

■ **Data Collection and Preliminary Analysis**

Prior to planning for activities that could impact water bodies, inquiry should be made regarding any local, state and/or federal regulations in place to protect impacted waters of the state. Water quality classification may impose restrictions or design requirements; therefore, it is important to identify and reference these in the early stages of planning.

The E&SC designer must first develop a base map for the E&SC Plan from detailed topographic maps or geographic data files. For TIP projects, reference existing environmental documents from NCDOT’s PDEA for delineated waters. For non-TIP projects, designers will work with the Division Environmental Office or will be responsible for acquiring the environmental documentation on a project. The following information should be recorded on the base map (NCDENR, 2006):

- Soil type and land slopes,
- Natural drainage patterns,
- Unstable stream reaches and flood marks,
- Watershed areas,
- Existing vegetation, noting any special vegetative features,
- Areas such as steep slope, eroding areas, rock outcroppings and seepage zones,
- Unique or noteworthy landscape values to protect,
- Adjacent land uses, especially areas sensitive to sedimentation, turbidity, or flooding and
- Critical or highly erodible soil areas that should be left undisturbed.

Analyze this information and identify:

- Buffer zones,
- Suitable stream crossing areas,

- Access routes for construction and maintenance of sedimentation control devices,
- Borrow and waste disposal areas and
- The most practical sites for control practices.

Note that for TIP projects, PDEA studies various alternatives and the impacts of each alternative, and then they generate an environmental document (Environmental Impact Statement (EIS), Environmental Assessment (EA), Categorical Exclusion (CE), etc.) that aids the designers in selecting the least environmentally damaging practical alternative (LEDPA). If environmental commitments are made, they will be noted on the associated Green Sheets.

**Green sheets are internal documents that summarize the department's special project commitments to the various regulatory agencies.**



Designers must review and incorporate these commitments into the E&SC plan and design.

For sensitive watersheds where NCDOT has environmental concerns (even if there are no Environmentally Sensitive Areas [ESAs]), NCDOT will incorporate special design standards. For example, if lakes or other recreational impoundments are adjacent to the proposed project, NCDOT will evaluate risks to determine if more stringent design standards are prudent.

Development of the base map and review of the environmental commitments allows the designer to define the limitations of the site and begin “fitting” the development to the site. If possible, conduct a site visit to verify the information gathered for the base map. The NCDENR DWR classifies and regulates all surface waters within the state. Refer to NCDENR DWR’s website for a complete list and description of surface water classifications at: <http://portal.ncdenr.org/web/wq/ps/csu>.

Certain watersheds have more stringent regulations concerning E&SCs and should be identified early on in the planning process. Additional guidance is given in the subsequent sections.

### ■ **E&SC Plan Strategy**

This section provides information to assist the E&SC designer in strategizing for optimum E&SC plan design. Before the plan can be developed, there are a multitude of factors that must be considered. Oftentimes, NCDOT has established department-specific guidelines that must be met. The designer must be familiar with North Carolina requirements as well as NCDOT Special Provisions and Standard Specifications before bringing pen to paper.

### ■ **Water Quality Classifications**

In the initial planning stages, the designer should identify and address water quality classifications. Table 2.1 lists some of the water quality classifications as outlined by NCDENR DWR and NCDOT requiring additional planning considerations and more aggressive application of BMPs. The categories listed in this table should alert the designer that these areas should be treated with the highest level of design standards.

### HQW

- HQW
- WS-I, Water Supply I
- WS-II, Water Supply II
- SA, Tidal salt waters used for shell fishing
- PNA, Primary Nursery Areas

### ESAs

- Streams, including HQWs and 303(d)s
- Wetlands
- ORW, Outstanding Resource Waters
- Critical Areas
- Regulated Riparian Buffers
- CAMA Areas of Environmental Concern
- T&E Species Habitat
- Trout Waters

### 303(d) Impaired Waters

- Streams impaired for Turbidity

### Critical Areas

- Land adjacent to water supply intake

### Regulated Riparian Buffers

- Falls Lake Watershed
- Jordan Lake Watershed
- Neuse River Basin
- Tar-Pamlico River Basin
- Catawba River Basin (the main stem of Catawba River and the main stem lakes from Lake James to the North Carolina / South Carolina border only)
- Randleman Lake Watershed
- Goose Creek Watershed

