North Carolina Ecosystem Enhancement Program
Priority HUC-14 and Subwatershed Screening Methods

The North Carolina Ecosystem Enhancement Program (NCEEP) applies a rigorous watershed planning process to identify priority watersheds (HUC-14s), subwatersheds, and priority sites within subwatersheds that, if restored, would cause the most significant improvement in degraded local watershed functions. NCEEP's approach is data-intensive and requires substantial time and funding and is distinguished by its use of a detailed multi-scale watershed planning process to prioritize specific restoration and conservation projects. The approach serves as an example for how input from a wide range of stakeholders can be systematically incorporated into a prioritization methodology to achieve multiple watershed benefits.

OVERVIEW

Lead developer(s): North Carolina Ecosystem Enhancement Program (North Carolina Department of Environment and Natural Resources).

Year developed: 2003 with ongoing development.[1]

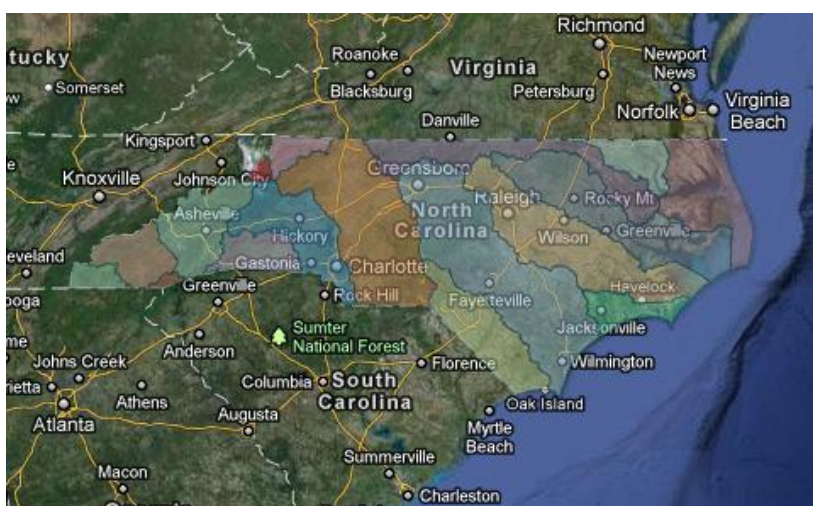**Geographic area:** Individual river basins throughout the state of North Carolina (Figure 1).[2]

Figure 1. NCEEP evaluates the seventeen river basins of North Carolina, shaded above, to identify subwatersheds in which to focus funding for restoration and conservation mitigation projects. Used with permission from North Carolina Ecosystem Enhancement Program (NCEEP).

Resource types: Wetlands and streams.

Restoration/conservation:
NCEEP prioritizes sites for traditional restoration (reestablishment and rehabilitation), enhancement, preservation/protection, and non-traditional watershed restoration approaches (e.g., stormwater BMPs).[1]

Stakeholders: The composition of the stakeholder group, which assists NCEEP in identifying watershed-specific objectives during the Local Watershed Planning (LWP) process, varies depending on the level of interest expressed by different organizations/agencies in a given region and may include both public and private entities.[3] In many cases, a Technical Advisory Committee composed of a subset of the larger stakeholder group may be developed for a Targeted Local Watershed (see below) to take a more active role in assisting EEP with plan development and implementation.[2]

Current status: The process used to identify priority sites is always evolving. Changing rules and regulations, improvements in available tools, staff available to apply the process (either consultants or EEP staff), and the target landscape/watershed all affect the prioritization process.

In addition, the NCEEP Science and Analysis group analyzes the results of EEP site monitoring efforts to evaluate the restoration/conservation approaches work best with given watershed and site characteristics.[1]

<u>**PRIORITIZATION ANALYSIS**</u>

Determination of prioritization objectives: In 2003, NCEEP's multi-agency Watershed Needs Assessment Team (WNAT) identified three major functions to serve as the basis of site prioritization efforts: water quality, hydrology, and habitat. As part of the River Basin Restoration Priorities screening method, these major functions are applied together with a set of identified needs related to watershed problems, assets, and opportunities to identify priority HUC-14s for further analysis (see below). Later in NCEEP's process, during LWP stage, NCEEP engages with stakeholders to identify watershed-specific objectives.[15]

Input data QA/QC: NCEEP ensures that important datasets, particularly aerial photography and land use data, are up-to-date prior to its LWP prioritization analyses.[14]

Landscape prioritization tool(s):

<u>River Basin Restoration Priorities (RBRP) HUC-14 screening method:</u> As part of its RBRP analysis, NCEEP applies a screening method to identify Targeted Local Watersheds (TLWs) within HUC-8 watersheds (Fig. 2) that serve as the basis for further prioritization. Using desktop GIS analysis, NCEEP ranks potential TLWs (HUC-14) within each cataloguing unit (HUC-8) based on various measures of watershed problems (i.e., restoration objectives), assets (i.e., preservation objectives), and opportunities (Table 1). Problem and asset measures are weighted by water quality, flood retention, and aquatic and riparian habitat functions/values (Figure 2), while opportunity measures receive no such weighting. Those measures that directly support these functions/values (e.g., percentage impervious land use for "water quality improvement potential") receive a weight of two and those measures that indirectly support the functions/values (e.g., projected population change for "water quality improvement potential") receive a weight of one. Based on these measures and weightings, final scores are obtained for each HUC-14 watershed for each category (problems, assets, and opportunities). The categories are then weighted and added to obtain final ranks for each HUC-14 within its containing HUC-8.[4]

Watershed Measure	WQ Improvement Potential	Flood Retention Improvement Potential	Riparian and Aquatic Habitat Improvement Potential	Composite Weight
% Impervious/ % Developed	2	1	1	4
% Agriculture	2	0	2	4
% Non-Forested/Disturbed Buffer	2	2	2	6
% Impaired	2	0	2	4
# Animal Operations	2	0	0	2
Projected Population Change	1	1	1	3
Shellfish Closures	2	1	0	3

Figure 2. Weightings in terms of water quality, flood retention, and habitat functions/values are assigned to landscape measures for watershed problems and opportunities as part of the RBRP HUC-14 screening method. Weightings assigned to watershed problems measures are shown above. Used with permission from North Carolina Ecosystem Enhancement Program (NCEEP).

