Rocky River Watershed Management Plan

Completed by:
Charlotte-Mecklenburg Storm Water Services

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1. SUMMARY

The Rocky River watershed is classified in the 14-digit Hydrologic Unit Code (HUC) 03040105010010. The main stem of the Rocky River originates in Iredell County and generally flows southward forming the border between Mecklenburg County and Cabarrus County. The main stem turns generally to the southeast and flows into Cabarrus County after the confluence with the West Branch Rocky River. The headwaters of the main stem are located in Iredell County within the Town of Moorseville. Portions of the West Branch Rocky River originate in the Towns of Davidson and Cornelius in Mecklenburg County.

The purpose of this Watershed Management Plan is to guide restoration; retrofit and preservation efforts aimed at achieving specific goals for improving water quality conditions in the Rocky River Watershed with a goal to meet or exceed the State designated uses and remove the watershed from the 303(d) list.

This Watershed Management Plan seeks to:

1. Summarize important information regarding the Rocky River Watershed relative to water quality.
2. Describe current and historical water quality conditions/trends in the watershed.
3. Describe current efforts underway in the watershed to protect and restore water quality.
4. Describe water quality goals for the watershed.
5. Prioritize areas for restoration, retrofit and preservation efforts aimed at achieving water quality goals.
6. Describe the process forward for implementing water quality efforts.

The ultimate goal after complete implementation of this Watershed Management Plan is a fully functioning and supporting stream ecosystem in the Rocky River. Of important note with regard to this plan is it only includes analysis and planning for the Mecklenburg County portion of the watershed. Significant areas outside of Mecklenburg County are not included in this plan as they lie outside of the jurisdictional control of Mecklenburg County or the Towns of Davidson and Cornelius.

Table 1 - General Rocky River Watershed Statistics

Watershed Population (2010 Census Blocks)	Total: 26,058 Mecklenburg: 9,029 Outside Mecklenburg: 17,029	
Watershed Area	Total: 37.02 mi^2 Mecklenburg: 15.21 mi^2 Outside Mecklenburg: 21.81 mi^2	
Dominant Land Uses (Inventoried for CMSWS Floodplain Mapping, 2009-2014) Total Acreage: 23,627 ac Mecklenburg: 9,733 ac Outside Mecklenburg: 13,894 ac	Vacant/Forest	Total: 9,460 ac (40.0%) Mecklenburg: 4,504 ac (46.3%) Outside Mecklenburg: 4,956 ac (35.7%)
	Rural Residential (Greater than 2 ac)	Total: 7,976 ac (33.8%) Mecklenburg: 3,158 ac (32.4%) Outside Mecklenburg: 4,818 ac (34.7%)
	Low Density Residential (½ ac to 2 ac)	Total: 2,206 ac (9.3%) Mecklenburg: 658 ac (6.8%) Outside Mecklenburg: 1,548 ac (11.1%)
	Medium Density Residential (up to ½ acre)	Total: 1,690 ac (7.2%) Mecklenburg: 624 ac (6.5%) Outside Mecklenburg: 1,066 ac (7.7%)
	Transportation	Total: 1,209 ac (5.1%) Mecklenburg: 452 ac (4.6%) Outside Mecklenburg: 757 ac (5.4%)
	Other	Total: 1,086 ac (4.6%) Mecklenburg: 337 ac (3.5%) Outside Mecklenburg: 749 ac (5.4%)
Major Political Jurisdictions	Town of Cornelius	Mecklenburg County
	Town of Davidson	Mecklenburg County
	Town of Huntersville	Mecklenburg County
	Town of Mooresville	Iredell County
	City of Kannapolis	Cabarrus County
Major Streams in the Watershed	Rocky River	
	West Branch Rocky River	
	South Prong West Branch Rocky River	
	Dye Creek	

2. BACKGROUND

A section of the Rocky River Watershed is located in the northern portion of Mecklenburg County and lies predominantly within Mecklenburg County's jurisdiction with smaller portions in the Towns of Davidson and Cornelius. Figure 1 shows the location of the Rocky River Watershed in Mecklenburg County along with its jurisdictional boundaries. Ultimately, the Rocky River drains to the Yadkin River in Cabarrus County. Figure 2 shows the position of the Rocky River Watershed in Mecklenburg, Iredell and Cabarrus Counties.

The drainage area for the Rocky River Watershed upstream of the crossing from Mecklenburg County to Cabarrus County is approximately 37 square miles. The drainage area within Mecklenburg County is approximately 15 square miles.

Historically, most of the land in the Rocky River Watershed was used for agriculture. In the early to mid-1800's Davidson College was founded and businesses were established in the watershed. Cornelius was later established in the late 1800's. The construction of I-77 through the area and the recent growth of the Charlotte region resulted in a significant increase in land development activities in the watershed which has dramatically altered the landscape (see Figure 3). Most of the development has occurred along the South Prong of the Rocky River within Davidson's jurisdiction. In addition to the recent changes brought about by urbanization, drastic changes to the stream system have occurred in the last century. At some point in the past, the stream was straightened, most likely by the U.S. Army Corps of Engineers, either to prevent flooding or to improve the land for agricultural uses (Charlotte-Mecklenburg Storm Water Services, 1997). Spoils piles from this process can still be seen along several of the stream reaches (Figure 4).

The Rocky River (AU 13-17a) is listed in the 2014 North Carolina 303(d) list (North Carolina, 2014) for impaired biological integrity (benthos). In addition to the parameters identified in the 2010 North Carolina 303(d) list a Total Maximum Daily Load (TMDL) was prepared by the North Carolina Department of Environment and Natural Resources (NCDENR) for fecal coliform and Fish Tissue Mercury. Typically, streams are listed on the 303(d) list dependent upon their intended uses. Intended uses are generally determined through the stream class.

Table 2 - Rocky River Stream Class Descriptions

Stream Class	Description
C	Freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. All freshwaters shall be classified to protect these uses at a minimum.

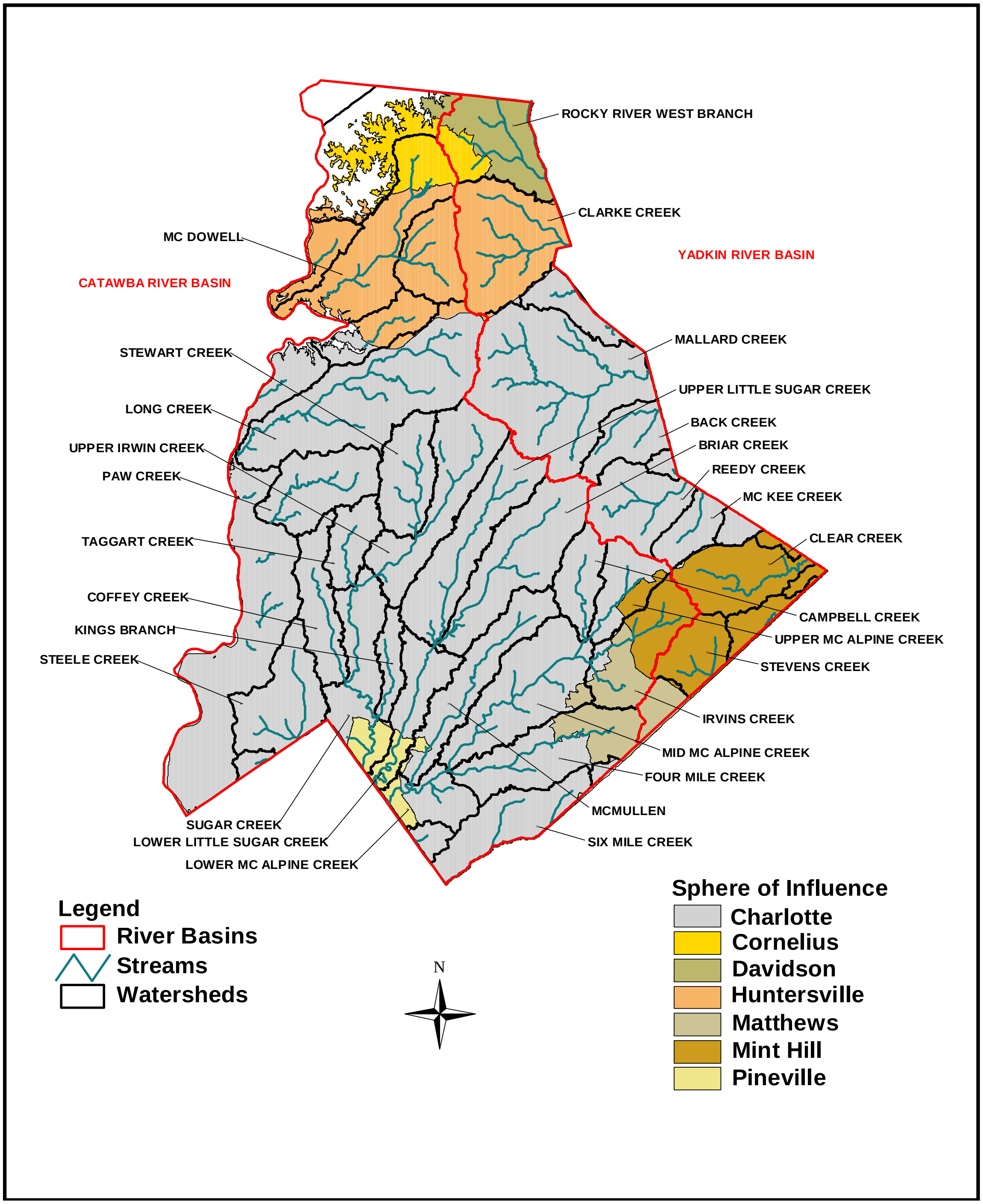


Figure 1 - Rocky River Watershed in Mecklenburg County

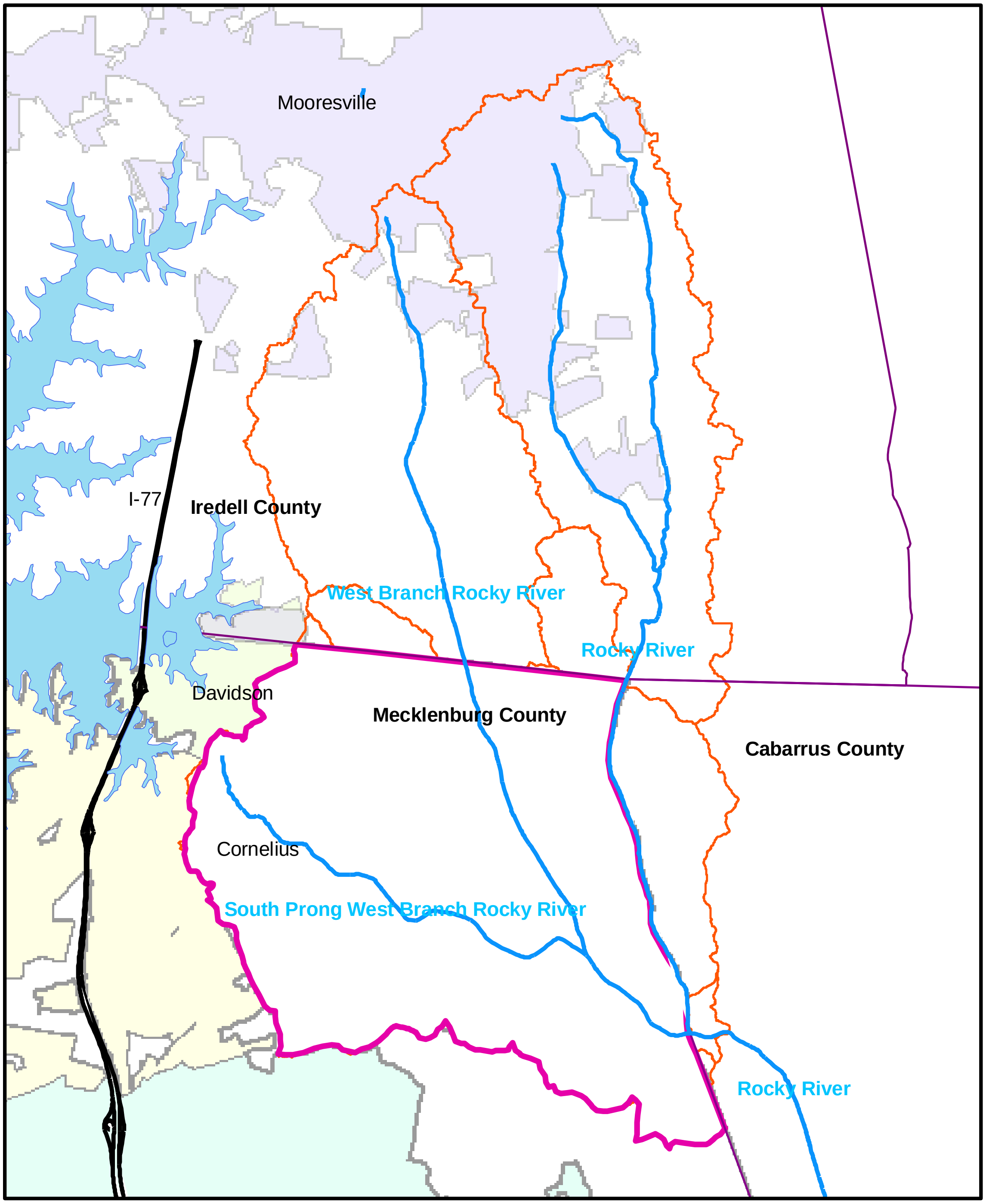


Figure 2 - Distribution of the Rocky River Watershed in Mecklenburg, Iredell and Cabarrus Counties.

Figure 3 - Urbanization near Davidson in the Rocky River Watershed

Figure 4 - Straightened tributary of Rocky River

Figure 5 shows the main segments of the Rocky River and its tributaries color coded by Stream Class along with the Assessment Unit number (AU). All streams in the Rocky River are categorized as Class C waters. Table 2 lists stream classes appropriate for the Rocky River Watershed and the associated description. In North Carolina, surface water quality regulations are defined for particular classes of use support. For instance, Class C waters must support aquatic life and secondary recreation (infrequent human body contact), while Class B waters must support aquatic life and primary recreation (frequent human body contact or swimming). Individual streams, lakes, and reservoirs (or portions of each) are assigned one or more classes. All of the contributing streams to a body of water receive the same designation when they are not specifically defined. Each class has a set of regulations, including water quality standards associated with it. If chemical/physical water quality monitoring reveals that a stream is not meeting a water quality standard, then it is considered “Impaired”. If biological monitoring indicates a lack of abundance and/or diversity of aquatic life in a stream, then it is considered as having “Impaired biological integrity”. Impaired streams are placed on the 303(d) list and a restoration method is specified such as the development of a TMDL.

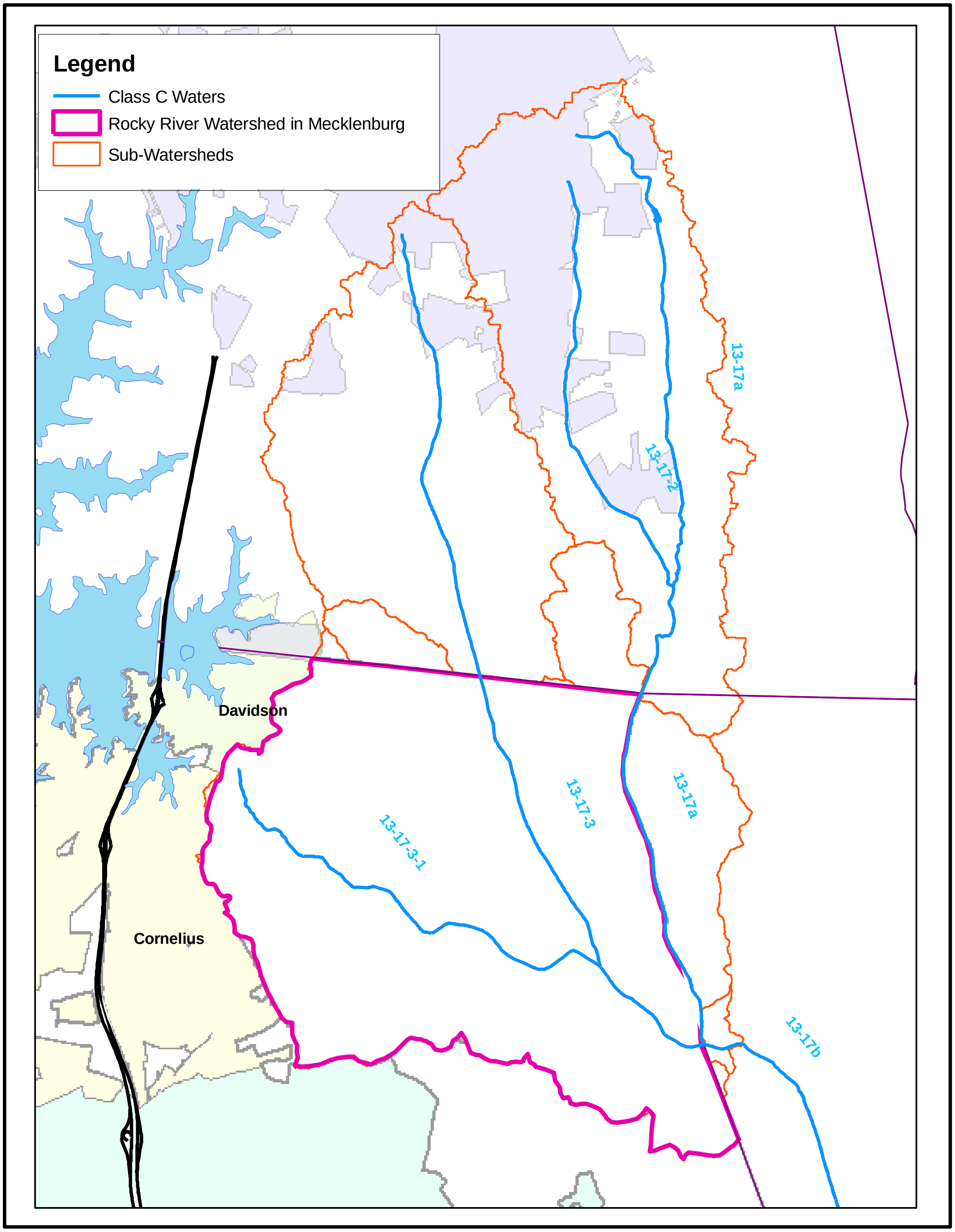


Figure 5 - Rocky River Creek Stream Classes and AU Numbers.

3. CURRENT AND HISTORICAL CONDITIONS

3.1. Previous Work

3.1.1. TMDL Annual Report

The WQRP for the Rocky River was completed and submitted to Mike Randall of NCDENR on August 23, 2012. Implementation of the WQRP has been ongoing since its completion. The WQRP includes specific BMPs to reduce non-point source pollutant loading to the maximum extent practicable. The WQRP is available on line at http://stormwater.charmeck.org (select "Storm Water Basics", select "Master Plans and Long-Term Strategies", select "Water Quality Recovery Plans and Watershed Master Plans", select "Rocky River Watershed Management Master Plan."). Phase II Storm Water Permit Number NCS000395 describes specific components of the WQRP for the Rocky River that are to be completed within 12, 24, 36 and 48 months from issuance of the Permit. The aforementioned WQRP for the Rocky River includes all the required information for the first 24 months following the issuance of the Permit as follows:

1. Identification of watersheds subject to an approved TMDL, with an approved WLA assigned to storm water.
2. Description of the TMDL watershed.
3. Map of the TMDL watershed showing streams and outfalls.
4. Identification of the locations of currently known major outfalls with the potential of contributing to the causes of the impairment to the stream, its tributaries and to segments and tributaries within the watershed contributing to the impaired segments.
5. Schedule to discover and locate other major outfalls that may be contributing to the cause of the impairment to the stream, its tributaries and to segments and tributaries within the watershed contributing to the impaired segments.
6. Description of existing measures being implemented by the Permittee to enhance water quality in the watershed to which the TMDL applies.
7. Explanation as to how those measures are designed to enhance water quality.
8. Assessment of available monitoring data.

Within 36 months of receipt of the Permit, a monitoring plan is to developed and submitted to NCDENR for review. However, Mecklenburg County does not plan to develop a monitoring plan for the listed segment for the following reasons:

1. <u>NC DENR maintains a monitoring site on the Rocky River.</u> Figure 2 shows the portion of the TMDL watershed within Mecklenburg County along with the existing NC DENR monitoring site #Q7330000. Additional monitoring on the impaired section of the Rocky River would duplicate the sampling conducted at this location.
2. <u>Outfall monitoring would provide little useful information.</u> There is only one storm water outfall located in the Mecklenburg portion of the watershed as approximately shown in Figure 4. It receives runoff from several large lot residential homes. The storm water from the outfall flows through more than 200

feet of forested buffer before discharging to the Rocky River. Inspection of the outfall shows very limited erosion or scour indicating very limited flow and a high degree of infiltration.

3. No perennial streams drain from Mecklenburg County to the impaired section of the Rocky River. All drainage from Mecklenburg County to the impaired section of the Rocky River flows through intermittent channels and/or direct overland flow. Sampling of intermittent channels and overland flow is very difficult and of questionable usefulness. Moreover, the stream buffer is largely forested ensuring ample treatment of the runoff conveyed to the Rocky River through the intermittent channels and overland pathways.
4. The majority of the watershed is forested. The Mecklenburg portion of the watershed is largely forested with very limited large lot single-family homes. Typically forested land uses produce very limited Fecal Coliform.

