Turning Analysis into Action:
Targeting likely sources of watershed impairment

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ABSTRACT. The South Carolina Department of Health and Environmental Control (SCDHEC) Bureau of Water, Division of Water Quality, in consultation with the Environmental Protection Agency (EPA) awarded a grant to Research Planning, Inc (RPI) to implement a Total Maximum Daily Load (TMDL) for fecal coliform bacteria in the Bullock and Turkey Creek Watersheds in the Catawba River Basin. RPI's responsibilities under this Grant include: 1) identifying landowners (farmers and septic owners) whose current land use practices may be contributing to impairment of the water bodies; 2) implementation of environmentally sound watering structures, wells, waterlines, creek exclusion fencing, and other best management practices (BMPs) on agricultural lands; 3) repairing failing septic systems; and 4) community outreach on how to solicit additional participation either through grant monies, other Federal programs, or on a volunteer basis to improve farm practices in the local watershed and beyond. Once a landowner is a part of the program, monies are set aside to pay a percentage of the cost for implementing improvements to their farm that are environmentally sound and positively impact water quality in the watershed.

During a kickoff meeting for the Turkey/Bullock Creek project, SCDHEC expressed interest in a more targeted approach to identifying participants (e.g. farmers) as the most desirable path forward. RPI suggested a geospatial analysis to identify agricultural lands that had the most impact on water quality within the watershed in an attempt to satisfy the need for a targeted approach. For this analysis, it was decided to identify hot spots of concern within the watershed in which to focus cost-share efforts. This paper highlights the methodology used to accomplish a targeted approach for watershed impairment regarding agricultural land use.

INTRODUCTION

SCDHEC Bureau of Water, Division of Water Quality, in consultation with the EPA, administers Grants for Nonpoint Source (NPS) Control Projects on impaired water bodies in South Carolina. Water bodies that do not meet water quality standards pursuant to Section 303(d) of the Federal Clean Water Act are considered impaired. The EPA provides monies for these projects to SCDHEC under the Clean Water Act, Section 319(h). Goals of the SCDHEC '319' program include reducing nonpoint source contributions to SC watersheds and implementing TMDLs. Most TMDL implementation projects in SC, focus on implementing BMPs on livestock farms and mitigating failing septic systems.

Past efforts for identifying participating landowners were focused on community meetings and word of mouth; however, improvements shown at the water quality monitoring station level are the most useful in restoring the full use of the water body in the future, which is SCDHEC's and EPA's goal. Targeting improvements on lands that are most likely to impact water quality upstream of the sampling stations was desired.

METHODS

After an initial literature review, a list was made of all possible GIS layers that could be used in the analysis and how/where to obtain them. The agricultural analysis focused on the following objectives as a stepped approach to accomplish this goal:

1) identification of Areas of Concern (AOC);
2) buffer creation;
3) slope analysis;
4) parcel size analysis; and
5) hot spot selection.

ESTABLISHMENT OF AOC

The AOCs were selected based on beef cattle production found in the United States Department of Agriculture (USDA) Census of Agriculture dataset from 2002 (USDA/NASS 2002). The most recent dataset available at the time of analysis, this was a free flat file describing farm statistics such as the number of beef farms, number of cattle, and other metrics. With the flat file nature of the data, in order to be useful in the analysis, it was necessary to create a spatial component. The data included zip code information, so along with ESRI's zip code shapefile (ESRI, 2008), the file was joined to reflect current estimates of beef cattle per zip code within our study area. Using the number of beef cattle, we were then able to rank zip codes within our watershed based on the number of cattle to AOC levels, with AOC 1 being the highest number of beef cattle, and so on. These areas would show the most impact within our study area/watershed of concern.
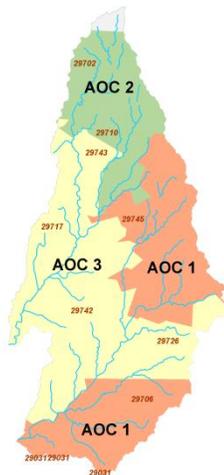

Figure 1. AOCs defined by zip code

BUFFER CREATION

A buffer analysis was used to create buffers around both hydrological features and Water Quality Monitoring Stations (WQMS). Hydrological datasets were obtained from ESRI at no charge, as it is standard data with an ArcGIS package (ESRI 2008). This dataset included streams of third order and higher. Other hydrological datasets from the local state government and other sources were considered, but they included smaller order streams. These streams covered too much area to achieve the goal of a

targeted approach. Also, some streams within these datasets were not permanent year-round water sources, as they contained ephemeral and intermittent water bodies. A trial and error approach was used to determine what buffer sizes best fit the analysis. Buffers that were too large encompassed too much area to be effective, while the use of smaller buffers was too selective. The resulting buffer sizes (in miles) chosen for the analysis around each hydrological segment were: 1) 0.125; 2) 0.25; and 3) 0.50.

