GIS--A Valuable Watershed Assessment Tool

Authors

Mark Johnston, Earth Tech; Jane Almon, Earth Tech; Kilmeny Stephens, Earth Tech.

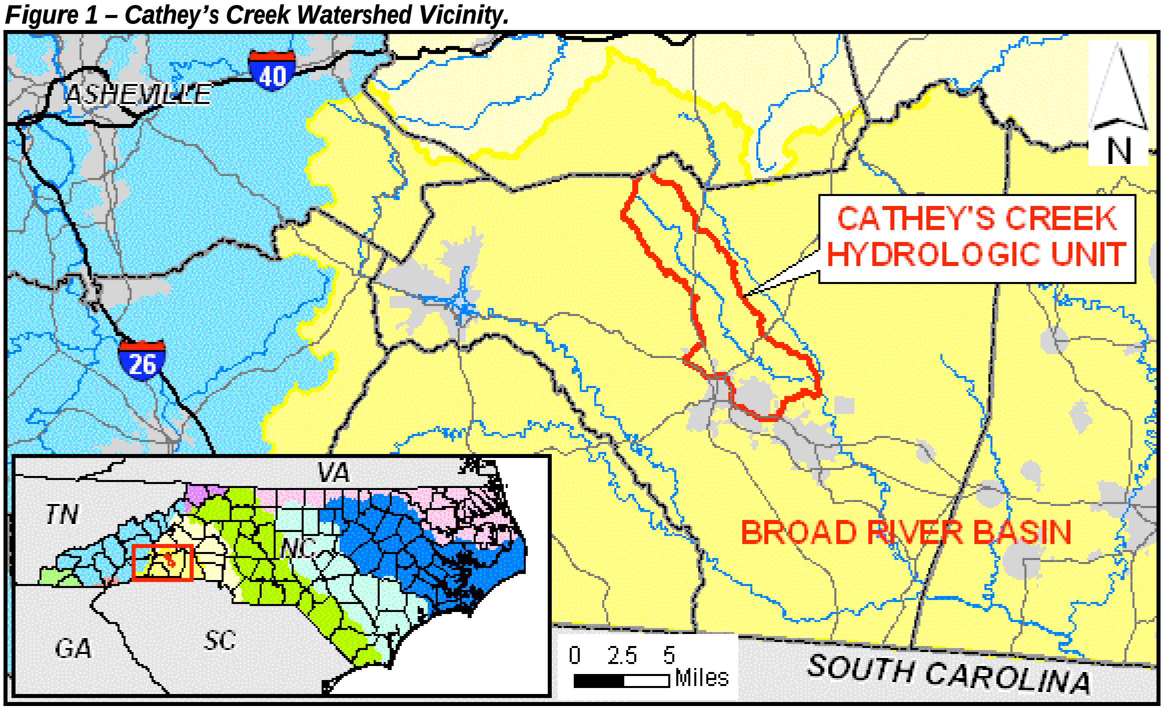
Abstract

GIS is transforming watershed planning approaches within the State of North Carolina. The North Carolina Ecosystem Enhancement Program selected Cathey's Creek Watershed, within the Broad River Basin of North Carolina, for a detailed technical watershed assessment. The purpose of the assessment was to characterize the watershed, identify general problem areas related to ecological functions, determine how to address these problems, and develop a plan that includes solutions to the problems. The bulk of initial characterization was based on existing GIS data. Summarization of existing data and detailed spatial analysis was used to describe the condition of the watershed in terms of hydrologic, water quality and habitat functions. Assessment of the watershed will support stakeholders in development of a Watershed Management Plan. A future management Plan will aid in facilitating reestablishment of water quality, hydrology, and habitat functions; produce mitigation credits; and meet the community's priorities to formulate optimum projects.

GIS--A Valuable Watershed Assessment Tool

GIS is transforming watershed planning approaches within the State of North Carolina. The North Carolina Ecosystem Enhancement Program selected Cathey's Creek Watershed (Figure 1), within the Broad River Basin of North Carolina, for a detailed technical watershed assessment. The overall approach includes new methods of watershed assessment that focus on ecological functions of the watershed.

Figure 1 – Cathey's Creek Watershed Vicinity.



The Purpose of the Assessment

The purpose of the assessment was to characterize the watershed, identify general problem areas related to ecological functions, and develop a plan that includes solutions to the problems.

Characterization of the watershed involved assessing the current state of the watershed in terms of water quality, habitat functions and hydrology. This was done with a combination of GIS analysis and fieldwork.

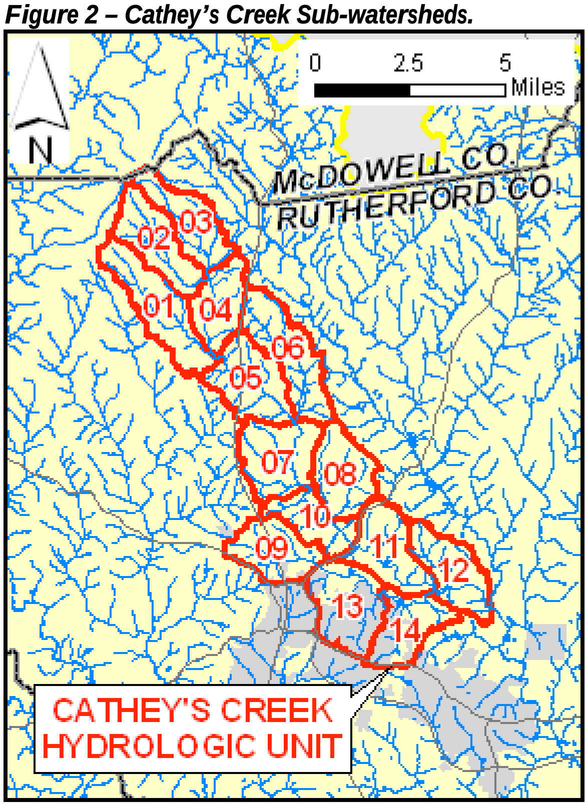
General problem areas were identified during the characterization and in consultation with stakeholders and local officials. Methods used to address these problems include stream and wetland restoration and enhancement, buffer protection, and best management practices (BMPs) for livestock, agriculture and stormwater runoff.

Creating a plan to provide solutions to these problems is taking the form of a Water Management Plan.

