Corpening Creek Watershed Plan

McDowell County, NC

September 2011





Prepared for the MUDDY CREEK RESTORATION PARTNERSHIP
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Executive Summary

This document represents the Muddy Creek Restoration Partnership's (Partners) restoration plan for the Corpening Creek watershed. The watershed is approximately 9 square miles and consists of two major stream systems - Corpening and Jacktown Creeks. Corpening Creek is the dominant drainage and is an impaired stream that is listed on the State of North Carolina's 303(d) list. Corpening Creek drains a substantial portion of the City of Marion, a community of just over 7,100 persons. Jacktown Creek is its most substantial tributary and drains a predominantly rural area of McDowell County just outside of the city limits. After its confluence with Jacktown, Corpening Creek then flows for several more miles to its confluence with North Muddy Creek. Eventually, the waters that flow in Corpening and Jacktown Creeks enter the Catawba River just below Lake James.

The NC Division of Water Quality has found that the benthic macroinvertebrate community in the watershed is severely compromised, and the Partners have substantiated this through our own watershed assessment conducted from 2007 to 2011. The species composition is not what a healthy piedmont-mountain stream should contain, and laboratory analysis of these aquatic insects indicates that toxins are having an impact in Corpening Creek. Sampling of water chemistry has also revealed elevated concentrations of nutrients and coliform bacteria and high conductivity readings – even in dry weather conditions. While conductivity is not a pollutant per se, it is indicative of water pollution. We have some limited data that suggest heavy metals are one type of toxin that accompany nutrients in the water column, but our data set is too limited to be more definitive. Our physical stream assessment of Corpening Creek revealed evidence of in-stream habitat deficiencies and some severe bank erosion, an indication of stream scouring activities that are commonly associated with urban watersheds and stormwater runoff. These problems appear to be more localized compared to the biological and water chemistry monitoring which shows a chronically impaired stream whose adverse impacts are watershed wide.

The Partners have a learned a great deal about the causes and sources of Corpening Creek's poor health since initiating the watershed assessment that is now culminating in this watershed restoration plan. At this juncture, we believe that the impairment is being caused by too much pollution and too much water entering the creek too rapidly after storms. We are confident that stormwater runoff from generalized urban development, especially in downtown Marion and the vicinity, is a major contributor to the toxicity and nutrients in the stream and also to stream scouring that is degrading habitat and eroding creekbanks. We are confident that toxins are also coming from waste disposal and spillage from the numerous commercial properties which line the banks of Corpening Creek and its tributaries, particularly gas stations and automobile repair shops. We are confident that while the wastewater treatment plant on Corpening Creek does have adverse impacts in the stream as might be expected, it is not the responsible agent for impairment. We are confident that the forested cover on the relatively undeveloped Mount Ida and Grants Mountain plays a significant role in keeping Corpening Creek's health from deteriorating even further.

While our confidence has undoubtedly increased about causes and sources of impairment, there remain some vexing issues that need further study without which we may never be able to isolate and eventually eliminate other contributors. The high nutrient, conductivity and coliform monitoring results collected in dry weather in downtown and the immediate vicinity points to other factors beyond stormwater runoff as the causes of pollution inputs. Are these inputs coming from illicit discharges, leaking sewers or groundwater contamination? We do not know. Additionally, there are over a dozen very large industrial and institutional facilities in the upper reaches of the watershed that were not included in our assessment due to their size and the complexity of the sites. Some of them are vacant and others are in partial use. The sheer size of the imperviousness of the roofs and surrounding parking lots make these sites definitive contributors to stormwater runoff volume into Corpening Creek. Considering the age of the buildings and typical practices of the time they were constructed, it would also not be surprising to learn of direct connections between sewers or internal drainage systems and adjacent creeks, which may be another source of pollution in the watershed. Unfortunately due to cost and complexity of sampling, one of our major limitations is that we do not possess a baseline data set of potential toxins that could be affecting Corpening Creek. Eventually, we need to collect this data so that we can increase our confidence about the specific toxins that are proving problematic here and adapt our management to focus more discretely on addressing the sources of those specific toxins.

While the Partners recognize that there is much left to learn, we believe that we know enough now to begin taking some well-informed measures to help Corpening Creek recover its health. This planning document outlines five core healing strategies that will be the focus of our effort over the next 15 years. Those include:

1. Manage Stormwater Better
2. Fix Hot Spots of Water Pollution
3. Protect Large Tracts of Undeveloped Land
4. Restore Degraded Streams & Riparian Areas
5. Learn More About How to Best Heal the Stream

Our plan is framed around the strategic theme of a ***Focus on Five***, with numerous specific project ideas developed for each strategy. There are lots of things we could do to help Corpening Creek heal, but we believe that five core strategies is a manageable number of areas that will help us focus our attention. Each project has enough complicating factors that must be worked through for the project to materialize on the ground. ‘Learning More’ is the fifth and an equally important part of our restoration plan strategy. This will enable us to adapt our management over time and incorporate other strategies if need be in the future. If the plan is fully implemented, the projects we recommend have the potential to help us reduce stormflow volume by over 80 million gallons annually and reduce Nitrogen by 239 pounds per year and Phosphorous by 76 pounds annually. Our projects also have the potential to help us reduce sedimentation in the watershed by 2,500 to 8,000 tons annually and improve in-stream and riparian habitat dramatically. These are only estimates and our learning more strategy should help clarify and refine these estimates over time.

Our plan will succeed in its implementation only with the widespread participation and support of the community and individual landowners and residents where project ideas have been identified. The Partners develop projects only through a voluntary and collaborative basis with willing landowners. Hence the importance of a resonant outreach and education approach that appeals to the unique qualities of Marion and McDowell County values. We actually refer to outreach and education as marketing and public relations because we are interested in not just generating better informed people but better informed people who are willing to change behavior or take other actions to help us heal this stream. Our goal is to build and sustain long-term positive relationships within the community such that those we service with projects become our best advertisement - advocates for other projects elsewhere and long term stewards of the stream resource.

Our focus is ultimately restoring Corpening Creek so that its biological integrity improves to the degree that it can be removed from the State 303 (d) list. We have designed a monitoring program to help us keep track of improvements over time, and that is described in this plan. Ultimately however, it will be NCDWQ's biological monitoring results that indicate when we have crossed that threshold. This plan has a life span of 15 years, but our work will likely be needed for many years afterward before Corpening Creek is restored.

We anticipate that it will cost upwards of $14.8 million to implement this plan as we have described it. Some types of projects are expensive while others carry no price tag or can be implemented at minimal cost. Some types require simple behavioral modifications that can sometimes be harder to implement simply because old habits for people can be hard to break. Grants and cost-share programs will be key funding mechanisms, along with local government and private business investments. There is need for in-kind contributions from Partners and members of the community. While the Partners will develop many of the projects in this plan, other project ideas will require landowners, residents and developers to undertake actions on their own. That's how this plan will be implemented successfully – through the combined efforts of the Partnership and broader community working together.

This watershed assessment and planning effort has been funded by the NC Division of Water Quality through a US EPA Section 319 grant and by the NC Clean Water Management Trust Fund. Watershed plans funded through the 319 program are required to address nine critical elements. Those nine elements have been addressed in this document and are listed below along with the location in the document where the information can be found.

USEPA 9 Element Plan Requirements & Their Location in this Planning Document		
Element #1)	***Identification of the causes and sources*** of impairment	Chapter 1 Appendix A
Element #2)	***Description of the NPS management measures*** to be implemented to address causes and sources of impairment	Chapter 2 Chapter 4
Element #3)	***Estimate of load reductions*** expected for management measures	Chapter 4 Appendix B-D
Element #4)	***Estimate of amount of financial and technical assistance needed*** to implement the plan	Chapter 4
Element #5)	***Information and education component*** that will be used to enhance public understanding of the project	Chapter 3 Chapter 4
Element #6)	***Schedule for implementing the NPS management measures*** that is reasonably expeditious	Chapter 4
Element #7)	***Description of interim measurable milestones*** for determining whether NPS measures are being implemented	Chapter 4
Element #8)	***Criteria that can be used to determine whether loading reductions are being achieved*** over time	Chapter 5
Element #9)	***Monitoring component to evaluate effectiveness*** of the implementation efforts over time	Chapter 5

Table of Contents

List of Figures

List of Tables

Chapter 1 Who Cares About Corpening Creek?