On September 3, 2013, a letter was mailed to Mike Randall of NCDENR stating that Mecklenburg County was not planning to develop a monitoring plan for the Rocky River based on the above stated reasons and requesting feedback if NCDENR was not in agreement. On June 26, 2014, Mecklenburg County received Mike Randal's response:

> *"The State concurs that conducting additional monitoring of fecal coliform in this watershed duplicate existing efforts and does not provide useful additional information.*
> *As pointed out NCDENR maintains a monitoring site on the Rocky River. Any additional monitoring on the impaired section of the Rocky River would duplicate the sampling conducted at this location. Further, the one storm water outfall located in the Mecklenburg portion of the Watershed receiving runoff from several large lot residential homes, flowing through more than 200 feet of forested buffer before discharging to the Rocky River with limited erosion or scour there would indicate very limited flow and a high degree of infiltration. Sampling of intermittent channels and overland flow would not provide useful additional information. NCDENR concurs that where the stream buffer is largely forested there is ample treatment of the runoff conveyed to the Rocky through the intermittent channels and overland pathways. As the majority of the watershed is forested, NCDENR concurs that forested land uses produce very limited fecal coliform.*
> *The state waives the requirement for a Monitoring Plan for the Fecal Coliform TMDL in the Rocky River (AU 13-17a). Mecklenburg County should continue to evaluate the land use and development within the watershed on an annual basis and if additional storm water infrastructure is installed or higher intensity land uses are constructed a monitoring plan may be warranted."*

3.1.2. McDowell Creek Watershed HSPF Model

In June 2000, Mecklenburg County contracted with Tetra Tech, Inc. to perform a detailed analysis of McDowell Creek with the ultimate goal of providing a watershed based water quality model. The HSPF model eventually developed by Tetra Tech was used to compare the potential range of water quality in McDowell Creek and McDowell Creek Cove under existing and future land use conditions. The model was developed using a number of data sources, including meteorological, water quality, and land use data from Mecklenburg County, stream gaging and water quality data from USGS, and several other sources of information needed to fully parameterize and calibrate the model. Details of the model, its calibration, and the results are available in a previous report (Tetra Tech, 2002). The results of the model indicated massive increases in sediment and nutrient loading as well as peak flow rates and runoff volume. Many of the tools and land use based runoff values used in this report were developed from this project.

3.1.3. USGS

The USGS performed a series of studies in Mecklenburg County during the 1990’s which included the Rocky River Watershed or contained information applicable to it (Weaver and Fine, 2003 and Bales, Weaver, and Robinson, 1999). Two of the aforementioned studies most pertinent to the Rocky River Management Plan are discussed below:

Weaver and Fine (2003): This report characterized the low flow characteristics for the Rocky River Watershed through 2002. It summarized low flow stream data collected at 12 sites in the watershed. It also identified the watershed as having intermediate or low potential to sustain low flows as compared to other areas of North Carolina. Furthermore, the report identified NPDES dischargers as contributing a significant percentage of stream flow during low flow conditions indicating a limited opportunity for dilution of these discharges.

Bales, Weaver and Robinson (1999): This report characterized storm water runoff at several sites throughout Mecklenburg County, including McDowell Creek at Beatties Ford Road (USGS Site 44). Results indicated that developing watersheds such as the Rocky River Watershed typically produce higher loads of nutrients, metals and sediment than do stable watersheds.

3.1.4. North Carolina Ecosystem Enhancement Program

In 2004, CDM completed a planning initiative for the North Carolina Ecosystem Enhancement Program (NCEEP, 2004). The planning initiative focused on the Rocky River Watershed and the Clarke Creek Watershed. Furthermore, the document identified a ‘Pilot Area’ along the South Prong of the West Branch of the Rocky River, which includes most of downtown Davidson and some of Cornelius. The plan identified much of the watershed as having excessive erosion potential. The initiative included analysis and prioritization of restoration needs and opportunities in each watershed. The analysis, which consisted mostly of office level screening, involved the scoring of areas based upon GIS characteristics such as soils, vegetation, air photos, hydrology and land-use. A modeling component was also included in the study. From this study, much of the West Branch and South Prong of the Rocky River were identified for restoration as shown on

Figure 6. Almost none of Mecklenburg County was included in the areas NCEEP identified for BMP retrofits.

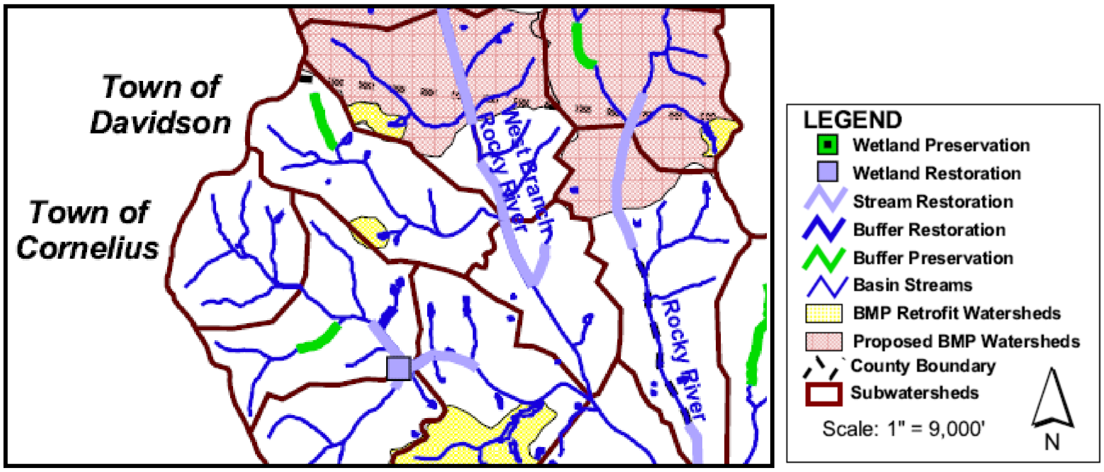


Figure 6 - Stream Restoration and BMP Sites Identified by NCEEP (2004)

3.2. Existing Conditions

3.2.1. Water Chemistry

Mecklenburg County collects in-stream water samples from the West Branch of the Rocky River at monitoring site MY1B, which is located at River Ford Road in Davidson. The monitoring site receives runoff from portions of Davidson, Cornelius and Mecklenburg County as well as areas in Iredell County. Approximately 4% of the samples analyzed for total nitrogen (TN) and 7% of those analyzed for total phosphorus (TP) exceeded the Mecklenburg County action level, which is not indicative of a nutrient problem in the watershed. Levels of fecal coliform bacteria in excess of the 400 cfu/100 ml instantaneous state standard were detected 37% of the time, which is indicative of a water quality problem in the watershed. Copper was detected above the state standard in approximately 14% of samples collected (Table 3), which is inconclusive with regard to a water quality problem. Turbidity was detected above the state standard in 23% of the samples collected.

Table 3 - Storm Water Chemistry Statistics for MY1B

Monitoring Site: MY1B	Total N	Total P	Fecal Coliform	Copper	Turbidity
Standard:	1.5 ppm	0.4 ppm	400 cfu/100 ml	7 ug/L	50 NTU
Sample size	49	111	171	59	10882
MIN	0.17	0.02	40	ND	0.1
MAX	14.4*	1.82	12000	140	1000
MEAN	0.87	0.13	678	11.4	76
MEDIAN	0.52	0.05	290	3	18
% over Standard	4%	7%	37%	14%	24%

*Value questionable, not able to be confirmed.

The distribution of the values for Fecal Coliform, Copper and Turbidity are presented as Figures 7, 8 and 9 respectively.

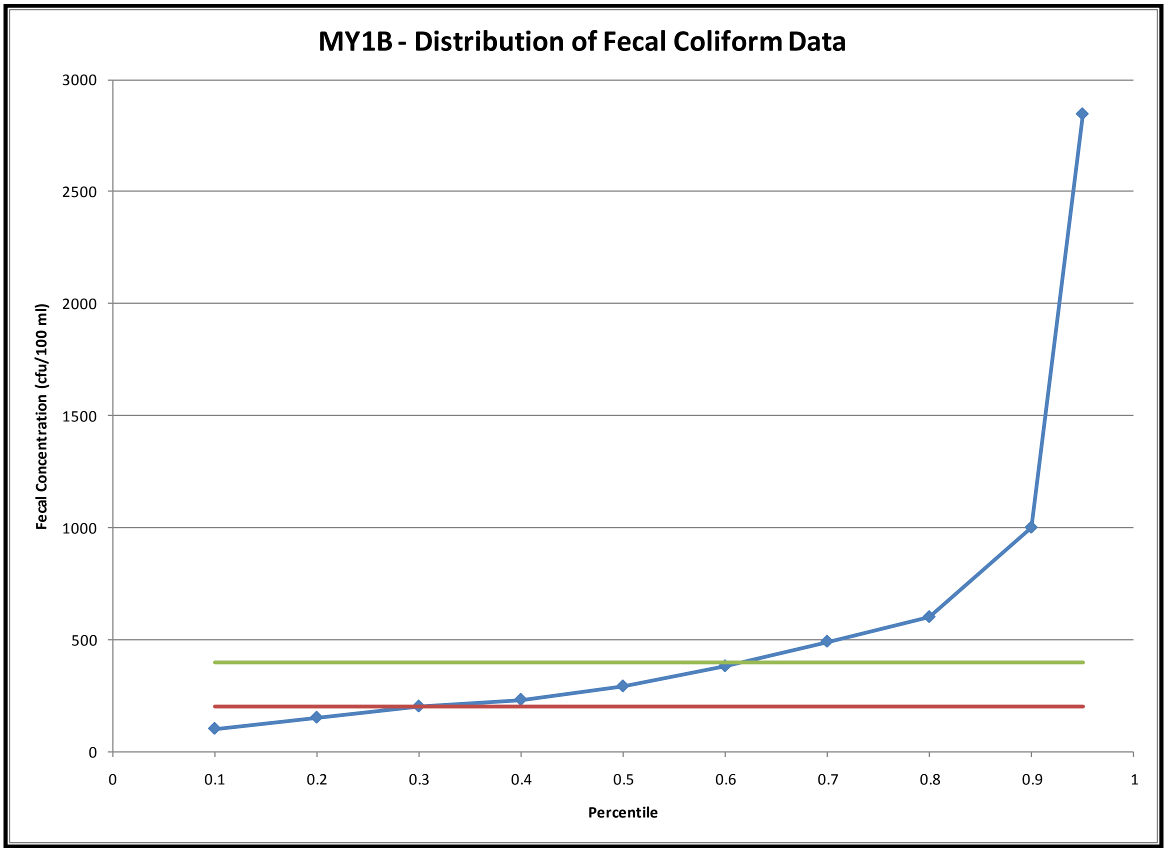


Figure 7 - Distribution of Fecal Coliform Data collected at MY1B

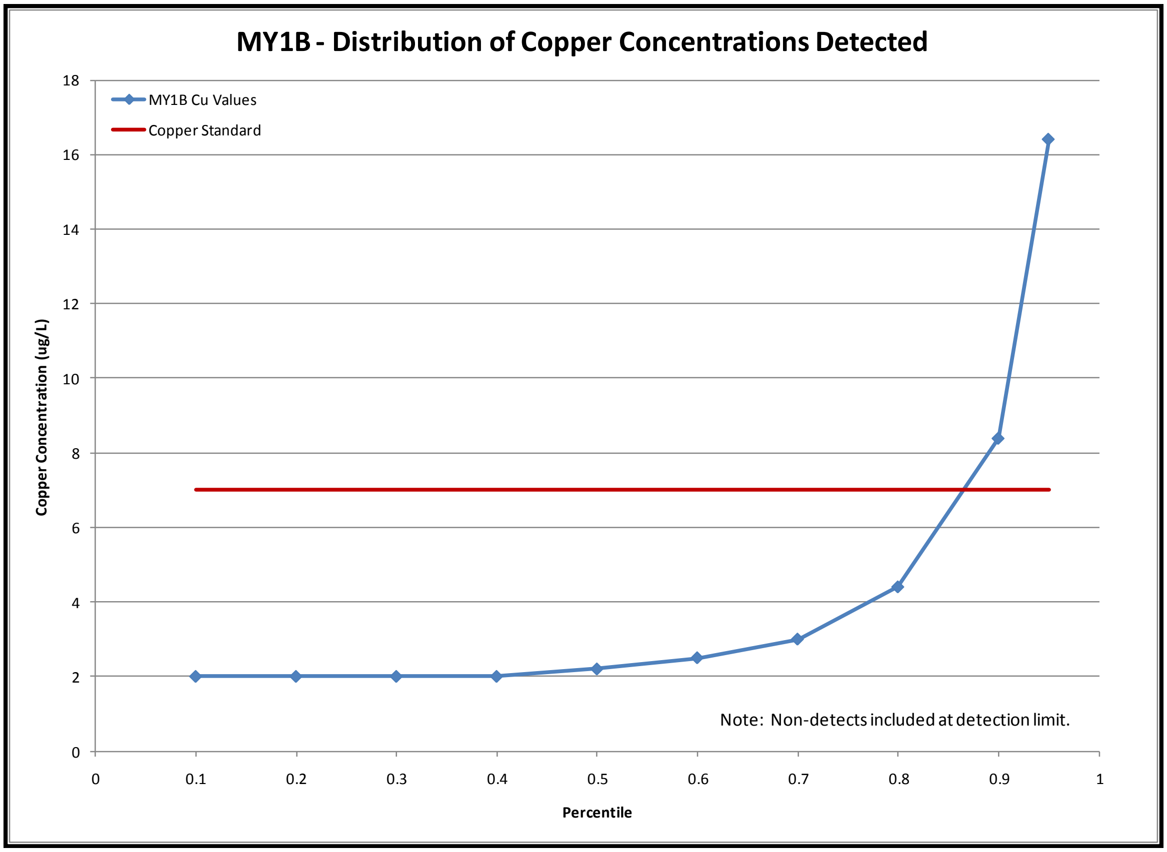


Figure 8 - Distribution of Fecal Coliform Data collected at MY1B

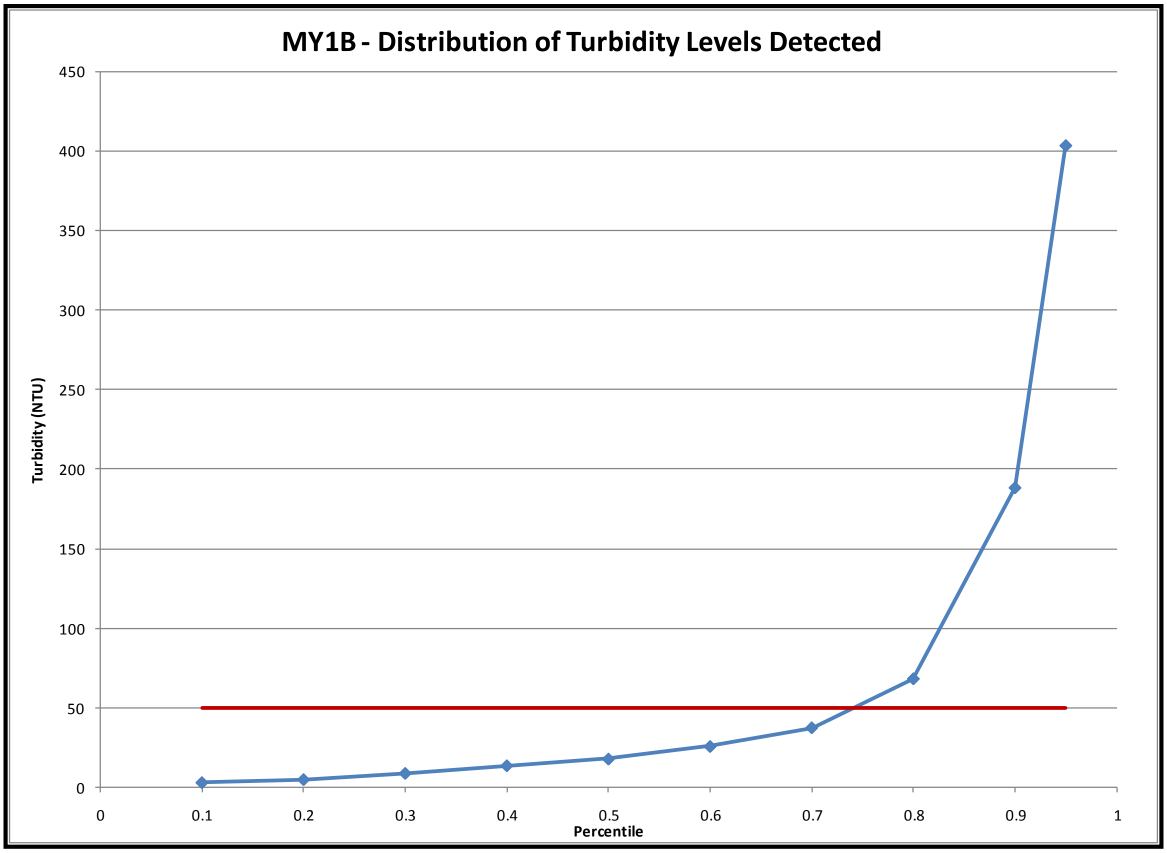


Figure 9 - Distribution of Turbidity Data collected at MY1B

A very strong relationship between Copper and Turbidity was detected from the data collected at MY1B. Figure 10 shows the relationship for Copper and Turbidity from data collected from July, 2004 through September, 2010.

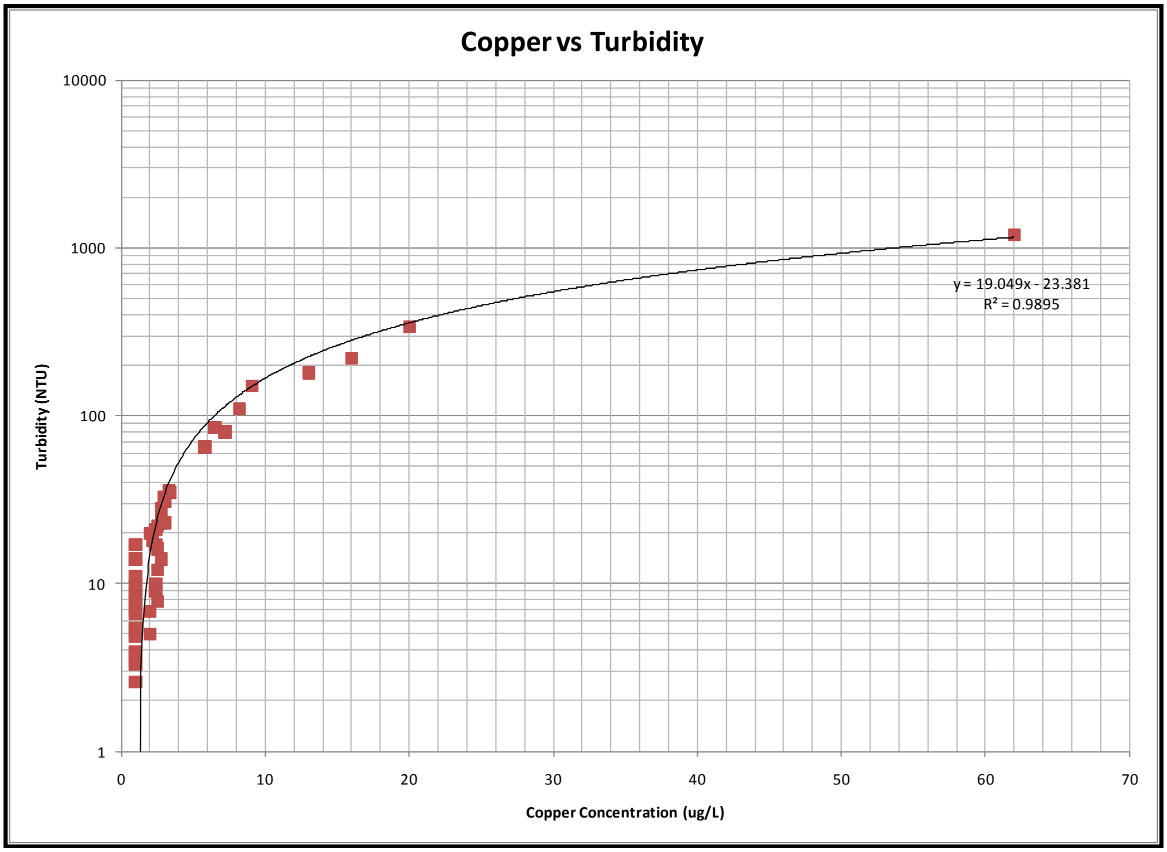


Figure 10 - Relationship between copper and turbidity at MY1B

3.2.2. Biological

The benthic macroinvertebrates in the West Branch of the Rocky River are monitored annually by Mecklenburg County at Gilead Road (site MY1B). The EPT taxa richness was generally below 12 species for all samples taken since 2000 in the West Branch of the Rocky River. Figure 11 presents the benthic macroinvertebrate scores for the West Branch since 2000. As can be discerned from the graph, scores declined into the 'Poor' range during 2002-2004. Scores have rebounded somewhat in the mid to high 'Fair' range. These results are expected in a stream that lacks a stable habitat such as the Rocky River, which has a shifting sand bottom and lacks riffles and other stable substrate.

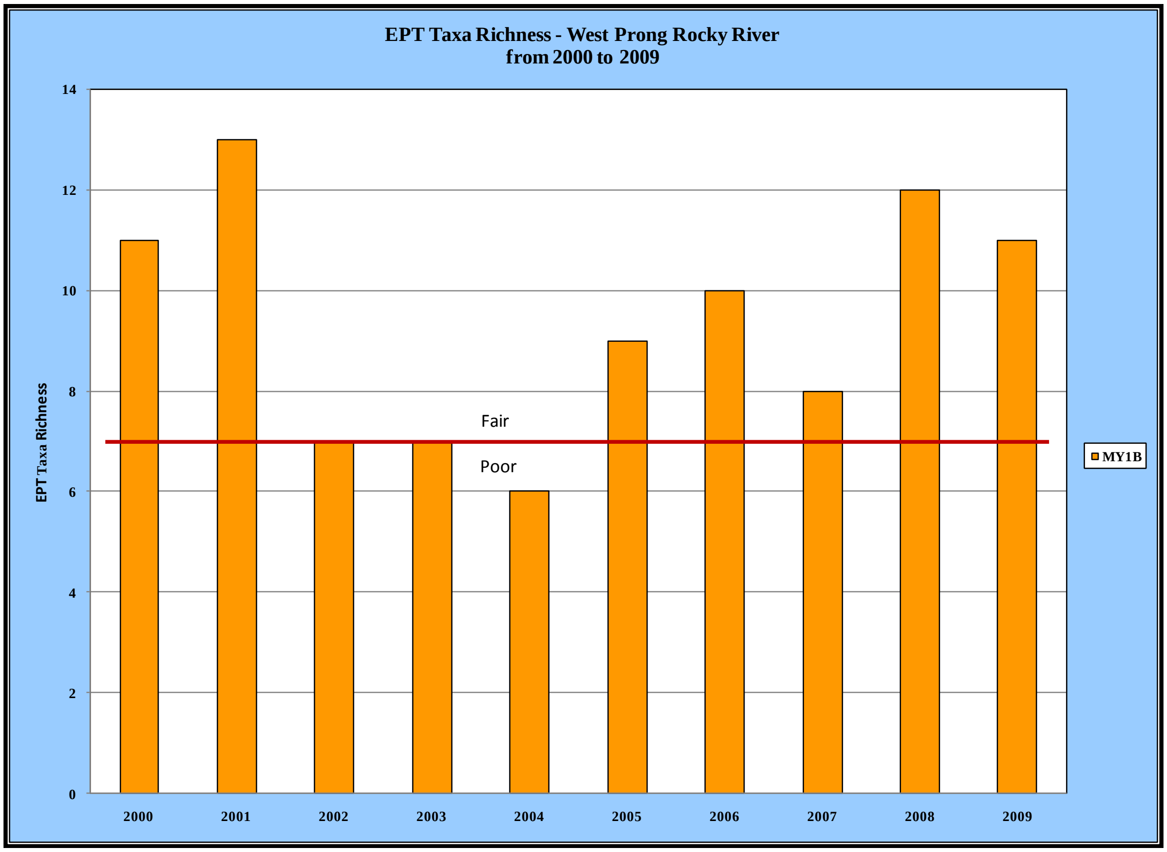


Figure 11 - Macroinvertebrate Scores from MY1B

Mecklenburg County last monitored the fish in the Rocky River in 2010 at MY1B.