Initial Characterization

The bulk of the initial characterization was based on existing published GIS data. Other sources of information included other databases regarding land use, water quality, ecosystem functions, current management measures, and existing restoration and protection needs. Sub-watersheds (SWs) were identified and classified for future field studies and monitoring, as shown in Figure 2.

Figure 2 – Cathey's Creek Sub-watersheds.



Summarization of existing data and detailed spatial analysis was used to describe the condition of the watershed in terms of water quality, habitat and hydrology. The GIS analysis involved examining the watershed functions and sub-functions in terms of indicators developed for each of the functions and sub-functions.

In addition to the digital data, existing watershed information was also gathered from local governments, stakeholders, and state agencies. The methods for gathering the data included phone calls, emails, onsite interviews, public meetings, and reviewing existing reports.

Data Sources and Types

The following agencies were consulted at their county, state, or regional office regarding the status of the watersheds' functions: N.C. Department of Transportation (NCDOT), N.C. Cooperative Extension Service (CES), Natural Resource Conservation Service (NRCS), N.C. Wildlife Resources Commission (WRC), Farm Services Administration (FSA, formerly ASCS), Federal Emergency Management Agency (FEMA), U.S. Forestry Service, U.S. Army Corps of Engineers, local and state land conservancies, federal and state park/refuge officials, and various divisions of the N.C. Department of the Environment and Natural Resources (DENR). The Parks and Recreation, Public Works, Engineering and Planning Departments of each municipality in the watershed were consulted to learn of any known areas of concern. These organizations helped in identifying watershed improvement projects that have already been implemented and by explaining current development trends.

Data sources used to develop the technical watershed analysis GIS include:

- United States Geological Survey (USGS): Quadrangle maps (1965, 1982, 1985 and 1993) and Land use/land cover;
- North Carolina Center for Geographic Information and Analysis (NCCGIA): Soils (field work 1983-1998, published 1998), hydrography;
- BasinPro Version 3.1 (NCCGIA): Various relevant subsets of topography, hydrography, managed lands, pollution sources, natural resources, county and municipal boundaries (CD dated 2002, data was updated as necessary using the World Wide Web, as described below);
- North Carolina Department of Transportation (NCDOT) GIS Unit: Infrastructure data including roads and railroads;
- Rutherford County: Tax map parcels (2003) and FEMA floodplains (2003).

Other data, statistics, and descriptions found throughout this document were obtained mostly from publications posted on the World Wide Web by various federal, state, and local agencies. GIS databases were updated with the most recent Web information available where appropriate, (*e.g.,* discharge permits).

Analysis Procedures

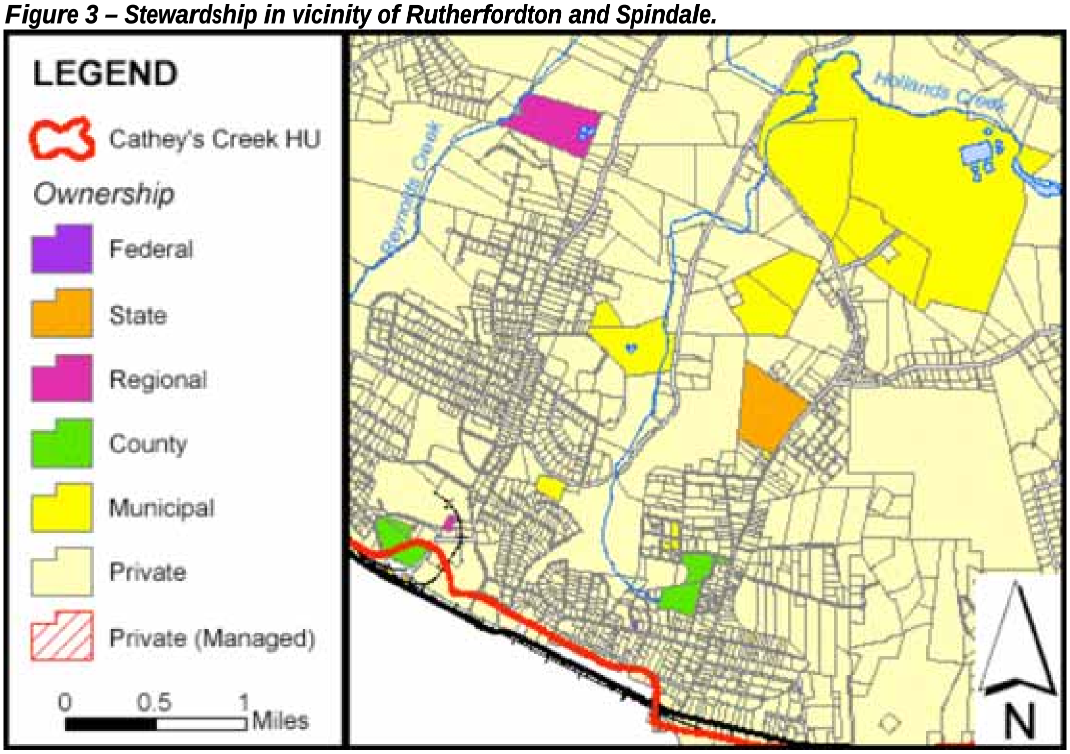
Characterization and Watershed Analysis Procedures

Earth Tech compiled all existing data layers and data sets into a GIS using Environmental Systems Research Institute (ESRI) ARCGIS projected in North American Datum of 1983 in meters (NAD 83). ESRI ArcView 8.3 and in some instances Arc/INFO 8.3 were used to analyze all GIS data. First, the USGS quadrangles were geo-rectified to the road infrastructure acquired from the NCDOT GIS Unit. The Cathey's Creek Hydrologic Unit (HU) polygon was overlaid on the USGS quadrangles. The Cathey's Creek HU polygon was used to reduce file size and processing time for the majority of the GIS databases by clipping and retaining data that only occurs within the watershed. After performing these procedures, the customized data was used to generate the following information. More detail on the functional indicators is in the 'Functional Analysis' section of this paper.

Stewardship

To evaluate stewardship (ownership) of lands within the Cathey's Creek HU, the parcel database was manually searched for 'owner' and 'secondary owner' names. This distinguished between private, federal, state, regional, county, and municipal government ownership. Next, state protected easements were identified within the study area using the BasinPro databases. In a study of this kind, a land owners' willingness to cooperate is beneficial, both in terms of access to the land for investigations, and also when investigating solutions to watershed issues.