1.1 Corpening Creek is in Poor Health and that is a Major Concern

Corpening Creek is in poor health and has been in this condition for a long time. Residents report that in the 1960s and 70s one could tell the day of the week by the color of the creek. Others say that even today you can tell that something just doesn't smell right at places along the creek. The NC Division of Water Quality has tested the waters since 1985 and has confirmed in each test over the past 25 years that Corpening Creek is indeed impaired (see Appendix A). The state's tests indicate that the stream simply does not contain the diversity and abundance of aquatic wildlife that should live there. Five samples of benthic macroinvertebrates (bottom dwelling aquatic insects) over the last three years taken by a local group of interested citizens and business owners have confirmed the validity of the state's conclusions. In addition to biological problems in the stream, many residents complain about flooding, collapsing streambanks, and trash. For these reasons, the state has determined that Corpening Creek is an ***impaired stream.*** It has been listed on the state 303(d) list, the formal list of impaired streams in North Carolina, since 1998.

1.1.1 There are Two Main Problems

There are a number of plausible explanations of why Corpening Creek is in poor health. Based on current knowledge, they can be lumped into two categories.

- **A.** There is too much water
- **B.** There is too much pollution

In heavy rains or even lighter rains that come over extended periods, rain runs off of rooftops and parking lots and into culverts where the stormwater is piped and dumped directly into the creek. The runoff causes the creek to become 'flashy'. The waters rise and flow more quickly through the channel. Not only does this erode creekbanks and endanger property and infrastructure, it also scours habitat that aquatic wildlife need for survival.

> *"Everybody's trash collects here. I pick tires out of here on a regular basis. I wish they were good ones and I would put them to use."*
>
> *- Bob Schemke*

In addition to higher and faster stream flow, a lot of pollution enters into Corpening Creek during rain events. Much of this pollution enters the stream with the stormwater runoff. These include toxins from:

- petroleum-based products
- chemicals
- litter

It also includes nutrients from human and animal waste and excessive fertilizer use. Fecal coliform bacteria levels are also very high throughout the Corpening Creek watershed. Another primary pollutant is dirt (or sediment) from improper management of excavated areas, unpaved roads and eroding creekbanks.

The recent assessment of the watershed reveals that not all of the pollution comes from stormwater runoff, however. Pollutant levels for nitrogen and phosphorus, for example, are high even during normal base flows. The exact sources delivering these pollutants to the stream remain unknown. It is possible that old fill material, leaking underground storage tanks, leaking sewers and straight pipes from residential and business property drains are all contributing to the baseflow pollution problem. Identifying those sources was beyond the scope of this watershed plan due to the complexity of the issue but this information will be needed at some point to most effectively address water pollution issues in Corpening Creek.

1.2 Why Should I Care?

There are four good reasons to be concerned about Corpening Creek.

A. The Stream Corridor is Unsafe.
B. An Unsafe and Unattractive Stream Corridor is Bad for Business, Health and Quality of Life.
C. A Polluted Stream Attracts Regulatory Attention.
D. Floods, Rapid Streamflow and Unstable Streambanks Put Infrastructure and Property at Risk.

Corpening Creek Stream Corridor

A. The Stream Corridor is Unsafe

- Assessments have revealed miles of creekbanks that are barren and in various stages of collapse. Many of these collapsing banks are 8 and 10 feet or higher above the stream channel.
- The velocities of the creek can be tremendous and combined with the rapid rise of the water during a storm, can erode creekbanks, wash out culverts and bridges, and even knock houses off of foundations.
- Trees, trash and other debris that fall into the creek during storms can cause logjams, further exacerbating erosion and flooding.
- The types of aquatic insects found in Corpening Creek are those that most people consider pests. Biting midges, black flies and bloodworms are by far the dominant families of benthic organisms found in the stream.
- Fecal coliform bacteria concentrations throughout Corpening Creek are consistently above state public health standards, and the assumption is that other disease causing pathogens are also likely present.

Pollution in the Corpening Creek Stream Corridor

B. An Unsafe and Unattractive Stream Corridor is Bad for Business, Health and Quality of Life.

- People tend to avoid places that appear to be in disrepair or are offensive to sight and smell. Conversely, people are more apt to congregate and spend time and money where the atmosphere is attractive and they feel safe.
- The assessment revealed a large amount of debris, fill material, and trash within the stream corridor. This is a widespread, dominant characteristic of the stream from the top to the bottom of the project area, though it's worse in town and along the Highway 221 corridor.
- Based on these findings and known coliform concentrations, it is likely that people playing or walking around in Corpening Creek and its tributaries are at risk of bacterial or viral infections or other disease.

Dumping in the Corpening Creek Stream Corridor

Examples of Attractive & User Friendly Stream Corridors

C. A Polluted Stream Attracts Regulatory Attention.

- The 'impairment' rating automatically puts Corpening Creek on the 303(d) list, which makes the stream come up on NCDWQ's and USEPA's radar as a stream requiring restorative attention.
- The 303(d) listing can bring resources to help fix the problem, but it could also in the future result in mandatory requirements.
- Two regulatory requirements that have been imposed on other communities and of which Marion may in the future be susceptible include:
    a. Phase 2 Storm Water Regulations. Currently, Marion's population is not large enough to meet the population threshold requiring a Phase 2 Stormwater permit. However, if Marion's stormwater is contributing to Corpening Creek's impairment, which is clearly the case here, then NCDWQ has the authority to require Marion to be part of the program.
    b. Total Maximum Daily Load (TMDL). A TMDL would develop pollutant loading reduction targets for particular sources or source areas. At this point taking action to meet these targets would not be mandatory, but there is the possibility that this could change in the future.
- It is possible, but not certain, that meaningful local action in the near term to address the problems in Corpening Creek could head off potential future regulatory action.

D. Floods, Rapid Streamflow and Unstable Streambanks Put Infrastructure at Risk.

- Runoff during storms can wash out roadways, clog and undermine culverts, and damage bridges.
- Creekbank erosion can damage water and sewer lines that cross the stream channel.
- Streambank erosion results in the loss of property and can damage and destroy buildings.

Infrastructure Damage and Risk in the Corpening Creek Stream Corridor

1.3 These People Care About Corpening Creek

"When people move land, we've got to be sure we know where the water is going."

"My husband and I owned some rental property on a small stream. In 1988 during a storm, debris caused a backup in a culvert and the floodwaters washed over the road and knocked the house off of its foundation."

- Freddie Killough

Freddie Killough

Freddie is a lifelong resident of McDowell County. She was raised in Old Fort but has lived in Marion since 1977. Freddie owns a business in downtown with her husband and serves as the Director of the Marion Business Association. She would like to see a clean and healthy Corpening Creek and has been contributing to this project as a member of the citizens and business owners advisory group for this watershed plan.

Freddie reports – "I am involved with the Corpening Creek restoration group because the stream is so close in town and due to my job with the Marion Downtown Business Association, we look at every aspect of the community. The headwaters of Youngs Fork start right here in the center of town. Its health is something we're concerned about. Even in an urban setting, we have a responsibility to make sure our natural resources are protected and that we make sure people understand that it is in their best interest to protect these resources."

Marc Cook

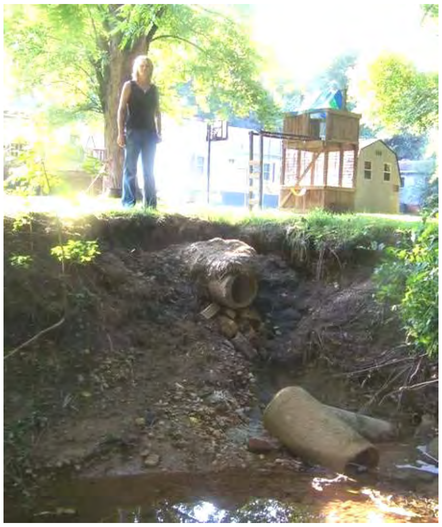
Mark was the vice president of Builders Supply in downtown Marion before it closed in 2010 and also serves on the citizens and business owners advisory group for this watershed planning process. Mark has lived in Marion for 23 years. Mark is involved with the Corpening Creek restoration group because he has property along the creek and there are some major streambank erosion problems that are threatening this property.

Mark says "I've also known the creek since I was a child. I've played in it and knew that it was dirty. I'd like to help fix it up. It's the ultimate experience for a kid growing up to have a creek to play in."

> *"My best friend when I was growing up lived on the creek. The creek was part of our lives – building forts, throwing rocks, catching frogs. We used to see the creek turn odd colors."*
>
> *- Marc Cook*

Renee Allison

Renee and her family have lived adjacent to a small stream that drains into Youngs Fork for two years. Her mother lived here for 15 years previous. Renee started noticing when she moved to the property some streambank failures and breakages in culverts and pipes. Her husband has tried to keep the bank from eroding, but big storms keep tearing the bank apart. She is concerned about losing property and for the safety for children and others who might be playing near the creekbank.