3.2.3. Physical

Systematic physical monitoring of the Rocky River watershed has not been conducted. As a part of the implementation of this watershed plan, routine physical monitoring will be conducted. Figure 12 shows a fairly typical location in the watershed with severe erosion and vertical banks.

Figure 12 - Severe Erosion along West Branch of the Rocky River

Analyses performed of the Rocky River by Tetra Tech in 2004 as part of the post-construction ordinance development process demonstrate a significant potential for further stream degradation. Tetra Tech predicted that approximately 15% of the Rocky River draining greater than one square mile was at risk for geomorphic instability and habitat degradation. It is important to note that the only portion of the Rocky River Watershed included in the analysis was that portion draining more than a square mile.

3.2.4. Stream Flow

A watershed will generate larger volumes of storm water runoff and discharge this runoff at higher rates as the amount of imperviousness increases as a result of development. The stream channels that receive the additional runoff are exposed to increased hydraulic forces that can lead to morphologic instabilities through erosion – a process that reduces the availability and quality of aquatic habitat. Aquatic species are dependent upon the channel boundary for shelter, foraging, reproduction, and rest. When boundary materials regularly erode, the aquatic habitat is impacted and unlikely to support a diverse, healthy aquatic community. Therefore, addressing the source of the habitat degradation, additional storm water runoff in this case will help reduce impairment to in-stream biological communities (Tetra Tech, 2004). The Rocky River and its tributaries were straightened in the past, which has caused an inherently instable stream channel. Particularly when the altered stream channel is exposed to increased flows from development.

3.2.5. Land Use/Land Cover

The land-use/land-cover data set used for this Watershed Management Plan was initially developed by Tetra Tech Inc. (2004) for the post-construction ordinance development process. The data set was developed through interpretation of a combination of parcel information, aerial photographs, and tree canopy data. The process is more thoroughly described in Tetra Tech Inc. (2004). Development has occurred in the watershed since the original data set was produced therefore the original land use/land cover data set was changed and updated to reflect current conditions as of 2010. The process used was a manual checking of parcel data along with recent aerial photography. The land-use data set provides a distribution and classification of all land-uses in the Mecklenburg County portion of the Rocky River Watershed. The land-use categories represented in the Rocky River Watershed are presented in Table 4 and the distribution of the land-uses for the Rocky River Watershed is shown in Figure 13.

Table 4 - Rocky River Land Use Categories

Land Use Class	Abbreviation
Heavy Commercial	COMM-H
Light Commercial	COMM-L
Golf Course	GC
High Density Residential	HDR
Heavy Industrial	IND
Institutional	INS
Interstate Corridor	TRANS
Low Density Residential	LDR
Medium Density Residential	MDR
Open Grass (un-manicured)	VCNT
Multi Family Residential	MFR
Medium Low Density Residential	MLDR
Office/Industrial	OI-H
Light Office/Light Industrial	OI-L
Rural Residential	RR

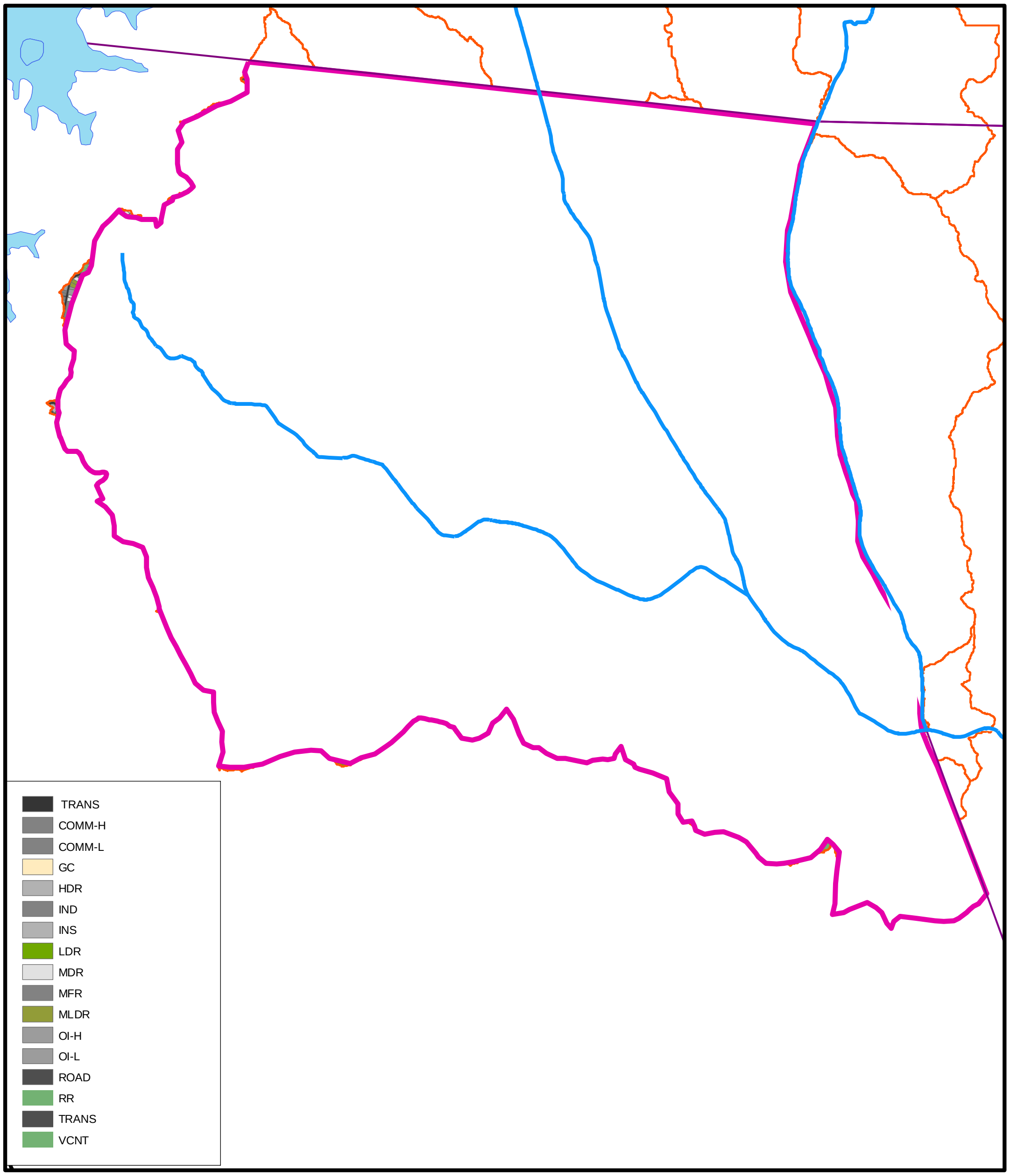


Figure 13 - Distribution of the Land-uses within the Rocky River Watershed

3.2.6. Soils

The distribution of soils within the Rocky River Watershed was determined through the Soil Survey of Mecklenburg County (USDOA – SCS, 1980). The hydrologic soil types found in the Rocky River Watershed are almost exclusively B and C. A description of each soil type and distribution within the watershed are shown in Table 5. Figure 14 shows the location of the hydrologic soil groups in the Rocky River Watershed.

Table 5 - Hydrologic Soil Groups Found Within the Rocky River Watershed

Hydrologic Soil Group	Description (USDOA –SCS, 1980)	Distribution in the Rocky River Watershed
B	Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission	2978 acres (69% of watershed)
C	Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water of soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.	6684 acres (31% of watershed)
D	Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission. Urban areas included in this category.	27 acres (<1% of watershed)

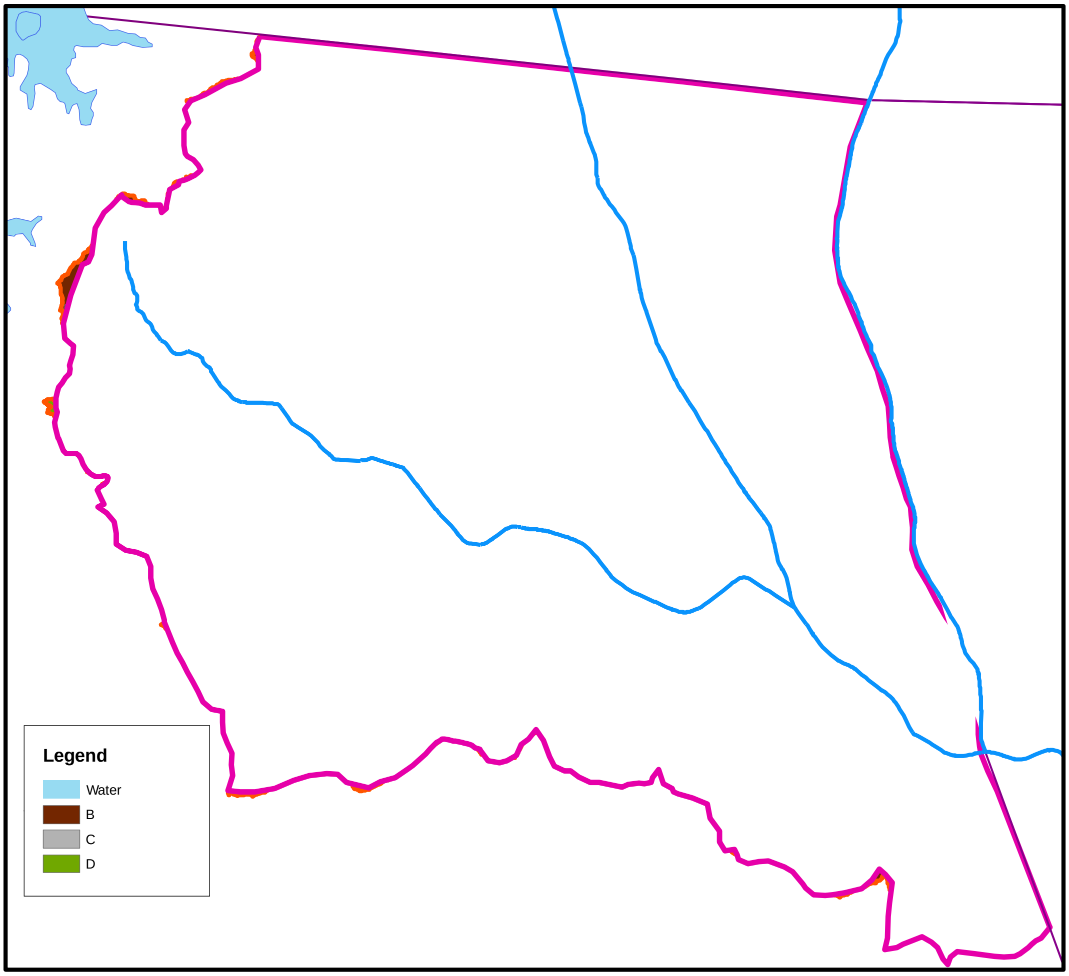


Figure 14 - Distribution of Hydrologic Soil Groups in Rocky River Watershed

3.3. Current Watershed Protection Efforts

3.3.1. S.W.I.M. Buffer Ordinance

A countywide stream buffer system was established in 1999 as part of the Surface Water Improvement and Management (S.W.I.M.) strategy, otherwise known as S.W.I.M. buffers. According to S.W.I.M., streams have the primary natural function of conveying storm and ground water, storing floodwaters and supporting aquatic and other wildlife. The buffer is the vegetated land adjacent to the stream channel, which functions to protect water quality by filtering pollutants and to provide both storage for floodwaters and suitable habitat for wildlife.

Required stream buffer widths vary from 35 to 100 feet or more based on the size of the upstream drainage basin. In Cornelius and Davidson, S.W.I.M. buffer requirements begin at a point where the stream drains 50 acres. Approximately 1,686 acres (9.2%) of the Rocky River watershed is S.W.I.M. buffer. Table 6 presents the S.W.I.M. buffer requirements for Davidson, Mecklenburg and Cornelius. Figure 15 shows the extent of the S.W.I.M. buffers in the Rocky River Watershed.

Table 6 - S.W.I.M. Buffer Requirements for Cornelius and Huntersville

Jurisdiction	Date Ordinance Adopted	Total Buffer Widths			
		≥ 640 acres	≥ 300 acres	≥100 acres	≥50 acres
Cornelius(2)	12/6/99	total = entire floodplain but no less than 100 feet	total = 50 feet no zones	total = 35 ft no zones	
Davidson(1)	2002	total =100 ft + 50% of floodfringe beyond 100 ft. streamside = 30ft managed use = 45 ft upland = remainder	total = 50 feet streamside = 20ft managed use = 20ft. upland = 10ft	total = 35 ft streamside = 20ft managed = none upland = 15ft	No buffer requirements
Mecklenburg(1)	11/9/99	total =100 ft + 50% of floodfringe beyond 100 ft. streamside = 30ft managed use = 45 ft upland = remainder	total = 50 feet streamside = 20ft managed use = 20ft. upland = 10ft	total = 35 ft streamside = 20ft managed = none upland = 15ft	No buffer requirements

All buffers are measure horizontally on a line perpendicular to the surface water, landward from the top of the bank on each side of the stream.

(1) Function, vegetative targets and uses for each of the buffer zones correspond to the buffer plan developed by the S.W.I.M. Panel dated April 20, 1999.

(2) No buffer zones have been designated. The entire buffer area is designated in the Ordinance as “UNDISTURBED.”

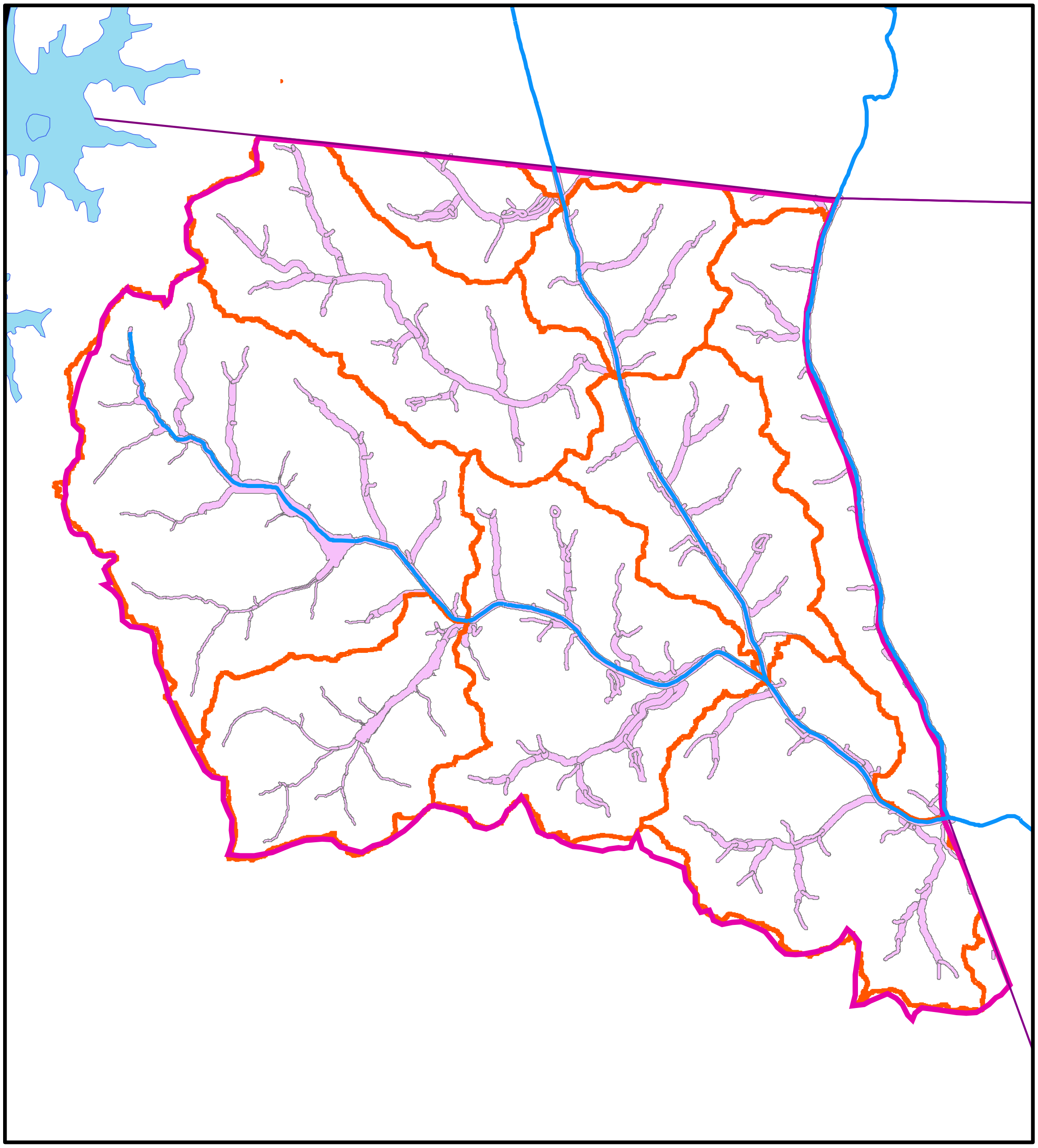


Figure 15 - Approximate Extent of Rocky River Watershed S.W.I.M. Buffers

3.3.2. Post Construction Ordinance

Davidson, Cornelius and Mecklenburg County adopted the Post Construction Storm Water Ordinances on June 30, 2007. They were adopted to comply with federal and state law and to offset potential negative impacts to surface water that can result from development and redevelopment of land. Table 7 summarizes the requirements for each of the jurisdictions in the Rocky River Watershed.

Table 7 - Post Construction Ordinance Requirements Summary

Jurisdiction	Structural Water Quality BMPs	Buffers	Volume and Peak Control	Open Space Requirements
Cornelius	>12% BUA requires 85% TSS removal for runoff from 1st inch of rainfall; LID optional; BUA area caps apply in water supply watersheds	30 ft. vegetated, no build zone on all intermittent and perennial streams draining <50 acres, including a 10 foot zone adjacent to bank. If this zone is disturbed, it must be revegetated and the banks stabilized with approved bioengineering techniques 35 ft. buffer on intermittent and perennial streams draining >50 and <300 acres 50 ft buffer on streams draining >300 and <640 acres 100 ft + entire floodplain on streams draining >640 acres All buffers delineated by GIS	Volume (Commercial & Residential): >12% BUA control entire volume for 1-yr, 24-hr storm Peak for Residential: >12% BUA perform a downstream flood analysis to determine whether peak control is needed and if so, for what level of storm frequency (i.e., 10, 25, 50 or 100-yr, 6-hr) OR if a downstream analysis is not performed control the peak for the 10-yr and 25-yr, 6-hr storms Peak for Commercial: >12% BUA control the peak for the 10-yr, 6-hr storm AND perform a downstream flood analysis to determine whether additional peak control is needed and if so, for what level of storm frequency (i.e., 25, 50 or 100-yr, 6-hr) OR if a downstream analysis is not performed control the peak for the 10-yr and 25-yr, 6-hr storms	NONE
Davidson	>10% BUA requires 85% TSS and 70% TP removal for runoff from 1st inch of rainfall; LID optional; BUA area caps apply in water supply watersheds	50 ft buffer on all intermittent and perennial streams draining <50 acres with 3 zones including a 20-foot streamside, 20-foot managed use and 10-foot upland 100 ft buffer on intermittent and perennial streams draining >50 with 3 zones including a 30-foot streamside, 45-foot managed use and 25-foot upland All buffers delineated on-site	Volume (Commercial & Residential): >10% BUA control entire volume for 1-yr, 24-hr storm Peak for Residential: >10% BUA perform a downstream flood analysis to determine whether peak control is needed and if so, for what level of storm frequency (i.e., 10, 25, 50 or 100-yr, 6-hr) OR if a downstream analysis is not performed control the peak for the 10-yr and 25-yr, 6-hr storms Peak for Commercial: >10% BUA control the peak for the 10-yr, 6-hr storm AND	Open space is undisturbed area <24% BUA = 25% open space >24% and <50% BUA = 17.5% open space >50% BUA = 10% open space

Jurisdiction	Structural Water Quality BMPs	Buffers	Volume and Peak Control	Open Space Requirements
			perform a downstream flood analysis to determine whether additional peak control is needed and if so, for what level of storm frequency (i.e., 25, 50 or 100-yr, 6-hr) OR if a downstream analysis is not performed control the peak for the 10-yr and 25-yr, 6-hr storms	

For the purpose of this Watershed Management Plan, it is assumed that the Post Construction Ordinance will mitigate future impacts to water quality from new development. For this reason, the remainder of the Plan and the recommendations listed are focused upon reducing pollution sources from existing development where limited or no water quality mitigation efforts have been required.