*Refer to NCDENR DWR for a complete List*

Table 2.1 Water quality classifications  
 required for sensitive design standards

## ■ **HQWs and ESAs**

NCDOT has special provisions in place for projects that occur in HQW zones and for projects that include ESAs within its limits of construction, as shown on the E&SC plan. An ESA is an NCDOT term used to direct attention to the E&SC designer and contractor, to provide the highest level of protection at these sensitive environmental areas. If the project falls within an HQW zone or an ESA, such as a stream located on the site, special procedures must be used for construction activities within a 50-foot zone on both sides of that stream measured from the top of the bank.

For projects with T&E species, the NCGO1 requires disturbed areas within 1 mile of and draining to waters where federally listed T&E aquatic species are present to be limited at any time to a maximum total area of 20 acres within the project boundaries. Portions of the project that are outside of the 1 mile and draining to limit can disturb more than the 20 acres.

PNAs, as defined by the North Carolina Administrative Code and regulated by the NCDENR Division of Marine Fisheries (DMF), are delineated waters within coastal areas that provided a habitat for young aquatic life in their developmental stages. More detailed information about PNAs is available at: <http://portal.ncdenr.org/web/mf/primary-nursery-areas>.

## ■ **303(d) Listed Waters**

If the project discharges to a water body that has been identified on the 303(d) list of impaired waters and is impaired for Turbidity, and is within 1 mile of the project and receives drainage from the project, the E&SC designer should design for the peak rate of runoff from the 25-year storm. To obtain North Carolina impaired 303(d) waters information:

- Refer to <http://portal.ncdenr.org/web/wq/ps/mtu/assessment> for a list of 303(d) streams in NC including those impaired for Turbidity and other impairments.
- Use the most current year's Final 303(d) list report to check for streams with Turbidity impairment.

### ■ **Critical Areas**

Critical Area is the land adjacent to a water supply intake where risk associated with pollution is greater than from remaining portions of the watershed. The Critical Area includes land within one-half of a mile upstream and draining to a river intake, or within one-half of a mile and draining to the normal pool elevation of water supply reservoirs. Critical Areas are more restrictive than areas outside this designation. Projects within the Critical Area require more sensitive design standards including E&SC protection from the peak rate of runoff from the 25-year storm.

### ■ **Regulated Riparian Buffers**

Riparian Buffers, as defined by NCDENR, are a vegetative area bordering a body of water, such as a stream, lake or pond. The buffer filters stormwater before it enters a body of water. Riparian Area Protection Rules (Buffer Rules) apply to NCDENR DWR jurisdictional streams projects within these areas.

### ■ **Rainfall Data References**

To access the National Oceanic and Atmospheric Administration's (NOAA's) Precipitation Frequency Data Server select this link: <http://dipper.nws.noaa.gov/hdsc/pfds/>.

### ■ **Ten Key Concepts to Effective E&SC Design**

To effectively manage each individual project, a unique and complete E&SC plan should be developed for each project. An effective plan will implement on-site erosion controls to reduce the rate of erosion as well as sediment control structures to capture and settle sediment from site runoff. The initial focus should be on implementing measures to reduce the potential for erosion. Sediment control measures are then incorporated to capture and settle sediment and prevent sedimentation into receiving waters. For each individual project, the proper, site-specific suite of BMPs must be selected. To meet the goal of protecting North Carolina waterways, the keys in Table 2.2 should be implemented; each of which may be comprised of multiple BMPs (adapted from EPA, 2007).