Dianne Wright

Dianne has lived beside Youngs Fork and one of its tributaries for 19 years and reports that she has lost 10 – 15 feet of creek frontage on average over a span of several hundred feet since that time. The erosion has gotten worse over time. She tells a story that one time a state employee came out to survey the culvert under Highway 221. She was inside the house and looked out the window and saw the man fall into one of their erosion holes. The creekbank is a vertical 8 to 10 feet in height from the bottom of the stream.

> *"This little creek can get up and kick, I'll tell you that. In one storm, the creek got up to where a Volkswagen Beetle came through the culvert and down the creek. We were worried it would take out the sewer pipe, but it went under. Not sure exactly how."*
>
> *- Dianne Wright*

Lloyd Cuthbertson

Lloyd was born and raised in McDowell County and has lived in Marion since 1971. He has lived in his present home, which is beside Youngs Fork, since 1990. Lloyd is a member of the citizens and business owners advisory group working on this watershed planning project. Lloyd says, "Because I grew up on North Muddy Creek, I've watched the creek and how it's been abused with pollution and how it's always flooded at least once per year. The Muddy Creek flood control dam projects seemed to help with the flooding. It doesn't flood now like it used to. Of course, Corpening Creek is one of the headwaters of North Muddy Creek."

Lloyd says that when he was a kid, you could almost tell the day of the week by the color of the creek. Monday – it was dingy. Every day it got darker. By Friday it was gray and there were suds a foot deep around the edges of the creek at different falls. As a citizen and a member of the Marion City Council, Lloyd wants to be involved in not only helping to clean up Corpening Creek but also to help neighborhoods with erosion problems.

> *"This little creek behind the house can go from 6 inches to 6 feet in 6 minutes."*
>
> *- Lloyd Cuthbertson*

Chris Goudreau

Chris has lived in Marion since 1991 when he came to work with the NC Wildlife Resources Commission. As a resident of Marion, Chris serves on the citizens and business owners advisory group working on this watershed plan. Chris reports that the initial reason he got involved with the Corpening Creek restoration group was work related. Chris says, "I had a previous history with the Muddy Creek Restoration Partnership, helping to found that group in the 1990s. The other reason I got involved was to make a difference at the local level in helping to clean up a stream."

"When my daughter was young, we used to stroll her around side streets that run beside and across the creek. Most of the places that we had access, you could tell were degraded. There was a lot of dirt and sediment in the creek and the habitat wasn't all that great. Sometimes you could tell that things just didn't smell right."

Bob Schemke

Bob has lived beside one of the tributaries to Youngs Fork for 10 years and has noticed erosion problems ever since he moved here. The creekbank at his property is 12 to 15 feet high and almost a vertical drop. Bob is concerned primarily about safety. He reports that one of his friends was visiting him in his backyard one night and walked over by the creek and fell in. Bob is also concerned about trash and the cleanliness of the water. Bob says, "this creek is treated like a toilet of the city, and it ain't right. My grandson used to come down here and catch minnows, frogs and crawdads, and now they are hard to find, if you can even find them"

Bill Hendley
Bill was born in McDowell County and has lived here all of his life except for the 22 years he spent in the military. Bill is involved in the Corpening Creek watershed planning effort because of his deep interest in clean water and greenways. Bill is an avid cyclist and runner. He envisions the possibility of this project helping to support greenway efforts in Marion, particularly helping to connect downtown with Mount Ida and the outskirts of town at the Community College.

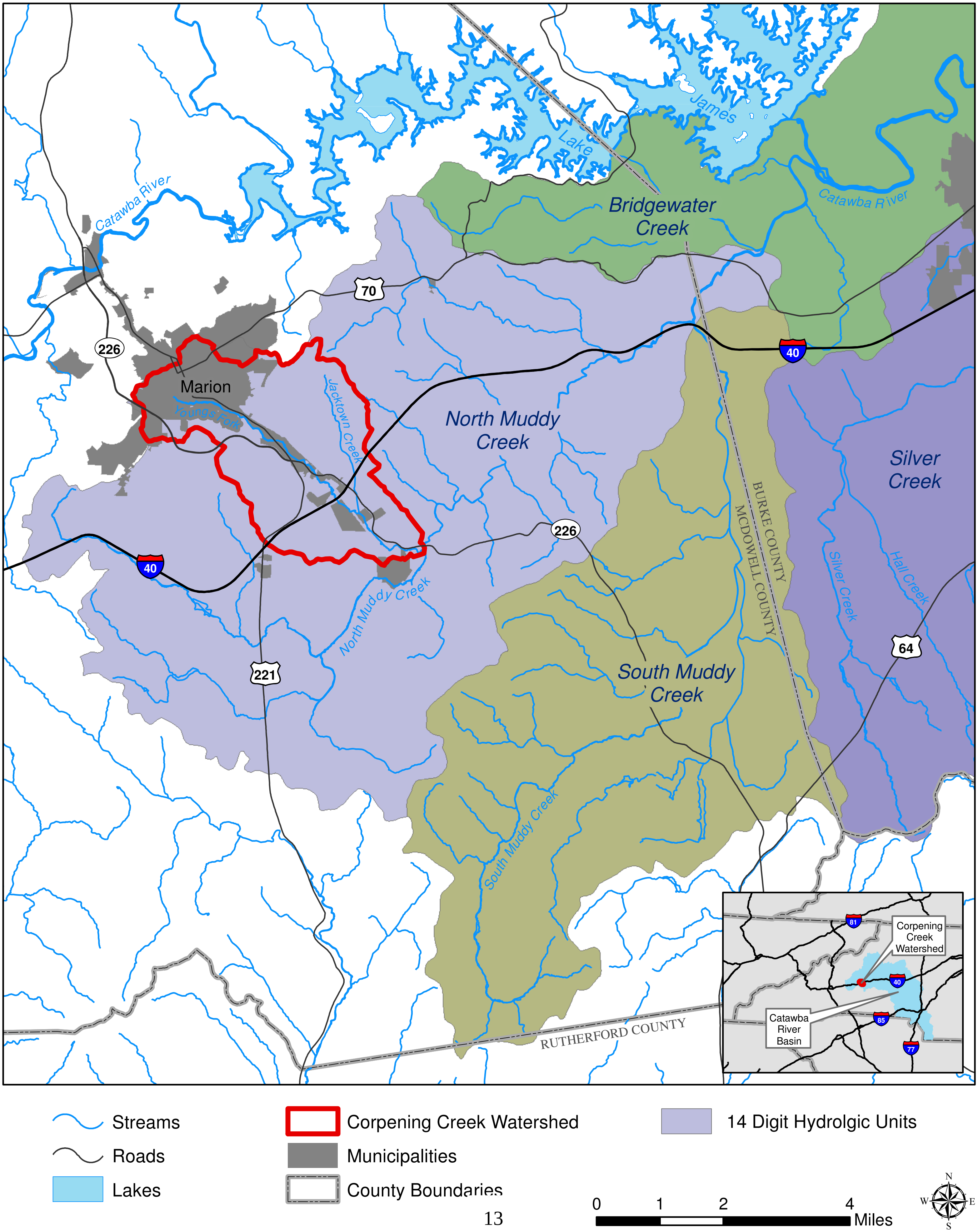
"I grew up on the Catawba River. It used to run mud or orange from 6 am to 5 pm because of washing of gravel upstream. I saw the scars of that and I would like to help heal such problems and ensure that it doesn't happen again without appropriate controls."

- Bill Hendley

1.4 Where Exactly is Corpening Creek?

Corpening Creek originates just above downtown Marion (Figure 1). These small streams flow through neighborhoods and commercial areas and converge in downtown, where the stream is also known as Youngs Fork. Youngs Fork flows south through the NC Highway 221 corridor to the outskirts of town at McDowell Technical Community College. Jacktown Creek, a large tributary, empties into Youngs Fork at the college. Where Jacktown Creek and Youngs Fork converge, the creek technically becomes Corpening Creek. In this plan the names Corpening Creek and Youngs Fork may be used interchangeably. We typically refer to Youngs Fork and Corpening Creek simply as Corpening Creek and we call the watershed the Corpening Creek watershed. Corpening Creek then flows through a rural area before emptying into North Muddy Creek. Eventually the water in Corpening Creek makes its way to the Catawba River. All totaled, the Corpening and Jacktown Creek watersheds drain an area of about nine square miles.