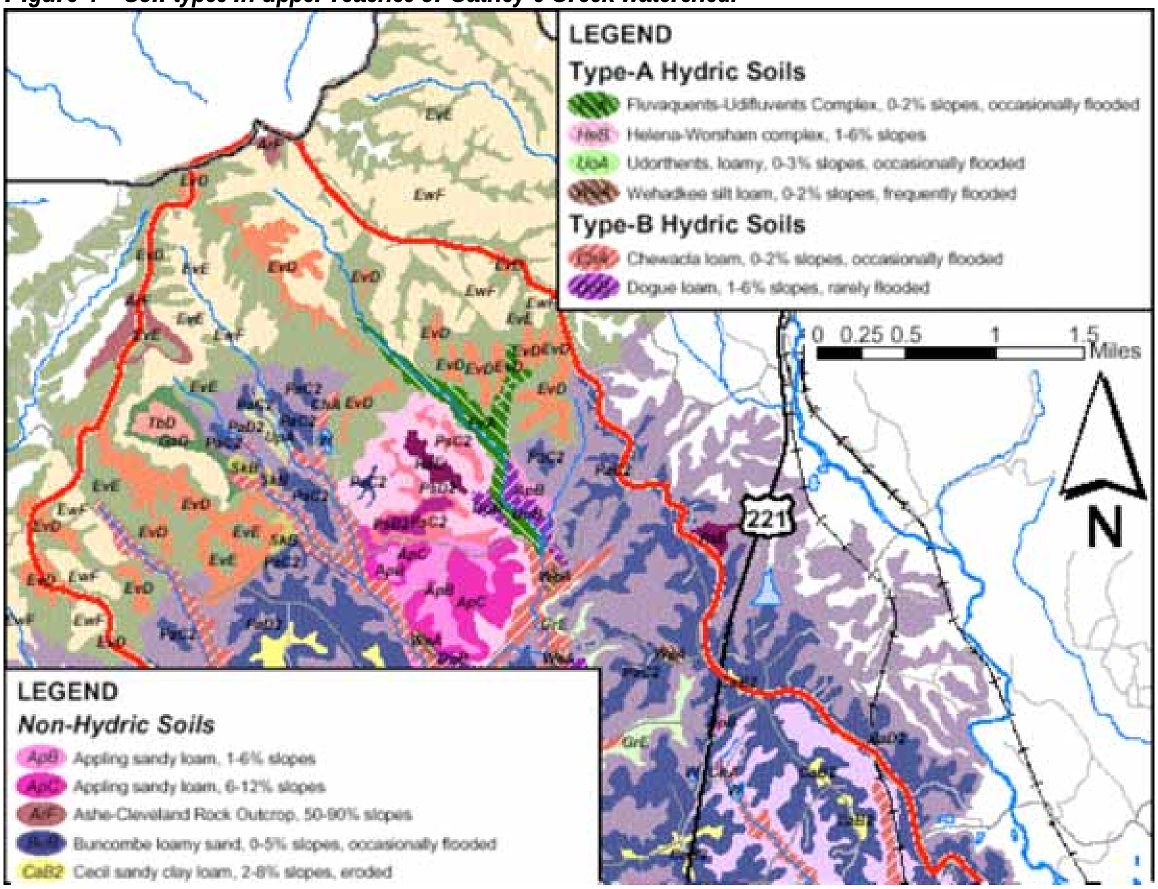
Figure 3 – Stewardship in vicinity of Rutherfordton and Spindale.



Soils

The soil survey polygon coverage was updated by creating a new attribute field in the database called "hydric". Using information supplied by the Rutherford County NRCS, each map unit was classified as Non-hydric, Type A Hydric (all hydric or have hydric soils as a major component), or Type B Hydric (map units with inclusions of hydric soils or with wet spots). Quantities of these three categories were calculated for the hydrological unit, and the classifications were used for identifying potential wetland restoration projects, in the ‘potential projects’ analysis portion of this study.

Figure 4 – Soil types in upper reaches of Cathey’s Creek watershed.



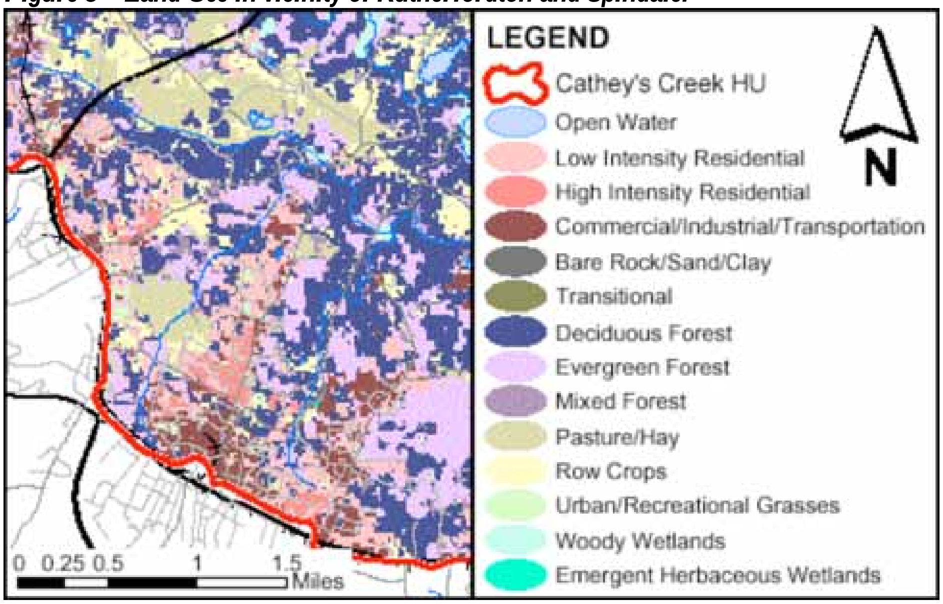
Land Use and Land Cover

The land use and land cover data was acquired from the USGS. The USGS raster data was converted to a polygon shapefile using Arc/INFO. It was then analyzed on a watershed and sub-watershed basis to determine quantities of forested, cleared, wetlands, and impervious cover types. These different land use types are used in identifying potential project locations, and to assess functional level of the watershed. All of these quantities were derived using a combination of different land use/land cover types.