The WQMS data were obtained from South Carolina Department of Health and Environmental Control's (SCDHEC) website at no charge (SCDHEC, 2008). Due to the fact that the WQMS dataset included only point features, the buffers chosen for this shapefile were larger than those chosen for the hydrological features: 1) 0.50; 2) 0.75; and 3) 1 mile.
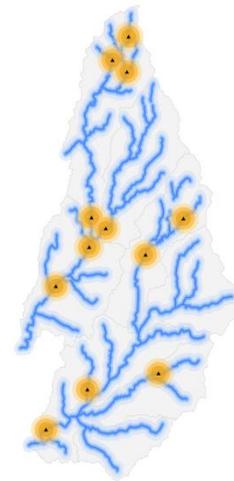

Figure 2. WQMS and hydro buffers

SLOPE ANALYSIS

The slope analysis was conducted on a merged soils dataset for the study area. This dataset was obtained free of charge from the South Carolina Department of Natural Resources (SCDNR, 2008). These datasets were merged together from multiple quadrangles in order to capture the entire study area. The merged dataset was then clipped to the study area. The dataset not only had soils information but also slopes for each soil type. We wanted to include only significant slopes, to highlight areas where runoff was more likely to occur. In order to determine what a significant slope for the area would be, an average of the slopes was calculated and any number greater than

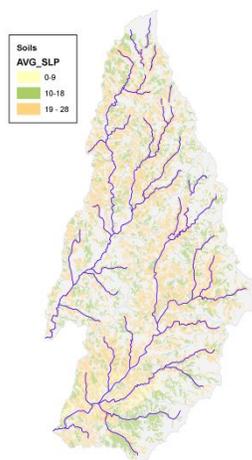the average was considered significant for our purposes.

Figure 3. Slope analysis of the study area

PARCEL SIZE ANALYSIS

The parcel size analysis was conducted in order to select parcels of land that were more likely to be used for agricultural purposes by choosing high acreage parcels. This was but one method in a multi-layered analysis that would aid the user in selecting the largest tracts of agricultural land that are potentially impacting the hydrology and subsequently the WQMS in the watershed. This analysis used a parcel dataset that we requested from the York county government GIS department (York County, 2008). This dataset is free to government agencies. Also obtained from the same source were land use and subdivision datasets, which will be described later. The parcel dataset contained information such as: 1) owner name; 2) owner address; 3) parcel address; and 4) parcel size (among other attributes). Another dataset that was used in conjunction with the parcel size dataset was future land use. The future land use dataset is a dynamic layer constantly being updated by the GIS department. Zoning changes are continuing to take place as land use in this particular county is trending towards non-agricultural functions. A dataset containing subdivisions was also used in this analysis.

Parcel selections were then made using the following system:

1. Removal of Subdivisions: Since this analysis was selecting agricultural lands, it was our goal to exclude parcels whose centroid was in a subdivision. This method would most likely eliminate parcels considered 'mini farms' in subdivisions, which is in reality houses with more acreage than is traditional for a subdivision. This was accomplished using a select by location command in both the subdivision and parcel datasets. The selected features were then exported to a new shapefile.

2. Removal of Non-Agricultural Parcels: The future land use dataset was queried to only reflect agricultural land use and exported to a new layer. The new parcel dataset excluding subdivisions (created in the step above) was used to clip the new agricultural shapefile reflecting only agricultural parcels, thus creating a dataset showing parcels currently in agricultural land use that are not subdivisions.

3. Selection of Large Acreage Parcels: We also wanted to further select for larger parcels to use in the final selection of hot spots. Using best professional judgment from experience in working with these types of cost-share programs, we determined 'large' parcels to be anything over 250 acres.

HOT SPOT SELECTION

After all the analyses were completed, we layered the final datasets to determine where the hot spots were in our study area. Areas were considered a hot spot if they obeyed at least **one** of the following criteria:

1. Parcels within both buffers (WQMS and hydro).

2. Parcels in at least one buffer containing soils with greater than a 10% slope (greater than average); **OR**

3. Parcels in at least one buffer and with a parcel size greater than 250 acres.

All of the selections were exported to new shapefiles. These shapefiles were then merged together, dissolved (to eliminate duplication of parcels that obeyed more than one of the criteria), and attributed to reflect all of the above conditions. The

final parcel shapefiles yielded information with which to solicit participation in the program.
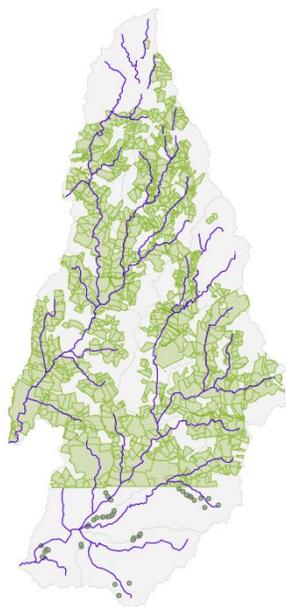

Figure 4. Final hot spots delineated during the study

RESULTS OF OUTREACH

The final hot spot parcels information was used during outreach efforts via direct mailings to target landowners within in the watershed. Large wall maps were made showing hot spot areas and taken to local cattleman meetings where farmers from the study area would be in attendance. Using this analysis, farms in hot spots were actively pursued. As of this writing, RPI has worked with 9 agricultural landowners in this watershed to help remediate just short of 2,000 acres with the installation of approximately 12,000 ft of waterline, over 20,000 ft of fencing, and 7 wells.

Figure 5. Before/after shot of a remediated riparian area

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