Figure 1 Location of the Corpening Creek Watershed



1.5 A Recovery is Underway but Will Take Time and Effort

1.5.1 The History of the Muddy Creek Restoration Partnership

In 1998, a group of concerned people and organizations banded together to form the Muddy Creek Restoration Partnership (Partnership). Members are listed in Table 1.1. Its primary goal was to reduce the sediment from the Muddy Creek watershed entering the Catawba River below Lake James to support the development of a trout fishery at the Bridgewater tailrace. In order to achieve this goal, the Partnership knew that its efforts would involve collaborating directly with private landowners in the primarily rural Muddy Creek watershed in McDowell and Burke Counties to stabilize eroding streambanks, remove livestock from streams, plant streamside vegetation, protect high quality ecological areas, and make other ecological improvements. This group, working through voluntary means with willing landowners, is now responsible for cultivating over 27 miles of stream restoration, though not all of this has been built as of the date of this planning document. Our projects in Muddy Creek have reduced over 350 dump truck loads of dirt from entering Muddy Creek annually. These 40 or so projects, and all the work that has gone into sustaining the Partnership, has had an economic impact of over $18 million. More stream conservation work remains to be done in Muddy Creek.

Table 1.1 Members of the Muddy Creek Restoration Partnership - 1998 - 2010

Organization	Representatives
NC Wildlife Resources Commission	Chris Goudreau, Doug Besler Win Taylor, Jim Borawa Mark Fowlkes
Duke Energy Corporation	Gene Vaughan, Steve Johnson Dave Braatz
Trout Unlimited	Captain Michael 'Squeak' Smith
NC Cooperative Extension Service	Daniel Smith
McDowell Soil and Water Conservation	Doc Buckner, Bill Lonon Stephen Banner
Natural Resources Conservation Service	Russell Lyday, Albert Moore Loring McIntyre
McDowell County	Chuck Abernathy, Ken McFadden
Burke County	Judy Francis, Marc Collins Susan Berley
Foothills Conservancy of North Carolina	Susie Hamrick Jones, Tom Kenney
Mountain Valleys RC&D	Sally Stokes
Carolina Land and Lakes RC&D	Dan McClure, Donna Lichtenwalner
Various Citizens	Hugh Franklin, Peggy Rowe Bobby Rowe
Equinox Environmental	Andy Brown, Steve Melton

As indicated in Figure 1, Corpening Creek is a major tributary within the Muddy Creek watershed. It is the only officially listed impaired stream in the drainage. In 2006, the Muddy Creek Partnership was approached by the NC Division of Water Quality about focusing some of its restorative efforts here. Erosion and sedimentation are problems in Corpening Creek just like in all places in the Muddy Creek watershed, and so the 'fit' was proper. The

Partnership secured a section 319 grant in 2006 from NCDWQ and began to invest significant attention on the urbanized Corpening Creek in addition to its work in Muddy Creek.

A local citizens and business owners advisory group was formed. Members are listed in Table 1.2. This group is not an incorporated entity but currently exists as a loose affiliation of private citizens, local business owners, non-profit groups, local government and other interested parties.

An assessment of stream conditions was performed from 2007 – 2010 to help clarify stressors and issues causing the impairment (Appendix A). A '9 Element' Watershed Restoration Plan was developed. This document is that plan. We anticipate that it has a life span of 15 years, though we also believe it will likely require ongoing efforts beyond that time period before Corpening Creek will recover. Several stream improvement projects have also been undertaken, primarily to serve as demonstrations of some of the types of projects that will need to be undertaken on a more widespread scale to clean up and restore Corpening Creek. Profiles of those projects are described below.

Table 1.2 Current Members of the Muddy Creek Restoration Partnership

Organization	Representatives
McDowell County	Ashley Wooten, Chuck Abernathy
McDowell County SWCD	Bill Lonon
City of Marion	Heather Cotton, Chris Hollifield, Bob Boyette
Marion Business Association	Freddie Killough
Keep McDowell Beautiful (proposed)	Gloria Burrough (invited)
McDowell Schools	Lloyd Cuthbertson
McDowell Trails Association	Bill Hendley
Business - vacant	
Business – Spencer's Hardware	Nancy Spencer
Citizen	Marc Cook (formerly representing business ownership w/ Builders Supply)
Citizen	Chris Goudreau
Natural Resources Conservation Service	Loring McIntyre
NC Cooperative Extension Service	Molly Sandfoss
Burke County	Susan Berley
NC Wildlife Resources Commission	Mark Fowlkes
Trout Unlimited	Captain Michael 'Squeak' Smith
Carolina Land and Lakes RC&D	Donna Lichtenwalner
Equinox Environmental	Andy Brown, Steve Melton, Jim Borawa, Lindsay Majer

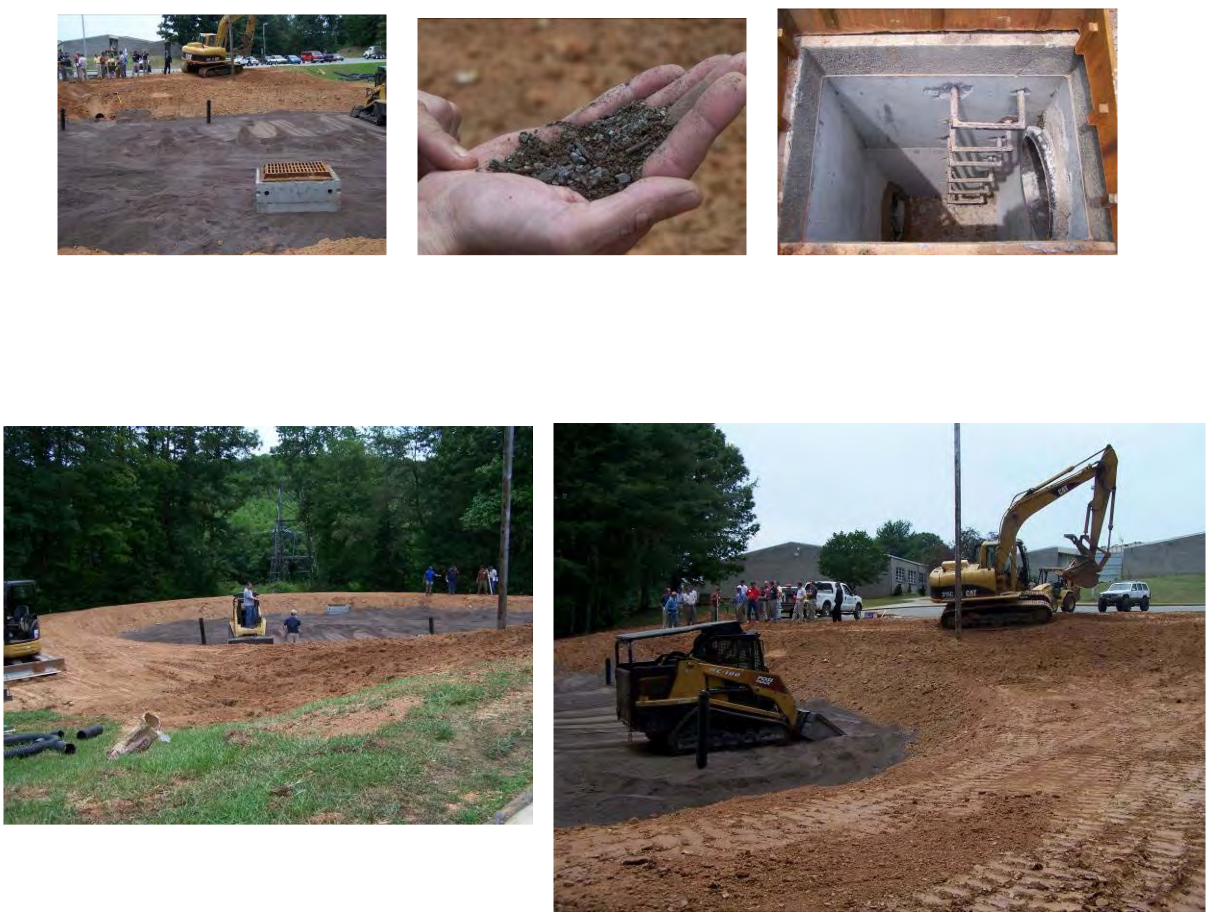
1.5.2 Featured Stream Improvement Projects in Corpening Creek

Eastfield Elementary School Rain Garden (Bioretention area)

A rain garden is one type of stormwater Best Management Practice (BMP) that helps treat polluted runoff from rooftops, parking lots, and other impervious surfaces. The BMP captures and holds runoff, slowly releasing it into the ground and into streams. This protects streams from the quick flash and resulting stream scouring, bank erosion and flooding that often occurs after a heavy rain. The rain garden also contains plants that help filter out pollutants like heavy metals and nutrients.

A rain garden was installed at Eastfield Elementary School to protect the headwaters of an unnamed tributary that feeds into Corpening Creek. In keeping with the Partnership's goal of utilizing investments in conservation and ecological restoration to benefit the local economy, the Partners selected, through a competitive bid process, Suttles Grading of Nebo to construct the Eastfield School rain garden.