- Forest
    - Deciduous Forest
    - Evergreen Forest
    - Mixed Forest
    - Woody Wetlands
- Cleared
    - Low Intensity Residential
    - High Intensity Residential
    - Commercial/Industrial/Transportation
    - Bare Rock/Sand/Clay

- o Transitional
  - o Row Crops
  - o Urban/Recreational Grasses
- Wetlands
  - o Woody Wetlands
  - o Emergent Herbaceous Wetlands
- Impervious - Proportions Of
  - o Low Intensity Residential
  - o High Intensity Residential
  - o Commercial/Industrial/Transportation

Figure 5 – Land Use in vicinity of Rutherfordton and Spindale.



Stream Type

The streams database for the hydrologic unit was expanded to include new attributes. A "Status" attribute field was created in the database and each stream segment was classified as "Perennial" or "Intermittent" according to its depiction on USGS quadrangles (solid or dotted blue line, respectively). The attribute field "DWQ_CLASS" was expanded to apply a DWQ Best Usage classification to all stream segments, since the existing data was not complete for intermittent streams. By definition, unclassified streams carry the same classification as their receiving streams.

Impervious Land

The contribution of road infrastructure to imperviousness (water cannot pass through it) of the watershed was determined by generating a 24-foot buffer around all road centerlines, assuming a 12-foot width per road lane. No roads wider than two lanes are present within the study area. This information was combined with impervious land use/land cover information to arrive at an overall impervious quantity for the HU and each sub-watershed. The amount of impervious cover is an indicator of the amount of runoff, and therefore erosion that can occur.

Pollution Sources
The watershed was further characterized by mapping the pollution sources within the basin. This was accomplished by creating a point file that identified NPDES permitted discharges based on parcel addresses and ownership. In addition, underground storage tanks, landfills, mines, water pumps, water tanks, sewage treatment plants, sewage pumps, sewage treatment plant discharges, and dams were all identified within the hydrological unit using BasinPro databases. Pollution sources within a watershed can influence water quality and habitat functions.

These processes were used to generate the mapping for general watershed characterization. Procedures for more detailed analyses are described in the latter part of this document.

Sub-watershed Analysis Procedure

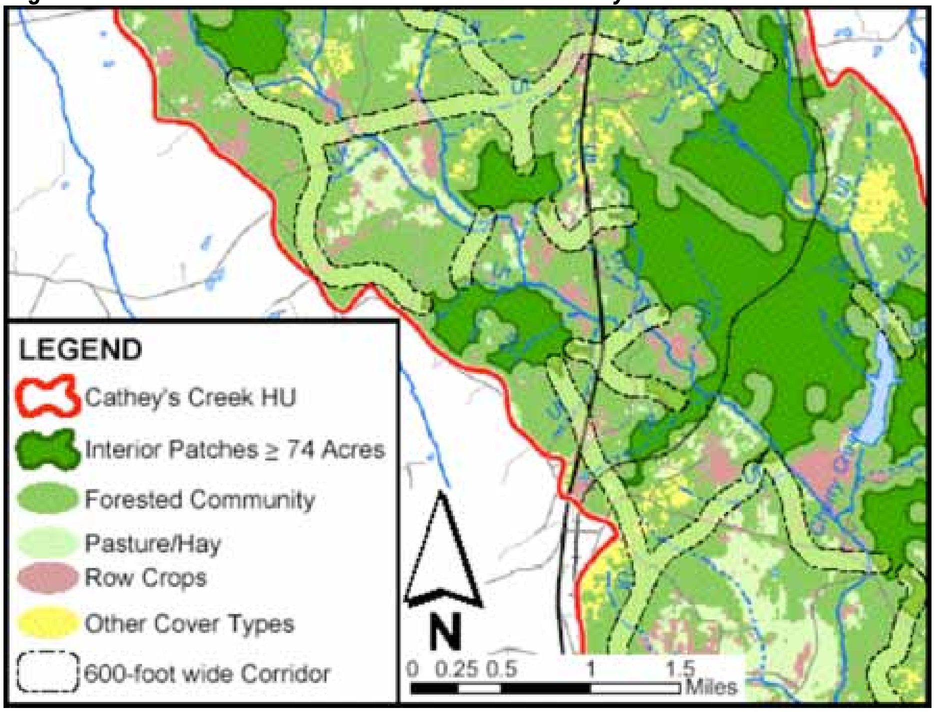
Analysis of the hydrology on the USGS quadrangles resulted in the delineation of 14 sub-watersheds ranging in size from 2.3 to 4.0 square miles. The Cathey's Creek sub-watershed polygon coverage was created using streams and elevation contours and then used to clip the watershed data sets for individual calculations. The sub-watershed analysis procedure included summarization of existing data (*e.g.,* total area of Woody Wetland polygons) as well as more detailed spatial analyses that describe the functional condition of the watershed on a sub-watershed scale.

Summary calculations included total areas of various combinations of land cover and land use categories for each sub-watershed. Land use/land cover information was used to calculate impervious surface, forested areas, wetland areas and agricultural use for each sub-watershed. Other summary calculations included total stream length within a sub-watershed and total length of impaired stream.

The percentage of total stream length protected on both sides by at least a 50-foot forested buffer was determined for each sub-watershed. A 50-foot buffer was created for each stream, resulting in polygons along each stream. This was then displayed with the forested layer and aerial photos. Both layers were visually inspected. The long polygons were cut perpendicularly to the stream, keeping the areas which were forested on both sides for at least 50-feet, and deleting the rest. This buffer layer was then used to clip the stream layer, leaving only sections of the stream that were forested on both sides. The lengths were then totaled by sub-watershed.

An analysis of the presence of large, high-quality habitat patches and connecting corridors was performed using methods developed by the Division of Coastal Management (Stanfill *et al*. 1999). Briefly, a 300-foot interior buffer was generated around patches of forested area to account for (remove) edge effects. Polygons greater than or equal to 74 acres inside the buffer were designated "interior patches". Connecting corridors 600 feet wide or greater consisting of forest or agricultural area were identified. The number of patches, the total interior patch area, and the number of corridors to adjacent patches were determined per sub-watershed. The presence of large forest patches and connecting corridors imply that the watershed can support a variety of species, and those with wide ranges.