It should be noted that the watershed measures and associated datasets used in the RBRP analysis are based on datasets only and are not exhaustive. NCEEP emphasizes that as additional datasets become available they are incorporated into the process. Per legislative mandate, RBRPs are updated at least every five years consistent with the Department of Water Quality (DWQ) Basinwide Planning Cycle.[2]
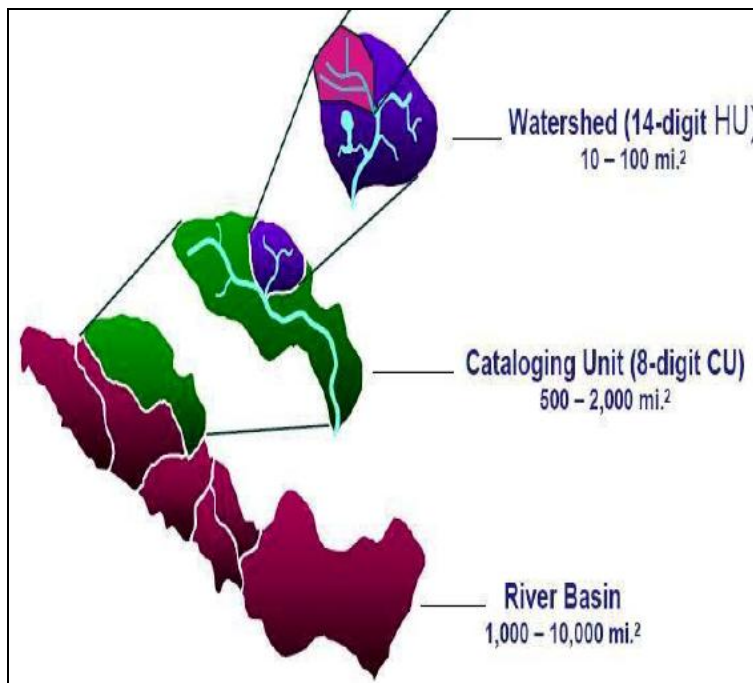
Figure 3. NCEEP ranks 14-digit HUCs within 8-digit HUCs as part of its RBRP analysis. Used with permission from North Carolina Ecosystem Enhancement Program (NCEEP).

Prioritization objectives assessed:
- Water quality
- Flood mitigation

- Habitat quality

Table 1. Factors and associated data sources used to assess problems, assets, and opportunities as part of the HUC-14 screening process.

Factor(s)	Data source(s)
Watershed problems	
Percentage impervious/developed land use	NLCD[5] and APES (1988) for coastal areas
Percentage agricultural land use	NLCD[5] and APES (1988) for coastal areas
Percentage non-forested/disturbed buffer land cover	NLCD[5] and APES (1988) for coastal areas
Percentage impaired	N/A
Number of animal operations	NCDENR and NCDWQ data available through NC One Map[6]
Projected population change	US Dept. of Commerce available through NC One Map[6]
Number of shellfish closures	NC One Map[6]
Watershed assets	
Percentage forest and wetland land cover	NWI and NCDCM CREWS data available through NC One Map[6]
Percentage conserved land use	NC One Map CPT[7]
Percentage significant natural heritage area	NC Natural Heritage Program data available through NC One Map
Miles of water supply waters	NC Division of Water Quality data available through NC One Map[6]
Miles of high quality waters	
Miles of outstanding resource waters	
Miles of trout streams	NCWRC data available through NC One Map[6]
Number of natural heritage element occurrences	NC One Map[6]
Watershed opportunities	
Percentage Hydric A Soils	NRCS and local Soil and Water Conservation Districts
TIP project miles	NCDOT
Number of other NCEEP Projects	NCEEP
Number of CWMTF Projects	NC CWMTF8
Number of §319 Projects	NCDENR §319 program data[9]
Percentage WRC Priority Area	NCWRC10
Percentage of HUC-14 area covered by Phase II Stormwater Area	NC Division of Water Quality available through NC One Map[6]
Number of agricultural BMPs	NC Division of Soil and Water Conservation[11]
Number of mitigation banks	NCDWQ and USACE RIBITS[12]
Number of Land Trust Conservation Properties	CTNC and NC One Map[6]
Number of dams	American Rivers data[13]

NCWRC = North Carolina Wildlife Resources Commission; TIP = Transportation Improvement Program; NCDOT = North Carolina Department of Transportation; CWMTF = Clean Water Management Trust Fund; NCWRC =

North Carolina Wildlife Resources Commission; NCDENR = North Carolina Department of Environment and Natural Resources; NCDWQ = North Carolina Division of Water Quality; USACE = U.S. Army Corps of Engineers; RIBITS = Regulatory In-lieu fee and Banking Information Tracking System; CTNC = Conservation Trust of North Carolina; NC CPT = North Carolina One Map Conservation Planning Tool; NCWRC CREWS = North Carolina Wildlife Resources Commission Coastal Region Evaluation of Wetland Significance; NLCD = National Land Cover Dataset; NWI = National Wetlands Inventory; NCDCM = North Carolina Division of Coastal Management; APES = Albemarle-Pamlico Estuarine Study (database)

<u>LWP Subwatershed Focus Area Identification Method:</u> As part of Phase 1 and 2 of the Local Watershed Plan (LWP) analysis (a completed description of Phase 1 and 2 of the LWP process is provided in the NCEEP Local Watershed Planning Manuel[14]), NCEEP identifies priority subwatersheds within the priority HUC-14 watersheds identified using the RBRP HUC-14 analysis (Figure 4).[14]
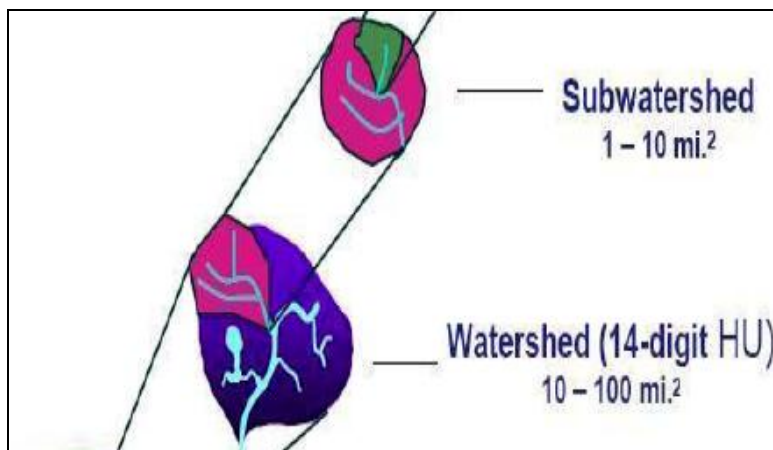
Figure 4. The LWP prioritization analysis determines priority subwatersheds or catchments within priority HUC-14s identified in the RBRP analysis. Used with permission from North Carolina Ecosystem Enhancement Program (NCEEP).