Eastfield School Rain Garden



<u>McDowell Tech Stormwater Wetland and Stream Enhancement</u>
A stormwater wetland is another type of BMP used to treat runoff and associated pollutants. Stormwater wetlands are shallow, depressions constructed to mimic the functions of natural wetlands. Stormwater entering the wetland slows down and dissipates energy allowing coarser sediment particles to settle out. The water is temporarily stored in shallow pools that support emergent vegetation. They are designed to promote diverse wetland vegetation and use physical, chemical, and biological processes to treat stormwater runoff. They can also be designed to provide stormwater volume control.

The stream enhancement constructed at this site is a way to reduce sedimentation from streambank collapse and enhance stream habitat. The vertical banks have been graded back and native trees and shrubs have been planted adjacent to the stream to help stabilize the streambanks, shade and cool the stream, and provide leaves and twigs to nourish the aquatic food chain. Approximately 500 feet of enhancement was constructed on Jacktown Creek at this site.

A viewing platform, signage, and trail system were also constructed at this site to connect students, faculty, staff and visitors to the college with these stream improvements. The trail and observation decking both provide inviting passive recreational opportunities and the signage informs readers about stream health in Corpening and Muddy Creeks and the role of these projects in restoring stream health.

In keeping with the goal of utilizing stream improvement projects to also provide local economic benefits, Baker Grading and Landscaping of Old Fort and Gary Poole Construction of Marion won the competitive bids for the stormwater wetland, viewing platform and trail system. The NCDOT highway maintenance group from Marion constructed the stream enhancement.

McDowell Tech Stormwater BMP and Stream Enhancement



City of Marion Public Works Facility Urban Stream Restoration
A stream and stream buffer restoration project was undertaken by the City of Marion at the municipal cemetery on Rutherford Road. This is a good example project of the type of urban stream restoration projects that may be required in Marion because of the narrow site constraints. This project is designed to reduce bank erosion and provide better in-stream and riparian habitat.

Public Works Facility – Cemetery Urban Stream Restoration

1.6 Our Vision for a New Corpening Creek

It will take the widespread installation of numerous of these types of projects - along with smaller, simpler, lower cost efforts; behavioral changes; and other types of conservation work - to help this stream system recover its health. This plan and the work undertaken by the current Partnership is a starting point. We do not know where the finish line is, but we do have an idea of what it will look like when we get there.

We envision Corpening Creek as an amenity for our community, not an eyesore or something to be avoided. We see beauty in the form of native trees, shrubs and grasses lining its banks. We see a corridor of natural beauty that meanders peacefully along and beside Highway 221 and Main Street, inviting and welcoming residents and tourists alike into town. When we stop on a bridge or in a park and look over at the stream, we want to once again see fish swimming in pools and breaking the surface and a stream that hatches stoneflies, mayflies and caddisflies in abundance. We believe that rain is one of God's blessing to the earth, and that we should use it with wisdom instead of pushing it away and to the creek as fast as we possibly can.

Chapter 2 Five Strategies to Help Corpening Creek Heal and Recover

Improving the health of Corpening Creek and its tributaries to the degree that it can be removed from the 303(d) list is the driving purpose behind this watershed planning and management effort. This will be difficult and will require a lot of money and effort over an extended period of time. It will require some behavior changes, which may also be difficult for many of us. While maintaining our focus on improving stream health, we want to accomplish three other objectives that will benefit our community. We want to simultaneously beautify our community, create local economic opportunities, and meet the recreational needs of our citizens and visitors. We believe these goals to be compatible with and reinforcing of our focus on improving stream health.

The number of options that people can select from to help promote the recovery and restoration of Corpening Creek can be overwhelming. We want this plan to be manageable and realistic, so we have selected five core healing strategies that will be the focus of our implementation efforts over the next 15 years. These five strategies include:

1. Manage Stormwater Better
2. Fix Hot Spots of Water Pollution
3. Protect Large Tracts of Undeveloped Land
4. Restore Degraded Streams & Riparian Areas
5. Learn More About How to Best Heal the Stream

As we implement projects in the first four strategies, we will remove pollutants and moderate the volume and speed of runoff that gets into Corpening Creek. We should see benefits first at the site specific areas where we install these projects. It will likely require numerous projects scattered throughout the watershed before benefits accumulate and detectable healing occurs in the stream system as a whole.

It is probable that other solutions beyond these five strategies will be needed at some point in order to gain a fully functioning Corpening Creek. Projects undertaken as part of the fifth strategy will help us identify other sources and causes of pollution and stormwater problems; document improvements from the first four strategies; learn from our experiences; test new ideas and technologies; and adapt our management to become more effective over time.

2.1 Manage Stormwater Better

As discussed in Chapter 1, stormwater is rain that has fallen on rooftops, parking lots, roads or other impervious surfaces that collects and flows rapidly into streams. It carries pollutants that have accumulated on these surfaces and creates significant storm surges into the stream, blasting out banks and scouring the stream channel. By capturing and holding storm runoff, releasing it more gradually to the stream, and removing pollutants in the process we can manage stormwater better. This strategy addresses both the problem of too much pollution and too much water.

Technologies are available to help us manage stormwater better. We call these stormwater BMPs or 'best management practices'. Some are relatively simple, straightforward solutions that essentially anyone with property to manage can adopt. Some are very complex and require engineered designs and professional construction. Both types are needed throughout this watershed. They can be retrofitted to fit within existing developed areas and can be incorporated into new developments. We also recommend that the City of Marion and McDowell County encourage developers to utilize 'Low Impact Development' techniques to better management stormwater in new developments.

2.1.1 Simple BMPs

Done properly these simple practices will beautify a property, protect basements and foundations from water seepage, and reduce water consumption and money that property owners spend on water utilities. Each property is unique. Prior to implementing any of these solutions, property owners should assess their site to ensure that their runoff will not cause or worsen storm runoff problems for neighbors or create or add to erosion and flooding conditions on their properties. Even though we refer to these solutions in this plan as 'simple', professional assistance with design and construction may be needed.

> ***Runoff Volume***
>
> *One inch of precipitation falling on 1,200 square feet of roof produces approximately 750 gallons of runoff.*

Downspout Re-Routing

Downspouts from rooftop gutter systems can be re-routed from driveways, parking lots and streams to lawns and wooded areas. People interested in helping streams through these practices should expect minimal investment in time and money. A homeowner with just a few downspouts will not incur as much cost as those who manage a large commercial facility. The site to which the downspout is re-routed should be assessed for its infiltration and erosion potential. Re-routing downspouts to steep slopes or clay soil areas may cause erosion or flooding. When these site conditions are unavoidable, use of stone, erosion control fabric and vegetation can help control erosion and promote infiltration. The more complicated a site, the more likely a design professional would be helpful. Many homeowners will find this solution easy and inexpensive to implement and can likely undertake such a project on their own.

Rain Barrels and Cisterns

Rain barrels provide a storage device to capture rooftop drainage for later use on the site. Many people capture and re-use this water for their gardens and landscape plantings. Rain barrels come in a variety of sizes, shapes, and colors. It has become fairly commonplace to find 50 to 75 gallon barrels that make attractive additions to the landscape. A simple, 50 gallon plastic rain barrel will typically cost around $100 or less. Users of this practice will need to make sure that they have screens over openings to keep mosquitoes from using the reservoir as a breeding ground. They will also need to direct overflow to a suitable location to keep it from seeping into foundations and basements.

Right - Chris Goudreau at his rain barrel. Below - Example of a cistern in use at a Commercial Facility

> *"I have installed a rain barrel. We had erosion beside our house that we wanted to control and we had water getting into our basement. We needed to put that water somewhere else than beside our foundation. Why not put it in the garden?*
>
> *Instead of using city water in our yard, the rain barrel was a way for us to get 'free water' for us to use in the garden and yard."*
>
> *- Chris Goudreau*

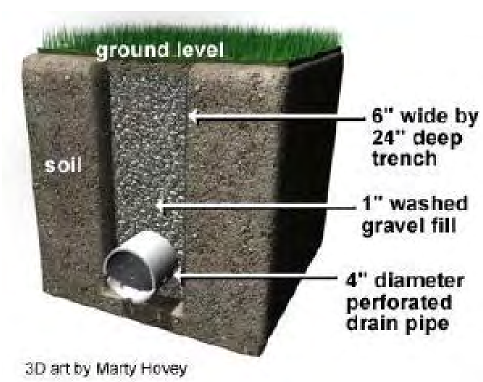
Dry Creek Beds

Dry creek beds can be an attractive landscape amenity that can serve the function of re-routing storm runoff from impervious driveways and parking lots into a yard area where infiltration can occur.