E&SC Key	Components of Key	Example BMP
<b>Erosion Control Keys</b>		
<b>Minimize disturbed area and protect natural features and soil</b>	<ul style="list-style-type: none"> <li>▪ Carefully delineate and control disturbed area</li> <li>▪ Only disturb area where construction is taking place</li> <li>▪ Maintain natural vegetation to maximum extent, it is the least expensive erosion control BMP               <ul style="list-style-type: none"> <li>▪ Protect and preserve topsoil, it aids in stormwater infiltration and preserves natural soil structure</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ This is primarily a nonstructural BMP as it is done through planning and management.</li> </ul>
<b>Phase construction activity</b>	<ul style="list-style-type: none"> <li>▪ Phase or schedule construction work so that soil exposure is minimized at any given time</li> <li>▪ Limit areas of disturbance to immediate construction activities</li> <li>▪ Stabilize areas as quickly as possible</li> </ul>	<ul style="list-style-type: none"> <li>▪ This is primarily a nonstructural BMP as it is done through planning and management.</li> </ul>
<b>Control offsite stormwater</b>	<ul style="list-style-type: none"> <li>▪ Plan for potential stormwater flowing onto the project area from upstream locations</li> <li>▪ Divert and slow down flows to prevent erosion</li> <li>▪ Manage on-site stormwater runoff in ways that minimize volume and velocity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Temporary Diversion</li> <li>▪ Earth Berm</li> <li>▪ Temporary Rock Silt Checks, Type A and B</li> </ul>
<b>Stabilize soils promptly</b>	<ul style="list-style-type: none"> <li>▪ Stabilize exposed soils as soon as possible when construction ends or is temporarily paused               <ul style="list-style-type: none"> <li>▪ Implement temporary cover BMPs if needed while activities are ongoing or before permanent BMPs are established</li> </ul> </li> <li>▪ Utilize NCG01 stabilization timeline</li> </ul>	<ul style="list-style-type: none"> <li>▪ Seeding and Mulching</li> <li>▪ Temporary Seeding</li> <li>▪ Temporary Mulching</li> </ul>

Table 2.2 E&SC key concepts

E&SC Key	Components of Key	Example BMP
<b>Erosion Control Keys</b>		
<b>Protect slopes</b>	<ul style="list-style-type: none"> <li>▪ Always protect slopes with appropriate erosion controls</li> <li>▪ Use a combination of BMPs on steep slopes or highly erodible soils</li> <li>▪ Implement diversion channels or berms and slope drains to keep stormwater away from slopes</li> </ul>	<ul style="list-style-type: none"> <li>▪ Matting</li> <li>▪ Special Sediment Control Fence</li> <li>▪ Temporary Slope Drains</li> <li>▪ Earth Berm</li> </ul>
<b>Sediment Control Keys</b>		
<b>Protect storm drain inlets</b>	<ul style="list-style-type: none"> <li>▪ Utilize inlet protection as a secondary BMP</li> <li>▪ Protect all inlets within your site that may receive stormwater</li> <li>▪ Provide inlet protection that can handle the volume of water from the respective drainage area</li> </ul>	<ul style="list-style-type: none"> <li>▪ Inlet Sediment Traps</li> </ul>
<b>Establish perimeter controls</b>	<ul style="list-style-type: none"> <li>▪ Maintain natural areas to the maximum extent possible</li> <li>▪ Supplement natural vegetation with silt fences and wattles around the perimeter, focusing on the downslope areas               <ul style="list-style-type: none"> <li>▪ For small areas only, use these barriers to protect stream buffers, riparian areas and waterways</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ Silt Fence</li> <li>▪ Wattle</li> </ul>

Table 2.2 E&SC key concepts continued



E&SC Key	Components of Key	Example BMP
<b>Sediment Control Keys</b>		
<b>Retain sediment on-site</b>	<ul style="list-style-type: none"> <li>▪ Use for larger areas and design to provide storage for the 10-yr or 25-yr, 24-hr storm based on designation of water quality</li> <li>▪ Locate sediment control BMPs at low-lying areas and down gradient of bare soil areas where flows meet</li> <li>▪ Always implement sediment controls at down gradient boundaries of site</li> </ul>	<ul style="list-style-type: none"> <li>▪ Stilling Basin</li> <li>▪ Skimmer Basin</li> <li>▪ Silt Basin</li> <li>▪ Special Stilling Basin</li> <li>▪ Infiltration Basin</li> <li>▪ Sediment Dam</li> <li>▪ Coir Fiber Baffle</li> </ul>
<b>Establish stabilized construction entrances/exits</b>	<ul style="list-style-type: none"> <li>▪ Utilize one or two exit/entrance(s) for vehicles to use and stabilize</li> <li>▪ Exit should be at least 50 feet long and graded</li> <li>▪ Use geotextile under a layer of 3-6 inch stone</li> <li>▪ Use large crushed rock, stone pads or concrete</li> <li>▪ Use a sweeper to further manage sediment from vehicle tracking</li> </ul>	<ul style="list-style-type: none"> <li>▪ Gravel Construction Entrance</li> </ul>
<b>Maintain BMPs</b>	<ul style="list-style-type: none"> <li>▪ Inspect and maintain all stormwater BMPs as they will quickly deteriorate without maintenance</li> <li>▪ Utilize NCDOTs inspection program for appropriate maintenance</li> </ul>	<ul style="list-style-type: none"> <li>▪ This is primarily a nonstructural BMP as it is done through planning and construction management.</li> </ul>