During Phases 1 and 2, NCEEP collects field-based information (e.g., from windshield surveys) to delineate subwatershed boundaries within each target HUC-14 using GIS software (e.g., ArcHydro).

NCEEP characterizes each of these subwatersheds by drawing upon two data sources:
- Readily available data from national, regional, and local sources (Tables A-1 and A-2).[14]
- Data that it gathers itself, including:[14]
  - Data from windshield surveys to verify subwatershed land cover information and assessments of the general condition of streams and the intensity of land use, among other observations (Table B-1).
  - GIS data that are particularly important for identifying watershed priorities (e.g., aerial imagery, parcel information, etc.; see Table B-2).
  - Biological community and physical/chemical/toxicological data for assessing stream habitat, integrity, specific stressors, and water quality (Table B-3)
  - Channel and riparian zone assessment data for assessing watershed functional integrity and stressors (Table B-4)
  - Wetland assessments to identify the locations, sizes, and features (soils, hydrology, vegetation) of wetlands in each HUC-14 using the 1987 U.S. Army Corps of

Engineers Routine Wetland Determination method and the North Carolina Wetland Assessment Method (NC WAM).

- o Nutrient loading model data (e.g., Soil and Water Assessment Tool (SWAT)) to understand the impact of particular stressor(s). Watershed modeling tools and the LWPs to which each has been applied are provided in Table B-5.

Based on this information, NCEEP reapplies its RBRP analysis method to rank subwatersheds in target HUC-14s in terms of water quality, hydrological, and habitat functions based on sets of indicators associated with each function (Table 2). For example, in its Bald Creek LWP, NCEEP identified quantitative indicators associated with a series of functions, including bank erosion potential, channel incision, forest area extent, and extent of stream channelization (Table 7). Other examples of such indicators – derived from NCEEP's Watershed Needs Assessment Team (WNAT) report (2003)[15] – are provided in Tables A-3, A-4, and A-5.[14]

NCEEP then assigns points to each indicator based on the indicator's overall range of values across subwatersheds. These point values are weighted based on stakeholder input and EEP priorities and summed to obtain a total score for each subwatershed indicator. NCEEP assigns a rank of high, moderate, or low to each indicator rank before combining these rankings to calculate each subwatershed's overall ecological condition (also using a scale of high, moderate, and low). The resulting rankings, which are presented in each LWP as a table (Figure 5) and map (Figure 6), are used to identify "focus areas." Focus areas are defined by NCEEP as "subwatersheds identified as priority areas for the development and implementation of management strategies to address concentrated areas…of key problems or assets." NCEEP may assign descriptors to each subwatershed ranking such as "high preservation potential" or "highest probable need for restoration."[14]

SubWS ID	SubWS Code	Attribute Ratings				Rating of Overall Ecological Condition
		Forest Cover	Riparian Condition	Biological Communities	Conductivity	
9	Beas	H	H		H	H
10	Mica	H	H		H	H
11	UCow	H	H	H	H	H
12	CFrk	H	H	H	M	H
13	Matl	H	H	M	H	H
17	Que	H	H		H	H
104	UBur	H	H		H	H
105	MBur	H	H	H	H	H
106	LBur	H	H	H	H	H
107	Tell	H	H	H	H	H
108	Need	H	H	H	H	H
109	Bru	H	H	H	M	H
110	Saw	H	H	M	M	H
4	LRab	H	M	M	M	M
5	UWat	H	H	M	L	M
6	Coon	H	M	M	M	M
7	LWat	H	L	M	L	M
8	Tip	H	M		M	M
14	LCow	M	L	H	H	M
15	Brad	H	M	M	H	M
16	Lak	H	M	M	H	M
18	Ulot	H	H	M	M	M
102	Rock	H	M	M	M	M
103	Rose	H	M	M	H	M
1	LEm	M	L		M	L
2	URab	H	M	L	L	L
3	Cat	M	L	L	L	L
19	Llot	M	L	M	L	L
101	Craw	M	L	L	L	L

Figure 5. NCEEP rates the overall ecological condition of each subwatershed based on ratings for individual function measures. All ratings are given as high ("H"), moderate ("M"), or low ("L"). Used with permission from North Carolina Ecosystem Enhancement Program (NCEEP).
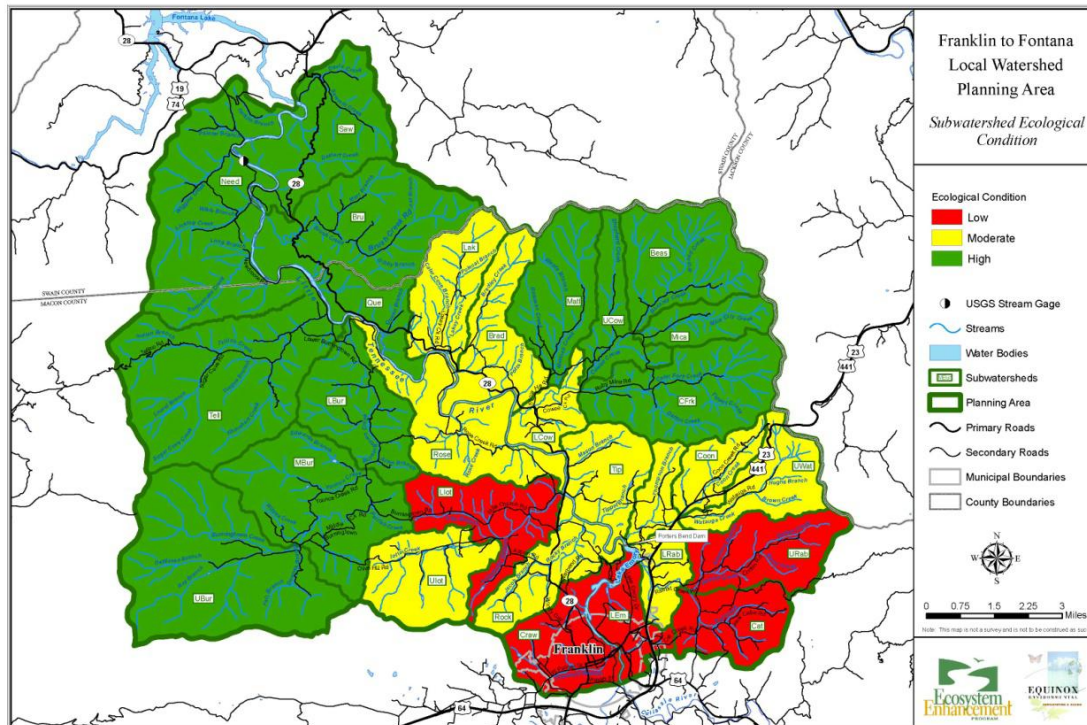

Figure 6. NCEEP uses color-coded maps, such as this one for the Franklin to Fontana LWP, to illustrate where ecological conditions are high, moderate, and low among individual subwatersheds. Used with permission from North Carolina Ecosystem Enhancement Program (NCEEP).