4. WATERSHED INDICATORS AND GOALS

4.1. Upland

4.1.1. Upland Water Quality Indicators

Upland water quality is associated with pollutants in storm water runoff from the watershed draining to the Rocky River. The upland water quality indicators selected for this Watershed Management Plan are Total Suspended Sediment (TSS) and Fecal Coliform (FC)These pollutants are indicative of the impact that contaminated storm water runoff has on water quality. Moreover, they are capable of being accurately simulated with relatively simple methods and are indicators of other parameters of concern. Specifically, the strong correlation between TSS and turbidity and the subsequent strong correlation between turbidity and copper indicate that reductions in TSS loading will attain necessary reductions in turbidity and copper to attain the designated use for the watershed. Similarly, attainment of the TSS goals will also equate to improvements in macroinvertebrate populations.

4.1.2. Upland Water Quality Goals

Tetra Tech (2004) conducted an analysis of watershed scale upland loading rates for existing conditions for all watersheds in Mecklenburg County for TSS. They correlated the loading rates back to biological health and scored each watershed based upon the results. They were able to determine that watersheds capable of sustaining a fully supporting biological community displayed very similar upland pollutant loading rates for TSS. The Fecal Coliform TMDL prepared for the Rocky River Watershed (NCDENR, 2002) provided specific reductions needed from various land-use types. Upland loading rates are presented in Table 8.

Table 8 - Upland Pollutant Loading Rate Goals

Upland Pollutant Loading Rate Goals		
TSS $\leq$ 0.22 tons/ac/year		
Fecal Coliform	High Density Development	91% Reduction
	Low Density Development	91% Reduction
	Livestock Grazing/Manure Application (pastureland)	86% Reduction
	Manure Application (Cultivated)	86% Reduction

The goals presented in Table 8 are appropriate to be applied to retrofit BMP projects as a catchment-wide design standard. In other words, retrofit BMP projects in a particular catchment should strive to meet the goals in Table 8; however, it is recognized that each individual project may not meet the goals.

4.2. In-Stream

4.2.1. In-Stream Water Quality Indicators

In-stream water quality is associated with pollutants in the stream channel. The in-stream water quality indicator selected for this Watershed Management Plan is TSS. This indicator will provide an indication of the TSS pollutant load conveyed by the channel.

4.2.2. In-Stream Water Quality Goals

Tetra Tech, Inc. (2002) summarized several reports pertaining to sediment production and biological health. Simmons (1993) summarized sediment characteristics of 152 North Carolina streams and rivers (including 100 within the Piedmont region) from data taken during the 1970s. Crawford and Lenat (1989) provide estimates of annual sediment yield from three (3) Piedmont watersheds near Raleigh, N.C., including 0.13 ton/acre for a predominantly forested watershed, 0.31 ton/acre from an agricultural watershed, and 0.59 ton/acre from an urban watershed. In both studies, sediment yield was estimated from in-stream suspended sediment concentrations, so the annual areal sediment yields reflect not only sediment from the land surface but also in-stream sediment transport and sediment from bank erosion/collapse. Crawford and Lenat (1989) performed extensive biological sampling in the three watersheds they studied and calculated metrics for taxa richness, abundance, and pollution tolerance for invertebrates and fish. In summarizing their biological data, they rated the forested watershed as having high measures of biotic characteristics, the agricultural watershed as having medium to high measures, and the urban watershed as having low measures. Under North Carolina water quality regulations, streams and lakes must be able to support aquatic life. A rating of Fair or Poor for Benthic Invertebrate Bioclassification or Fish Community Structure prevents a water body from being rated as “fully supporting” under Section 305(b) of the Clean Water Act. Based on the two studies investigated by Tetra Tech, Inc., an approximate in-stream sediment load goal of 0.30 ton/acre/year is recommended as a goal.

Currently, in-stream data allowing assessment of the sediment load goal of 0.30 tons/acre/year is not available in the Rocky River Watershed. In order to determine progress toward the goal, it is proposed that a long term sediment monitoring station be installed in the watershed. The site should coincide with long term monitoring sites established for assessing channel properties (permanent cross sections, etc.). Additionally, these sites should also be monitored for macroinvertebrates and fish. Data collected at these sites will allow the development of a yearly sediment loading curve. Each year will be compared against previous years to determine if the sediment carrying characteristics of the Rocky River (and hence the sediment loads) are improving. Also, the data collected will be used to estimate progress toward attaining the overall goal of 0.30 tons/acre/year. Table 9 presents the in-stream water quality goals.

Table 9 - : In-Stream Water Quality Goals

In-Stream Water Quality Goals
1. TSS $\leq$ 0.3 tons/ac/year
2. Benthic Macroinvertebrates = Fully Supporting
3. Fish = Fully Supporting

5. WATERSHED ASSESSMENT

5.1. Upland Characterization

In order to prioritize areas of the Rocky River Watershed, an upland characterization methodology was developed based upon work completed by Tetra Tech, Inc. (2004) for the post-construction ordinance stakeholder group. The resulting prioritization will be used to guide property acquisition for installation of water quality BMPs and to focus efforts on voluntary retrofitting of existing upland sources of pollution.

The upland characterization was completed through an evaluation of existing levels of pollutant loading, impervious cover and buffer impacts. Specifically, the indicators used were TSS, Fecal Coliform, impervious percentage of the catchment and percent of the stream buffer currently un-forested. The information presented in this Section of the Watershed Management Plan deals only with existing sources of pollution in the Rocky River Watershed. For the purpose of this document, it was assumed that future sources of pollution will be attenuated through implementation of the Cornelius and Davidson Post Construction Ordinance, which is presented in Section 2.3.3.

5.1.1. Methodology

The basis for the upland characterization presented herein is an existing land-use dataset developed by Tetra Tech Inc. (2004). The land-use data set was developed through interpretation of a combination of parcel information, aerial photographs, and tree canopy data. The process is more thoroughly described in Tetra Tech Inc. (2004). The land-use data set provides a distribution and classification of all land-uses in the Rocky River Watershed. The land-use categories represented in the Rocky River Watershed are presented in Table 10.

Table 10 - Typical Land Use Categories

Land Use Class	Typical Lot Size	Percent Impervious	Abbreviation
Agriculture	NA	0	AG
Heavy Commercial	Variable	85	COMM-H
Light Commercial	Variable	45	COMM-L
Forest	NA	0	FRST
Golf Course	NA	8	GC
High Density Residential	0.125 – 0.25 ac	41	HDR
High Density Multifamily Residential	Variable	70	HMFR
High Density Mixed Urban	Variable	70	HMX
Heavy Industrial	Variable	66	IND
Institutional	Variable	40	INS
Interstate Corridor	NA	36	INTERSTATE
Low Density Residential	2 – 5 ac	9	LDR

Land Use Class	Typical Lot Size	Percent Impervious	Abbreviation
Medium Density Residential	0.25 – 0.5 ac	30	MDR
Meadow	NA	0	MEADOW
Multi-Family Residential	<0.125	60	MFR
Medium Low Density Residential	0.5 – 2 ac	19	MLDR
Mixed Urban	Variable	60	MX
Office/Industrial	Variable	72	OI-H
Light Office/Light Industrial	Variable	30	OI-L
Park	NA	9	PARK
Rural Residential	>5 ac	4	RR
Ultra High Density Mixed Urban	Variable	90	UHMX

The distribution of the land-uses for the Rocky River Watershed is shown in Figure 13.

The land-use data for the Rocky River Watershed was sub-divided into catchments using GIS software. The catchments were delineated using the Watershed Information System (WISe) with an approximate drainage area of 100 acres per catchment. Catchments with very small drainage areas (<1 acre) were merged into nearby catchments to reduce the number of reporting units. A total of 131 catchments were delineated for the Rocky River Watershed. Figure 16 shows the distribution of the catchments in the Rocky River Watershed.

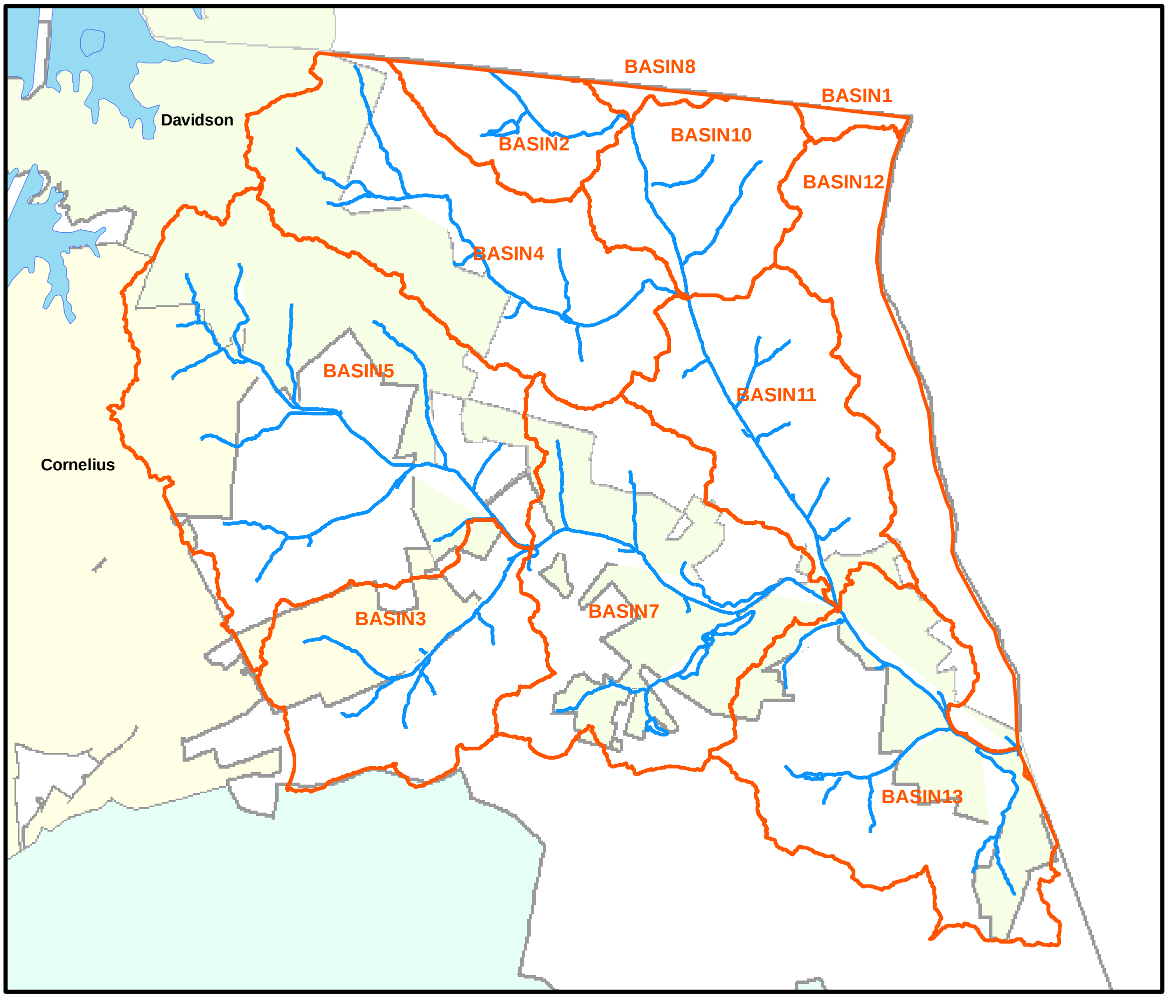


Figure 16 - Rocky River Watershed Catchments

The upland pollutant loading rates by land-use were adopted from Tetra Tech Inc. (2004) and are listed in Table 11. Catchment loading rates were determined by multiplying the area of each land-use in the catchment by the appropriate loading rate and summing the total for all land-uses within the catchment.

Table 11 - Upland Pollutant Loading Rates by Land-Use

Land-use	Fecal Coliform (cfu/year)	Total Nitrogen (lb/ac/yr)	Total Phosphorus (lb/ac/yr)	TSS (tons/ac/yr)	Copper (lb/ac/yr)
COMM-H	3.75E+11	19.44	2.85	0.73	0.12
COMM-L	2.00E+11	12.44	1.88	0.69	0.07
GC	3.81E+10	5.17	0.83	0.47	0.01
HDR	1.83E+11	8.73	1.4	0.47	0.06
IND	3.18E+11	11.87	1.86	0.34	0.11
INS	1.78E+11	8.63	1.39	0.48	0.06
LDR	4.25E+10	4.1	0.66	0.28	0.02
MDR	1.34E+11	7.61	1.24	0.52	0.03

Land-use	Fecal Coliform (cfu/year)	Total Nitrogen (lb/ac/yr)	Total Phosphorus (lb/ac/yr)	TSS (tons/ac/yr)	Copper (lb/ac/yr)
MFR	2.66E+11	10.65	1.668	0.39	0.09
MLDR	8.62E+10	6.5	1.07	0.57	0.02
OI-H	3.18E+11	11.87	1.86	0.34	0.11
OI-L	1.34E+11	7.61	1.24	0.52	0.03
RR	2.06E+10	3.59	0.58	0.52	0.01
TRANS	1.61E+11	7.81	1.25	0.4	0.12
VCNT	3.20E+09	2.5	0.4	0.15	0.01

Note: See Table 10 for abbreviation descriptions.

The percent of impacted buffer in the Rocky River Watershed was also characterized. The characterization was completed using tree canopy data for Mecklenburg County intersected with the FEMA floodplain delineation and the Post Construction Buffer and Watershed buffer coverages. The resulting GIS dataset, which depicts the presence or absence of tree canopy within stream buffers, was intersected with the catchment coverage to determine the percent of un-forested buffer within each catchment. Figure 17 shows the distribution of forested and un-forested buffer within the Rocky River Watershed.

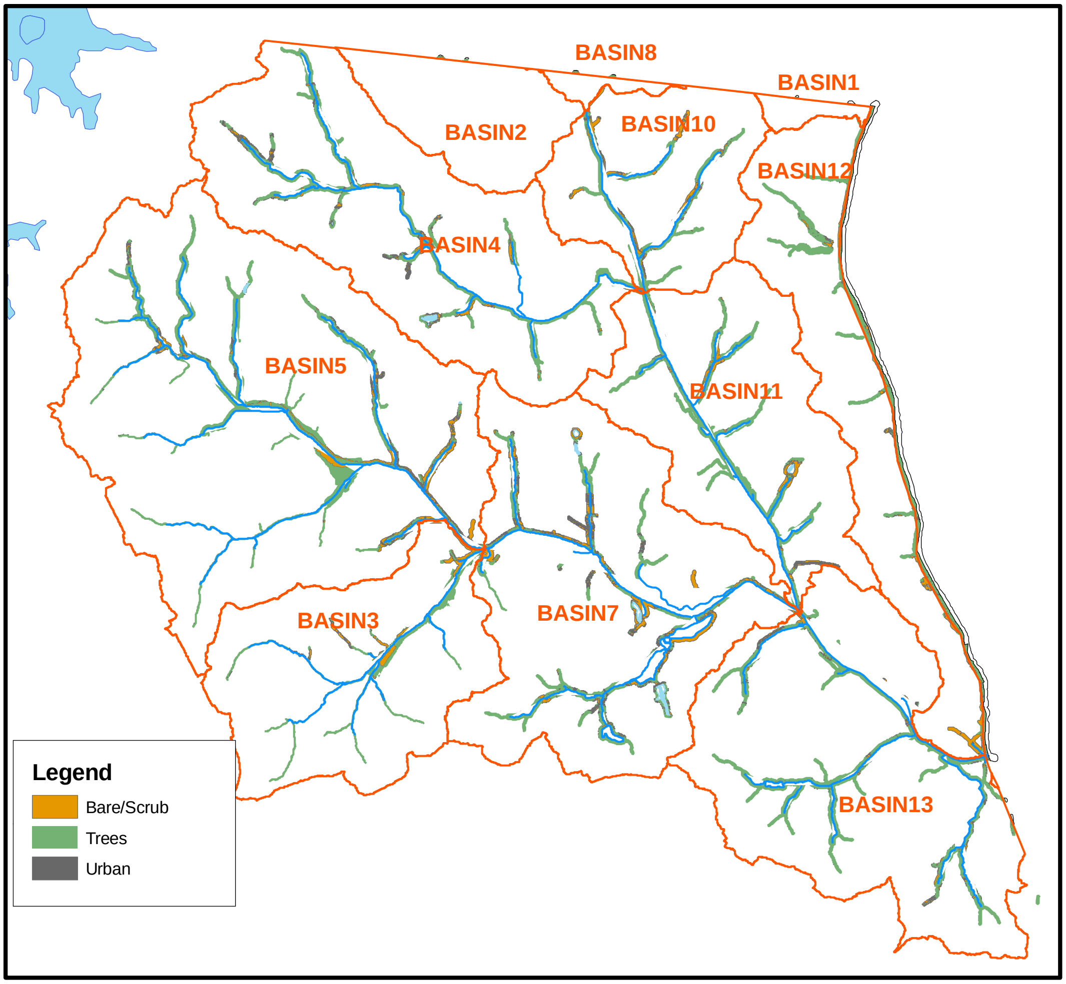


Figure 17 - Distribution of Forested and Un-forested Stream Buffers in the Rocky River Watershed

Levels of impervious area, which are indicative of level of development, for the Rocky River Watershed were characterized by catchment. Impervious percentages by catchment were determined by multiplying the area of each land-use within the catchment by the appropriate impervious percentage (Table 12) and summing the resulting impervious areas for the entire catchment.

5.1.2. Results

Results for each of the catchments for each indicator evaluated were ranked to determine the catchments with the highest level of impairment. They are presented as Table 13 below.

Table 12 - Basinwide loading rates normalized by land area

Basin ID	FC (col/ac/yr)	TN (lb/ac/yr)	TP (lb/ac/yr)	TSS (ton/ac/yr)	Cu (lb/ac/yr)	Impervious Percentage
Basin 1	1.5E+10	3.2	0.52	0.37	0.01	2.8%
Basin 2	2.0E+10	3.5	0.56	0.45	0.01	3.8%
Basin 3	6.4E+10	4.8	0.78	0.38	0.02	13.9%
Basin 4	5.8E+10	4.6	0.75	0.37	0.02	12.5%
Basin 5	6.4E+10	5.0	0.81	0.42	0.03	13.9%
Basin 7	5.4E+10	4.8	0.77	0.43	0.02	11.6%
Basin 8	1.7E+10	3.3	0.53	0.40	0.01	3.1%
Basin 9	3.2E+09	2.5	0.40	0.15	0.01	0.0%
Basin 10	1.5E+10	3.1	0.50	0.30	0.01	2.6%
Basin 11	2.7E+10	3.7	0.60	0.44	0.01	5.5%
Basin 12	2.6E+10	3.6	0.59	0.37	0.01	5.2%
Basin 13	3.7E+10	3.9	0.63	0.33	0.02	7.7%

Table 13 - Ranking of Upland Characterization. Note: Higher rank indicates increasing level of impairment (ie Number 1 produces the most pollution)

Basin ID	FC Rank	TN Rank	TP Rank	TSS Rank	Cu Rank	Impervious Rank	Buffer Impact Rank
Basin 1	10	10	10	9	10	10	8
Basin 2	8	8	8	1	9	8	5
Basin 3	2	2	2	6	3	2	6
Basin 4	3	4	4	8	2	3	11
Basin 5	1	1	1	4	1	1	7
Basin 7	4	3	3	3	4	4	2
Basin 8	9	9	9	5	11	9	1
Basin 9	12	12	12	12	12	12	12
Basin 10	11	11	11	11	8	11	4
Basin 11	6	6	6	2	6	6	9
Basin 12	7	7	7	7	7	7	3
Basin 13	5	5	5	10	5	5	10

Figures 18 – 22 present the overall ranking based upon the results of the upland characterization for Fecal Coliform, TSS, Copper and Imperviousness and Buffer ImpactTN, TP, TSS, Imperviousness, Level of Buffer Impact. Note that hotter colors (reds and yellows) indicate increased levels of impairment.