**Table 2.2 E&SC key concepts continued**

In addition to these keys, the E&SC plan should constitute a design that addresses and complies with the five Mandatory Standards for Land Disturbing Activities as presented in Article 113-57(A) of the SPCA:

- Prior to any land-disturbing activity including one or more acres, an E&SC plan is required to be approved.

- The plan must provide a buffer zone along all natural watercourses. Buffers should allow for “sufficient width to confine sediment within 25% of the buffer zone nearest to the land-disturbing activity.” Any project adjacent to designated trout waters requires an “undisturbed buffer zone 25 feet wide.” It should also be noted that certain river basins such as, but not limited to, the Neuse and Tar-Pamlico have specific buffer restrictions (i.e., a 50-foot wide buffer zone).
- Other standards and considerations necessary in the planning and design stages include graded slopes and fills as well as groundcover requirements throughout the life of the project. The angle of graded slopes and fill areas cannot be greater than “that which can be retained by a vegetative groundcover or other erosion control devices and structures.”
- A temporary groundcover shall be provided on all slopes and bare areas within 14 calendar days of completion of any phase of grading. A permanent vegetative groundcover shall be provided within 14 calendar days to those areas having reached final grade.
- Finally, the land-disturbing activity must be conducted as shown on the approved set of erosion and sediment control plans.

Note that specific project areas may be required to meet more restrictive ground cover requirements per NCG01.



### ■ Managing Turbidity

Managing turbidity on site will further minimize the impacts of construction activities and degradation of the project site ecosystem. Turbidity control measures can include BMPs that require large amounts of surface area to those that utilize passive treatment systems in runoff conveyances; therefore, attention must be given to securing adequate space for these measures in the planning phase. Surface skimmers are effective measures for managing turbidity that can be incorporated into planning, especially in sensitive areas. Typically, baffles are used in all outlet measures to manage turbidity.

Utilizing flocculants is also another step in managing turbidity. Use of flocculants, however, requires matching the flocculant chemistry to the soil chemistry. During the planning phase, the designer needs to perform on-site tests to determine the soil types and confirm that the appropriate flocculant is selected for the project site needs.

NCDOT has developed a Turbidity Reduction Options Sheet for borrow pits, which is available in Appendix A of this manual.

### ■ **NCDOT Watershed-Related Special Provisions**

NCDOT has developed Special Provisions to provide guidance for E&SC designers. This section will focus on the watershed/regulatory guidelines while Chapter 4 on E&SC BMPs will discuss those provisions that provide guidance on installation and placement of structural BMPs. Special provisions often reference NCDOT's Standard Specifications that must be followed. Review special provisions as needed at the following link: [http://www.ncdot.gov/doh/operations/dp\\_chief\\_eng/roadside/soil\\_water/special\\_provisions/](http://www.ncdot.gov/doh/operations/dp_chief_eng/roadside/soil_water/special_provisions/).

### ■ **Falls Lake Watershed**

The Falls Lake Watershed has more stringent groundcover requirements as summarized in Table 2.3

<b>Falls Lake Watershed Groundcover Requirements</b>	
<b>Permanent Groundcover</b> Required to be established no later than 7 days after the <u>final phase</u> of grading of any portion of the site.	
<b>Temporary Groundcover</b> Slope-specific groundcover requirements upon completion of <u>any phase</u> of grading.	
<b>For slopes steeper than 3:1</b>	<b>7 days</b>
<b>For slopes equal to or flatter than 3:1</b>	<b>10 days</b>
<b>For areas with no slope</b>	<b>14 days</b>

Table 2.3 Falls Lake Watershed groundcover requirements

### ■ **Jordan Lake Watershed**

The special provision for Jordan Lake Watershed requires a web-based training exercise to be successfully completed by the person(s) responsible for conducting the application of fertilizer to a project located within the Jordan Lake Watershed.

