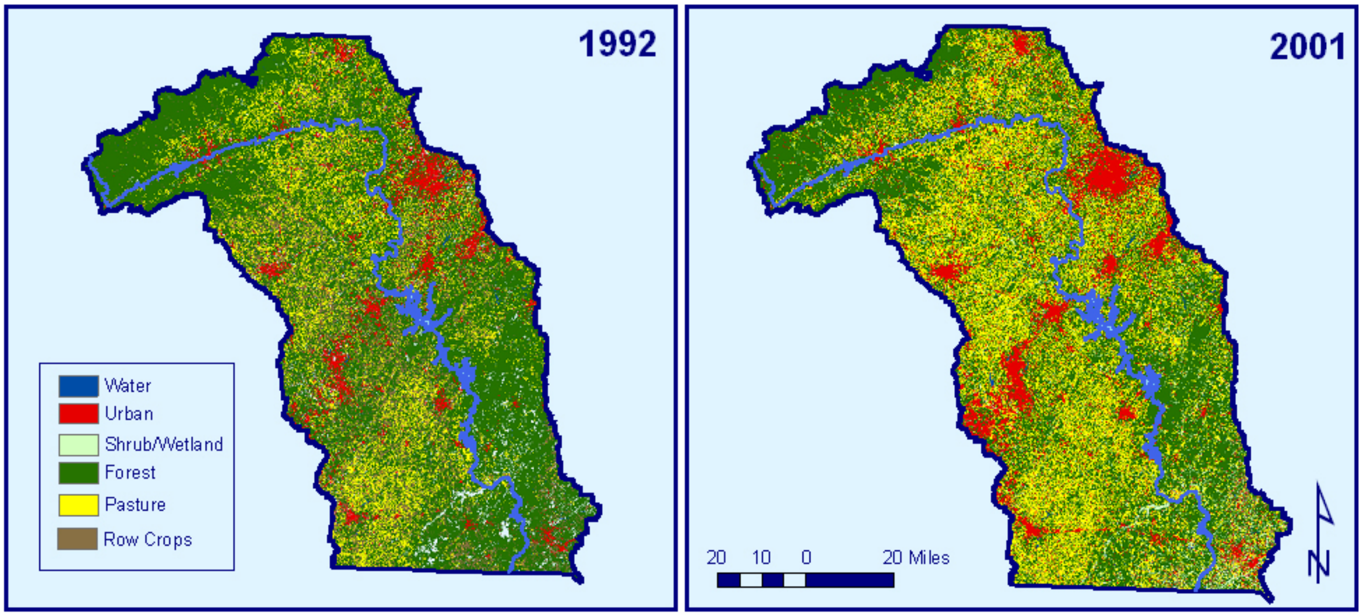
Managing Population & Land Use Change for Water Quality Protection

The Yadkin Pee Dee River Basin encompasses much of the North Carolina piedmont. Large tracts of fertile agricultural lands, rural communities, and forests also fall within its borders. Conversely, it contains two of North Carolina's largest population centers. Several major interstate corridors including I-85, I-40, and I-77 cross it. Population growth is booming around the major cities and transportation corridors. With this growth comes increased pressure on the natural environment. Every person living in or passing through a watershed creates water quality impacts. If water pollution is to be reduced, each individual must be aware of these contributions and take actions to reduce them. The following paragraphs discuss the most common impacts of human activity and offer suggestions to lessen those impacts.

Figure 1. Land Cover Patterns in the Yadkin Pee Dee River Basin



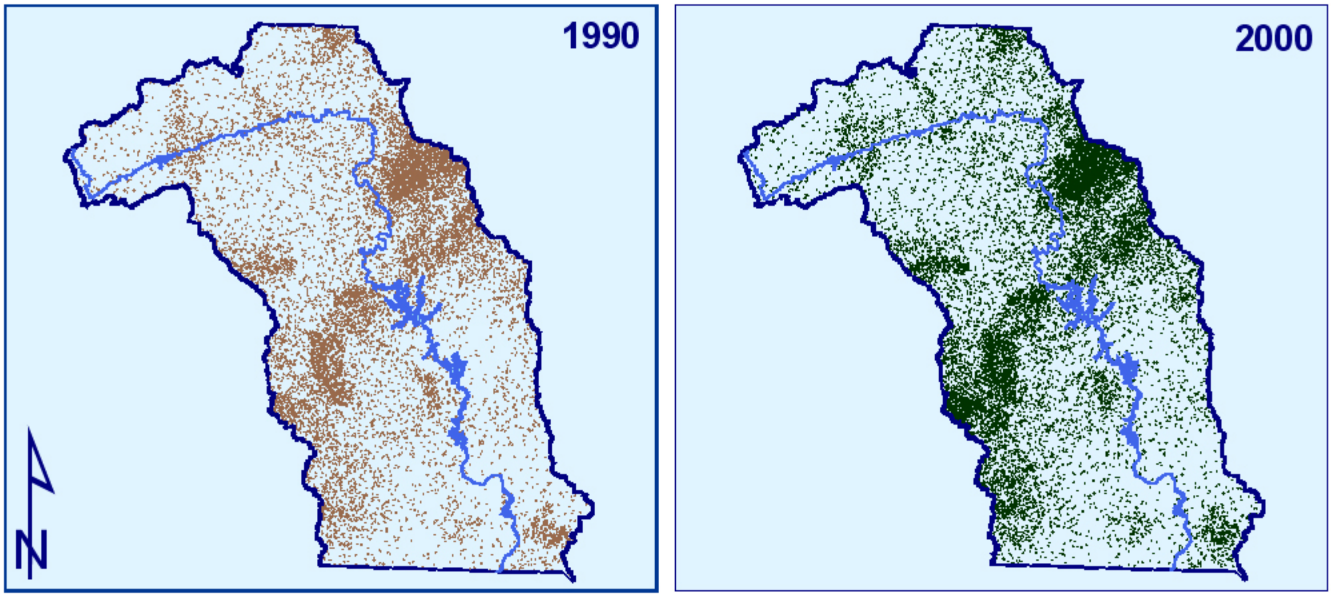
Source: Multi-Resolution Land Characteristics Consortium http://www.mrlc.gov/
Note: Due to sampling and classification differences, data from 1992 and 2001 cannot be compared directly. These maps are prepared here to qualitatively demonstrate general land cover patterns.