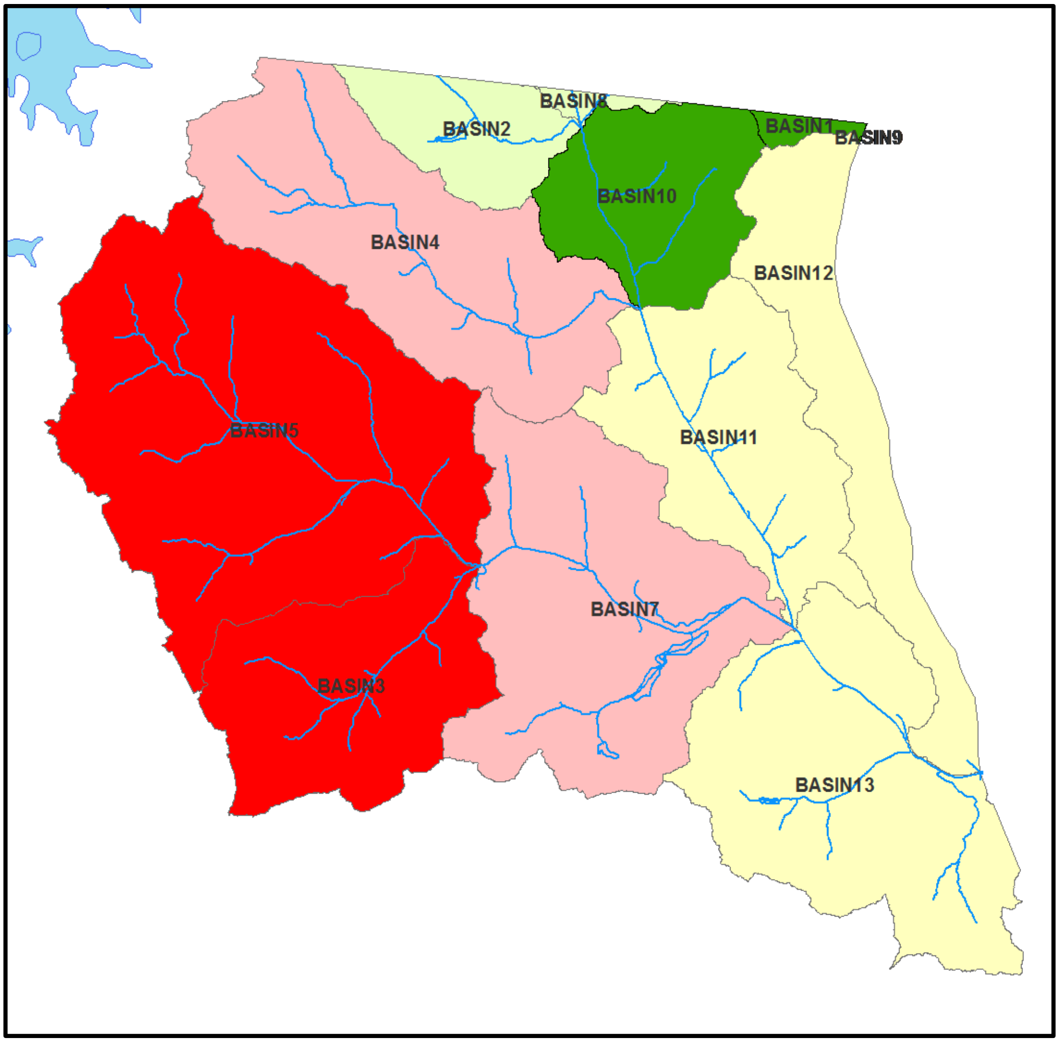


Figure 18 - Fecal Coliform Ranking

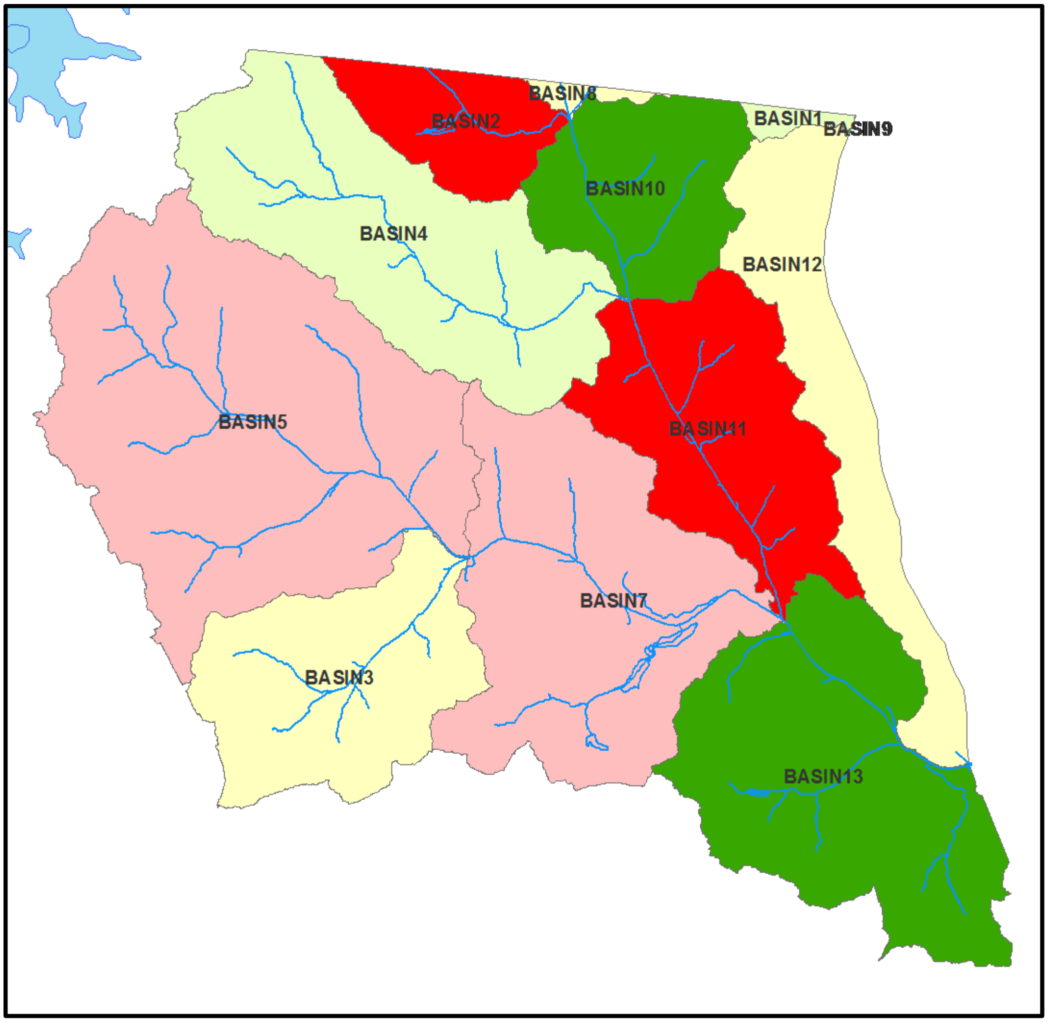


Figure 19 - TSS Ranking

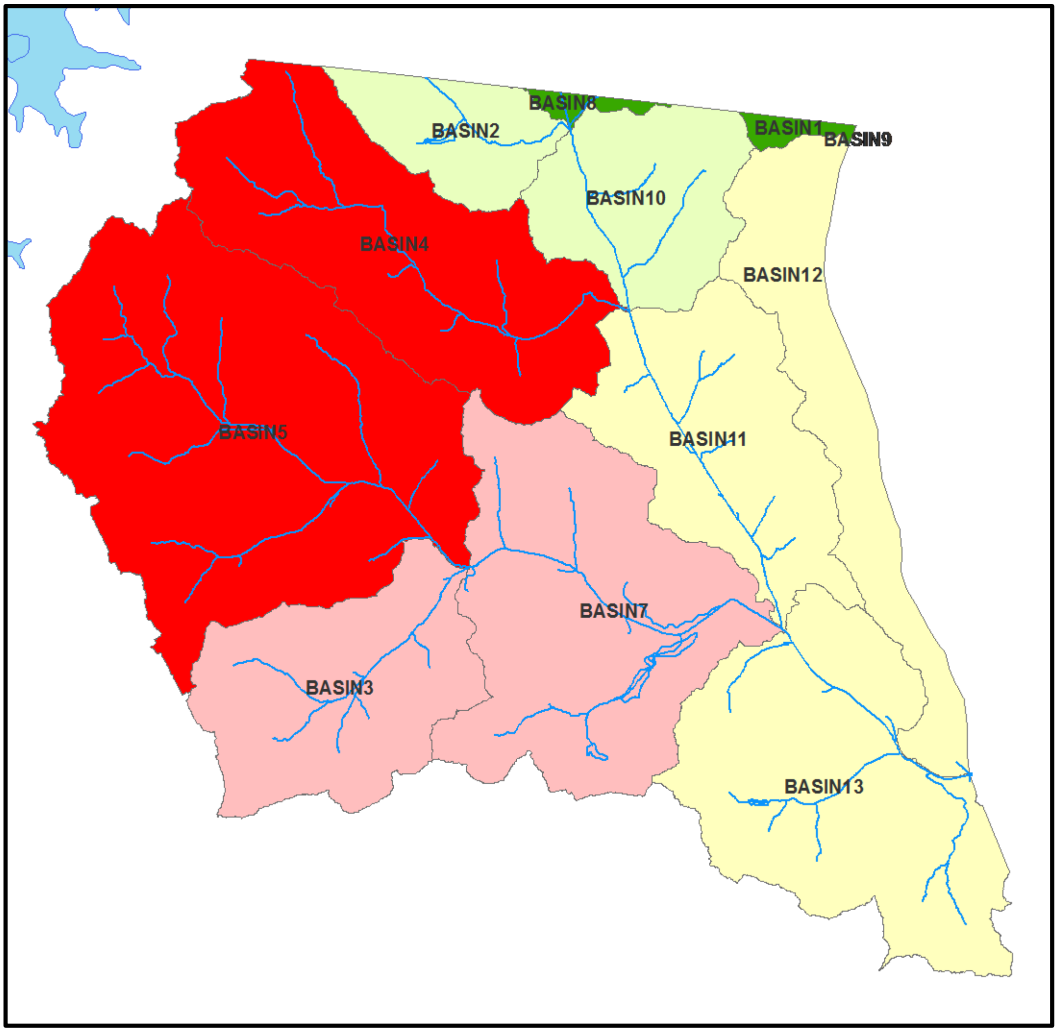


Figure 20 - Copper Ranking

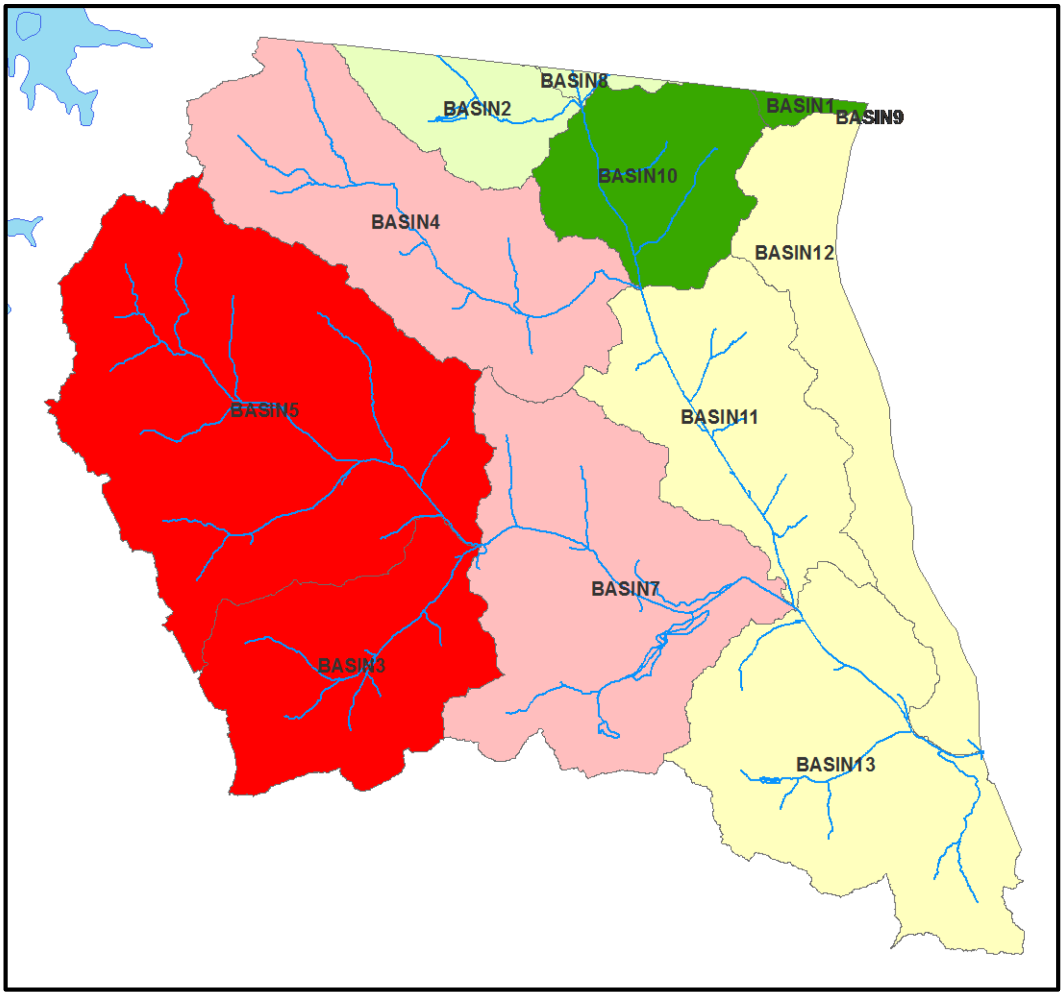


Figure 21 - Impervious Ranking

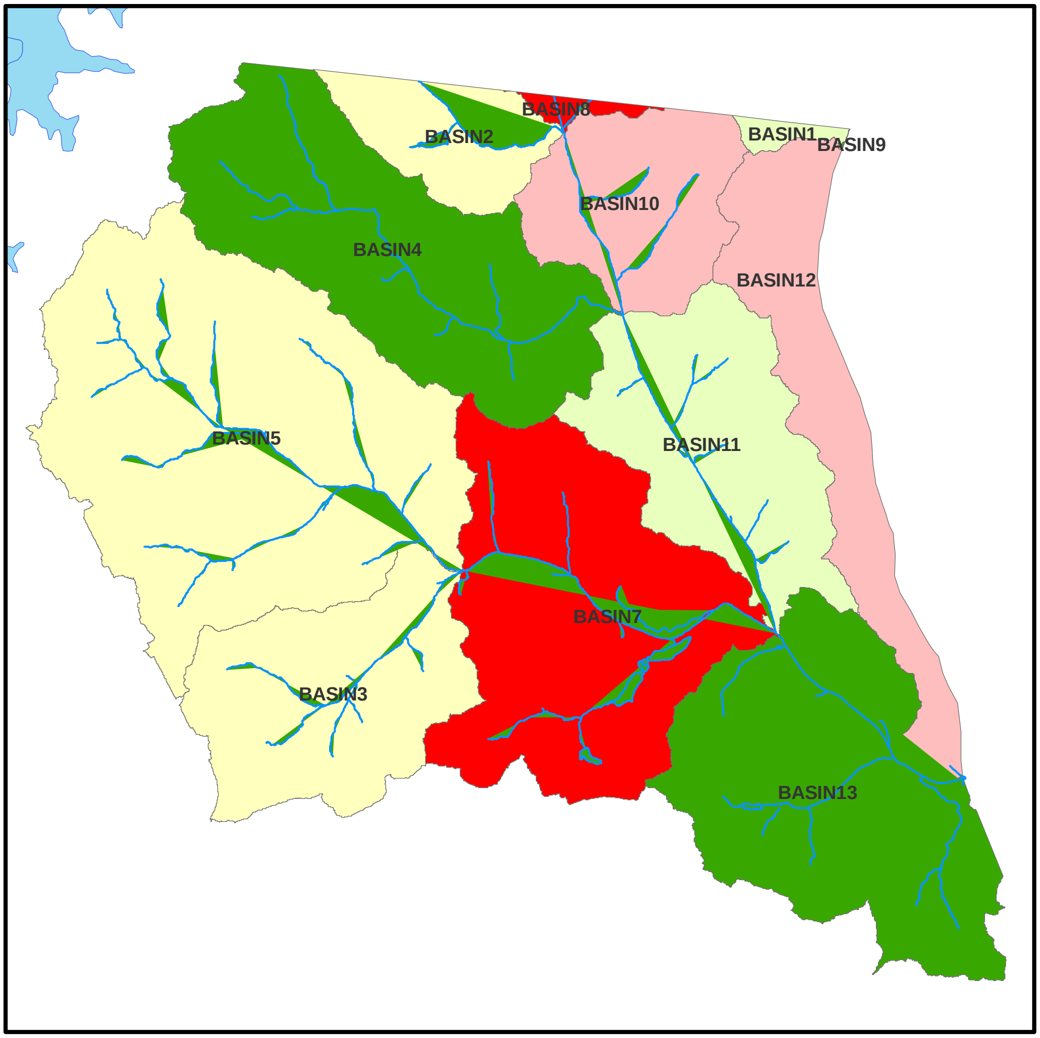


Figure 22 - Buffer Impact Ranking

5.2. Stream Channel Characterization

In order to prioritize areas of the Rocky River Watershed for stream channel restoration, enhancement and preservation, a characterization methodology was developed by MCSWS. The characterization was completed through an evaluation of existing stream channel conditions that allowed reach-level prioritization based on biological integrity and geomorphic stability, as well as predicted bank erosion rates.

5.2.1. Methodology

MCSWS utilized base data in GIS format, including recent aerial photography, stream locations, roads and parcel boundaries. Using GIS, the Rocky River Watershed was divided into 45 separate reaches (37 of which were able to be assessed) (Figure 23). For the purposes of this study the definition of a reach was a discrete segment of stream that consistently exhibits a set of physical features that appear to be significantly different from its contiguous upstream and downstream segments. Nine basins were chosen for assessment that appeared to represent a range of stream conditions and land uses found throughout the watershed. Because perennial streams were to be assessed, only streams receiving 100 acres or greater of drainage were chosen, which resulted in 37 individual reaches approximating 22.5 miles of stream for direct assessment.

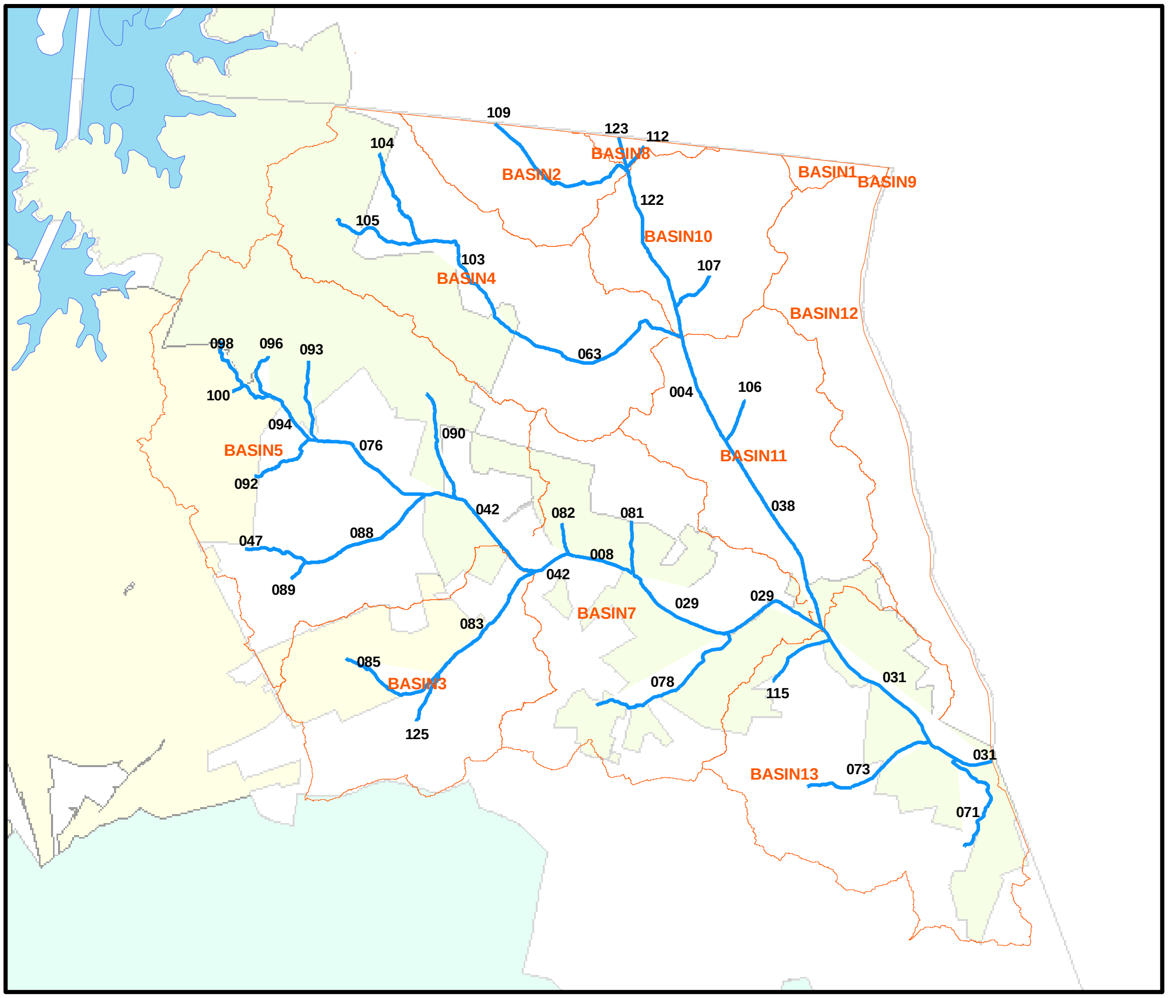


Figure 23 - Stream Assessment Reaches

Stream Classification

Each reach was visually classified according to the Rosgen classification system (Rosgen, 1994). This heirarchial methodology categorizes streams based on geomorphic features that describe channel geometry in the three dimensions of planform, cross-section and longitudinal profile. Most of these parameters are expressed as dimensionless ratios such as width/depth. The use of dimensionless ratios allows categorization and comparison of streams of varying sizes.

Bank Erosion

Streambank erosion rates were determined by measuring the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) (Rosgen, 2001) throughout each study reach. This semi-quantitative method is widely used in North Carolina and is based on measured values and visual estimates made at discrete sections of streambank. BEHI provides results in adjective ratings, ranging from very low to extreme. BEHI is based on the following:

- bank height/bankfull height
- root depth/bank height
- root density (%)
- bank angle
- surface protection (%)
- bank materials and stratification

NBS provides a measurement of the distribution of flow through a cross section. The near bank region is that third of stream cross section nearest a bank being studied. Rosgen (1996) correlated the ratio of shear stress in the near bank region to mean shear stress and developed an adjective rating system for reporting. Reasonably accurate estimates of NBS can be made quickly using professional judgment.

Erosion rates have been associated with the adjective ratings for bank erodibility and near-bank stress based on data collected from Colorado. Data collected at the Mitchell River in North Carolina supports the use of the Colorado data (Rosgen, 2001). The erosion rate was then multiplied by the height and length of the streambank. Rates are expressed as cubic feet of sediment eroded annually per linear foot of streambank. Total tons per year were also calculated for each study reach.

Channel Evolution

Simon's Channel Evolution Model (1989) was used to assign one of the six stages listed below to each reach based on field observations.

- Stage I**:** The waterway is a stable, undisturbed natural channel.
- Stage II: The channel is disturbed by some drastic change such as forest clearing, urbanization, dam construction, or channel dredging.
- Stage III: Instability sets in with scouring of the bed.
- Stage IV: Destructive bank erosion and channel widening occur by collapse of bank sections.
- Stage V**:** The banks continue to cave into the stream, widening the channel. The stream also begins to aggrade, or fill in, with sediment from eroding channel sections upstream.
- Stage VI: Aggradation continues to fill the channel, re-equilibrium occurs, and bank erosion ceases. Riparian vegetation once again becomes established.