The following link,

<http://portal.ncdenr.org/web/jordanlake/fertilizer-management>,

specifies Fertilizer Management requirements in the Jordan Lake Watershed and provides direction to the online training.

### ■ **The Central Coastal Plain Capacity Use Area (CCPCUA)**

The CCPCUA was created in response to the Water Act of 1967 and over pumping of important aquifers in the coastal plain area of North Carolina. The CCPCUA includes a 15 county region in the state's central coastal plain. For ground water users using more than 10,000 gallons of ground and surface waters per day, the CCPCUA requires registration and reporting of capacities. For withdrawals of ground water of more than 100,000 gallons per day, the CCPCUA requires a permit.

NCDOT applies for CCPCUA permits for all proposed TIP projects requiring sizeable earthwork quantities in the affected 15 county area. Each contractor that utilizes a pump to dewater a borrow pit or utilizes a pump to withdraw surface water in the counties mentioned above is required to record the volume of water pumped from each site on a daily basis. These daily recorded quantities should then be submitted for each pit on a monthly basis to the District or Resident Engineer. The complete set of guidelines for CCPCUA are available in the special provision at the link below and a map of CCPCUA is shown in Figure 2.1:

[http://www.ncdot.gov/doh/operations/dp\\_chief\\_eng/roadside/soil\\_water/pdf/CCPCUA.pdf](http://www.ncdot.gov/doh/operations/dp_chief_eng/roadside/soil_water/pdf/CCPCUA.pdf).



Figure 2.1 Map of CCPCUAs

### ■ Other E&SC Planning Considerations


While there are no dedicated special provisions for the following topics, they still require special planning considerations and have regulatory implications for the E&SC Plan.

### ■ Trout Waters

Implement the following trout buffer guidelines when planning for the construction of roads and bridges within and around trout waters that are located within the 25 westernmost counties of the state. The trout buffer zone is a 25-foot wide swath measured horizontally from the top of the bank. The E&SC design measures must adhere to the design standards for sensitive watersheds to contain the peak rate of runoff for the 25-year storm. Groundcover requirements differ within designated trout buffers.

Permanent riparian vegetation of native species should be planted immediately following the completion of any phase of grading; use of tall fescue is not allowed in the buffer. Biodegradable erosion control matting may also be included in conjunction with seeding to promote the establishment of vegetation. If such areas are contained by perimeter measures, straw mulch may be utilized. Although hydroseeding is allowed, it may not be discharged into surface waters. Should the designer require a variance of the trout buffer requirements, a request can be made to the Director of the Division of Energy, Mineral and Land Resources (DEMLR).

**In-stream work and land disturbance inside the 25-foot wide buffer zone is prohibited from October 15 through April 15 due to the spawning seasons of trout species.**

A stylized orange map of North Carolina is positioned to the right of the callout box, partially overlapping its right edge.

If the project design necessitates the disturbance of more land within the buffer zone than allowed by North Carolina Administrative Code, a variance request must be submitted to the Land Quality Section of DEMLR. The variance should include the information listed in Figure 2.2. The variance is **only** required if the stream(s) impacted are designated Trout (Tr) by NCDENR DWR.