IMPACTS FROM POPULATION GROWTH AND LAND COVER CHANGE

Rapid Urbanization

Population growth results in dramatic impacts on the natural landscape. The most obvious impact is the expansion of urban and suburban areas. New stores, roads, and subdivisions are products of growing populations. What is not so obvious is the astonishing rate at which rural landscapes are converted to developed land. Between 1982 and 1997, the United States population increased by 15 percent. Over the same period, developed land increased by 34 percent – more than double the rate of population growth (NRI, 2001; U.S. Census Bureau, 2000). Locally, the trend can be even more pronounced. Between 1992-1997 the population in North Carolina increased by approximately 11 percent, concurrently the state ranked sixth in the nation for annual rate of land developed, at over 100,000 acres per year (NC OSBM, 2008; NRCS, 2008). Studies have not been completed for the Yadkin-Pee Dee river basin, but similar trends are expected. Figures 1 and 2 demonstrate the increase in urban land area corresponding to the population increase along the southeastern basin boundary, around the Charlotte Metropolitan area.

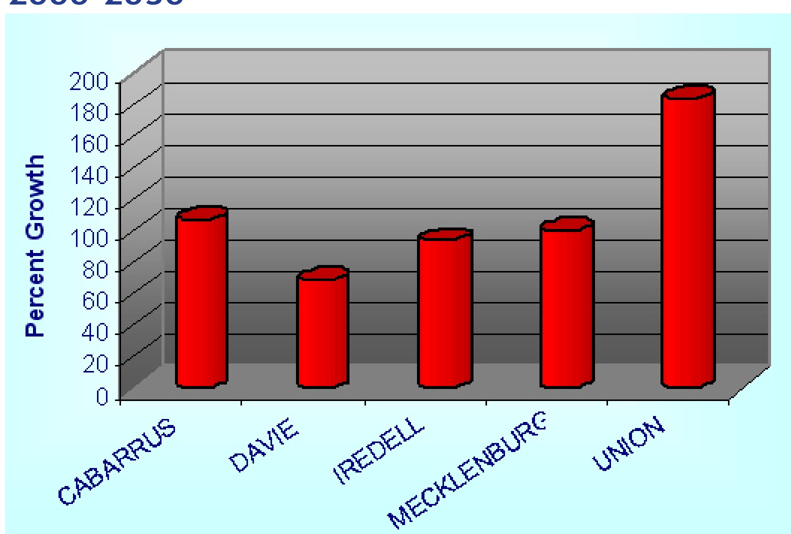
Figure 2. Population Distribution in the Yadkin Pee Dee River Basin



1 dot = 100 persons

Most county populations in counties wholly or partial contained in the Yadkin-Pee Dee river basin will grow significantly between 2000 and 2030 (See Tables 1 and 2). County growth rates over this period range from slight decreases in Richmond and Anson Counties to a staggering 184 percent increase in Union County. If development patterns follow the trends described above, urban land use may increase by over 350 percent in Union County by 2030. Cabarrus, Davie, Iredell, and Mecklenburg Counties are projected to nearly double in population over the same period. Such an increase in developed land poses a significant threat to water quality and stream health because it will be accompanied by a similar increase in impervious surfaces.

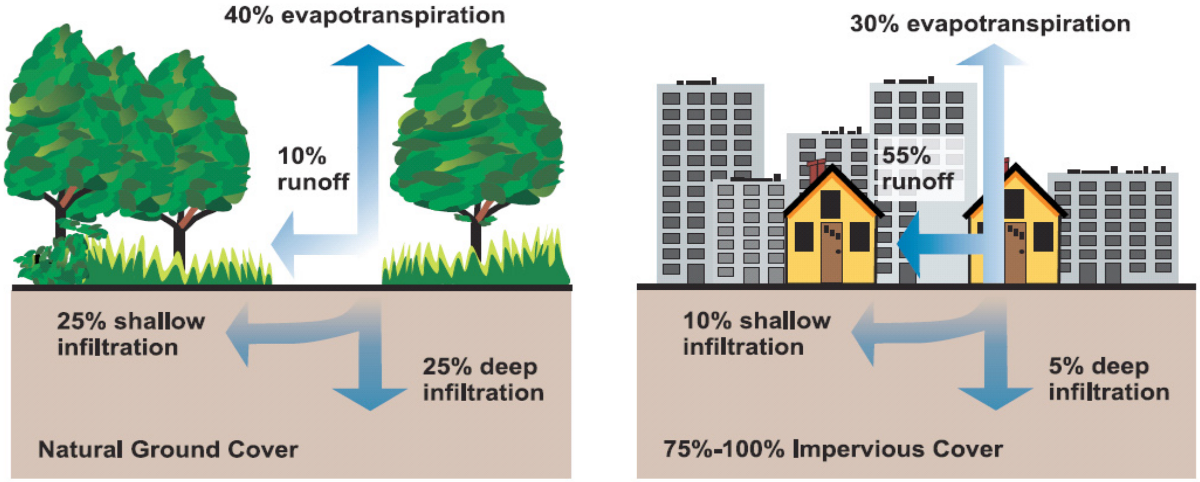
Figure 3. Population Growth Rates for the 5 Fastest Growing Counties in the Yadkin Pee Dee River Basin 2000-2030