Habitat Assessment

Rapid Bioassessment Protocol forms were completed by field staff and assigned a score per parameter with a total possible score of 100 being the best. The parameters of the habitat assessment are broken into primary, secondary, and tertiary categories. Primary parameters describe those instream physical characteristics that directly affect the biological community. Primary conditions evaluate substrate and available cover, embeddedness, epifaunal substrate, velocity and depth regimes, and pool variability. Secondary parameters (channel alteration, bottom scouring and deposition, channel shape, and channel sinuosity) relate to channel morphology, which controls the behavior of stream flow and the sediment deposits the stream collects. The tertiary parameters in the habitat assessment matrix include bank stability, bank vegetative protection, and the riparian vegetative zone. Each stream reach was photographed using a digital camera so that all aspects of the study area were photo-documented.

5.2.2. Results

A total of 37 study reaches were delineated and assessed. Reach lengths varied from several hundred feet to over 6800 feet. The number of reaches per basin ranged from one to fourteen (headwater basins tended to have more reaches). Once in the field the predetermined reach lengths (based on drainage) were sometimes broken into smaller reaches or combined into larger reaches based on field observations. For example, if the land use adjacent to the stream channel changed significantly (e.g., forest to industrial) a new reach would begin. Due to the large number of study reaches, data was also compiled and presented per basin (Table 14) to aid in management efforts. Table 15 presents the stream channel sediment load by basin.

Table 14 - Reach Characteristics with Basin ID

Basin_ID	Reach Name	GIS-LENGTH	Assessed Length	RBP Score	FT3_FT	TONS_YR	Management	Tons/ft
BASIN13	075	1389	1375	101	0.47	31	Restoration	0.02
BASIN13	071	3753	2427	85	0.02	2	Enhancement II	0.00
BASIN13	073	2799	3000	94	1.05	151	Restoration	0.05
BASIN7	031	13	7048	79	0.6	202	Restoration	0.03
BASIN11	031	71	7048	79	0.6	202	Restoration	0.03
BASIN13	031	6818	7048	79	0.6	202	Restoration	0.03
BASIN7	078	5258	2250	88	0.87	95	Restoration	0.04
BASIN3	085	3452	3544	76	1.85	317	Enhancement I	0.09
BASIN3	125	1638	1528	88	1.44	106	Restoration	0.07
BASIN13	115	2239	2470	84	0.78	93	Enhancement II	0.04
BASIN3	083	4344	4344	76	3.65	760	Restoration	0.17
BASIN5	083	10	4344	76	3.65	760	Restoration	0.17
BASIN7	083	9	4344	76	3.65	760	Restoration	0.17
BASIN5	088	4323	5642	103	1.89	512	Enhancement II	0.09
BASIN5	047	2037	2162	108	0.82	86	Enhancement II	0.04
BASIN7	081	1622	1614	71	0.22	17	Enhancement II	0.01

Basin_ID	Reach Name	GIS-LENGTH	Assessed Length	RBP Score	FT3_FT	TONS_YR	Management	Tons/ft
BASIN5	092	2300	2701	100	1.14	148	Restoration	0.05
BASIN11	106	1360	999	80	1.71	82	Restoration	0.08
BASIN4	063	5960	6289	80	1.67	506	Restoration	0.08
BASIN10	063	14	6289	80	1.67	506	Restoration	0.08
BASIN5	098	2705	2795	85	0.98	132	Restoration	0.05
BASIN5	090	3385	3360	109	0.7	113	Restoration	0.03
BASIN5	093	2548	2132	89	0.39	40	Enhancement I	0.02
BASIN11	038	6484	5400	78	1.03	269	Restoration	0.05
BASIN4	105	2987	2635	127	0.38	48	Enhancement II	0.02
BASIN2	109	5209	4274	91	0.74	153	Restoration	0.04
BASIN10	109	7	4274	91	0.74	153	Restoration	0.04
BASIN8	112	833	830	70	1.69	67	Restoration	0.08
BASIN4	104	3264	3370	124	1.1	179	Enhancement II	0.05
BASIN10	122	5107	5100	94	2.39	595	Restoration	0.12
BASIN5	100	397	506	110	0.56	14	Enhancement II	0.03
BASIN5	096	1558	1278	95	3.17	195	Restoration	0.15
BASIN5	089	697	679	91	1.3	42	Restoration	0.06
BASIN7	082	958	1027	91	0.15	7	Enhancement II	0.01
BASIN8	123	1038	1019	86	1.8	88	Restoration	0.09
BASIN10	123	265	1019	86	1.8	88	Restoration	0.09
BASIN4	103	4557	4401	80	1.43	303	Restoration	0.07
BASIN5	094	2064	2145	91	1.76	182	Restoration	0.08
BASIN10	004	6	3282	80	0.54	86	Restoration	0.03
BASIN11	004	3315	3282	80	0.54	86	Restoration	0.03
BASIN10	107	1500	1823	105	0.28	25	Restoration	0.01
BASIN5	042	3482	4683	92	1.55	349	Restoration	0.07
BASIN7	042	1357	4683	92	1.55	349	Restoration	0.07
BASIN5	076	3540	1872	72	1.53	138	Restoration	0.07
BASIN7	076	1915	1872	72	1.53	138	Restoration	0.07
BASIN11	076	3	1872	72	1.53	138	Restoration	0.07
BASIN5	008	1196	4980	85	1.57	376	Restoration	0.08
BASIN7	008	1825	4980	85	1.57	376	Restoration	0.08
BASIN7	029	4995	7230	88	0.85	296	Enhancement II	0.04

Note: Occasionally reaches cut across basins, therefore some reaches appear with multiple basins.

Table 15 - Results of Stream Channel Sediment Load Characterization by Basin

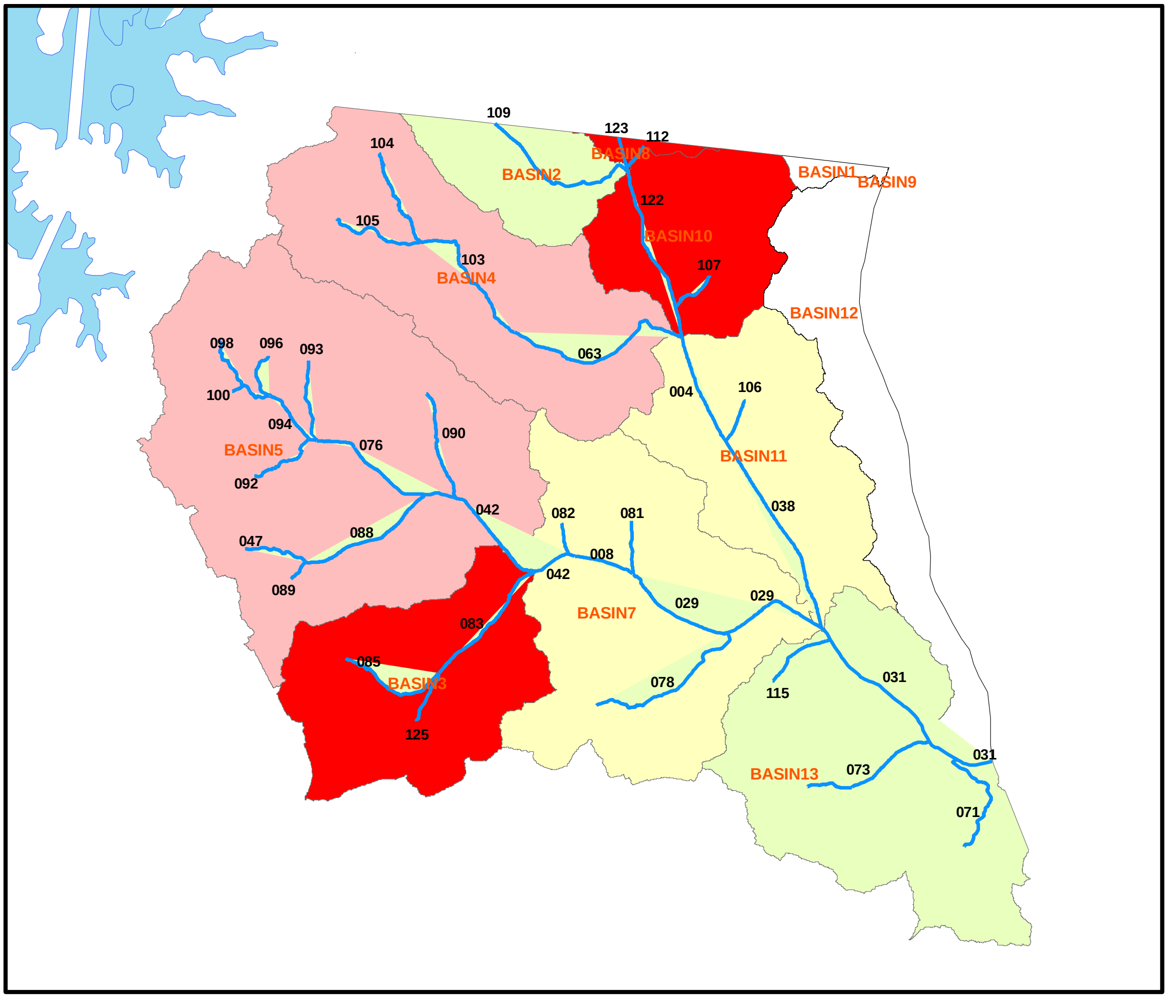
Basin	Stream Length/basin (ft)	Average Erosion Rate (tons/ft)	Total Tons of Sediment	Tons/ac/year from stream	Tons/ac/year from upland
BASIN10	6899	0.09	640	1.1	0.30
BASIN11	11233	0.05	523	0.6	0.44
BASIN13	16998	0.03	456	0.3	0.33
BASIN2	5209	0.04	186	0.5	0.45
BASIN3	9434	0.13	1182	1.3	0.38
BASIN4	16768	0.06	1021	0.8	0.37
BASIN5	30242	0.07	1967	0.9	0.42
BASIN7	17953	0.05	832	0.6	0.43
BASIN8	1871	0.08	158	4.4	0.40
BASIN1	No streams assessed				0.37
BASIN9	No streams assessed				0.15
BASIN12	No streams assessed				0.37

A single erosion rate was calculated for each of the 95 reaches based on BEHI/NBS. The erosion rate per basin is an average erosion rate of the total reaches per basin. In the Rocky River Watershed, erosion rates exceeding 1.6 cubic feet/linear foot are highly unstable. Rates of 1.26 to 1.59 are unstable, whereas from 0.76 to 1.25 is stable and less that 0.76 is very stable. The total Channel Evaluation score for all of the reaches for a given basin were divided by its total reach number to obtain the Average Channel Evaluation Score. The Average Erosion Rate is useful for prioritizing the worst basin-wide degradation (Figure 24; Table 16).

Table 16 - Ranking Based on Average Erosion Rate Per Reach by Basin

Basin ID	Rank
BASIN3	1
BASIN10	2
BASIN8	3
BASIN5	4
BASIN4	5
BASIN11	6
BASIN7	7
BASIN2	8
BASIN13	9
BASIN1	Not Assessed
BASIN9	Not Assessed
BASIN12	Not Assessed

Table 17 - Basin Ranking based on Predicted Erosion Rates



6. CANDIDATE RESTORATION, RETROFIT AND PRESERVATION SITES

6.1. Upland BMP Retrofit Sites

The intent of this section is twofold:

1. Identify publicly owned parcels that are significant sources of pollution that would benefit from BMP retrofit.
2. Identify catchments for detailed field investigation to identify privately owned parcels that are significant sources of pollution and appropriate for BMP retrofit.

All retrofit BMPs installed in the Rocky River Watershed should be designed with the Upland Pollutant Loading Rate Goals (Table 8) as a design standard. Appendix A includes the Rocky River Watershed Retrofit and Restoration Master Plan. The purpose of this Plan is to present retrofit and restoration opportunities throughout the watershed targeted at existing sources of pollution.

6.1.1. Priority Basins

Based upon the upland pollutant load analysis, BMP retrofit efforts should be concentrated on or downstream of the most impacted basins. The 2 most impacted basins were focused upon for this plan. Figure 25 shows the extent of these priority basins within the Rocky River Watershed. Specifically, Basin5 and Basin 3 ranked as the most impaired basins due to upland sources of pollution. The following Section discusses each priority basin in detail.

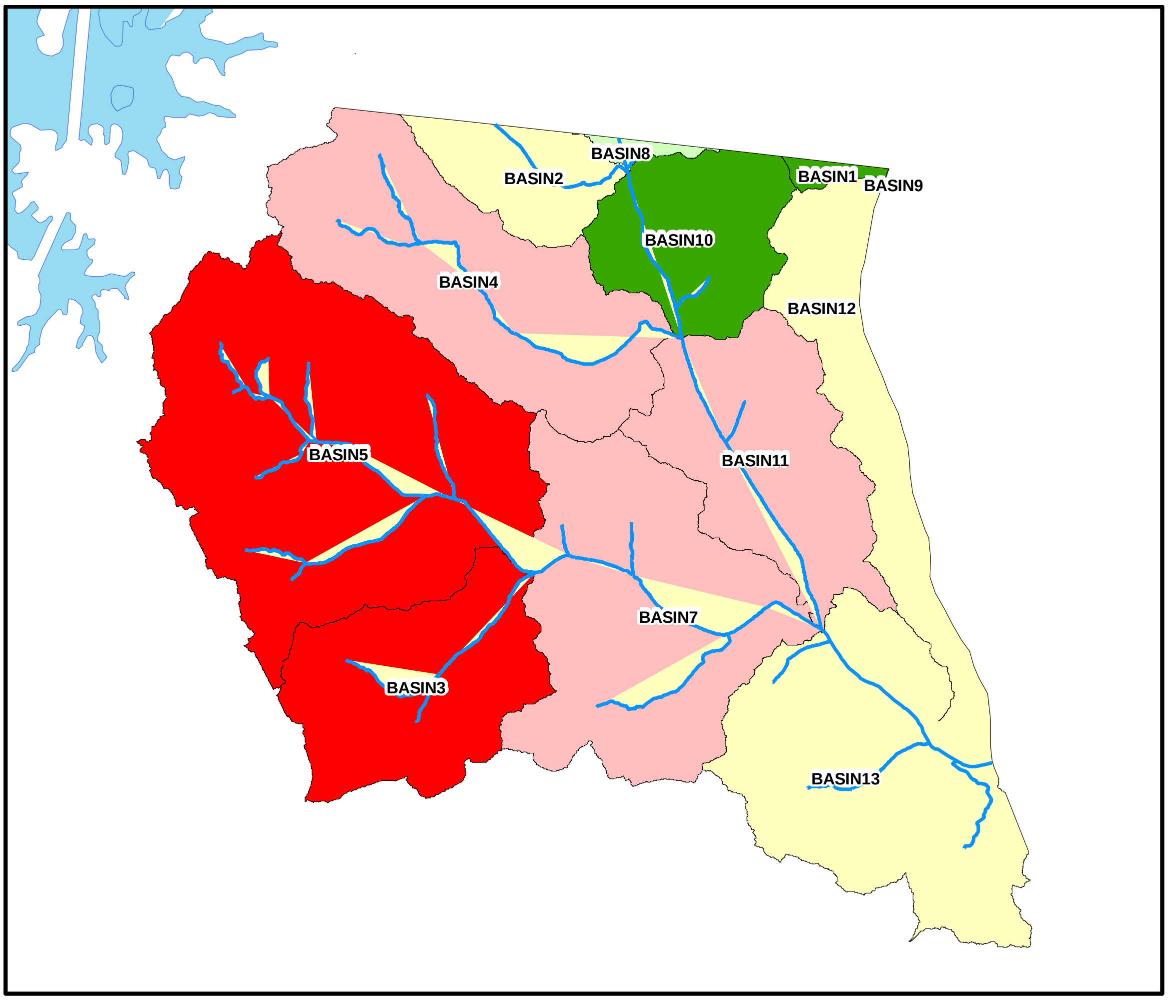


Figure 24 - Priority Basins in the Rocky River Watershed

Priority Basin 5

Priority Basin 5 is comprised of portions of Davidson and Davidson's ETJ and Cornelius. The basin contains significant amount of single family residential development as well as some of the downtown business center of Davidson and multifamily in Cornelius. Public property in the watershed is limited, however some of the headwaters of the South Prong are publicly held. BMP retrofits will likely be challenging in this Basin as will stream restoration because of the dominance of private ownership of the land surrounding the stream. Figure 26 shows a detailed view of Priority Basin 5 with public parcels in green hatching.

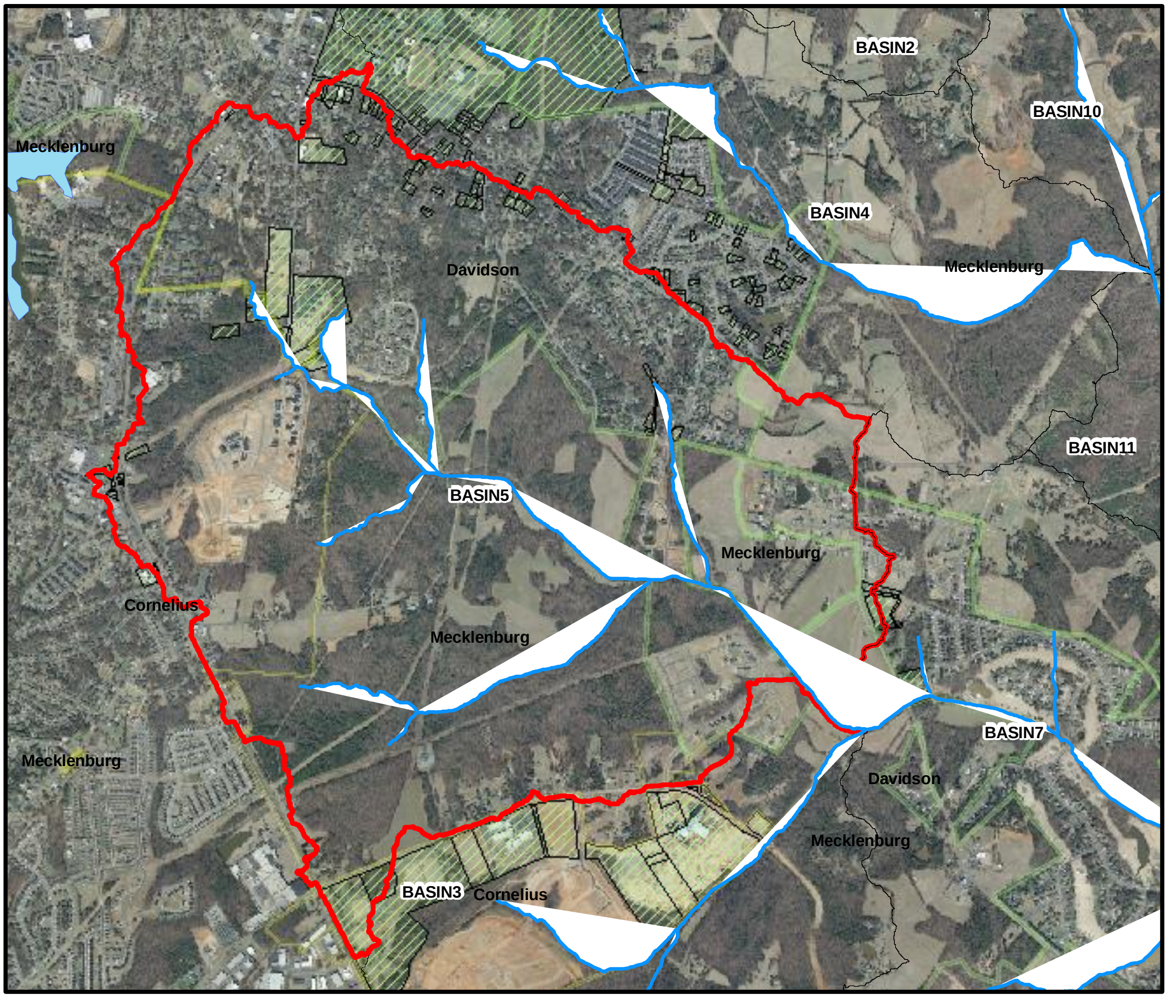


Figure 25 - Detail of Priority Basin 5

Priority Basin 3

Priority Basin 3 is comprised of portions of Cornelius and Cornelius' ETJ. The primary reason for the high priority designation for Basin 3 is the presence of significant institutional land use in the basin as well as the high density residential development occurring in the watershed. Figure 27 shows a detailed view of Priority Basin 3 with public parcels identified in green hatching. The presence of a significant amount of public parcels in the watershed will simplify BMP retrofits and encourage stream restoration and buffer reforestation.