<p><b>Documentation will include</b></p>	<ul style="list-style-type: none"> <li>▪ A narrative including a description of the disturbance</li> <li>▪ Description of actions taken to minimize impacts on the buffer</li> <li>▪ Documentation on why disturbance will have temporary impacts on the buffer and stream from erosion and sedimentation</li> <li>▪ Include linear temporary and permanent impacts to trout stream along with the estimated acreage of buffer disturbance</li> </ul>
<p><b>Plans will include</b></p>	<ul style="list-style-type: none"> <li>▪ A construction schedule showing how the buffer is to be disturbed</li> <li>▪ Identification of the top bank of trout stream</li> <li>▪ Identification of the 25-foot buffer</li> <li>▪ The length and width of the buffer to be disturbed</li> <li>▪ The erosion and sedimentation control measures to be used in the buffer with details and calculations</li> <li>▪ Any measures needed to control water and sediment from areas outside of the buffer</li> <li>▪ Reforestation planting details</li> <li>▪ Special provisions including specifications pertaining to seed mixes, construction activities, and erosion control measures</li> </ul>
<p><b>Other considerations to address</b></p>	<ul style="list-style-type: none"> <li>▪ Equipment, excavated material storage and sediment control measures should not be stored in the buffer. Appropriate E&amp;SC measures should be used if materials are placed above the buffer.</li> <li>▪ The buffer should remain undisturbed where possible.</li> <li>▪ If the buffer is in a 100-year flood plain, a larger riparian area may be needed.</li> <li>▪ Ensure sufficient stream shade is maintained to prevent adverse temperature fluctuations. Coldwater BMPs may be required.</li> <li>▪ All materials for construction must be on site before land-disturbing activities begin.</li> <li>▪ Native plants, grasses and woody species, must be used for permanent stabilization in the trout buffer. Temporary ground cover should be provided until permanent ground cover is established.</li> </ul>

**Figure 2.2 Land Quality Section of NCDENR variance request**

A map of the trout waters of North Carolina is included in Figure 2.3. Projects within trout waters are regulated by the North Carolina Wildlife Resources Commission (NCWRC). Trout waters have two designations: NCDENR DWR designated trout waters (Tr) and NCWRC designated trout waters. Projects with only NCWRC designated trout waters are not regulated under the Trout Buffer variance requirements of the Land Quality Section of DEMLR.