Impervious surfaces are materials that prevent infiltration of water into the soil and include roads, rooftops, and parking lots. Impervious surfaces alter the natural hydrology, prevent the infiltration of water into the ground, and concentrate the flow of stormwater over the landscape. In undeveloped watersheds, stormwater filters down through the soil, replenishing groundwater quantity with water of good quality.

Vegetation holds down the soil, slows the flow of stormwater over land, and filters out some pollutants, by both slowing the flow of the water and trapping some pollutants in the root system. As the imperviousness of a watershed increases, the greater volume of stormwater it produces increases the possibility of flooding and reduces the potential for pollutants to settle out. Thus, more pollution is delivered to streams and drinking water supplies. Too much paving and hardening of a watershed can reduce infiltration and groundwater levels which in turn can decrease the availability of aquifers, streams and rivers for drinking water supplies (Kauffman and Brant, 2000). It is well established that stream degradation begins to occur when 10 percent or more of a watershed is covered with impervious surfaces. The stream is significantly degraded when imperviousness reaches 30 percent of the watershed (Schueler, 1995). If projects described in the preceding paragraphs hold true, many more streams in these areas will be Impaired by 2030 unless bold and comprehensive measures are taken immediately to protect water quality. The following discussion provides a general overview of potential solutions that must be catered to suit individual communities.

Figure 4. Impervious Cover and Surface Runoff (EPA, 2003)



Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface ruunoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.

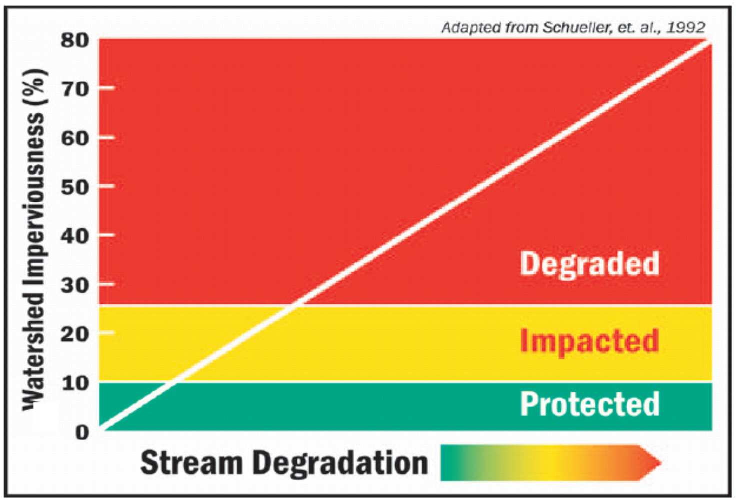
POPULATION GROWTH AND IMPACTS ON AQUATIC RESOURCES

Urbanization poses one of the greatest threats to aquatic resources. For example, a one-acre parking lot produces 16 times more runoff than a one-acre meadow (Schueler and Holland, 2000). A wide variety of studies over the past decade converge on a central point: when more than 10 percent of the acreage in a watershed is covered in roads, parking lots, rooftops, and other impervious surfaces, the rivers and streams within the watershed become seriously degraded. Brown trout populations have been shown to decline sharply at 10 to 15 percent imperviousness. If urbanized area covers more than 25 percent of a watershed, these studies point to an irreversible decline in ecosystem health (Beach, 2002 and Galli, 1991).

Greater numbers of homes, stores, and businesses require greater quantities of water. Growing populations not only require more water, but they also lead to the discharge and runoff of greater quantities of waste and pollutants into the state's streams, rivers, lakes and groundwater. Thus, just as demand and use increases, some of the potential water supply is lost (Orr and Stuart, 2000).

As development in surrounding metropolitan areas consumes neighboring forests and fields, the impacts on rivers, lakes, and streams can be significant and permanent if stormwater runoff is not controlled (Orr and Stuart, 2000). As watershed vegetation is replaced with impervious surfaces, the ability of the landscape to absorb and diffuse the effects of natural rainfall is diminished. Urbanization results in increased surface runoff and correspondingly earlier and higher peak stream flows after rainfall. Flooding frequency also increases. These effects are compounded when small streams are channelized (straightened) or piped, and storm sewer systems are installed to increase transport of stormwater downstream. Bank scour from these frequent high flow events tends to enlarge streams and increase suspended sediment. Scouring also destroys the variety of habitat in streams, leading to degradation of benthic macroinvertebrate populations and loss of fisheries (EPA, 2003).