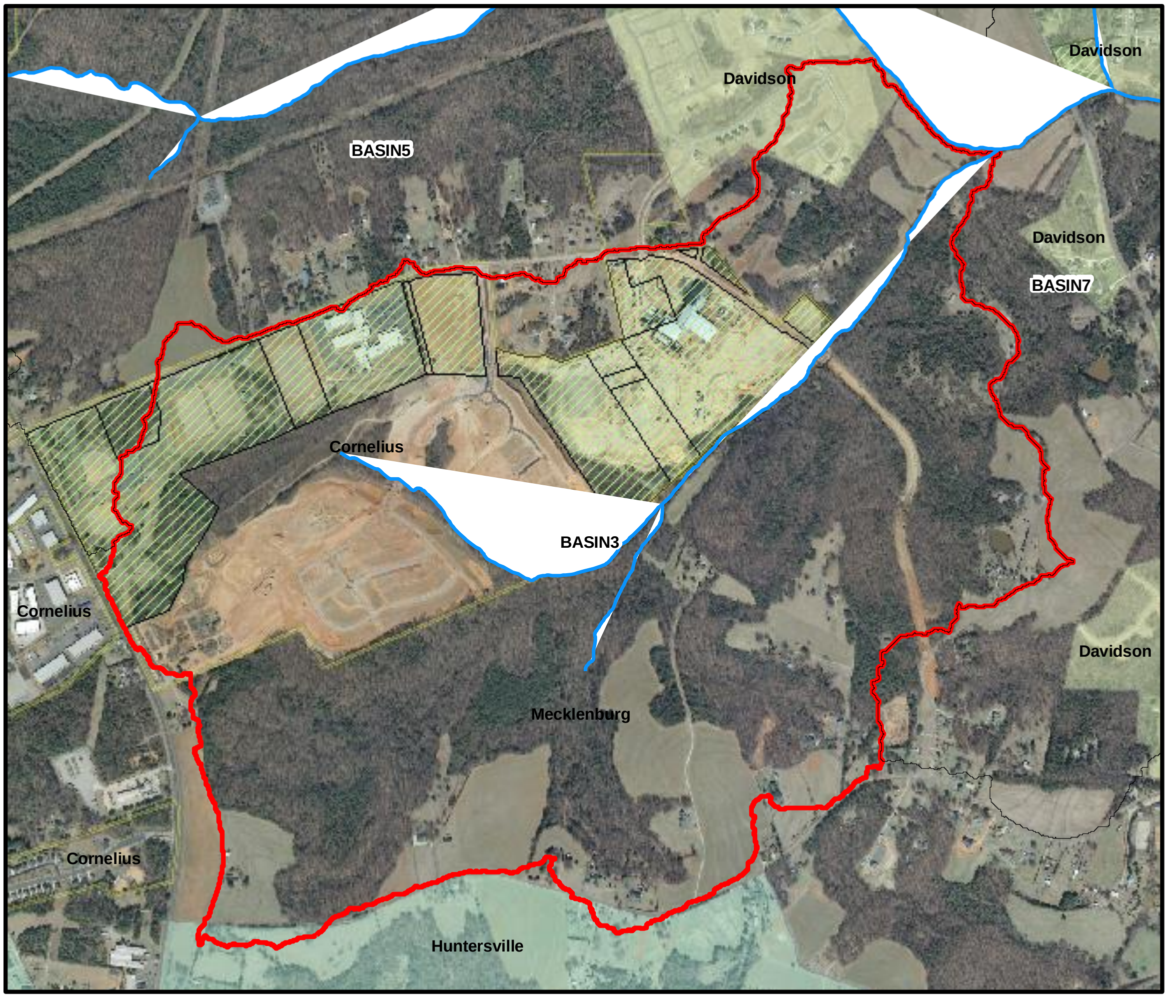


Figure 26 - Priority Basin 3

6.2. Buffer Restoration

An excellent buffer restoration opportunity exists within the Rocky River Watershed within Davidson's ETJ. It is located on public property (Mecklenburg County Owned) along the major system segment of the West Branch of the Rocky River. Figure 28 shows a detail of the area. There are approximately 20 acres of un-forested FEMA Floodplain on the property that should be re-forested.

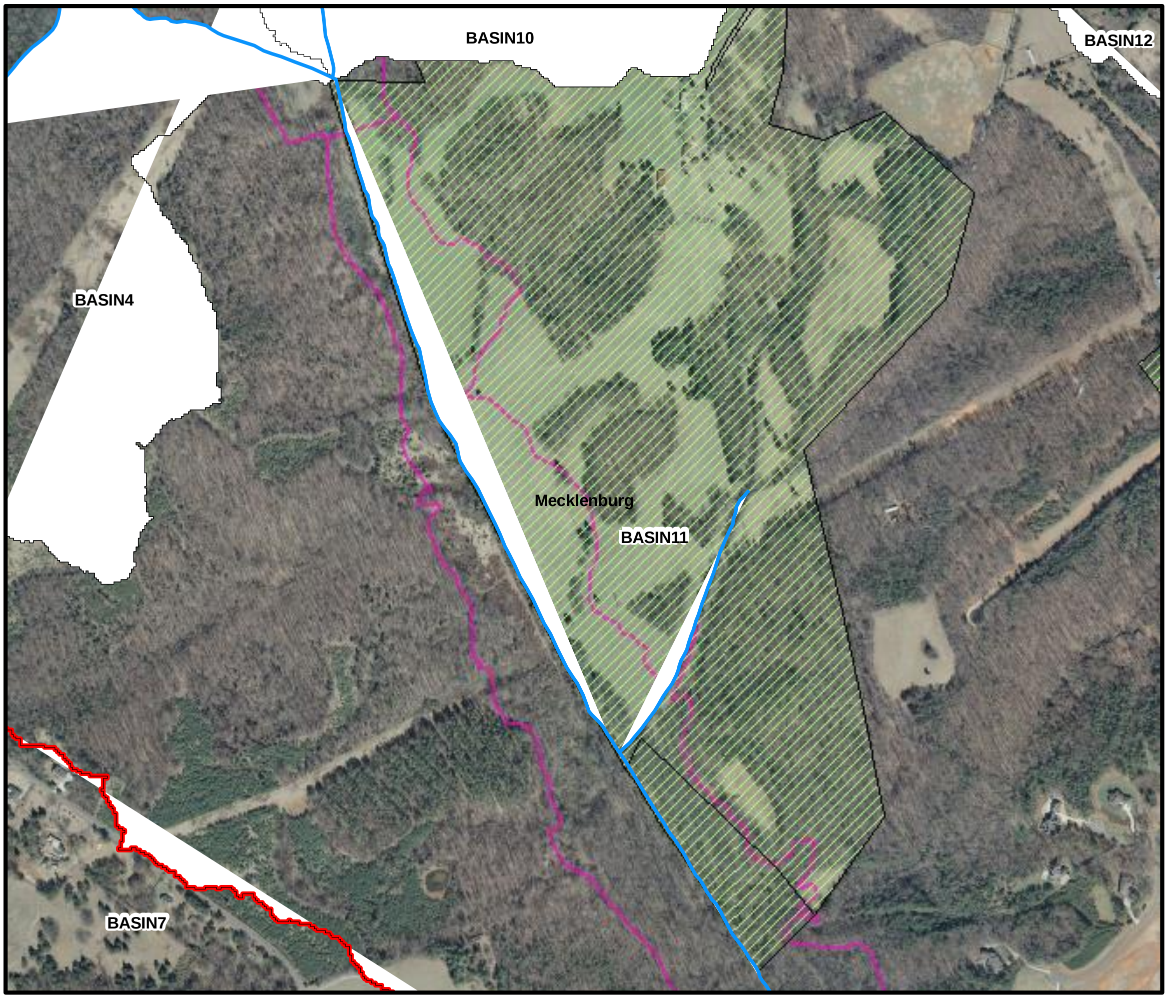


Figure 27 - Buffer Restoration Opportunity in the Rocky River Watershed

6.3. Stream Restoration

Basin 5 was the highest ranked basin with respect to in-stream erosion rates. Basin 5 is a headwater catchment of the South Prong of the Rocky River. It contains portions of Davidson, Cornelius and Davidson's ETJ. It also contains significant major and minor system assets that are all in need of either restoration or enhancement. Basin 5 was also the highest ranked basin for BMP retrofits, which indicates that it is the most impaired catchment in the watershed and therefore the most in need of repair. Unfortunately, there are very limited public parcels in the catchment and those that exist are in the extreme upstream areas. However, most of the stream frontage in the watershed is owned by a relatively small number of large-lot property owners. These property owners should be approached as soon as possible to establish their willingness for allowing restoration work to be conducted on their property and to grant easements. Figure 29 shows a detailed view of the streams in Basin 5 along with the parcel boundaries and aerial imagery.

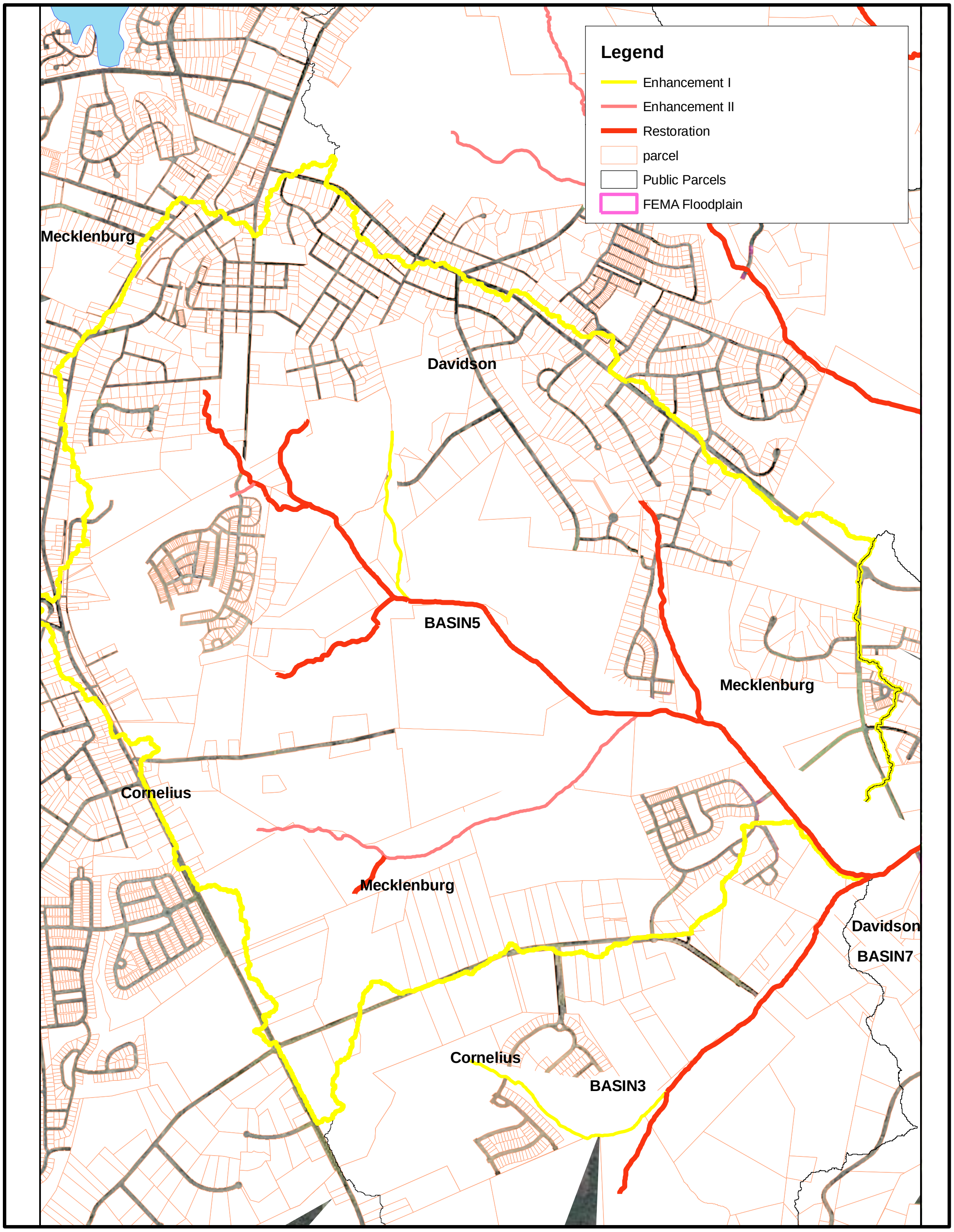


Figure 28 - Detail of Basin5

7. MEASURING SUCCESS AND ADAPTIVE MANAGEMENT

7.1. Establishing an Ongoing Water Quality Monitoring Program

As discussed in Section 2.2, Mecklenburg County has historically collected storm water samples from the Rocky River at monitoring site MY1B. Benthic macroinvertebrate and fish samples are also collected at MY1B with macroinvertebrates collected annually and fish samples collected every five (5) years. Historically there has been one (1) USGS flow gauge station located on the Rocky at MY1B. There has been a continuous automated monitoring station in operation at this location since July 2004. Monitoring will continue as in the past, however evaluation of the data will be conducted so as to measure progress with the Watershed Restoration Goals (Table 17).

Table 18 - Watershed Restoration Goals

Upland Pollutant Loading Rate Goals (for BMPs)
1. Reduce fecal coliform by 91% from developed areas.
2. Reduce fecal coliform by 86% from manure application areas.
3. TSS $\leq$ 0.22 tons/ac/yr
In-Stream Water Quality Goals
1. TSS $\leq$ 0.3 tons/ac/yr
2. Benthic Macroinvertebrates = Fully Supporting
3. Fish = Fully Supporting

7.2. Annual Status Report

By December 31 of every year beginning in 2011 and continuing through the completion of the Watershed Management Plan (anticipated for December 31, 2025), the Mecklenburg County Water Quality Program will complete a Rocky River Management Plan Annual Status Report to at a minimum include the following information:

- Status of compliance with goals identified in Table 17.
- Status of compliance with the schedule included in Section 9.
- Status of all projects underway in the watershed.
- Recommended changes to Watershed Management Plan.

This report will be made available to all the key players involved in the implementation of the Watershed Management Plan, including the Director of Water & Land Resources, Manager of Storm Water Engineering, Manager of the Water Quality Program, Supervisor of the Yadkin Section and a representative from the Towns of Davidson and Cornelius. This group will serve as the "Watershed Management Evaluation Team."

7.3. Adaptive Management

The Watershed Management Evaluation Team described in Section 6.2 above will meet at least annually following the completion of each Watershed Management Plan Annual Status Report to evaluate the effectiveness of the Plan at meeting the goals described in Table 17 above. This evaluation will be based on the data and information contained in the Report as well as other pertinent facts and information provided regarding the effectiveness of the Plan at meeting established goals. During these meetings, consideration will also be given as to the effectiveness of the goals at measuring the effectiveness of the Plan. It may be necessary that goals be changed or that changes be made to the Plan.

8. CONCLUSION

The Rocky River Watershed is impaired for macroinvertebrate populations, turbidity and copper and Fecal Coliform. A TMDL has been prepared for the watershed. Implementation of the Post Construction Ordinances is designed to prevent continued degradation of stream water quality from new development; however, pre-existing sources of pollution remain partially or completely un-mitigated. In order to restore the water quality in the Rocky River, pre-existing sources of pollution will need to be mitigated and in-stream stressors to benthic macroinvertebrate life removed. In this way Mecklenburg County can achieve its ultimate goal for the Rocky River of improving water quality conditions such that designated uses are met and the creek is no longer impaired. The effective implementation of this Watershed Management Plan will enable this to be accomplished but it will take time. It is currently anticipated that this process will take a minimum of 15 years between 2010 and 2025.

9. REFERENCES

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Appendix A: Rocky River Watershed Retrofit and Restoration Master Plan

Appendix A
Rocky River Watershed Retrofit and Restoration Master Plan

The purpose of this BMP Master Plan for the Rocky River Watershed is to present retrofit and restoration opportunities throughout the watershed targeted at existing sources of pollution. Complete implementation of this plan is designed to remediate the existing sources of pollution resulting in removal of the watershed from the North Carolina State 303(d) list for all parameters with the exception of fecal coliform. At the time of writing of this Master Plan it is anticipated that the North Carolina Department of Environment and Natural Resources will require the development of a Water Quality Recovery Program (WQRP) for fecal coliform in the Rocky River Watershed. If this occurs, a specific process will need to be followed during the implementation of the program to identify the reason for fecal coliform impairment and prepare a plan for restoration of the designated use of the watershed. Final determination regarding the WQRP is expected in January, 2011. This document, in combination with the stream assessment and prioritization portion of the Rocky River Watershed Management Plan, will guide future restoration efforts within the Watershed. This document is intended to be modified and amended as new projects are created and current projects are completed. The basic structure of this document presents each focus area. Each BMP recommendation within the focus area is then documented.

This BMP Master Plan was prepared through intensive windshield surveys of the focus areas. The focus areas were a result of the modeling exercise presented in the Rocky River Watershed Management Plan. The focus areas were the most polluted areas as predicted by the model.

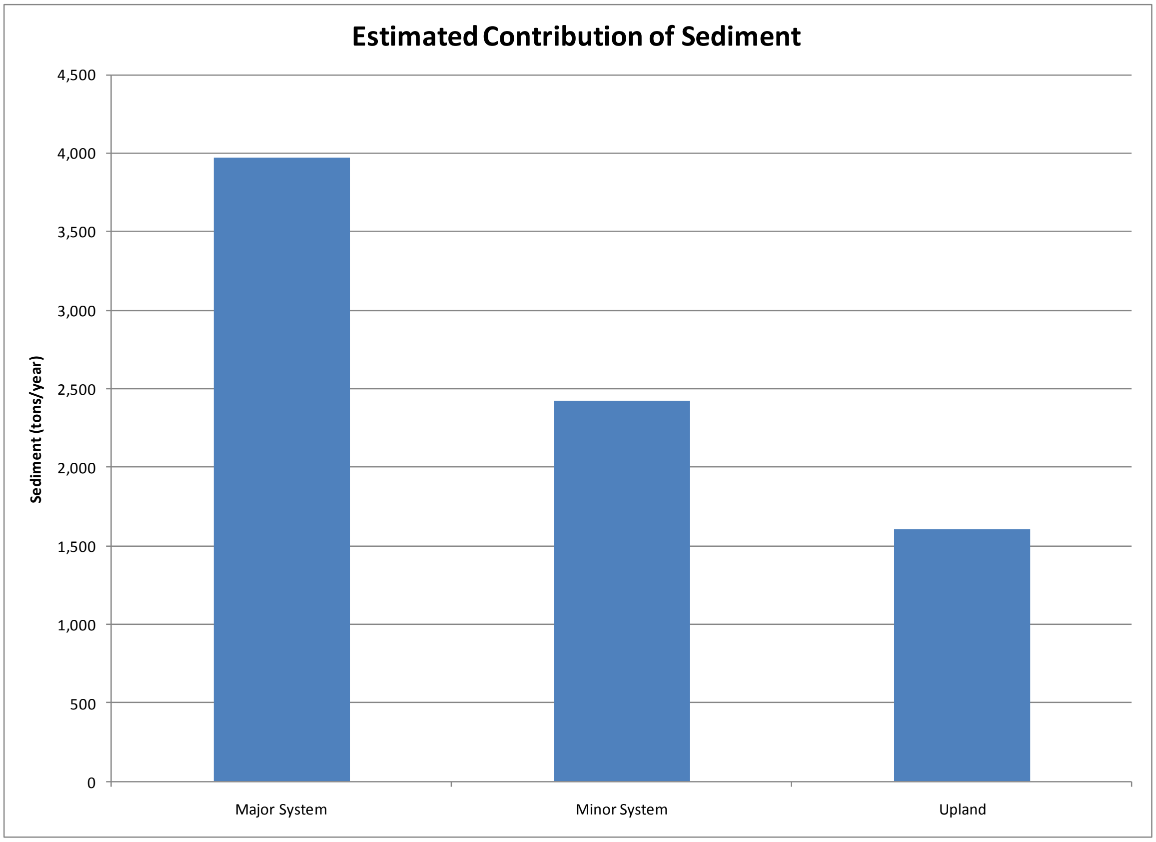
I. Load Comparison

The relative contribution of sediment to the Rocky River was able to be estimated through evaluation of the results of the in-stream assessment and the calculated upland load (presented in the Rocky River Watershed Management Plan). For the purposes of the calculation sediment loading from forested and rural residential land uses was removed. Under certain circumstances loading from these land uses can be significant, however retrofitting these areas is impractical. It is important to note that opportunities for stream buffer enhancement will be sought, which will help to reduce sediment contributions from these areas. The following table presents the estimated annual sediment production by category:

System	Assessed Length (miles)	Estimated Annual Sediment Load (tons)	Percent Breakdown
Major Stream System	10.7	3,968	50%
Minor System	11.4	2,424	30%
Developed Upland	NA	1,606	20%
Total	22.1	7,998	100%

The following chart shows the relative contributions graphically:

The In-Stream Water Quality goal for TSS is 0.3 tons/acre/year. If this goal is multiplied by the area of the watershed (18,283 acres) the goal can be expressed as an overall annual load of 5485 tons. Comparison of this goal with the existing conditions presented above is presented in the following table:



Existing TSS Load in tons/year (from above)	7,998
In-Stream TSS Goal Expressed in tons/year	2922
Load Reduction Required (tons)	5076
Load Reduction Required in percent	64%

II. Cost Analysis

A detailed cost analysis comparing BMP installation, minor system stream enhancement/restoration and major system stream enhancement/restoration was prepared to guide budgetary and planning decisions. The analysis compared typical installation costs for various types of BMPs with rule of thumb estimates for stream enhancement/restoration. The results were distilled down to cost per pound of sediment removed in order to compare stream restoration with BMP installation. Not included in the cost estimates was the cost of land or easement acquisition however, design and planning are included. The results of the assessed portion of the minor system were used to estimate the costs for the un-assessed portion of the minor system.

A. Stream Restoration

The following cost per linear foot for stream restoration and enhancement and was used to prepare the estimated costs.

Stream Need	Cost per linear feet
Restoration	$175
Enhancement I	$165
Enhancement II	$95

To estimate the amount of stream to be restored the results of the in stream assesssment were used. Sediment loading per reach was obtained from the BEHI sediment load estimates and divided by the length of reach to obtain sediment loading per LF for both major and minor system. It was also assumed that upon restoration the sediment load from the stream bank would approach zero. These values were assumed to be typical of the entire Rocky River Watershed. The results of the evaluation are as follows:

System	Cost per pound of sediment removed	Percent Restoration	Percent Enhancement I	Percent Enhancement II	Percent Preservation
Major	$1.19	91%	0%	9%	0%
Minor	$1.81	54%	10%	36%	0%

The costs presented are based upon experience constructing similar projects, however the costs do not include easement acquisition. Not all assessed reaches will require full stream restoration to eliminate bank erosion, which will reduce cost significantly (stream maintenance is estimated at $50/LF).

B. BMP Retrofits

In order to estimate the relative cost/benefit of BMP retrofits several typical BMPs were analyzed along with several typical land uses in the McDowell Creek Watershed, which are assumed to be applicable for the Rocky River Watershed. For the analysis, commercial, high density residential, medium density residential and institutional land-uses were analyzed. BMP cost per acre of land treated and TSS removal efficiencies were obtained from research prepared for Mecklenburg County's Post Construction process. Sediment loading per acre of land-use values was obtained from Tetra Tech reports prepared for the Post Construction Ordinance Process. The results of the analysis are as follows:

BMP Type	Cost/ac Treated	TSS Removal Efficency	Average $/lb TSS removed
Sand Filter	$20,000	85%	$24.43
Wet Pond	$22,000	65%	$35.15
Wetland	$31,500	65%	$50.33
Rain Garden	$16,000	85%	$19.55
Extended Detention	$31,500	47%	$69.60
WQ Swale	$3,000	80%	$3.89
Filter Strip	$3,000	50%	$6.23
Pond Retrofit	$6,700	35%	$19.88

C. Conclusions of the Cost/Benefit Analysis

From the aforementioned analysis it is evident that stream restoration is the most cost effective method of removing sediment from the Rocky River. It is more than 3 times cheaper to remove a pound of sediment through stream restoration than from the most cost effective BMP (WQ Swale), which may not be appropriate in many situations. Stream restoration appears to be the most expedient method of removing sediment from the Rocky River, however BMPs will continue to play a role in attenuating temperature and removing hydrocarbons from built upon areas. Furthermore, BMPs will have a significant role if a WQRP for fecal coliform bacteria is required by NCDENR.