Figure 6 – Habitat Corridors in middle reaches of Cathey's Creek watershed.



Potential Project Analysis Procedure

In addition to performing a functional analysis for the watershed, conventional GIS methods were also used to locate potential stream and wetland restoration areas. Streams mapped on the USGS quadrangles were intersected with land use categories that indicated cleared areas, based on the assumption that cleared areas or the lack of a forested buffer would suggest alterations, resulting in some degree of degradation. Land use categories included were Low Intensity Residential, High Intensity Residential, Commercial/Industrial/Transportation, Bare Rock/Sand/Clay, Pasture/Hay, Row Crops, and Urban/Recreational Grasses. A reselection was performed then to identify sites with more than 1,000 linear feet of channel within these cover types. Valley slope and stream sinuosity were not considered in this analysis because of the data quality. Intersecting cleared areas with Type A hydric soils identified potential wetland restoration sites. A reselection was then performed to identify sites larger than 5 acres. The number of landowners was not considered when identifying either stream or wetland sites at this stage of work for the watershed management plan. The following paper, presented at the 2002 ESRI Users' Conference, has more information about potential restoration site searches: http://gis.esri.com/library/userconf/proc02/pap0994/p0994.htm.

Functional Analysis

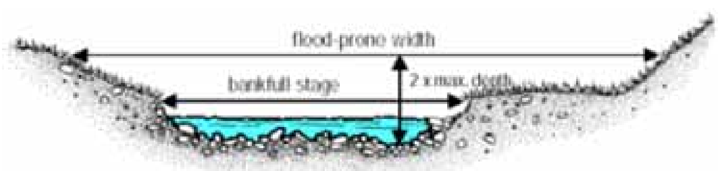
Earth Tech biologists performed the functional analysis, by summarizing the sub-watershed values in a matrix used to rank functional status. The SWs were ranked for each indicator with a value of 1 to 14, with lower values indicating higher functional status. Once the SW rankings for each of the indicators were determined, an average rank for each major function was calculated.

Addressing ecological impacts in terms of functional losses and replacements on a watershed level is a new approach to mitigation planning and implementation in North Carolina. The approach used in this report is based on preliminary guidance provided to EEP by technical committees charged with developing the functional analysis methodology. This report addresses three main watershed functions and to the extent possible with the available data, a number of sub-functions. The three main functions are Water Quality, Hydrology, and Habitat. The actual analysis was limited to data currently available in GIS or other databases. The analysis relied on a simple ranking system rather than calculated models indexed to a reference watershed.

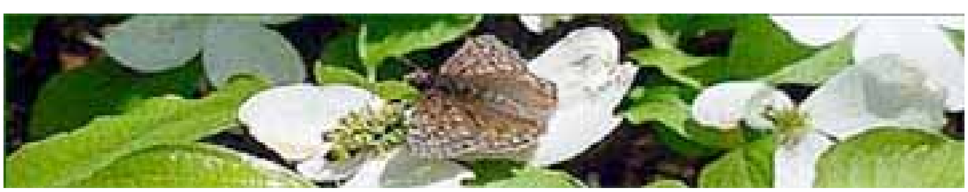
The analysis involved examining the watershed functions and sub-functions in terms of indicators developed for each of the functions and sub-functions. Some of the indicators are simple values that are obtained from attribute tables in the GIS, whereas others are derived from overlays and calculations using the data in the GIS. Percentages are based on total surface water length in a SW or total SW area.

Ecological functions include:

- The **water quality** subfunctions of
  - elemental cycling and spiraling,
  - removal and transport,
  - retention, and
  - thermal regulation;



- The **hydrology** subfunctions of
  - sub-surface water storage,
  - moderation of groundwater flow or discharge,
  - surface water flow or discharge,
  - dynamic surface water storage,
  - and long-term surface water storage and;



- The **habitat** subfunctions of
  - maintain characteristic plant populations and abundance,
  - maintain characteristic animal plant populations and abundance,

- o physical habitat characteristics.

The SWs were ranked for each indicator with a value of 1 to 14, with lower values indicating higher functional status. Once the SW rankings for each of the indicators were determined, an average rank for each major function was calculated.

Water Quality Functions

Water quality functions were assessed by evaluating relative amounts of forested area and cleared or impervious area, length of stream protected by a forested buffer, and length of stream classified as impaired. It was assumed that the highest level of water quality function would be achieved with 100% forested cover, 100% buffer protection, less than 12% impervious cover, and no streams classified as Impaired. These assumptions do not take into account the range of variation within which full function may be achieved, nor do they account for the possibility that sustainability may be achieved at lower levels of function.

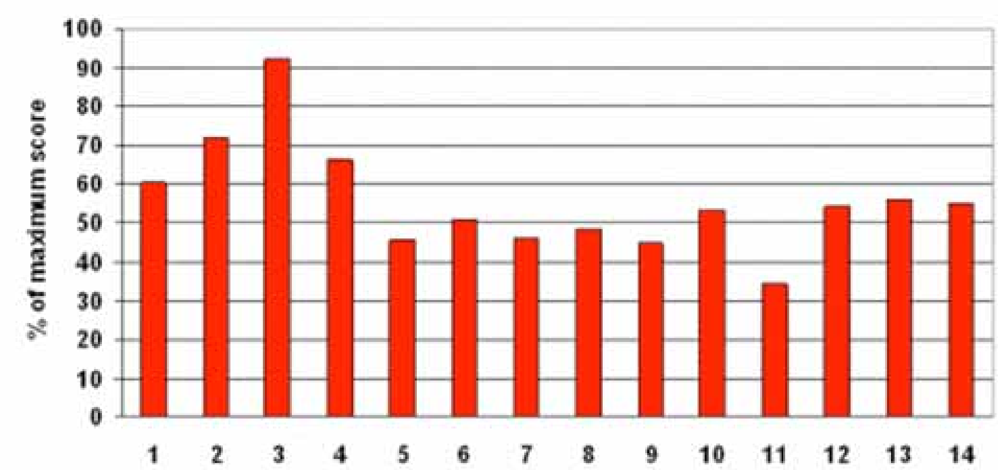
Hydrology Functions

Hydrology functions were assessed by evaluating relative areas of forested area and cleared or impervious area, length of stream protected by a forested buffer, area of ponds, and area of wetlands. The assumptions for forested and impervious area and buffered stream length are the same as noted above.