## North Carolina Trout Waters

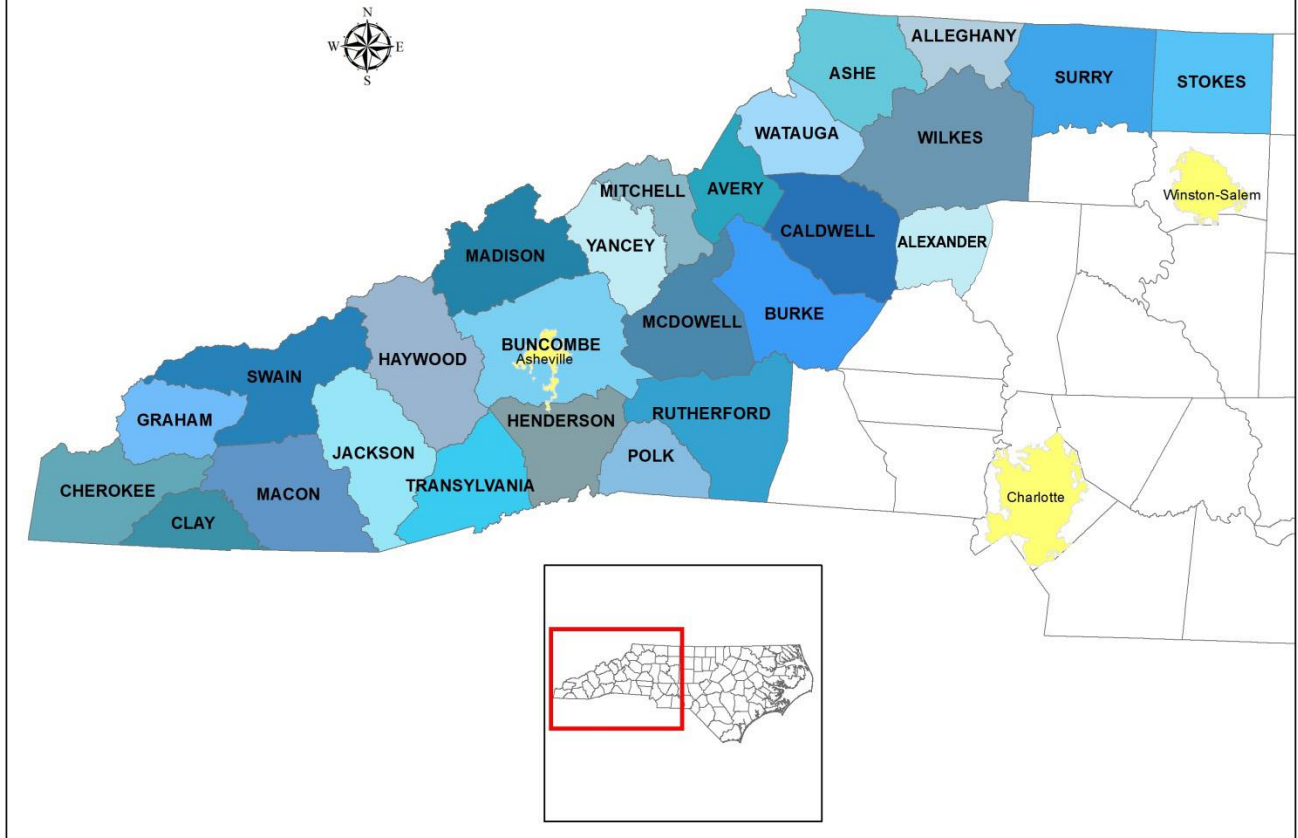


Figure 2.3 NC map showing counties with trout (Tr) designations

### ■ Post-Construction BMPs

Post-construction stormwater BMPs are permanent stormwater control measures that remain in place once the project activities are complete. These measures are installed or converted from existing measures in order to preserve the water quality of the post-construction stormwater runoff. The E&SC designer should explore opportunities at the early planning phase to utilize E&SC BMPs for conversion to post-construction structures, when feasible.



Post-Construction Stormwater Management is outlined in NCDOT's NPDES permit. NCDOT is required to address post-construction stormwater runoff from new development and redevelopment that disturb more than 1 acre. NCDOT includes the following post-construction controls in their BMP Toolbox: level spreaders, filter strips, preformed scour holes, dry detention basins, swales, infiltration basins, hazardous spill basins, bridge stormwater controls, stormwater wetlands, bioretention basins and wet detention basins.

Incorporating low impact development and green infrastructure (LID/GI) techniques in the design phase of the project as part of the temporary E&SC BMPs and permanent post-construction stormwater BMPs can effectively preserve natural vegetation and drainage patterns. For more information, refer to the Green Infrastructure and Low Impact Development Considerations section in this chapter.

**LID/GI controls focus on preserving the natural, pre-development hydrology of an area by incorporating stormwater controls that infiltrate, store or evaporate the stormwater near its source.**



Figure 2.4 identifies a few temporary E&SC measures that can be transitioned to post-construction stormwater BMPs. NCDOT has begun incorporating this practice as part of a comprehensive stormwater management approach where post-construction considerations are considered during the planning phases of a project.

### Temporary E&SC Measures

- Diversions
- Sediment Basins

### Permanent Post-Construction Measures

- Swales
- Basin-type BMPs

Figure 2.4 Temporary E&SC measures that can be transitioned to post-construction stormwater BMPs

#### ■ NCDOT Division-Specific E&SC Preferences

North Carolina is divided into 14 NCDOT divisions. Figure 2.5 shows the NC counties and the 14 divisions in which they are located. Within each division, regional design and construction considerations have been requested. While dynamic and subject to change, some division preferences have been listed in Appendix B.



Figure 2.5 NCDOT's 14 divisions

### ■ LID and GI Considerations

LID is a term used to describe an innovative approach to site development and stormwater management. The goals of LID are to minimize impacts to land, water and air while also reducing infrastructure and maintenance costs. (See the [NC\\_LID\\_Guidebook.pdf](#) from NCDENR's website.)

There are three distinct principles that distinguish LID from traditional (conventional) approaches to E&SC:

1. LID works with existing conditions of a project site to manage stormwater and employ principles such as preserving natural vegetation/landscape features. Examples of these include preserving soils with good infiltration rates and minimizing impervious areas to the extent possible.
2. In addition to traditional end of pipe E&SC measures / treatment measures, LID treats stormwater runoff in smaller areas throughout the site (e.g., amended soils, rain gardens, bioretention cells).