III. Approach

Review of Sections I and II of this document reveal that stream restoration is the most cost effective means of controlling sediment in the Rocky River Watershed. Moreover, unstable reaches also appear to be the largest source of sediment in the watershed (approximately 80%). Therefore, reduction of TSS load in the McDowell Creek Watershed will focus upon stream restoration and enhancement. However, sediment is not the only reason for the impaired use designation for the watershed. Habitat, water temperature, volume and velocity as well as toxic pollutants (such as copper and hydrocarbons) are also likely causes of the impairment. For this reason, BMP retrofits listed in subsequent sections will focus upon reducing runoff and stream temperature and sources of toxic pollutants. This will be accomplished as follows:

1. Conduct stream restoration and enhancement in the major and minor systems.
2. Retrofit currently untreated concentrations of impervious cover with BMPs designed to reduce temperature and toxic pollutants. BMP type will be determined on a site by site basis with the purpose of the device being to attenuate first flush temperature and hydrocarbon runoff. Because the BMPs are focused on the first flush of runoff, they only need to be designed to treat

0.25 inches of rainfall and not the 1 inch of rainfall currently specified in design manuals.

3. Reforest buffers as needed to attenuate temperature spikes through providing additional shade for the stream corridor. An ancillary and unaccounted for benefit from buffer restoration may be further reduction of sediment load from the near stream environment.
4. Design stream restoration and enhancements to focus upon improving habitat in addition to limiting sediment load.
5. When possible and cost effective, retrofit existing ponds to provide additional TSS removal and, if possible, temperature attenuation. Each project should be evaluated prior to design for the possible improvements in TSS loading, runoff volume and velocity and temperature.

IV. Stream Restoration

Stream reaches evaluated during the in stream assessment were prioritized based on need and feasibility for restoration using the data matrix. Using the SWIM buffer GIS layer, assessed reaches were coded by drainage system type so minor system and major system reaches could be prioritized independently. Reaches coinciding with a SWIM buffer width of 100 feet were coded as major system reaches and all other reaches were considered to be part of the minor system.

The need for restoration alone was represented by the total score from the data matrix (channel evaluation sheet) with lower scores signifying a higher need. However, such a ranking scheme completely neglected a feasibility component. Therefore, feasibility levels from the data matrix were assigned weights (Table below) which were multiplied by the data matrix total score per reach to arrive at a prioritized list of reaches incorporating both the feasibility component with the need for restoration. Once again, lower scores signify a higher priority. This methodology generally enabled reaches having a higher cost/benefit ratio to be promoted to higher priorities ahead of reaches where vast improvements are hindered by constraints and constructability issues.

Feasibility Weights per Level

Feasibility Level	Weight
Low Feasibility (many constraints)	0.50
Medium Feasibility	0.75
High Feasibility (few constraints)	1.00

After carefully reviewing the results of prioritized reaches from the major and minor systems, at least five reaches were selected from each system that represent the most viable projects in terms of restoration implementation based on our best professional judgment. Results from the prioritization of major and minor system reaches are presented in Table 1.1 and 1.2 respectively. Highlighted reaches indicate those that Buck has recommended as the highest priority. Description of each column header in the subsequent tables is as follows:

RANK (NEED & FEASIBILITY): Describes the priority of the project (or reach). Complete description can be found above.

REACH: Corresponds to the Buck reach nomenclature found in the McDowell Creek Watershed Management Plan

RECOMMENDATION: Corresponds to the type of activity need for the reach. A detailed description of each activity can be found in Section 5.2 of the McDowell Creek Watershed Management Plan.

FEASIBILITY: Described above.

ASSESSED LENGTH: Stream Length of particular reach.

RANK: Described above.

BASIN: Corresponds to the Buck sub-basin nomenclature described in the McDowell Creek Watershed Management Plan.

SEDIMENT LOAD REMOVED: Describes the anticipated annual sediment load in tons that will be removed from McDowell Creek after completion of the project.

APPROXIMATE COST: Project cost estimate associated with either maintenance or restoration of the stream reach. Wetland restoration costs, where noted, are assumed to be incidental and included in the cost of stream restoration or maintenance. Rates for stream maintenance and restoration are as follows:

Enhancement I = $165/linear foot

Enhancement II = $95/linear foot

Restoration = $175/linear foot

Property owners for each of the reaches listed below are included with this document as Attachment 1

Major System Stream Restoration Prioritization List

overall rank	NAME	REACH	RECOMMENDATION	LENGTH	Sediment Rank	Cost/Benefit Rank	Habitat Need Rank	Overall Need Rank	Feasibility	JURISDICTION	Total Cost
1	083	SP-083-033010	Restoration	4363.409	1	1	4	2	Medium	MECK	$763,597
4	063	WB-063-042610	Restoration	5973.733	10	9	8	9	Medium	MECK	$1,045,403
5	008	SP-008-012810	Restoration	3021.507	11	3	13	9	Low	MECK	$528,764
7	122	WB-122-061510	Restoration	5107.327	3	4	26	11	Medium	MECK	$893,782
8	123	WB-123-062110	Restoration	1302.972	6	14	16	12	Medium	MECK	$228,020
11	103	WB-103-040110	Restoration	4557.115	15	15	9	13	Medium	MECK	$797,495
12	029	SP-029-041310	Enhancement II	4994.838	23	5	17	15	Low	MECK	$474,510
13	076	SP-076-042710	Restoration	5458.016	13	30	3	15	Low	MECK	$955,153
16	038	WB-038-051010	Restoration	6484.28	20	24	6	17	Medium	MECK	$1,134,749
17	042	SP-042-041310	Restoration	4839.018	12	13	25	17	Low	MECK	$846,828
22	031	WB-031-061410	Restoration	6901.706	28	28	7	21	Medium	MECK	$1,207,799
27	004	WB-004-051010	Restoration	3321.34	30	29	11	23	High	MECK	$581,234

Minor System Stream Prioritization List

overall rank	NAME	REACH	RECOMMENDATION	LENGTH	Sed Rank	Cost/Benefit Rank	Habitat Need Rank	Overall Need Rank	Feasibility	JURISDICTION	Total Cost
2	085	SP-085-031610	Enhancement I	3451.716	5	7	5	6	Medium	CORN	$569,533
3	112	WB-112-062110	Restoration	833.3447	9	10	1	7	Medium	DAVID	$145,835
6	096	SP-096-012610	Restoration	1557.567	2	2	28	11	Medium	CORN/DAVID	$272,574
9	094	SP-094-012810	Restoration	2064.122	7	8	21	12	Medium	CORN/DAVID	$361,221
10	106	WB-106-051010	Restoration	1360.197	8	20	10	13	High	DAVID	$238,035
14	125	SP-125-031610	Restoration	1638.086	14	16	18	16	Medium	CORN	$286,665
15	115	WB-115-042710	Enhancement II	2238.851	25	12	12	16	Low	DAVID	$212,691
18	098	SP-098-012610	Restoration	2704.892	21	22	14	19	Medium	CORN/DAVID	$473,356
19	089	SP-089-040810	Restoration	697.3498	16	19	22	19	High	CORN	$122,036
20	088	SP-088-040810	Enhancement II	4322.871	4	23	31	19	Medium	CORN	$410,673
21	104	WB-104-022310	Enhancement II	3263.883	18	6	36	20	High	DAVID	$310,069
23	092	SP-092-021110	Restoration	2299.904	17	17	29	21	Medium	CORN	$402,483
24	073	WB-073-060710	Restoration	2798.86	19	21	27	22	Medium	DAVID	$489,801
25	047	SP-047-040810	Enhancement II	2037.36	24	11	33	23	Medium	CORN	$193,549
26	081	SP-081-030410	Enhancement II	1622.085	35	32	2	23	Low	DAVID	$154,098
28	078	SP-078-022510	Restoration	5257.742	22	33	19	25	Low	DAVID	$920,105
29	109	WB-109-062110	Restoration	5216.252	26	27	23	25	Medium	DAVID	$912,844
30	100	SP-100-010710	Enhancement II	397.4193	29	18	35	27	Medium	CORN/DAVID	$37,755
31	093	SP-093-021110	Enhancement I	2547.953	32	34	20	29	Low	DAVID	$420,412
32	090	SP-090-030410	Restoration	3385.073	27	25	34	29	Medium	DAVID	$592,388
33	071	WB-071-060710	Enhancement II	3753.463	37	37	15	30	High	DAVID	$356,579
34	075	WB-075-060710	Restoration	1389.439	31	31	30	31	Medium	DAVID	$243,152
35	082	SP-082-030410	Enhancement II	957.5574	36	36	24	32	Medium	DAVID	$90,968
36	105	WB-105-022310	Enhancement II	2986.839	33	26	37	32	High	DAVID	$283,750
37	107	WB-107-061510	Restoration	1499.956	34	35	32	34	High	DAVID	$262,492

V. BMP Retrofits

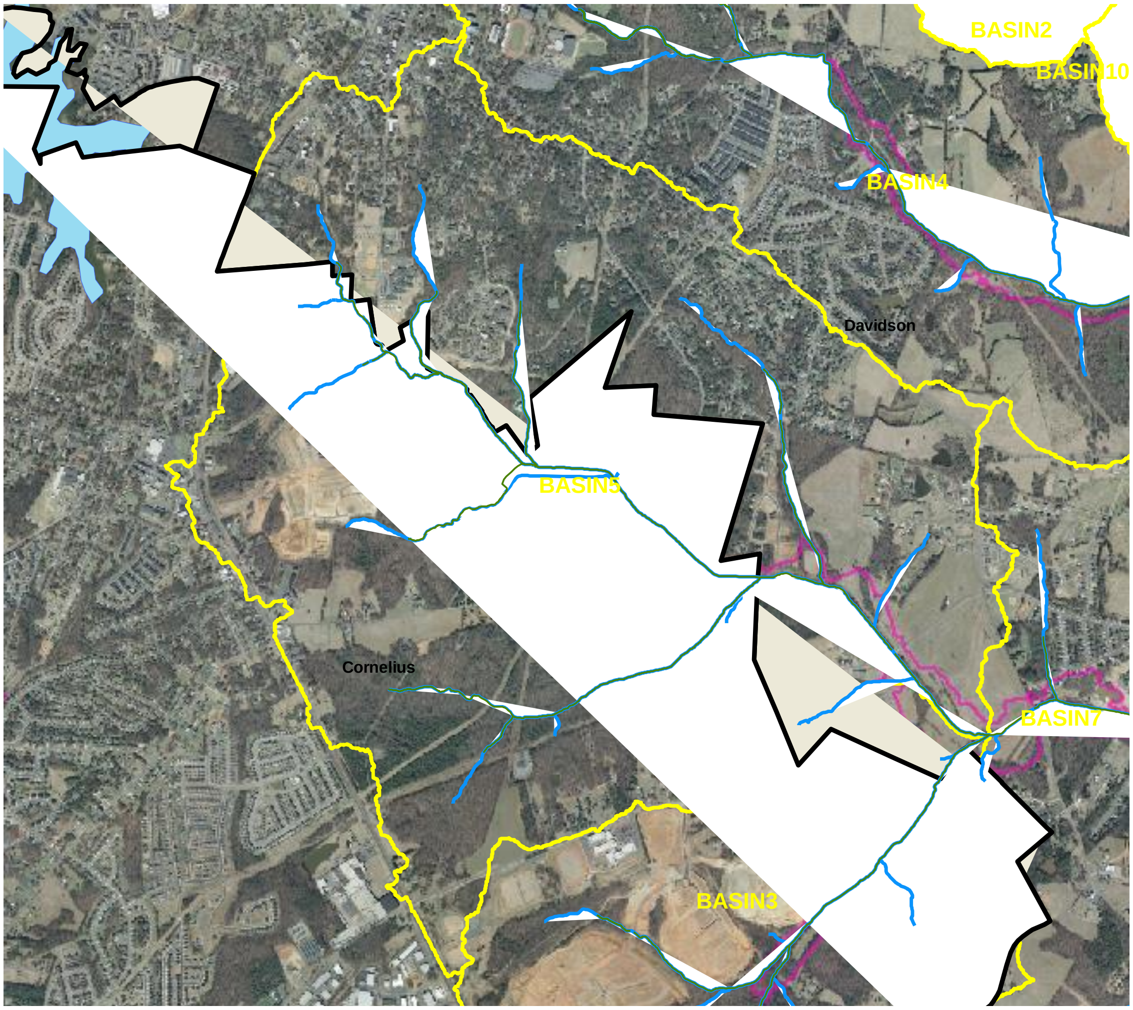
A. Focus Area 1

Focus Area 1 is comprised of Basin 5 from the Rocky River Watershed Management Plan. It is an area of recent and older development where little of the runoff is routed through BMPs. Specifically, the Antiquity Neighborhood has been built with BMPs.

Priority and Existing Projects in Focus Area 1:

Priority 1 Project:	Northcross Pond Parcel # 005-36-109
Priority 2 Project:	The Landings Retrofit Parcel # 005-05-209
Existing Project:	Northcross Shopping Center

Focus Area 1



1. Catchment MD20

1. Catchment MD1

Catchment MD1 is located in the Town of Cornelius. It is comprised of older single family residential, multifamily residential and some commercial land use. The Ange project, which is just downstream of the catchment, will be designed to treat the runoff from catchment MD1.

Catchment MD1, Focus Area2
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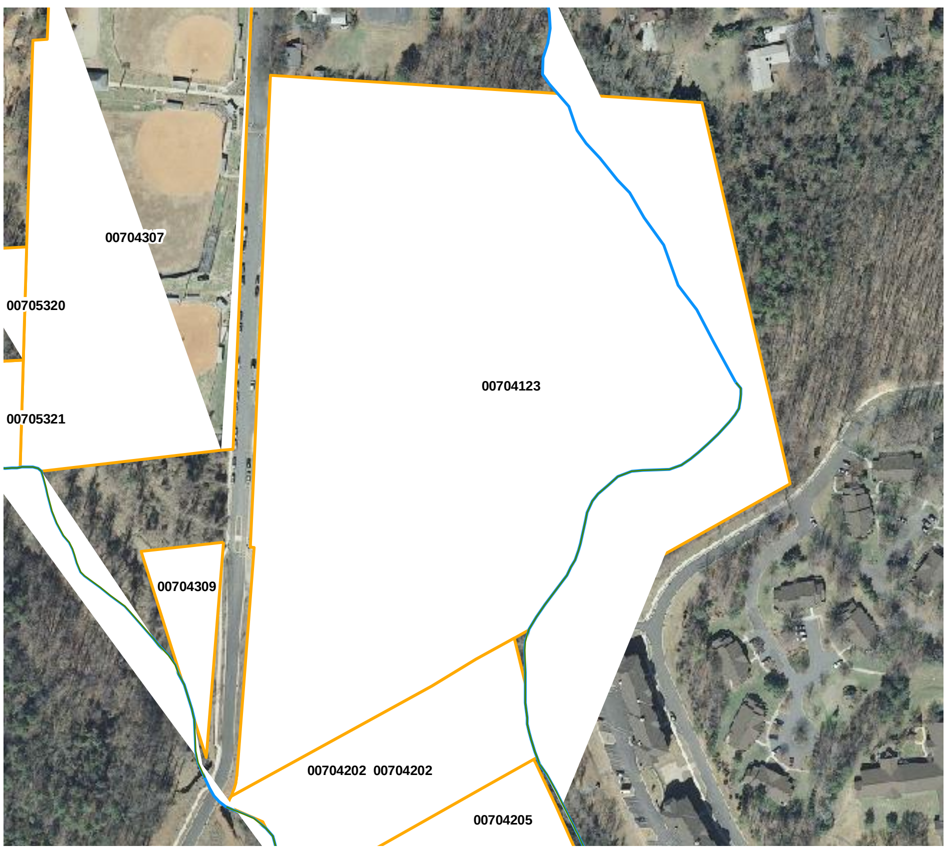
2. Catchment MD2

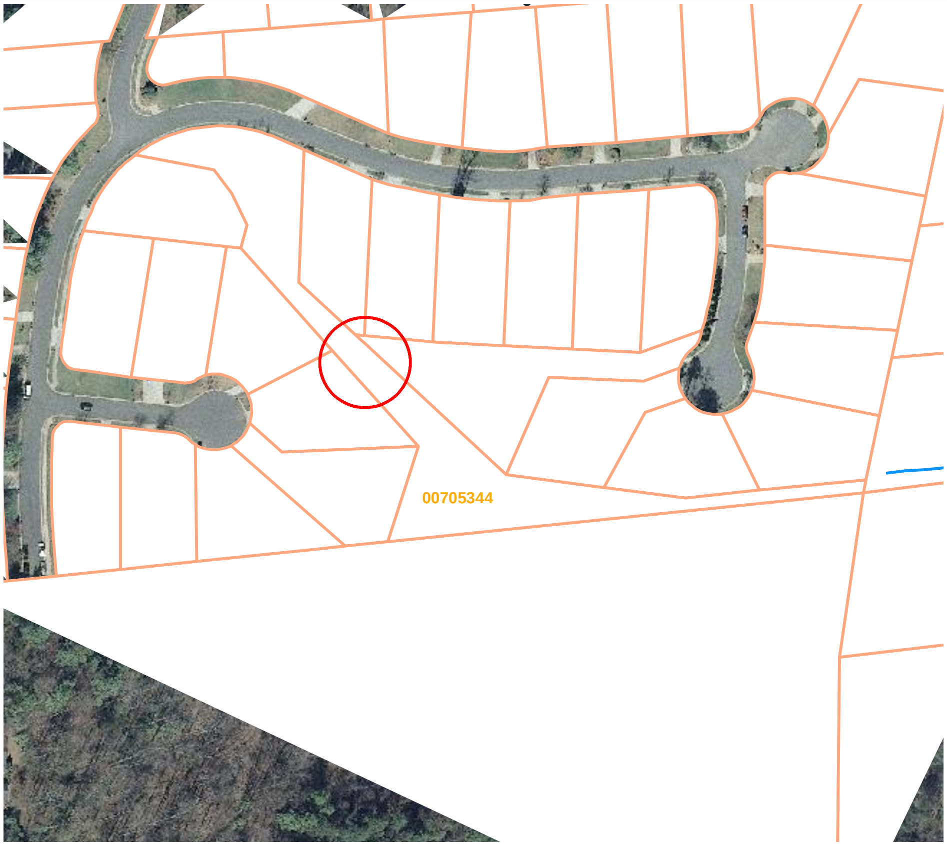


Parcel 00704123, Focus Area 1

Parcel: 007-04-123
Owner: Charlotte/Mecklenburg Board of Education
Description: Existing school site has former sediment basin that would be a relatively simple retrofit (presuming storm water is routed to it). Stream is highly impacted from school storm water runoff, however areas upstream of school are stable.
Cost: $100,000
Priority: High

Parcel 007-03-127

Parcel:	00703127
Owner:	The Pines at Davidson
Description:	Multi-family residential site that is currently partially treated with bioretention/stepped wetlands. Existing drainage to the south of the site is not currently treated. Opportunity for simple retrofit device.
Cost:	$125,000 (does not include property)
Priority:	Medium



Parcel 007-05-344

Parcel:	00705344
Owner:	Town Heights HOA
Description:	Single family residential neighborhood with a centrally located drainage feature. Several storm water pipes converge as noted. Wetland plants (cattails) are present. Site could be converted into a functional pocket wetland.
Cost:	$100,000 (does not include property)
Priority:	Medium

VI. Buffer Re-Forestation

Buffer reforestation in the Rocky River watershed is a critical component of returning it to a condition of fully supporting its designated uses. Specifically, a forested buffer provides shade for the creek, which limits heating of the stream during summer months. Also, a forested buffer provides treatment of direct runoff to the stream as well as organic material in the form of leaf litter during the fall. There are 298 different parcels with un-forested buffer area in excess of 0.1 acres totaling 197 acres. The top 20 land owners of un-forested buffer are presented below:

Parcel ID	Unforested Buffer Acres	Owner Name
00316201	2.85	DAVIDSON COLLEGE
00712209	2.86	WESTMORELAND
00303122	2.86	POTEAT
00302107	2.96	SERENE VALLEY LLC
00334104	3.05	THORSON
00303102	3.14	POTEAT
00302113	3.15	BROOME
00309207	3.45	GARMON
00736199	4.52	RIVER RUN GOLF & COUNTRY CLUB
00333102	4.61	MECKLENBURG COUNTY
00726333	4.96	RIVER RUN GOLF & COUNTRY CLUB
00715216	5.33	WESTMORELAND R Y &
00708102	6.48	HUNTER
00728110	6.63	WESTMORELAND R Y
00304103	6.82	FIFTH THIRD BANK
00738199	7.02	RIVER RUN GOLF & COUNTRY CLUB
00728106	7.48	WESTMORELAND R Y
00737199	7.98	RIVER RUN GOLF & COUNTRY CLUB
00311104	9.00	DAVIDSON TOWN OF
00749106	9.12	RIVER RUN LTD PARTNERSHIP

For the purpose of this plan, only publicly owned property with at least 2 acres of un-forested buffer were targeted for reforestation. For all cost calculations re-forestation of buffers is estimated to cost $2200/acre. This value was developed assuming mixed hardwood trees (seedlings) would be planted on eight-foot grid. Specific parcel information on publicly owned parcels to be reforested is as follows:

Parcel ID	Unforested Buffer Acres	Owner Name	Cost
00311104	9.00	DAVIDSON TOWN OF	$19,799
00333102	4.61	MECKLENBURG COUNTY	$10,132
00316201	2.85	DAVIDSON COLLEGE	$6,277