Prioritization objectives (and associated data sources) assessed:
- Water quality
- Flood mitigation
- Habitat quality

Table 2. Factors and data sources used to assess habitat function, water quality, and hydrologic function as part of NCEEP's process for identifying subwatershed focus areas.

Factor(s)	Data source(s)
Habitat function	
Overall Aquatic Habitat Quality	Mean total habitat score, NCDWQ stream habitat protocol (Equinox field survey)
Pool Frequency and Variety	Mean pool score, NCDWQ stream habitat protocol (Equinox field survey)
Microhabitat Diversity and Abundance	Mean microhabitat score, NCDWQ stream habitat protocol (Equinox field survey)
Riparian Forest Area Extent	% of stream length with forested riparian zone 100 ft* wide (GIS analysis)
Water quality function	
Specific Conductance	Mean specific conductance (Equinox field measurement)
Bacterial Contamination	Geometric mean fecal coliform concentration (NCDWQ sampling)
Riparian Forest Area Extent	% of stream length with forested riparian zone 30 ft* wide (GIS analysis)
Housing Density	Homes per square mile (Equinox windshield survey)
Hydrologic function	
Stream Bank Erosion Potential	Mean BEHI score (Equinox field survey)
Channel Incision	Mean bank height ratio (Equinox field survey)
Forest Area Extent	% total sub-watershed area forested (GIS analysis)
Extent of Stream Channelization	% of low gradient streams channelized (GIS analysis)

NCDWQ = North Carolina Department of Water Quality; BEHI = Bank Erosion Hazard Index
*Width of forested riparian zone used should vary depending on data available, ecoregion, and stream and watershed characteristics.

Refinement of landscape priorities:

Candidate watersheds that are identified through the HUC-14 screening method are evaluated more thoroughly using windshield surveys and input from local resource professionals. After gauging local interest and verifying that appropriate restoration opportunities are likely to exist, NCEEP produces a refined short list of candidate watersheds. NCEEP then obtains further feedback from local interests, before making a final selection of HUC-14 watersheds in which to target conservation actions in order to produce the largest functional benefit.[14]

In addition, based on the priority subwatershed "focus areas" identified using its landscape prioritization methods, NCEEP draws upon the following sources of information it has collected throughout the LWP process to identify specific project sites for mitigation activities:[14]

- GIS assessments: Desktop GIS analyses, such as the LWP subwatershed prioritization method described above, help NCEEP identify subwatershed-scale focus areas in which it can target wetland/stream restoration and conservation to improve watershed functions.
- Field assessments: In Phases 1 and 2 of the LWP, NCEEP evaluates the target HUC-14(s) for assets (e.g. taxonomically-rich benthic communities), problems (e.g., 303(d) listed impaired streams), and stressors (e.g., unbuffered streams). NCEEP uses this information to identify potential project sites.
- Stakeholder input: Local stakeholders may contribute projects that they believe to be important to the final set of potential project sites.

With a set of potential project sites identified, NCEEP proceeds to develop a final Project Atlas that ranks projects based the criteria listed below:[14]

- *Ecological criteria:* NCEEP uses ecological criteria to rank projects or project combinations based on the amount of functional uplift that they could potentially generate within their subwatershed. The highest ranked projects generally have the highest potential to produce functional uplift and are located within focus areas in optimal landscape positions (e.g., headwaters areas) in the subwatershed.

  NCEEP often evaluates ecological criteria by using watershed modeling to determine the functional benefits (e.g., pollutant load reductions) that might result from specific projects. The models rank projects according to how much each will improve watershed functions, with the most functionally impaired areas receiving the highest ranks for restoration and enhancement projects and the most asset-rich or functionally unimpacted areas ranking highest for preservation projects. NCEEP recognizes, however, that implementing a set of top ranked projects does not always maximize function uplift and that sometimes implementing a strategic combination of projects produces the best results. For this reason, it sometimes uses simulation modeling to determine which combinations of projects are together capable of maximizing functional uplift.[14]
- *Feasibility criteria:* Feasibility criteria considered in project ranking include number of landowners (obtained from County parcel data layers), site constraints (e.g., utility lines, road/bridge crossings), and landowner willingness.[14]
- *Stakeholder criteria:* Local stakeholders may develop criteria for ranking sites that are unrelated to ecological and feasibility criteria (e.g., proximity of project to schools/parks for educational purposes).[14]

Final site-specific projects generally include traditional mitigation projects (stream and water restoration, enhancement, or preservation) and best management practices (BMPs) in agricultural and urban areas.[14]