Figure 5. Impervious Cover and Stream Degradation



KEY ELEMENTS OF A COMPREHENSIVE WATERSHED PROTECTION STRATEGY

Extensive research on the impacts of development and sobering population growth projections make it clear that comprehensive land use planning is necessary to protect aquatic resources. In order for land use planning to effectively protect watersheds in the long-term, tools and strategies must be applied at several scales. Effective implementation will require commitment ranging from the individual citizen to the state government. A comprehensive watershed protection plan should act on the following elements:

Basin Scale (Implemented by Town, County, and State Governments)

1. Characterize the watersheds within a basin as developed or undeveloped, identifying the watersheds that are currently less than 10 percent impervious and those that are more than ten percent impervious.
2. Focus new construction projects to the already developed watersheds first. Then assign any construction that cannot be accommodated in developed watersheds to a limited number of undeveloped watersheds. The watersheds to be developed should be determined by their ecological importance and by other regional growth considerations, such as the value of terrestrial ecosystems, the economic development potential as determined by proximity to roads and rail lines, and the disposition of landowners in the area toward land preservation and development.
3. Adopt policies that maintain impervious surfaces in undeveloped watersheds at less than ten percent. These can include private conservation easements, purchase of development rights, infrastructure planning, urban service boundaries, rural zoning (20-200 acres per unit, depending on the area), and urban growth boundaries.
4. Ensure that local governments develop land use plans to provide adequate land for future development within developed or developing watersheds.

Neighborhood Scale (Implemented by Town and County Governments)

1. Allow residential densities that support transit, reduce vehicle trips per household and minimize land consumption. The minimum density for new development should be seven to ten net units per acre.
2. Require block densities that support walking and reduce the length of vehicle trips. Cities that support walking and transit often have more than 100 blocks per square mile.
3. Connect the street network by requiring subdivision road systems to link to adjacent subdivisions.
4. Integrate houses with stores, civic buildings, neighborhood recreational facilities, and other daily or weekly destinations.
5. Incorporate pedestrian and bike facilities (greenways) into new development and ensure these systems provide for inter-neighborhood travel.
6. Encourage and require other design features and public facilities that accommodate and support walking by creating neighborhoods with a pleasing scale and appearance. (e.g., short front-yard setbacks, neighborhood parks, alleys, and architectural and material quality)

Site Scale (Implemented by Individual Property Owners, Developers, and Town and County Governments)

1. Require application of the most effective structural stormwater practices, especially focusing on hot spots such as high-volume streets, gas stations, and parking lots.
2. Establish buffers and setbacks that are appropriate for the area to be developed – more extensive in undeveloped watersheds than in developed watersheds. In developed watersheds, buffers and setbacks should be reconciled to other urban design needs such as density and a connected street network.
3. Educate homeowners about their responsibility in watershed management, such as buffer and yard maintenance, proper disposal of oil and other toxic materials, and the impacts of excessive automobile use (Beach, 2002).

FOCUS AREAS FOR MANAGING THE IMPACTS OF POPULATION GROWTH

The elements of watershed protection listed in above are intended to guide land use planning and population density decision-making. This section discusses specific concepts necessary to reduce the impacts of population growth.

CONTROL STORMWATER RUNOFF AND POLLUTION

Stormwater runoff is rainfall or snowmelt that runs off the ground and impervious surfaces (e.g., buildings, roads, parking lots, etc.). Because urbanization usually involves creation of new impervious surfaces, stormwater can quickly become a major concern in growing communities.

The porous and varied terrain of natural landscapes like forests, wetlands, and grasslands traps rainwater and snowmelt and allows them to filter slowly into the ground. In contrast, impervious (nonporous) surfaces like roads, parking lots, and rooftops prevent rain and snowmelt from infiltrating, or soaking, into the ground. Most of the rainfall and snowmelt remains above the surface, where it runs off rapidly in unnaturally large amounts.

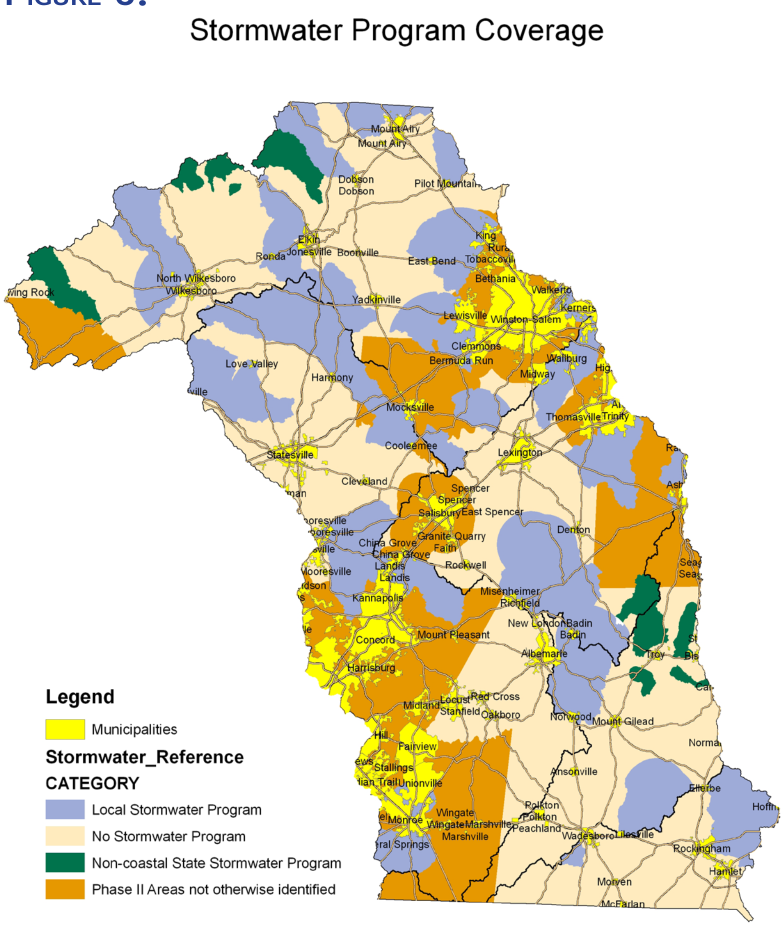
Common Pollutants in Stormwater

Storm sewer systems concentrate runoff into smooth, straight conduits. This runoff gathers speed and power as it travels through the pipes. When this runoff leaves the storm drains and empties into a stream, its excessive volume and power blast out streambanks, damaging streamside vegetation and destroying aquatic habitat. These increased storm flows carry sediment loads from construction sites and other denuded surfaces and eroded streambanks. They often carry higher water temperatures from streets, rooftops, and parking lots, which are harmful to the health and reproduction of aquatic life. The steep slopes and large elevation changes in western North Carolina intensify this effect as water rushes downhill.