Habitat Functions

Habitat functions were assessed by evaluating relative areas of forested and cleared land, area of wetlands, buffered stream length, size of forest interior patches, and presence of suitable corridors between the large patches. The presence of forest patches with greater than 74 acres of interior area with at least one connection to another large patch implies the ability of the watershed to support a variety of species, including habitat specialists and wide-ranging species. Habitat Indicator Scores are shown in Figure 7, below.

Figure 7 – Habitat Indicator Scores.



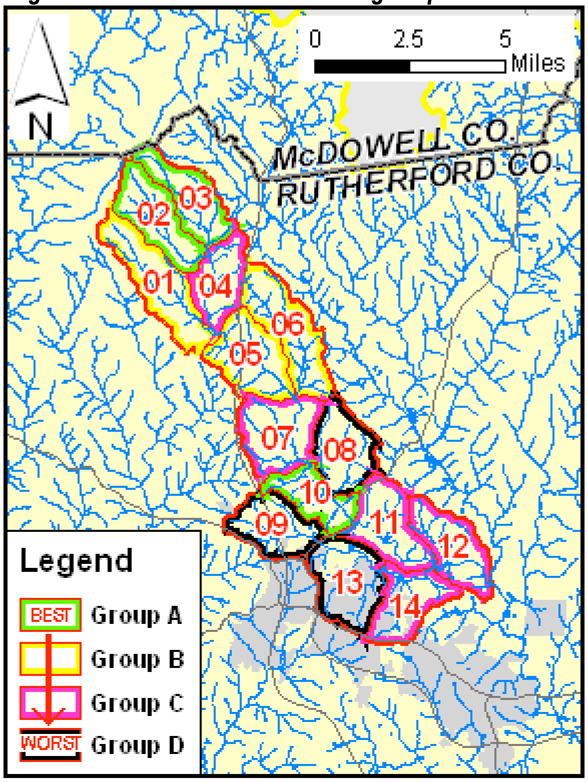
Stream reaches and hydric soils in cleared areas were targeted as degraded areas of interest for further analysis and potential watershed improvements, such as potential wetland or stream restoration or enhancement. These degraded areas were identified using GIS procedures.

The functional analysis calculations resulted in an average rank for each of the 14 SWs for each of the three main ecological functions. These three average ranks were summed to obtain an overall functional score for each of the SWs. The functional scores clustered into four groups distinguished by shared characteristics. Group A sub-watersheds have the greatest ability to carry out their natural watershed functions, whereas Group D is the most degraded. The differences in land use and land cover are the most apparent reason for degradation. Functional ability declines as both forested cover decreases and impervious area increases.

Table 1 – Sub-watershed Ranking.

	Percent of						Number of		Functions				
SWs	Forested Area	Impaired Stream	Wetland Area	Streams Buffered	Impervious Area	Interior Area	Corridors	Interior Patches	Water Quality	Hydrology	Habitat	Total	Group
03	1	1	13	1	1	1	9	7	3	3	5	11	A
10	6	1	3	4	5	5	8	9	4	3	6	13	A
02	2	1	14	2	2	2	5	6	4	3	5	13	A
06	5	1	7	6	10	4	3	1	6	5	4	15	B
01	4	1	10	10	3	3	2	3	6	5	5	15	B
05	3	1	12	7	8	9	1	2	6	5	6	17	B
12	12	12	1	3	6	11	12	12	7	4	9	19	C
11	8	13	2	9	9	6	7	10	8	5	7	20	C
07	9	1	8	11	7	7	6	5	7	6	8	21	C
04	7	1	11	12	4	12	4	4	7	6	8	21	C
14	10	14	4	5	12	8	11	11	9	5	8	22	C
08	11	1	9	8	11	10	10	8	8	7	9	24	D
09	14	1	6	14	13	14	14	14	10	8	13	30	D
13	13	11	5	13	14	13	14	14	11	8	12	31	D

Figure 8 – Sub-watershed Ranking Map



Problems Within the Sub-watersheds, Identified with GIS

Based upon the findings of this study by an Earth Tech senior biologist, the CCW appears to be in a transitional state. Urban runoff and sediment are suspected to be the leading causes of water quality impairment within the watershed. The urban runoff volumes, peak flows, and pollutant loads will continue to increase as development continues in the three municipalities. Water quality monitoring results in the urban areas of the CCW have been consistently indicative of stressed stream biota. Other areas of concern include the effects on water quality of the Spindale Wastewater Treatment Plant discharge and potential mercury contamination from old mining operations.

The altering of the streams as a result of mining and farming practices along with the changes to the floodplain and upland areas (increased impervious surface, loss of forest cover, and changes in soil permeability) are believed to be the main causes of impairment in the hydrologic functions of the watershed. The watershed is not efficient at absorbing overbank flows through short- or long-term storage and the channels do not handle peak flows in a stable manner. The flood control ponds also have affected the hydrologic functions by changing the timing and sediment balance of the stream flows.

Figure 9 - Miners

The same causes of impairments to water quality and hydrology most likely have also impaired the habitat functions. The increased velocity and volume of urban runoff and the resulting scour, increased sediment load, and sandy substrates create a hostile environment for aquatic species. Straightened and entrenched streams lack the riffle-pool sequence that provides a variety of habitat types.

The major stressor on terrestrial habitat functions is the removal and fragmentation of native vegetation. The decline in timber and farming has resulted in reforestation in many areas, but from observations made during windshield surveys, the species richness appears to be low and exotic invasive species have become established. It is not known whether the presence of exotic species on the stream banks affects aquatic communities.

Problems identified with Field Analysis

Earth Tech conducted stream and landscape assessments during March 2004 and DWQ conducted water quality and biological sampling throughout the summer and fall of 2004. The findings of these studies were described in the Critical Area Analysis report.