Prioritization products: Prioritized project sites identified as part of NCEEP's LWP process are listed in a Project Atlas, which includes a large-scale map of all projects in addition to site-specific maps and information for at least the highest-ranking projects. The map in Figure 6 shows restoration/enhancement sites determined to provide high potential for functional benefits in the Bald Creek watershed. Prioritization maps can be accessed in each LWP, which can be downloaded from: http://www.nceep.net/services/lwps/.
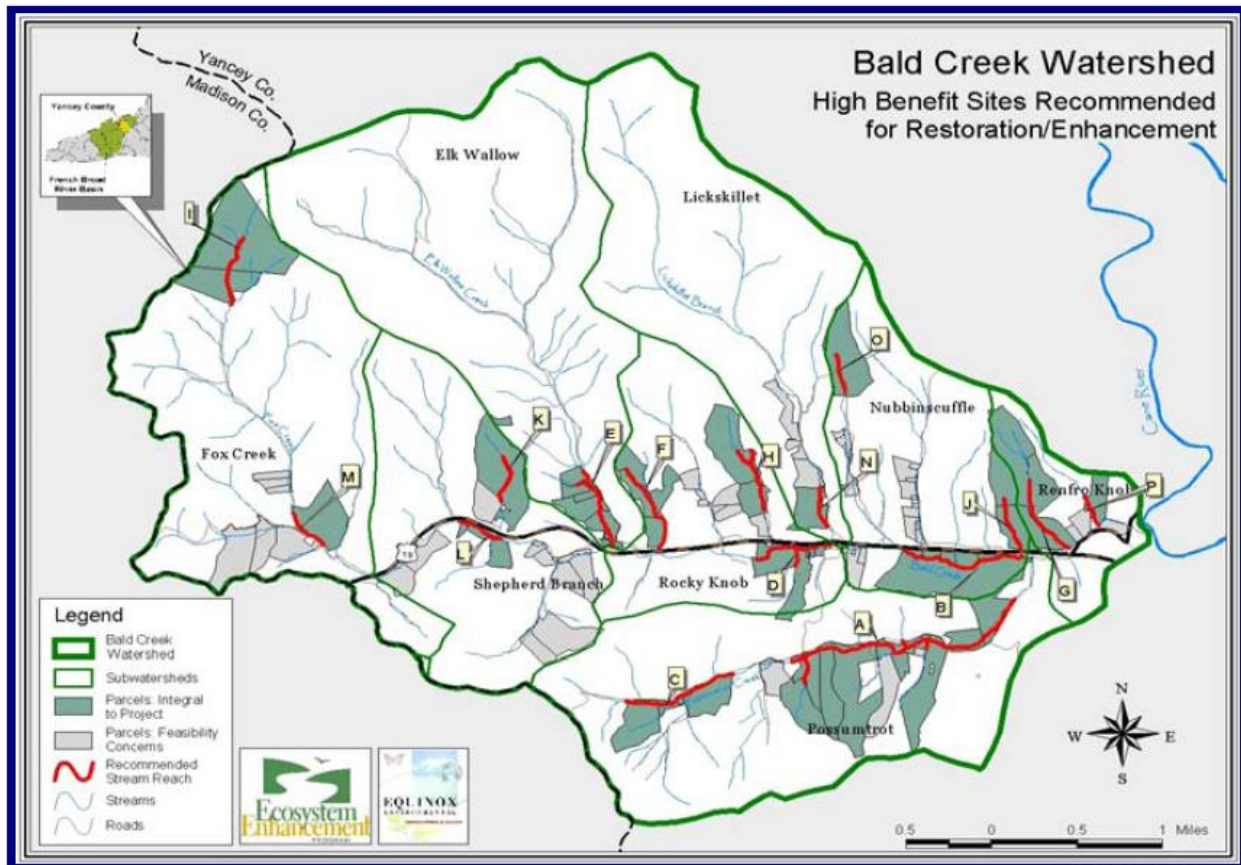

Figure 7. Priority sites for restoration/enhancement identified in the Bald Creek LWP. Map obtained from: http://www.nceep.net/services/lwps/Bald_Creek/NEW_baldcreek.pdf. Used with permission from North Carolina Ecosystem Enhancement Program (NCEEP).

IMPLEMENTATION

Regulatory/non-regulatory programs:
- Section 404 compensatory wetland and stream mitigation.[1]
  - Watershed approach to compensatory mitigation: The process applies a rigorous approach to identifying priority sites that benefit overall watershed function.
- State-level wetland and stream compensatory mitigation regulations.[1]

- State water quality regulatory programs – NCEEP applies its process to satisfy state regulations for riparian buffers and nutrient offsets in applicable river basins.[1]
- CWA §319 restoration or conservation projects conducted by the North Carolina Department of Environment and Natural Resources (NCDENR) and the state's Clean Water Management Trust Fund (CWMTF).[1] North Carolina's CWMTF evaluates potential aquatic resource restoration and conservation projects for funding based on a point system. In scoring projects, CWMTF awards additional points if projects are located in NCEEP priority areas.[1]
- Achieving multiple functional goals: Because state agencies (particularly those conducting restoration or conservation under §319) often have different objectives (e.g., addressing water quality, habitat conservation, etc.), the ability of NCEEP's approach to address multiple agency needs could serve as an incentive for its application.[1]
- An important area where additional incentives could be created would involve the use of NCEEP priority areas to inform the §319 program.[1]

Transferability:
- After applying this approach to the many different types of ecoregions found in North Carolina (ranging from coastal to mountainous) NCEEP has gained substantial experience integrating data across a variety of environments. This approach could be a good model for other states to follow due to its multi-scale process that begins with prioritization at the river basin level and proceeds to identify finer-scale priority areas.[1]
- The approach serves as an example of how fine-scale input from a broad range of stakeholders can be incorporated into a process for prioritizing restoration/conservation sites in a way that produces multiple benefits. The NCEEP representative noted that they would encourage this kind of stakeholder input in other states.[1]
- Limiting NCEEP's Planning approach is the fact that the fine-scale analysis (local watershed planning or LWP) is time-consuming to complete, requires substantial dedicated staff time, and can be data intensive.[1]
- Transferability may also be limited because the River Basin Restoration Priority assessment part of the process requires comprehensive high-quality data on a state-wide scale. Such data may be limited for states with few existing high-quality statewide datasets.[1]
- Transferability of the RBRP assessment process may also be limited for particularly small/fragmented states (e.g., Hawaii), in which very small drainages could complicate the application of NCEEP's tiered watershed-based approach. A direct application of the LWP process might be more appropriate for small states or regions.[1]

Data gaps:
- Aerial photography data errors: A common data gap involving aerial photography occurs when aerial data are rectified and the resulting map is patchy or the tiles comprising an area are from different years. Since LWPs are conducted in HUC-14s, which tend to cover small land areas (10-100 mi^2), these errors can be problematic for conducting LWPs by requiring that more data gaps be filled as a result.[1]
- A lack of fine-scale imperviousness data: Although imperviousness data can be derived simply from land use and aerial photography, these data sources produce only coarse-scale data. Fine-scale data is generally only available at high cost.[1]

- Difficulty obtaining accurate population data on a watershed basis: Because census data are organized by county, dividing population data at a watershed scale requires substantial time.[1]
- U.S. Department of Agriculture (USDA) agricultural land use data: The USDA has GIS layers for the aerial extent and number of animals on larger farms that are required to have USDA permits, such as Contained Animal Feeding Operations (CAFOs). For LWPs, these would be helpful for analyses that include the land use for farms. The USDA data are currently unavailable, however, for privacy protection reasons. Because intermediate-scale data, such as those collected by USDA, will be important for NCEEP's recently-initiated effort to produce Regional Watershed Plans (RWPs), NCEEP plans to continue working to obtain them.[1]
- Coastal habitat data: In the past, data on fish habitat distributions (e.g., submerged aquatic vegetation) were included as part of Coastal Habitat Protection Plans, but due to recent funding cuts the availability of this information has become less certain.[1]