Storm sewers should not be confused with sanitary sewers, which transport human and industrial wastewaters to a treatment plant before discharging into surface waters. There is no pre-treatment of stormwater in North Carolina.

Uncontrolled stormwater runoff has many impacts on both humans and the environment. Cumulative effects include flooding, undercut and eroding streambanks, widened stream channels, threats to public health and safety, impaired recreational use, and increased costs for drinking and wastewater treatment. For more information on stormwater runoff, visit the DWQ Stormwater Permitting Unit at ***http://h2o.enr.state.nc.us/su/stormwater.html*** or the NC Stormwater information page at ***http://www.ncstormwater.org/***. Additional fact sheets and information can also be found at ***http://www.stormwatercenter.net/intro_factsheets.htm*** and ***www.bae.ncsu.edu/stormwater/***. Areas covered by regulated stormwater programs are indicated in Figure 6.

Figure 6.



Controlling Stormwater Runoff and Pollution

Many daily activities have the potential to cause stormwater pollution. Any situation where activities can contribute more pollutants to stormwater runoff is an area that should be considered for efforts to minimize stormwater impacts. A major component in reducing stormwater impacts involves planning up front in the design process. New construction designs should include plans to prevent or minimize the amount of runoff leaving the site. Wide streets, large cul-de-sacs, long driveways, and sidewalks lining both sides of the street are all features of urbanizing areas that create excess impervious cover and consume natural areas. In many instances, the presence of intact riparian buffers and/or wetlands in urban areas can reduce the impacts of urban development. Establishment and protection of buffers should be considered where feasible, and the amount of impervious cover should be limited as much as possible.

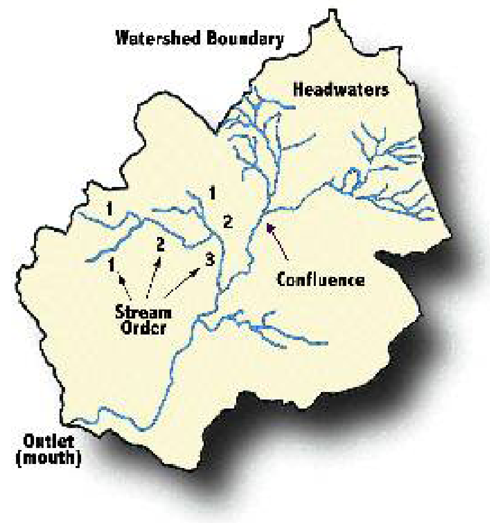
"Good housekeeping" to reduce the volume of stormwater leaving a site and reducing the amount of pollutants used in our own backyards can also minimize the impact of stormwater runoff. DWQ has published a pamphlet entitled Improving Water Quality in Your Own Backyard: Stormwater Management Starts at Home. The pamphlet provides information on how homeowners and businesses can reduce the amount of runoff leaving their property and how to reduce the amount and types of pollutants in that runoff. This document is available on-line at ***http://h2o.enr.state.nc.us/nps/documents/BackyardPDF.pdf*** or by calling (919) 807-6305.

Preserving the natural streamside vegetation (riparian buffer) is one of the most economical and efficient BMPs. In particular, forested buffers provide a variety of benefits including filtering runoff and taking up nutrients, moderating water temperature, preventing erosion and loss of land, providing flood control and helping to moderate streamflow, and providing food and habitat for both aquatic and terrestrial wildlife (NCDENR-DWQ, 2004). For more information or to obtain a free copy of DWQ's Buffers for Clean Water brochure, call (919) 807-6305.

PROTECT HEADWATER STREAMS

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 (Figure 6). 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, degradation of headwater streams can (and does) impact the larger stream or river.

Figure 7. Diagram of Headwater Streams within a Watershed Boundary



There are three types of headwater streams: 1) perennial (flow year-round); 2) intermittent (flow during wet seasons); and 3) ephemeral (flow only after precipitation events). All types of headwater streams provide benefits to larger streams and rivers. Headwater streams control flooding, recharges groundwater, maintain water quality, reduce downstream sedimentation, recycle nutrients, and create habitat for plants and animals (Meyer et al., 2003).

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***.

REDUCE IMPACTS FROM STEEP SLOPE DISTURBANCE

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. This is of particular interest to communities in the northwestern portiong of the Yadkin-Pee Dee river basin, where second home development is increasing along mountain ridges.