3. LID reduces stormwater runoff by using techniques that promote infiltration and groundwater recharge. It also uses and reuses stormwater runoff (e.g., cisterns, rain barrels, irrigating landscaping)

GI is often associated with LID. It is an approach to maintain healthy waters and surrounding environments by using vegetation and soil to provide stormwater management in a more natural way (EPA, 2013a). Figure 2.6 includes some examples:

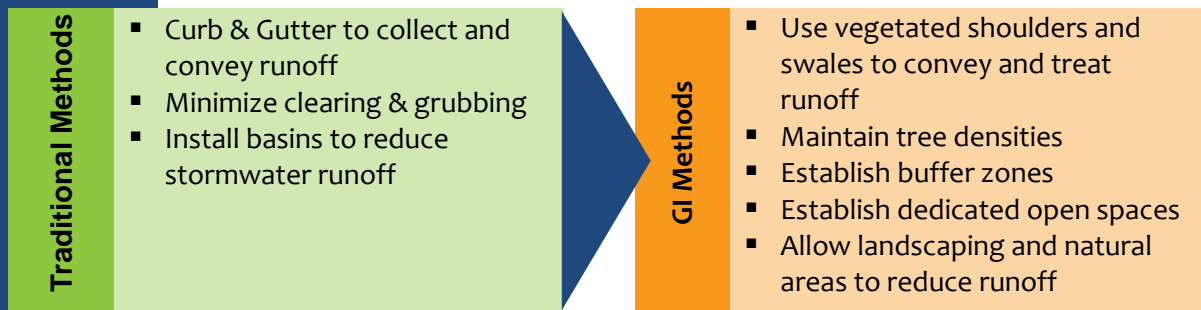


Figure 2.6 LID and GI considerations

The Department proactively incorporates LID and GI as part of the temporary construction phase as well as in the final post-construction phase. These innovative methods promote infiltration and evapotranspiration. NCDOT encourages the use of these methods. Consider the example in Figure 2.7.

### Case Study

**Design Needs:** A sediment basin needed to address sediment containment needs for the project.

**Design Decision:** Utilize alternative design methods to include LID and GI.

**Design Justification:** Basin installation would have required tree canopy within project to be removed and required years to replace. The natural area was preserved to minimize tree removal. Rather than one treatment area that would have required tree removal, smaller measures in other locations throughout the project are proposed.

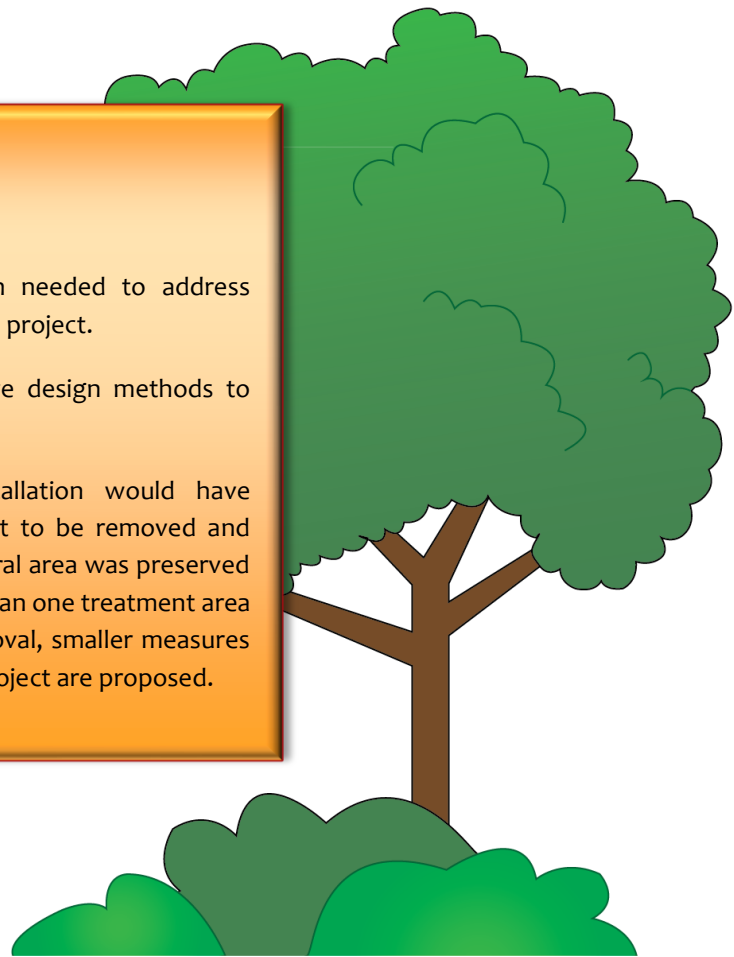


Figure 2.7 LID and GI case study