Barriers:
- A lack of staff trained in advanced GIS analysis. Currently EEP must contract additional staff to obtain these skills. Having an advanced GIS analyst on staff who is dedicated to their mission could greatly improve the state's technical capacity and efficiency.[2]
- Data management: Better data management could increase the state's capacity for capturing, organizing, and storing data. NCEEP is currently developing a database to improve data management.[2]
- LWP funding and timing tied to impacts. NCDOT and EEP ILF programs fund all EEP activities. These programs have traditionally tied funding approval to volume and timing of impacts and the window for using the funds under these programs is compressed due to compliance requirements. Beginning the LWP planning process further in advance of impacts would allow for better-focused resource expenditures. EEP is working on these issues.[2]
- NCEEP believes that data created by agencies should be freely available and notes that cooperation among agencies with regard to data management is now being discussed at high levels of the state government. To this end, the program reported that the state has recently begun moving all state-specific data – including GIS data – to a single clearinghouse, which should make datasets created by other agencies more readily accessible. NCEEP believes, however, that the availability of some data should nevertheless be screened for quality assurance.[1]
- NCEEP reports that because aerial photography and land use data are so critical to their process, maintaining up-to-date land use and aerial data is always an issue. Although NCEEP is capable of updating this information in house, the program often cannot afford to do so and must use older data.[1]

Future goals:
- Improve data management by developing a well-organized and functional database.[1]
- Determine whether NCEEP projects have produced measureable benefits for watersheds by completing more follow-up monitoring in LWP watersheds. Such data could provide valuable information that would improve the planning process.[1]

- NCEEP cited a lack of sufficient technical staff and funding as primary obstacles to achieving these goals, adding that additional training and staff time would be helpful as well.[1]

[1] Interviews on 8/16/11 and 9/28/11 with Nancy Daly, Marc Recktenwald, and Rob Breeding, North Carolina Ecosystem Enhancement Program.

[2] Feedback received on 3/14/12 from Nancy Daly, Marc Recktenwald, and Rob Breeding, North Carolina Ecosystem Enhancement Program.

[3] At a minimum, the stakeholders from the following agencies/organizations are notified of the planning process at initiation of Phase I and following completion of the Watershed Assessment Report and Watershed Management Plan and Project Atlas: DWQ Regional Office; DWQ Basinwide planner; Local Natural Resource Conservation Service (NRCS), Soil & Water Conservation District (SWCD), and Resource Conservation and Development Program (RC&D) representatives; County Cooperative Extension Office; NC Department of Transportation (DOT) Project Development & Environmental Analysis Assistant Manager; NC DOT Division Office; NC Wildlife Resource Commission Regional Office; NC Division of Forest Resources; CWMTF field representative; Local Governments (including Planning Director and Utilities Director); Regional Councils of Government; Metropolitan Planning Organizations (MPOs)/Rural Planning Organizations (RPOs); Representatives from universities and/or colleges in study area; US Fish and Wildlife Service Regional Office; United States Army Corps of Engineers Regional Office; Local land trusts; The Nature Conservancy; Environmental Defense Fund; Private landowners/community representatives

[4] RBRP Weighting Methodology. Accessible from: http://www.nceep.net/pages/Methodology%20for%20Weighting_Attachment%20B_20101122.pdf.

[5] http://www.mrlc.gov/mrlc2k_nlcd.asp

[6] http://data.nconemap.com/geoportal/catalog/search/browse/browse.page

[7] http://www.onencnaturally.org/pages/ConservationPlanningTool.html

[8] http://www.cwmtf.net/

[9] http://portal.ncdenr.org/web/wq/ps/nps/319program

[10] http://www.ncwildlife.org/Conserving.aspx

[11] http://www.ncagr.gov/sw/about-the-division.html

[12] http://geo.usace.army.mil/ribits/index.html

[13] http://www.americanrivers.org/your-region/southeast/north-carolina-trp.html

[14] North Carolina Ecosystem Enhancement Program. 2011. NC Ecosystem Enhancement Program Local Watershed Planning Manual (draft).

[15] NCEEP. October 2005. Report from the Watershed Needs Assessment Team to the Mitigation Coordination Group. Accessible from: http://www.nceep.net/news/reports/WNAT%20Mit%20Group%20Final.pdf.

Appendix A: Existing data NCEEP obtains for LWP assessments

Table A-1. Datasets gathered in phase 1 of the LWP analysis for the preliminary evaluation of watershed conditions. Table modified from NCEEP's LWP Planning Manual.[14]

Factors used in analysis	Data source(s)
Basics	
1:24,000 scale topographic maps	NCDOT (http://www.ncdot.org/it/gis/DataDistribution/USGSTopoMaps/default.html)
Aerial photography—most recent digital:	CGIA; local; NAIP; Bing; County aerials; recent historic aerials--National Archive, SWCDs, NRCS, FSA; Google Earth; TerraServer (http://www.terraserver.com/); Image Trader (http://www.landsat.com/)
Land use/cover	EEP; 2001 NLCD (http://www.mrlc.gov/). Coastal areas: APES (1988), C-CAP (http://www.csc.noaa.gov/crs/lca/southeast.html), OR more recent dataset
Impervious cover	Local; EEP; MRLC has national lu/lc from 2001 satellite imagery; see http://www.mrlc.gov/mrlc2k_nlcd.asp, NC OneMap (http://www.cgia.state.nc.us/Default.aspx?tabid=55)
DEMs	FMP; LIDAR through Division of Floodplain Management
Parcel data	Local
County boundaries	CGIA
Municipal boundaries	NCDOT; local; http://www.ncdot.org/it/gis/DataDistribution/DOTData/default.html
Hydrography	
1:24,000 scale, complete with use support designation, DWQ classification.	CGIA
1:100,000 scale	CGIA
Wetlands	DCM; Division of Costal Management wetland dataset for coastal areas
Detailed hydrography dataset if available	CGIA; DWQ
National Hydrography Dataset	EEP; NHD; NHD+
National Wetland Inventory	CGIA
Flood zones: floodway, 100 yr floodplain, etc.	FMP, local; http://floodmaps.nc.gov/fmis/Download.aspx
8, 14, 12 digit hydrological units	EEP
Natural Resources	
Soils—including hydric classification	Local