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) best management practice (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 Division of Land Resources (DLR) Land Quality Section (LQS) has the primary responsibility for assuring that erosion is minimized and sedimentation is reduced during construction activities. Under the Sedimentation Pollution Control Act, 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 NC Sedimentation Control Commission. Once approved, local staff performs plan reviews and enforces compliance. If for some reason the local program is not being enforced, the NC Sedimentation Control Commission may rescind delegation and the program be taken back by the State. Once the local government shows that they are able to carry out the responsibilities of a delegated program, they may request that delegation be reinstated by the NC Sedimentation Control Commission. The Sedimentation and Pollution Control Act as well as an example of a local ordinance can be found on the DLR website: ***http://www.dlr.enr.state.nc.us/pages/sedimentation_new.html***

The requirements outlined in the Sedimentation Pollution Control Act 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.

THE ROLE OF LOCAL GOVERNMENTS

REDUCING IMPACTS FROM EXISTING URBANIZATION

Below is a summary of management actions recommended for local authorities, followed by discussions on large, watershed management issues. These actions are necessary to address current sources of impairment and to prevent future degradation in all streams. The intent of these recommendations is to describe the types of actions necessary to improve stream conditions, not to specify particular administrative or institutional mechanisms for implementing remedial practices. Those types of decisions must be made at the local level. Because of uncertainties regarding how individual remedial actions cumulatively impact stream conditions and in how aquatic organisms will respond to improvements, the intensity of management effort necessary to bring about a particular degree of biological improvement cannot be established in advance. The types of actions needed to improve biological conditions can be identified, but the mix of activities that will be necessary – and the extent of improvement that will be attainable – will only become apparent over time as an adaptive management approach is implemented. Management actions are suggested below to address individual problems, but many of these actions are interrelated (NCDENR-DWQ, 2003).

Actions one through five are important to restoring and sustaining aquatic communities in watersheds, with the first three recommendations being the most important.

(1) **Feasible and cost-effective stormwater retrofit projects should be implemented throughout the watershed to mitigate the hydrologic effects of development** (e.g., increased stormwater volumes and increased frequency and duration of erosive and scouring flows). This should be viewed as a long-term process. Although there are many uncertainties, costs in the range of $1 million per square mile can probably be anticipated.

- (a) Over the short term, currently feasible retrofit projects should be identified and implemented.
- (b) In the long term, additional retrofit opportunities should be implemented in conjunction with infrastructure improvements and redevelopment of existing developed areas.
- (c) Grant funds for these retrofit projects may be available from EPA initiatives, such as EPA Section 319 funds, or the North Carolina Clean Water Management Trust Fund.

(2) **A watershed scale strategy to address toxic inputs should be developed and implemented, including a variety of source reduction and stormwater treatment methods.** As an initial framework for planning toxicity reduction efforts, the following general approach is proposed:

- (a) Implementation of available best management practice (BMP) opportunities for control of stormwater volume and velocities. As recommended above to improve aquatic habitat potential, these BMPs will also remove toxics from stormwater.
- (b) Development of a stormwater and dry weather sampling strategy in order to facilitate the targeting of pollutant removal and source reduction practices.
- (c) Implementation of stormwater treatment BMPs, aimed primarily at pollutant removal, at appropriate locations.
- (d) Development and implementation of a broad set of source reduction activities focused on: reducing non-storm inputs of toxics; reducing pollutants available for runoff during storms; and managing water to reduce storm runoff.

(3) **Stream channel restoration activities should be implemented in target areas, in conjunction with stormwater retrofit BMPs, in order to improve aquatic habitat.** Before beginning stream channel restoration, a geomorphologic survey should be conducted to determine the best areas for stream channel restoration. Additionally, it would be advantageous to implement retrofit BMPs before embarking on stream

channel restoration, as restoration is best designed for flows driven by reduced stormwater runoff. Costs of approximately $200 per foot of channel should be anticipated (Haupt, et al., 2002 and Weinkam, 2001). Grant funds for these retrofit projects may be available from federal sources, such as EPA Section 319 funds, or state sources including North Carolina Clean Water Management Trust Fund.

(4) Actions recommended above (e.g., stormwater quantity and quality retrofit BMPs) are likely to reduce nutrient/organic loading, and to some extent, its impacts. Activities recommended to address this loading include the identification and elimination of illicit discharges; education of homeowners, commercial applicators, and others regarding proper fertilizer use; street sweeping; catch basin clean-out practices; and the installation of additional BMPs targeting biological oxygen demand (BOD) and nutrient removal at appropriate sites.

(5) Prevention of further channel erosion and habitat degradation will require effective post-construction stormwater management for all new development in the study area.

(6) Effective enforcement of sediment and erosion control regulations will be essential to the prevention of additional sediment inputs from construction activities. Development of improved erosion and sediment control practices may also be beneficial.

(7) Watershed education programs should be implemented and continued by local governments with the goal of reducing current stream damage and preventing future degradation. At a minimum, the program should include elements to address the following issues:

(a) Redirecting downspouts to pervious areas rather than routing these flows to driveways or gutters;
(b) Protecting existing woody riparian areas on all streams;
(c) Replanting native riparian vegetation on stream channels where such vegetation is absent; and
(d) Reducing and properly managing pesticide and fertilizer use.

REDUCING IMPACTS OF FUTURE URBANIZATION

Proactive planning efforts at the local level are needed to assure that urbanization is done in a manner that maintains water quality. These planning efforts will need to find a balance between water quality protection, natural resource management, and economic growth. Managing population growth requires planning for the needs of increased population, as well as developing and enforcing environmental protection measures. These actions are critical to water quality management and the quality of life for the residents of the basin. Public education is also needed in the Savannah River basin so that citizens can learn and understand the value of urban planning and stormwater management.