Dry Creek Beds in a Residential Setting

The rough edges of the stones and the interstitial spaces in between slow down runoff and allow it to be absorbed by the ground. Landscape plantings within and surrounding the dry creek bed also slow the water and promote infiltration. The stones and plants can also work together to create natural habitat for birds and small mammals.

Figure 2.1 Illustrations of a French Drain



French Drains

A French drain utilizes a trench, perforated pipes and gravel to capture, route and infiltrate runoff. French drains have been used in construction for centuries to solve drainage problems around foundations and to relieve water pressure from behind retaining walls. This is a relatively straightforward solution that protects structures from potential water damage and also benefits streams by allowing storm runoff to percolate into the ground rather than discharging directly to driveways, gutters, storm sewers and streams.

2.1.2 Engineered BMPs

Many situations are too complex for simple practices. Effective stormwater control requires professional design and construction. These projects can be costly. However, their costs are often lower than traditional 'hard' stormwater management technologies such as curbs, gutters, and pipes.

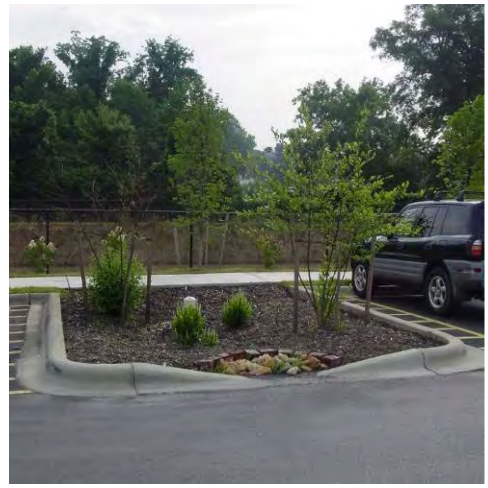
<u>Rain Gardens (also known as bioretention)</u>

Rain gardens are also known as bioretention areas. They are shallow landscape depressions that use soils and plants to treat storm runoff, using many of the water storage and pollutant-removal mechanisms that operate in healthy forests. During storms, water temporarily ponds on the surface of a sand/soil bed, then infiltrates through the bed into an underdrain system. Bioretention areas can be designed to infiltrate water directly into native soils, if these soils are permeable. Bioretention can be used in a variety of topographic conditions, although individual retention areas are usually small and can generally treat runoff from areas of one acre or less.

The median construction cost for bioretention areas is approximately $25,400 per impervious acre treated (CWP, 2007). BMP design will increase this cost by about 1/3. The total cost for design and construction of the bioretention area recently completed at the Eastfield Elementary School was almost $82,000. The advantage of bioretention is that it makes a cost-effective compliment to parking lot and streetscape improvements where improved landscape aesthetics are also a goal. Rain gardens can also fit nicely in a back yard and as part of the stormwater management system of a residential development. Routine maintenance similar to landscape maintenance will be required, including replacement of top-most mulch every few years, removal of invasive exotic weeds, occasional pruning and some tilling or aeration of the soil if fine sediments accumulate on the surface.

Examples of Bioretention Used in Medians at a Parking Lot

Rain Gardens in Residential and Commercial Applications



<u>Constructed Wetlands and Ponds (also known as stormwater wetlands)</u>
Constructed wetlands are shallow depressional wetlands constructed to mimic the functions of natural wetlands. They temporarily store stormwater in shallow pools that contain diverse wetland vegetation. The wetland uses physical, chemical and biological processes to filter pollutants. They can also be designed to provide stormwater volume control.

A forebay is an important design feature placed near the inlet to the wetland. This allows coarser sediment particles that often accompany runoff to settle into a basin rather than enter the wetland and reduce the wetland's treatment capacity. The forebay also protects the physical integrity of the wetland by dissipating the energy of the incoming stormwater.

In contrast to rain gardens, wetlands can be used to treat runoff from a larger area. Because they are shallow, stormwater wetlands require more surface area than similar wet detention ponds.

Costs for retrofitted constructed wetlands, as reported by the Center for Watershed Protection, can be upwards of $38,400 per impervious acre treated. BMP design will increase this by about 1/3. The estimated total cost for design and construction of the stormwater wetland at McDowell Tech is approximately $118,000. Sediments that accumulate in the forebay need to be dug out every 5 years or when the depth of the forebay diminishes by 50%. The wetland should also be monitored for the invasion of exotic plant species and those removed promptly when found. Other maintenance requirements include periodic inspection of the flow delivery mechanisms upstream of the wetland to ensure that stormwater is able to get to the wetland as designed. Otherwise, the wetland plant species may die. Trash and other debris removal may also be needed periodically.

Examples of Constructed Wetlands

Wet Detention Ponds

Wet detention ponds act in a similar manner as stormwater wetlands, removing pollutants and temporarily holding stormwater volume. Like wetlands, detention basins can handle runoff from large areas. In contrast, wet detention basins are usually deeper, are armored with concrete embankments and do not utilize vegetation in the pollution treatment. While they may not require as much space to install as a wetland, they lack some of the aesthetic qualities that are provided by wetlands. Because of the safety issues posed by the pond depth, fencing is often required around the perimeter. Constructions costs for wet pond retrofits can be upwards of $57,500 per impervious acre of treatment. Routine maintenance can be expected to cost about 3 to 5% of the construction cost.

Examples of Wet Detention Ponds

Water Quality Swales

Swales are essentially ditches, but these are ditches that do more than simply convey water from one point to another. Swales are designed to slow down water flow and allow infiltration. Swales can vary from simple grass channels to more sophisticated channels with underdrains. Swales are often utilized in conjunction with other BMPs.

Costs for grass swales in the NC Mountain region average $1.24 per square foot (Hathaway and Hunt, 2007). Swales on steep slopes may need turf reinforcement matting or other support, which would be an additional expense ($0.50/square foot, per (Hathaway and Hunt, 2007).

Examples of Water Quality Swales

Permeable Paving

Permeable paving allows water to percolate through, rather than running off, solid surfacing materials. New engineered paving materials are designed to be porous and allow rain water to infiltrate. Conventional impervious paving materials can also be installed on gravel and sand beds rather than on concrete in a mortar bed, which also allows for some infiltration. Weight and volume of traffic as well as slope are important considerations when deciding to use permeable paving instead of conventional impervious paving. Permeable paving is an appropriate paving technique in many residential applications or to satisfy overflow parking requirements of small businesses. Permeable paving usually costs as much or can exceed conventional paving costs by two or three times.

Examples of Permeable Paving

Permeable weirs

This is a type of extended detention BMP suitable for use at some sites in the Corpening Creek watershed. They consist of a check dam made of permeable materials that retain water and sediment during rainfall events. The stored water is released downstream by seeping through the porous material. These features are designed to empty completely between storm events and to remain dry until the next runoff event (dry detention). The check dams should be constructed of materials other than treated lumber to avoid toxic impacts to the aquatic community. Suitable alternatives include gabion baskets or permeable block walls. Weirs constructed of these materials should have longer life spans, require less maintenance, and be more stable than those constructed of treated lumber.

Photo of Permeable Weir

Green Roofs

A green roof is a roof that has plants on it. While still a relatively novel concept in the southeastern United States, this engineered construction practice has been time tested throughout Europe and is beginning to show up in North America (Chicago's City Hall has a green roof). This practice is a great way to manage rooftop stormwater when space is limited for BMPs on the ground surrounding the building. Green roof technology is not only a good way to manage stormwater runoff, these types of roofs provide greater insulation from heat and cold, soundproofing, and last up to two times longer than conventional roofing. Green roofs can also help moderate the 'heat island' effect of urban areas.

Green roof technology is applicable in residential, commercial and institutional applications. Installation costs of green roofs can range from $8 to $25 per square foot, depending upon design and plant materials utilized. This is higher than conventional roofing costs, but owners can expect reduced maintenance and energy costs over the long term. Structural engineering analysis is a prerequisite before construction. Figure 2.2 shows the layers required for a functioning green roof. Figure 2.3 shows the amount of runoff capture of a green roof compared to a conventional roof.