Ecoregion—level IV	EEP; NRCS
NC GAP	EEP
Significant natural heritage areas, NHP element occurrences	CGIA; NHP
Lands managed for conservation and open space—state/federal/county parks, forest, conservancy	CGIA
Fish nursery areas, anadromous fish spawning areas, WRC trout waters, shellfish harvest areas	EEP
Monitoring Data	
Ambient monitoring locales	CGIA
Benthic and fish monitoring locales	CGIA; DWQ
Non-DWQ data—e.g., volunteer monitoring networks, other agency, etc.	Local
Stream gauges	CGIA
Pollution Sources	
NPDES facilities	CGIA
Underground Storage Tanks (USTs), brownfields, landfills	DWM; http://portal.ncdenr.org/web/wm/gis/data.
Sanitary sewer systems-land application sites	CGIA
Swine lagoons	CGIA
Hazardous waste disposal sites (Superfund)	CGIA
Infrastructure	
Roads	Local; DOT
Ordinance areas—e.g., DWQ WS, zoning, Phase II jurisdiction, etc.	Local; CGIA
Railroads	CGIA
Dams	EEP
Powerlines	Private—power companies maintain GIS data, but acquisition is difficult
Sewer, storm sewer	CGIA; local
Other	
TIP locales	EEP; DOT
Federal Lands	EEP
Stream restoration/enhancement projects: EEP, USFWS, 319, CWMTF	EEP; CGIA
Other watershed information	Studies completed by universities; land trust and other non-profit groups; mitigation banks; local governments; DOT NEPA documents (Cumulative Impact Assessments, Environmental Impact Assessments, or

	Environmental Assessments); NC Wildlife Resources Commission (e.g., NC Wildlife Action Plan)
Existing projects within the LWP watershed	NCEEP; mitigation banks; Clean Water Management Trust Fund; 319 grant funds; Conservation Reserve Enhancement Program; local land trusts

CGIA= NC Center for Geographic Information and Analysis (http://www.nconemap.com/default.aspx?tabid=286); MRLC=Multi Resolution Land Characteristics Consortium; EEP=available through EEP; DOT = Available through NC Department of Transportation GIS website; DCM=NC Division of Coastal Management; FMP=NC Floodplain Mapping Program; DWM=NC Division of Waste Management; NAIP = National Agriculture Imagery Program; TIP = Transportation Improvement Program.

Table A-3. Factors suggested in WNAT (2003) for evaluating habitat function[2,14]

Factor used in analysis	Data source
Indicators of terrestrial vegetation and physical habitat	
Percentage forested	Land cover information or other existing information
Percentage agricultural	
Percentage developed (including amount of impervious surface)	
Percentage natural composition	Extent of vegetation types described in *The Natural Communities of North Carolina* (Schafale and Weakley, 1990)
Sensitive plant species	Natural Heritage Program data, including Threatened and Endangered species and other species identified by the stakeholder group as conservation targets
Percentage Significant Natural Heritage Area	NC Natural Heritage Program GIS data
Floodplain condition	FEMA maps combined with land cover information and incorporating riparian buffer considerations
Percentage conserved land (including state and federally owned land)	NC One Map; NC Conservation Planning Tool
Landscape functions (connectivity, contiguousness, spatial distribution, and patch size)	NC Conservation Planning Tool; NC Natural Heritage ProgramLandscape Habitat Indicator Guilds
Invasive species information	Regional lists and resource professionals, with presence and degree of infestation confirmed through limited data collection.
Indicators of Terrestrial Animals and Semi-aquatic Animals (upland and riparian)	
Habitat types and associated animal species and guilds	Land cover and existing data; NC Natural Heritage ProgramLandscape Habitat Indicator Guilds
Invasive species information	Regional lists and resource professionals, with presence and degree of infestation confirmed

	through limited data collection.
Aquatic vegetation and physical components	
Vegetation	Limited information available for invasive aquatic species from the Division of Marine Fisheries and the Division of Water Resources
Rare, Threatened, and Endangered species habitat	Methods to evaluate substrate composition and complexity developed by the Steam Functional Assessment Team
General aquatic habitat	DWQ habitat assessment that is conducted when benthic macroinvertebrates or fish communities samples are collected; field collection of additional data for where limited data are available using EPA's Rapid Bioassessment Protocol or DWQ's habitat protocol.
Aquatic life	
RTE species	Existing data
Community indicators	DWQ benthic macroinvertebrate and fish community data

DENR = Department of Environment and Natural Resources

Table A-4. Factors suggested in WNAT (2003) for evaluating water quality functions.[15]

Factor used in analysis	Data source
Biologic community indicators	DWQ benthic macroinvertebrate and fish data
Water and sediment chemistry data	DWQ
Land use	Impervious cover; forested area

Table A-5. Factors suggested in WNAT (2003) for evaluating hydrologic functions.[15]

Factor used in analysis	Data source
Presence of drainage districts	Local Soil and Water Conservation Districts
Flood prevention projects	N/A
Channel and stream bank modification	Aerial imagery; field evaluations
Land use	Land cover data sets
Impervious surface extent	Land cover data sets
Storm sewer mileage	Local government
Floodplain encroachment	FEMA mapping
Repetitively flooded structures	Local stakeholder input
Impoundments	Land cover data sets; American Rivers dam data set
Withdrawals	NC Division of Water Resources; local goverment
Floodplain disconnected from the creek	Landcover data sets; FEMA mapping, field evaluation
Instream habitat surveys	NCDWQ data; field evaluation using NCDWQ habitat forms
Growth and development trends (zoning,	Census data; local government

population)	
Wetland extent and location	NWI; NC CREWS data

Appendix B: New data NCEEP obtains for watershed assessments

Table B-1. Features observed for each subwatershed as part of windshield surveys.[14]

Feature observed
Dominant land use and cover (if developed, be specific as to mix of types—e.g., residential vs. commercial—and location)
Intensity of use (density)
Land management (if urban, document observed stormwater BMPs; if agricultural, note conservation tillage, or field borders; for either, document stream buffers and their extent)
Active land disturbance—type and extent
General stream condition
Other obvious problems
Positive features (e.g.—large tracts of mature forest)

Table B-2. GIS data considered particularly important by NCEEP for identifying watershed priorities.[2,14]

GIS dataset	Purpose
Aerial imagery	Although county staff usually has the most recent aerial GIS datasets, the most recent data sometimes lies with other sources, such as the Google Earth and USGS. NCEEP planners may sometimes hire contractors (such as Tennessee Valley Authority) to fly over the LWP watershed to obtain orthophotos or may hire a local pilot to personally fly them over the LWP watershed so that they can take simple photos and record notes.
Parcel information	Parcel GIS data is obtained from county GIS staff and is updated for each LWP due to the frequency with which it changes. Parcel information is necessary for identifying project locations and landowners who may need to be contacted during assessment activities.
Imperviousness data	If the LWP contains urbanized areas, NCEEP obtains recent impervious cover data by analyzing aerial imagery or parcel information using automated methods. Accurate imperviousness data provide critical measures of habitat and hydrologic alteration that enable NCEEP to determine the best areas to concentrate projects to address these impacts.