Streams in areas adjacent to high growth areas of the basin are at a high risk of loosing healthy aquatic communities. These biological communities are important to maintaining the ecological integrity in the Savannah River basin. Unimpacted streams are important sources of benthic macroinvertebrates and fish for reestablishment of biological communities in nearby streams that are recovering from past impacts or are being restored.

To prevent further impairment to aquatic life in streams in urbanizing watersheds local governments should:

(1) Identify waters that are threatened by construction activities.
(2) Protect existing riparian habitat along streams.
(3) Implement stormwater BMPs during and after construction.
(4) Develop land use plans that minimize disturbance in sensitive areas of watersheds.
(5) Minimize impervious surfaces including roads and parking lots.
(6) Develop public outreach programs to educate citizens about stormwater runoff.
(7) Enact a Stormwater Control Ordinance. EPA offers a model ordinance at: ***http://www.epa.gov/nps/ordinance/stormwater.htm***

For more detailed information regarding recommendations for new development found in the text box, refer to EPA's website at www.epa.gov/owow/watershed/wacademy/acad2000/protection, the Center for Watershed Protection website at www.cwp.org, and the Low Impact Development Center website at ***www.lowimpactdevelopment.org***. For an example of local community planning effort to reduce stormwater runoff, visit ***http://www.charmeck.org/Home.htm***.

THE ROLE OF HOMEOWNERS AND LANDOWNERS

TEN SIMPLE STEPS TO REDUCE POLLUTION FROM INDIVIDUAL HOMES

1. To decrease polluted runoff from paved surfaces, households can develop alternatives to areas traditionally covered by impervious surfaces. Porous pavement materials are available for driveways and sidewalks, and native vegetation and mulch can replace high maintenance grass lawns.
2. Homeowners can use fertilizers sparingly and sweep driveways, sidewalks, and roads instead of using a hose.
3. Instead of disposing of yard waste, use the materials to start a compost pile.
4. Learn to use Integrated Pest Management (IPM) in the garden and on the lawn to reduce dependence on harmful pesticides.
5. Pick up after pets.
6. Use, store, and dispose of chemicals properly.
7. Drivers should check their cars for leaks and recycle their motor oil and antifreeze when these fluids are changed.
8. Drivers can also avoid impacts from car wash runoff (e.g., detergents, grime, etc.) by using car wash facilities that do not generate runoff.
9. Households served by septic systems should have them professionally inspected and pumped every 3 to 5 years. They should also practice water conservation measures to extend the life of their septic systems.
10. Support local government watershed planning efforts and ordinance development.

Table 1. County Population Growth Projections 2000-2030

COUNTY	% of County in Basin	2000	Estimated Population 2010	% Change `00 -`10	Estimated Population 2020	% Change `10 -`20	Estimated Population 2030	% Change `20 -`30	% Change `00 -'30
ALEXANDER	32	33,609	37,839	13	41,509	10	44,976	8	34
ALLEGHANY	9	10,680	11,320	6	11,869	5	12,266	3	15
ANSON	100	25,275	24,729	-2	24,303	-2	23,748	-2	-6
ASHE	1	24,384	26,808	10	28,450	6	29,780	5	22
CABARRUS	100	131,030	176,774	35	221,997	26	271,194	22	107
CALDWELL	25	77,710	81,057	4	83,830	3	85,966	3	11
DAVIDSON	100	147,269	160,499	9	175,834	10	191,080	9	30
DAVIE	100	34,835	43,165	24	50,846	18	58,682	15	68
FORSYTH	76	306,044	350,784	15	394,528	12	439,967	12	44
GUILFORD	1	421,048	474,605	13	533,495	12	593,830	11	41
IREDELL	78	122,664	161,561	32	198,632	23	237,564	20	94
MECKLENBURG	26	695,427	925,084	33	1,151,640	24	1,391,703	21	100
MONTGOMERY	88	26,836	28,222	5	30,299	7	32,486	7	21
RANDOLPH	44	130,470	144,643	11	162,178	12	180,076	11	38
RICHMOND	81	46,551	47,046	1	47,019	0	46,757	-1	0
ROWAN	100	130,348	138,931	7	152,160	10	165,647	9	27
SCOTLAND	1	35,998	37,569	4	37,670	0	37,392	-1	4
STANLY	100	58,100	60,134	4	63,401	5	66,247	4	14
STOKES	15	44,707	47,515	6	51,279	8	54,723	7	22
SURRY	97	71,227	74,629	5	79,594	7	84,859	7	19
UNION	75	123,738	203,527	64	274,147	35	350,928	28	184
WATAUGA	17	42,693	44,433	4	45,984	3	46,866	2	10
WILKES	100	65,624	67,778	3	70,564	4	72,983	3	11
YADKIN	100	36,348	39,341	8	43,234	10	47,243	9	30
Total		2,842,615	3,407,993		3,974,462		4,566,963		61