Figure 2.2 A Green Roof Cross Sectional Diagram

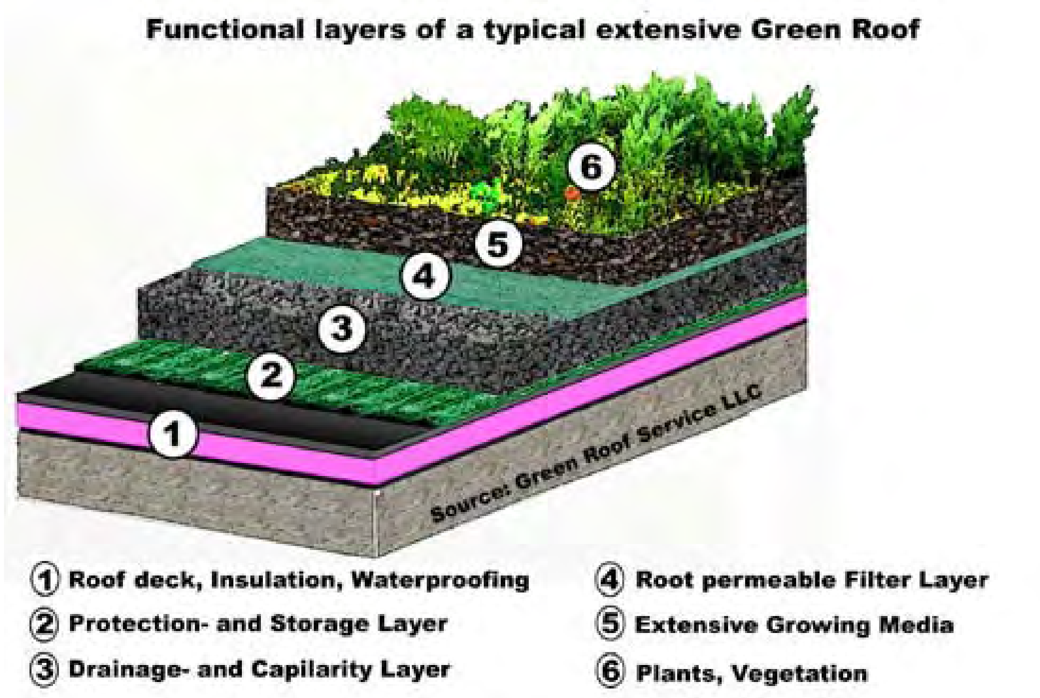
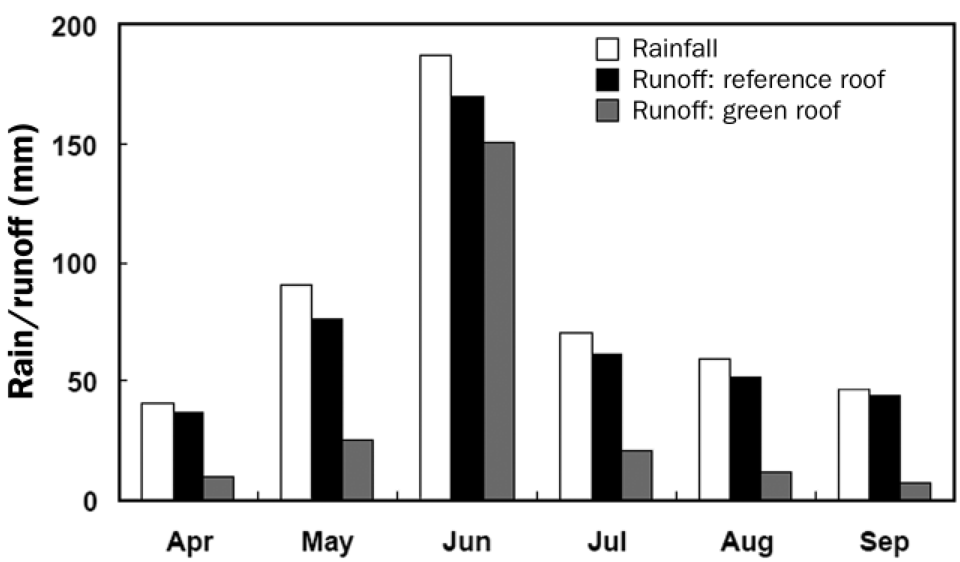


Figure 2.3 Comparing Green and Traditional Roofs at Controlling Runoff



Source: BioScience, November 2007

Examples of Green Roofs

Photos Courtesy of Weston, Inc.

2.1.3 Low Impact Development

Over the next several decades, Marion will probably grow. If traditional patterns of development are pursued, forests and other green space will get paved over and built upon adding more rooftops, parking lots and streets. Rain that now percolates into the ground will in the future be routed rapidly to a stream via curbs, gutters and pipes. Corpening Creek and its tributaries will get flashier. High flow events and floods in low lying areas will become more frequent. Streambanks will erode and collapse.

This scenario is preventable. Low Impact Development (LID) is a way of creating new residential, commercial and industrial spaces which simultaneously protect trees and green space, use less pavement, and make extensive use of the types of stormwater BMPs discussed previously. LID treats stormwater as a resource rather than a waste product. Its goal is to maintain the pre-development hydrology of a property. Perhaps most intriguing from a developers' point of view is that LID often costs less to develop than traditional approaches (Table 2.1).

Table 2.1 Low Impact Development Costs versus Conventional Development Costs

Project	Conventional Development Cost	LID Cost	Cost Difference	Percent Difference
2nd Avenue SEA Street	$868,803	$651,548	$217,255	25%
Auburn Hills	$2,360,385	$1,598,989	$761,396	32%
Bellingham City Hall	$27,600	$5,600	$22,000	80%
Bellingham Bloedel Donovan Park	$52,800	$12,800	$40,000	76%
Gap Creek	$4,620,600	$3,942,100	$678,500	15%
Garden Valley	$324,400	$260,700	$63,700	20%
Kensington Estates	$765,700	$1,502,900	-$737,200	-96%
Laurel Springs	$1,654,021	$1,149,552	$504,469	30%
Mill Creekc	$12,510	$9,099	$3,411	27%
Prairie Glen	$1,004,848	$599,536	$405,312	40%
Somerset	$2,456,843	$1,671,461	$785,382	32%
Tellabs Corporate Campus	$3,162,160	$2,700,650	$461,510	15%

Source: USEPA, December 2007

This table summarizes results of a USEPA case study involving 17 development or re-development projects nationwide. The study compared actual or estimated LID costs versus actual or estimated conventional development costs. LID usually saved the developer money due to reductions in road and stormwater infrastructure.

Low Impact Development Land Planning

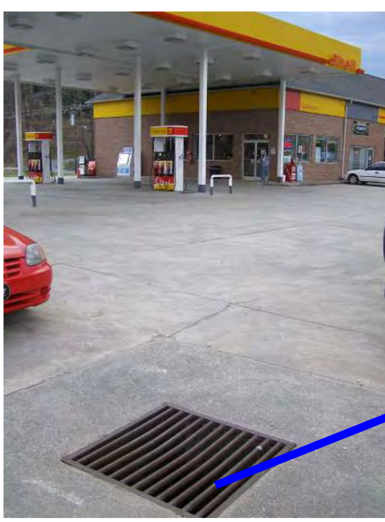
Low Impact Development is a comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrology of urban and developing watersheds.

LID strategies integrate green space, native landscaping, bioretention, green roofs, and other techniques to generate less runoff from developed land. While most conventional engineering plans pipe water to low spots as quickly as possible, LID uses techniques to retain and infiltrate precipitation as close to where it hits the ground as possible.

By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within a watershed.
(See http://www.epa.gov/nps/lid and http://www.lowimpactdevelopment.org/about.htm)

2.2 Fix Hotspots of Water Pollution

Hotspots are areas that, due to the commonplace use and handling of chemicals and petroleum products on site and an uninterrupted path to a storm drain or creek, pose a risk for higher levels of toxic water pollution from spills, leaks and storm runoff. Hotspots are characteristically gas stations, vehicle repair facilities, restaurants and other commercial and industrial operations. Fixing hot spots means essentially two things: 1) changing behaviors to minimize the risk of pollution getting into a stream; and 2) improving containment systems around those sites. Like BMPs, some solutions carry minimal cost while some treatments have a higher price tag due to inconveniences or design and construction requirements.



Hot Spot in the Corpening Creek Watershed

2.2.1 Behavioral Modifications

Generally, the tendency of people is to react with skepticism or resistance to requests of them to change. For that reason, it will be difficult to achieve widespread participation in this healing strategy in the short term regardless of how simple or inexpensive the behavioral change may seem. Yet change we must. Some of the old ways of doing things, while usually not intentional, have resulted in a great deal of harm to Corpening Creek. All of us have a role in preventing pollution from entering our streams, and prevention cannot be underestimated as the most effective and efficient healing strategy available to us. The Center for Watershed Protection (CWP, 2005) has developed detailed fact sheets on many of the pollution prevention activities mentioned below.

Trash Cans and Dumpsters

Dumpsters and trash cans servicing restaurants and gas stations are often sited directly beside a stream or storm drain. A simple 3-step process can be employed by property owners or managers of these sites to reduce the risk of their wastes entering a stream.