Field data obtained during the assessment period, combined with visual observation of channel processes support the contention from the IWC that sediment is a significant problem within the Cathey's Creek HU. Poor scores for Bottom Substrate, Pool Variety, and Riffle Habitat are directly related to increased embeddedness, pool filling, and deposition of sediment throughout low-gradient segments in the watershed. Although the watershed transitions from the Blue Ridge physiographic province in the headwaters of Cathey's Creek to the Piedmont physiographic province farther down the watershed, sediment transport becomes almost universally dominated by smaller particle sizes reminiscent of coastal plain systems. As the transition to Piedmont occurs, sand becomes the principal component of bedload and overwhelms the transport capacity of the system, resulting in cases of extreme deposition, pool filling, and embeddedness in the few riffles that have survived. A certain amount of sand in the system is not necessarily unexpected, given the typical geology and soil types of the area. However, the large amounts observed in this study demonstrate the sensitivity of the system to in-stream or landscape disturbances such as mining, agriculture, forestry, or urban development. The detrimental effects of this excess sand on aquatic habitat are reflected in the Habitat Degradation scores as discussed above, again supporting the concerns raised by the functional assessment of the IWC.

The urban runoff volumes, peak flows, and pollutant loads will continue to increase as development continues in the Cathey's Creek watershed. The population statistics showing slow growth and migration into the area and economic trends suggest that significant changes in land use may be imminent. During the field assessment, it was noted that several large forested tracts in both the upper and lower ends of the watershed (SWs 01, 02, 11, 13, 14) have been cleared since the 1998 aerial photography was obtained. These changes have the potential to significantly degrade water quality and other watershed functions even further by increasing the volume of stormwater runoff and sediment pollution, and this was reflected in the scores of individual sampling points located downstream of these disturbances (01-02, 11-02, 11-05, 13-01).

The threat of habitat degradation from deforestation and fragmentation was identified as a concern in the IWC, along with low species richness and spread of exotic invasives. The field assessment confirmed previous observations from the windshield survey and the IWC that species richness is low and invasive exotic species are well established in the watershed. Sub-watershed averages of exotic cover at sampling points ranged from 16% in SW 01 to 58% in SW 09 (excluding the low of 10% in SW 03 which was based on a single sample point). SW 09 included an individual sample point with 100% cover of kudzu (*Pueraria lobata*). Other common invasive species included Japanese honeysuckle (*Lonicera japonica*), mimosa (*Albizia julibrissin*), Japanese grass (*Microstegium vimineum*), multiflora rose (*Rosa multiflora*), and Chinese privet (*Ligustrum sinense*).

The field assessment findings show that limited high-quality habitat is available in the watershed for certain species of interest, although some significant pockets do exist. The terrestrial habitat suitability for federal Threatened and Endangered Species was evaluated in the vicinity of the sampling points. Forested habitat that is marginally suitable for dwarf-flowered heartleaf (*Hexastylis naniflora*) and/or small whorled pogonia *(Isotria medeoloides*) was found in small areas adjacent to 10 sampling points. Searches for individuals of these plants were beyond the scope of this project.

Potential Solutions to the Problems

Various solutions are available to address the range of problems present in the Cathey's Creek Watershed. They include stream and wetland restoration and enhancement, buffer protection, and best management practices (BMPs) for forestry, livestock, agriculture and stormwater runoff. Below are descriptions of ways these solutions can be applied to the sub-watersheds.

Forestry BMPs

Sediment control activities can be focused on timber. There are BMPs designed to reduce sediment export associated with forestry operations and an established program, administered by the NC Division of Forest Resources, to track compliance. Excellent sediment control on a forest harvesting site should have several components, including the following:

- **Develop a harvesting plan** that considers weather, soils, topography, surface waters, and access to trees.
- **Locate and design access roads to minimize erosion** by such practices as locating on the contour, crossing as few streams and dry washes as possible, and stabilizing places where crossing streams is unavoidable. Studies have shown that careful planning of access roads can reduce erosion by 50%.
- **Maintain streamside management zones** of at least 35 to 50 feet along any perennial streams in the harvested area. The zones should be left undisturbed. Rip-rap and wash stone check dams should be placed across significant streams where the stream enters the management zone to help filter sediment from runoff.
- **Orient skidder trails on the contour** throughout the clear cut and retire them following use by installing water bar diversions or seeding to reestablish vegetation.

Roadway BMPs

Sediment export from gravel and dirt roads can be significant. While an illustrated example in this sub-watershed is not available, the extensive use of water bars, turnouts, and crowned cross-sections for all unimproved roads and driveways can help reduce erosion of road beds and roadside ditches. Maintaining vegetation on the cut slopes of roads and driveways can also reduce erosion.

Livestock BMPs

Accelerated stream bank erosion in pastures because of unlimited livestock access to streams can be significantly reduced by installing fencing to exclude the animals from streams. The amount of sediment reduction depends on many factors including the type of livestock, stocking density, the size of the stream, and the amount and type of vegetation present.