Riparian buffers data	Data on the width of riparian buffers is essential for watershed assessment and project identification because of the strong influence intact buffers have on in-stream habitat, bank stability, water quality, and water temperature. NCEEP measures buffer widths using aerial photographs to classify buffers as 0 ft, 0-30 ft, 30-100 ft, and >100 ft and avoids using land use data which can result in imprecise measures due to large pixel size.
Wetland assessment data, including Hydric soils, USDA soil survey wet areas, LiDAR data, NWI wetlands, NC floodplain maps, USGS topographic mapping and stream layers, NC Coastal Region Evaluation of Wetland Significance (NC-CREWS) data.	To find wetlands in a watershed, NCEEP examines the above datasets in association with historic and current land use data and aerial photography. A common indicator it uses for wetland restoration opportunities is the overlap of hydric soils with agricultural lands in an area.

Table B-3. Biological community and physical/chemical/toxicological field data collected by NCEEP.[14]

Parameter	Watershed type	Flow	Justification
Benthic Macroinvertebrates	All	Baseflow	To diagnose overall watershed functionality at a point or reach (or of a tributary)
Fish Community Assessment	All	Baseflow	To diagnose overall watershed functionality at a point or reach (or of a tributary)
Field Measures (dissolved oxygen, water temperature, pH, and specific conductance)	All	Both	Measured at all sites each visit for baseline
Turbidity	All	Stormflow	Measured primarily at sites where sediment and erosion are issues
Total Residual Chlorine	Urban	Baseflow	Measured above and below known sources such as waste water treatment plants
Salinity	All	Both	Taken with other field measurements only at coastal and estuarine sites as baseline data

Nutrients	All	Both	Measured in agricultural and residential areas to detect fertilizer runoff from chemical application to crops and lawns and from livestock waste
Metals (typically includes an array of the most common ones associated with treatment plants)	Urban	Both	Measured where treatment plant or industrial inputs suspected; or high amount of impervious cover
Suspended Residue	All	Stormflow	Measured in conjunction with turbidity to quantify sediment runoff
Fecal Coliform Bacteria	All	Both	Measured as a surrogate when bacterial issues are expected in streams
Organic Compounds (usually limited to known chemicals applied to crops or used in industrial processing)	All	Both	Measured to quantify specific pesticides and herbicides in agricultural areas; in urban areas used to document particular industrial inputs
Toxicity Screening	Urban, mixed	Both	Used where toxicity is suspected; indicates where traditional projects may not be effective

Table B-4. Channel and riparian zone field data collected by NCEEP.[2,14]

Method	Scale	Description
Bank Erosion Hazard Index	Site-Specific	Multiple parameters are estimated by field personnel and input into an index equation; measures are typically estimated by sampler, therefore more experience is better (Rosgen, 2001)
Bank Height Ratio	Site-Specific	Empirical measure of potential bank instability based on slope measure and rise; rapid method lends itself to large watersheds; requires minimal training
Center for Watershed Protection, Unified Subwatershed and Site Reconnaissance	Reach, Catchment, Site-Specific	Detailed information collected at sites along sampling reaches; time consuming and expensive if performed for entire watershed; requires moderate training (CWP, 2005a)

Center for Watershed Protection, Unified Stream Assessment	Subwatershed	Detailed information collected at sites along sampling reaches; time consuming and expensive if performed for entire watershed; requires moderate training (CWP, 2005a)
Natural Resources Conservation Service, Stream Visual Assessment Protocol	Reach, Catchment	Multiple parameters are each rated according to a uniform numerical scale with detailed descriptions; method requires moderate training but more experience is better (USDA, 1998)
Eastern Carolina University, Coastal Riparian Assessment Methodology	Reach, Subwatershed	A reference-based method developed for the inner coastal plain. Assesses 100 yd reaches, observing 9 indicators that are aggregated logically into scores reflective of the current understanding between indicators and ecosystem function for the riparian zone (Rheinhardt et al., 2005)
NC Division of Water Quality, Habitat Assessment	Reach	Data collected by DWQ during biological assessments; estimates measures related to instream and riparian habitat within the sampling reach; requires minimal training (NCDWQ, 2001)

Table B-5. Watershed models used by NCEEP to understand hydrologic and water quality functions for various LWP analyses where available data on the impacts of a stressor is sparse.[14]

Model	Purpose	Example LWP
Model for Stormwater Improvement Conceptualization (MUSIC)	Evaluate pollutant removal effectiveness of stormwater BMPs	Fishing Creek LWP; Middle Tar Pam LWP; Little River & Bledsoe Creek LWP
Various pollutant loading models	Estimates of TSS, BOD, total N, total P from specific land uses	Pasquotank LWP; Upper Swift Creek LWP; White Oak LWP
Spreadsheet Tool for Estimating Pollutant Load (STEP-L)	Evaluate pollutant removal performance of stream projects and BMPs	Indian and Howards Creek LWP
GIS Pollutant Load (PLOAD)	Predict annual runoff and pollutant concentrations under various scenarios	Lockwoods Folly LWP
SWAT (Soil & Water Assessment Tool)	Sediment and nutrient loading estimates determined to assess landuse impacts to water quality and provide baseline estimate of watershed conditions	Middle Cape Fear LWP

Loading Simulation Program in C+ (LSPC)	Address urban and rural watershed hydrology, surface water quality analysis and pollutant decay and transformation	Swift Creek LWP
Modeling System Unified Stormwater Treatment Model (USTM)	Evaluate pollutant removal effectiveness of stormwater BMPs	Little River & Bledsoe Creek LWP
Watershed Management Model (WMM)	Estimate event mean concentrations based on land use/cover; existing and future land use scenarios	Upper Rocky River & Clarke Creek LWP
HEC-HMS	Conduct stream stability assessments	Troublesome & Little Troublesome Creek LWP
HEC-RAS	Conduct stream stability assessments	Troublesome & Little Troublesome Creek LWP
EUTROMOD	Predicted sediment trapping and nutrient loadings in local lakes	Troublesome & Little Troublesome Creek LWP
USGS Sparrow	Estimate the portion of nutrient load delivered from subwatersheds for existing and buildout conditions	Morgan & Little Creek LWP
Generalized Watershed Loading Function (GWLF)	Assess contribution of upland sediment and nutrient loads under existing and buildout scenarios	Morgan & Little Creek LWP; Rocky River LWP
USLE combined with spreadsheet model	Determine sediment and nutrient loading sources	Peachtree-Martins Creek LWP