Table 2: Yadkin-Pee Dee Basin Municipal Populations

Municipality	County	Apr-00	Jul-05	% Change
ALBEMARLE	STANLY	15,680	15,645	-0.2
ANSONVILLE	ANSON	636	624	-1.9
ARCHDALE	GUILFORD, RANDOLPH	9,007	9,472	5.2
ASHEBORO	RANDOLPH	21,672	23,213	7.1
BADIN	STANLY	1,154	1,964	70.2
BERMUDA RUN	DAVIE	1,431	1,504	5.1
BETHANIA	FORSYTH	354	372	5.1
BISCOE	MONTGOMERY	1,700	1,752	3.1
BLOWING ROCK	CALDWELL, WATAUGA	1,418	1,427	0.6
BOONVILLE	YADKIN	1,138	1,153	1.3
CANDOR	MONTGOMERY	825	841	1.9
CHARLOTTE	MECKLENBURG	540,167	640,270	18.5
CHINA GROVE	ROWAN	3,616	4,219	16.7
CLEMMONS	FORSYTH	13,827	17,234	24.6
CLEVELAND	ROWAN	808	817	1.1
CONCORD	CABARRUS	55,977	63,429	13.3
COOLEEMEE	DAVIE	905	951	5.1
CORNELIUS	MECKLENBURG	11,969	16,856	40.8
DAVIDSON	IREDELL, MECKLENBURG	7,139	8,162	14.3
DENTON	DAVIDSON	1,450	1,694	16.8
DOBBINS HEIGHTS	RICHMOND	936	898	-4.1
DOBSON	SURRY	1,457	1,497	2.7
EAST BEND	YADKIN	659	667	1.2
EAST SPENCER	ROWAN	1,755	1,700	-3.1
ELKIN	SURRY, WILKES	4,109	4,175	1.6
ELLERBE	RICHMOND	1,021	991	-2.9
FAITH	ROWAN	695	703	1.2
GRANITE QUARRY	ROWAN	2,175	2,252	3.5
HAMLET	RICHMOND	6,018	5,837	-3.0
HARMONY	IREDELL	526	573	8.9
HARRISBURG	CABARRUS	4,493	5,451	21.3
HEMBY BRIDGE	UNION	1,414	1,704	20.5
HIGH POINT	DAVIDSON, FORSYTH, GUILFORD, RANDOLPH	85,839	92,491	7.7
HOFFMAN	RICHMOND	624	662	6.1
HUNTERSVILLE	MECKLENBURG	24,960	31,646	26.8
INDIAN TRAIL	UNION	11,749	22,030	87.5
JONESVILLE	YADKIN	2,259	2,255	-0.2
KANNAPOLIS	CABARRUS, ROWAN	36,910	40,139	8.7
KERNERSVILLE	FORSYTH, GUILFORD	17,126	21,277	24.2
KING	FORSYTH, STOKES	5,952	6,206	4.3
LAKE PARK	UNION	2,093	2,840	35.7
LANDIS	ROWAN	2,996	3,036	1.3
LEWISVILLE	FORSYTH	8,826	12,852	45.6
LEXINGTON	DAVIDSON	19,953	20,918	4.8

Municipality	County	Apr-00	Jul-05	% Change
LILESVILLE	ANSON	459	447	-2.6
LOCUST	CABARRUS, STANLY	2,416	2,790	15.5
LOVE VALLEY	IREDELL	30	50	66.7
MARSHVILLE	UNION	2,360	2,762	17.0
MATTHEWS	MECKLENBURG	22,125	25,442	15.0
MINT HILL	MECKLENBURG	15,609	18,804	20.5
MOCKSVILLE	DAVIE	4,178	4,454	6.6
MONROE	UNION	26,228	32,454	23.7
MOORESVILLE	IREDELL	18,823	23,125	22.9
MORVEN	ANSON	579	567	-2.1
MOUNT AIRY	SURRY	8,484	8,579	1.1
MOUNT GILEAD	MONTGOMERY	1,389	1,396	0.5
MOUNT PLEASANT	CABARRUS	1,259	1,417	12.5
NEW LONDON	STANLY	326	604	85.3
NORMAN	RICHMOND	72	74	2.8
NORTH WILKESBORO	WILKES	4,116	4,168	1.3
NORWOOD	STANLY	2,216	2,858	29.0
OAKBORO	STANLY	1,198	1,153	-3.8
PEACHLAND	ANSON	554	578	4.3
PILOT MOUNTAIN	SURRY	1,281	1,293	0.9
POLKTON	ANSON	1,916	2,910	51.9
RANDLEMAN	RICHMOND	3,557	4,088	14.9
RICHFIELD	STANLY	515	512	-0.6
ROCKINGHAM	RICHMOND	9,672	9,484	-1.9
ROCKWELL	ROWAN	1,971	1,998	1.4
RONDA	WILKES	460	476	3.5
RURAL HALL	FORSYTH	2,464	2,566	4.1
SALISBURY	ROWAN	26,462	29,058	9.8
SEAGROVE	RANDOLPH	246	252	2.4
SPENCER	ROWAN	3,355	3,394	1.2
STALLINGS	UNION	3,171	9,508	199.8
STANFIELD	STANLY	1,113	1,277	14.7
STAR	MONTGOMERY	807	811	0.5
STATESVILLE	IREDELL	23,320	25,344	8.7
TAYLORSVILLE	ALEXANDER	1,813	1,924	6.1
THOMASVILLE	DAVIDSON, RANDOLPH	19,788	26,084	31.8
TOBACCOVILLE	FORSYTH, STOKES	2,209	2,501	13.2
TRINITY	RANDOLPH	6,714	6,880	2.5
TROUTMAN	IREDELL	1,592	1,700	6.8
TROY	MONTGOMERY	3,430	4,103	19.6
UNIONVILLE	UNION	4,797	6,617	37.9
WADESBORO	ANSON	3,568	5,617	57.4
WALKERTOWN	FORSYTH	4,009	4,599	14.7
WILKESBORO	WILKES	3,159	3,178	0.6
WINGATE	UNION	2,406	3,706	54.0

Municipality	County	Apr-00	Jul-05	% Change
WINSTON-SALEM	FORSYTH	185,776	198,593	6.9
YADKINVILLE	YADKIN	2,818	2,809	-0.3

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