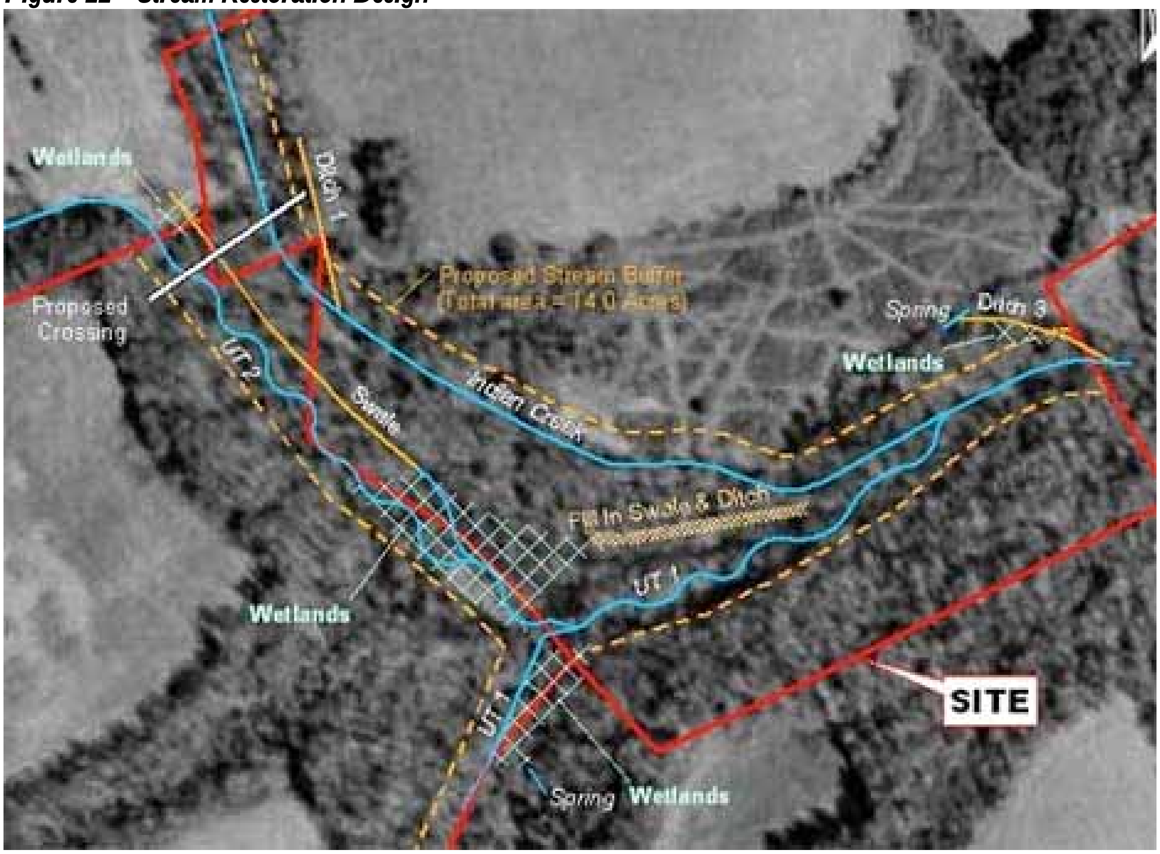
Figure 10 – Cattle Exclusion

Extending the excluded area further can also reduce sediment, nutrients, and fecal coliform bacteria. Planting a succession of native species of grasses, upland trees, and bottomland hardwoods from the fence to the stream would help maximize the water quality and wildlife habitat benefits along the stream. Alternate sources of water would need to be constructed if the stream is the only source of drinking water for the cattle.

Stream Channel Restoration

A solution to severely eroding stream banks is to use stream channel restoration/ stabilization. Restoration can take the form of a variety of stream channel protection or restoration techniques including rock vanes, channel restoration, revegetation of streambanks, and grade control structures. Altering straight channels to more stable natural patterns may be also be done. Stabilization of half the stream banks should result in a 50-60% reduction in sediment load in the stream.

Figure 11 – Stream Restoration Design



Agricultural BMPs

BMPs installed on land in row crops can result in a significant reduction in sediment yield and are always recommended.

Stormwater BMPs

Uncontrolled runoff from paved areas such as airports and parking lots can erode stream channels and destroy aquatic habitat by the force of the water as well as carrying sediment and other pollutants to the streams. Large areas of impervious surface require the use of wet detention ponds or a very large bioretention areas to treat the runoff from the area. Effluent from a pond could be further treated by a bioretention area, a constructed wetland, or wooded or grassed buffers with a level spreader along the upslope edge.

Residential Stormwater BMPs

In residential areas, some neighborhoods drain to streams that are inadequately buffered. Where feasible, these segments can be revegetated. Because of multiple property owners, existing buildings, and other common constraints, it is unlikely that any extensive stream restoration techniques, such as restoring sinuosity, can be applied. Some stabilization structures may be appropriate in some locations.

The most important measures to take in these residential areas, however, are stormwater management BMPs to reduce pollutant loading and runoff. A number of common residential BMPs can be considered. Rain barrels and rain gardens are the primary structural BMPs recommended to reduce runoff volume. Preventive BMPs to reduce nutrients, chemicals, and fecal coliform bacteria in runoff are also recommended. These preventive measures include the use of plants with low water, nutrient, and pest management requirements in the landscape; sweeping paved surfaces following fertilizer application; selecting the type, amount, and timing of fertilizer application to match plant needs; limiting the use of fertilizer as a de-icing agent, and proper collection and disposal of pet wastes.

Some municipalities across the state as well as many across the nation have been successful at obtaining grant funding or raising funds locally to organize comprehensive neighborhood stormwater programs. These programs usually include multiple methods of education for the homeowners such as brochures, newsletters, workshops, and individual technical assistance. Incentives to participate include immediate rewards such as discounts on rainbarrels or landscape plants. Longer-term rewards such as increased property values are realized when a concerted effort results in a neighborhood where rain gardens and other practices enhance the aesthetic appeal of the neighborhood.

Watershed Management Plan

Assessment of the watershed will support stakeholders in development of a Watershed Management Plan. A future Management Plan will aid in

- facilitating reestablishment of water quality, hydrology, and habitat functions
- produce mitigation credits
- meet the community's priorities to formulate optimum projects

The Watershed Management Plan will identify the subwatersheds most in need of solutions to ecological functions. It will be distributed to stakeholders, such as local officials, local and regional conservation groups, resource professionals and state agencies.

Report Publication

The Initial Watershed Characterization report was completed in February 2004 and may be viewed on WECO's website at the following URL:
http://www.ces.ncsu.edu/depts/agecon/WECO/Catheys_Creek/techassess.html

The Critical Area Report was completed in February 2005 and a summary may be viewed on WECO's website at the following URL:
http://www.ces.ncsu.edu/depts/agecon/WECO/Catheys_Creek/Critical_Summary_Feb2005-1.pdf

What next?

Earth Tech has submitted a Draft WMP, and is currently revising it, based on constructive comments by the client, EEP. These include making some figures less complicated so that the stakeholders can more easily comprehend them. An “atlas” is also being developed, in digital and paper formats, for use in implementation of the plan.

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Author Information

Mark Johnston, GIS Technician, Earth Tech, 701 Corporate Center Drive, Suite 475, Raleigh, NC 27607-5074, phone 919-854-6247, fax 919-854-6259, mark.johnston@earthtech.com

Jane Almon, Project Manager and Project Biologist, Earth Tech, 701 Corporate Center Drive, Suite 475, Raleigh, NC 27607-5074, phone 919-854-7745, fax 919-854-6259, jane.almon@earthtech.com

Kilmeny Stephens, GIS Specialist, Earth Tech, 701 Corporate Center Drive, Suite 475, Raleigh, NC 27607-5074, phone 919-854-6216, fax 919-854-6259, kilmeny.stephens@earthtech.com