Step 1

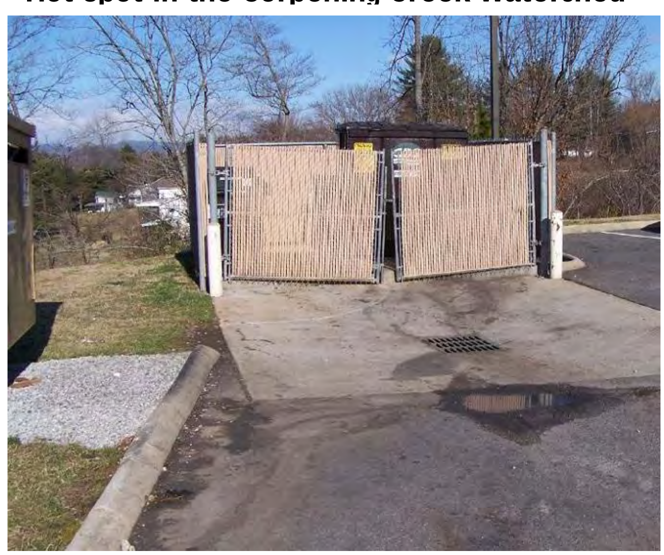
RELOCATE WASTE CONTAINER IF POSSIBLE – If the site will allow it, moving the dumpster or trash can away from the stream or storm drain will create a greater distance for contaminants to travel if a spill or leak from the container were to occur. This will allow more time for the spill to be absorbed by the ground or to dissipate in the air, keeping a greater proportion of the spill out of the creek. At some sites, it may not be feasible to move the waste container.

BUILD BERM IF NOT POSSIBLE – A small quantity of asphalt or concrete can be used to build a curb around waste containers to provide secondary containment. In most cases, this solution would cost less than $100 and a half day of time. The secondary containment would hold spills so that they could be cleaned up before they flow to the creek or storm drain.

Step 2

CLOSE LIDS - Dumpsters and trash receptacles that are left open allow rain to collect inside and percolate through discarded materials. This liquid waste can then more easily seep out of the container and flow to a creek or storm drain. Closing lids will reduce this risk.

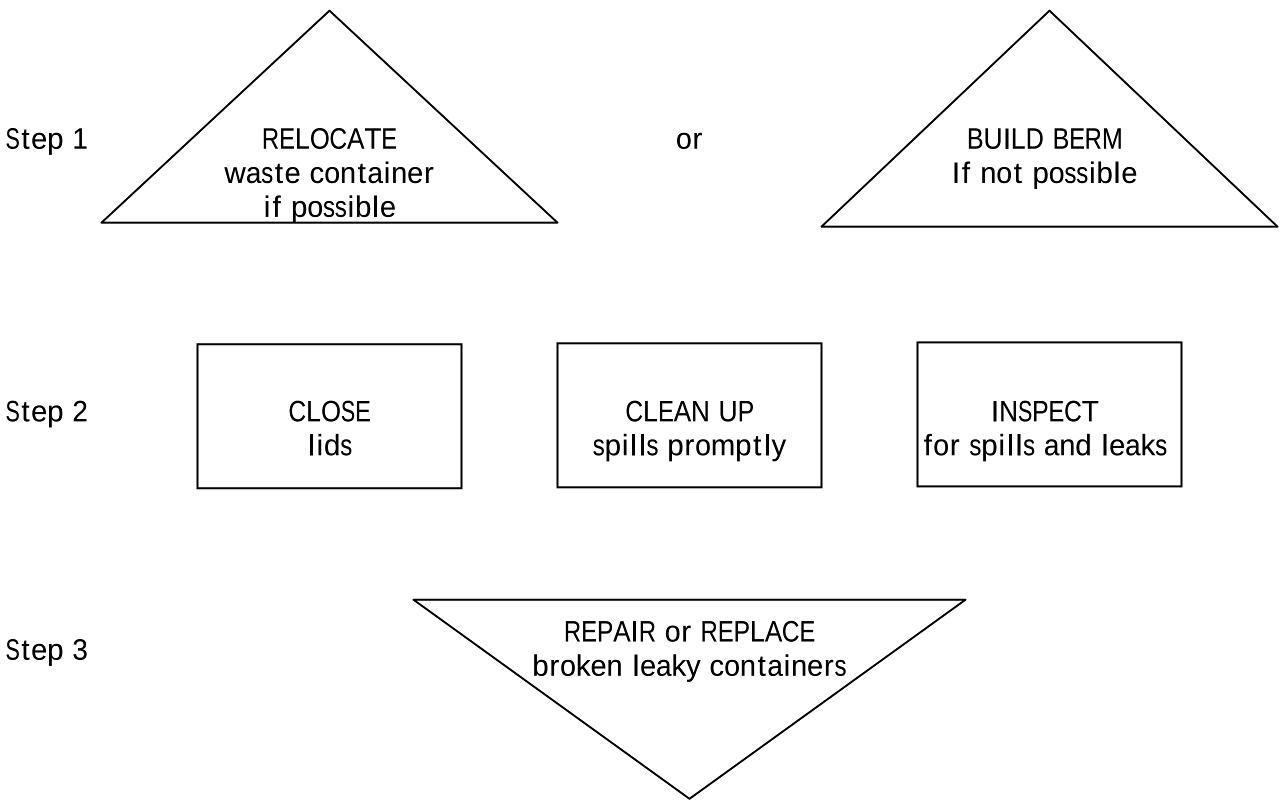
Hot Spot in the Corpening Creek Watershed



CLEAN UP SPILLS PROMPTLY – Most people practice care to avoid spills, but accidents do happen. Cleaning spills around waste containers immediately after they occur should minimize the chance for stream pollution. Spraying down the spill with a water hose will only dislodge the contaminants and transport them to a drop inlet, pipe and then to a stream. Spills need to be cleaned up with absorbents and rags that can either be thrown away with other solid waste or washed in laundry where the wastewater can be treated by the community wastewater treatment facility.

INSPECT REGULARLY – By periodically looking at and around the waste container, the owner or manager can spot spills, leaks, and seepage. Closer inspections may even reveal the drainage pathway that waste travels from the container to a drain or creek. By paying closer attention to waste disposal, property owners and site managers can see firsthand how their operations may be harming the creek. They will also be better equipped to respond to problems they might observe.

Figure 2.4 Schematic to Managing Trash Can and Dumpster Leakage



Step 3

REPAIR OR REPLACE LEAKING CONTAINERS – Waste containers that are rusted out or that have broken lids can be a real threat to a stream, particularly if they are located adjacent to that stream or a storm drain. When a waste container fails to fulfill its function of containing waste, it needs to be replaced.

<u>Automobile Service Operations</u>

Gas stations, repair shops, and washing/detailing operations present a significant threat to water quality, especially when they are located directly adjacent to a stream or storm drain. The chemicals, corrosives and petroleum products that are commonplace at these sites are highly toxic and get into the stream not only during storms but also when the sites are hosed down during cleaning. As part of the hotspot fixing strategy, this plan seeks widespread cooperation among owners and managers of such facilities to clean spills promptly with dry absorbents and disposable rags, contain their runoff, avoid using storm drains, and transfer their waste and spills to the sanitary sewer system or solid waste facility. While engineered retrofits and other solutions may be necessary at many facilities, alterations in behavior would be helpful in the short and long term.

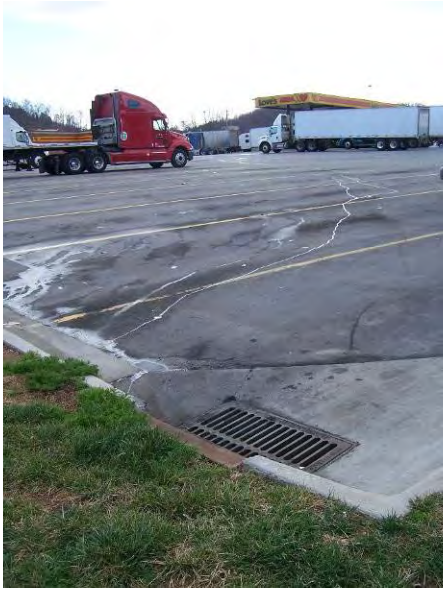
2.2.2 Engineered Treatments

Some sites, because of the frequency and intensity of traffic or lack of space available for other treatments, need engineered pollution treatment devices. The goal of this treatment is not to reduce runoff volume, as was the case with most of the stormwater BMP healing strategies discussed earlier, but is focused specifically on pollutant removal. Though relatively expensive, these treatment methods have small footprints and are suitable for sites where space is limited. Some can be located below grade.

Numerous treatment options are available, including sand filters (USEPA, 1999; Debo and Reese, 2003) as well as a variety of proprietary treatment technologies. Though it is premature to make specific recommendations, examples of commonly used proprietary hot spot treatment technologies include units manufactured by Stormceptor® (http://www.stormceptor.ca/index.html), StormTreat™ (http://www.stormtreat.com/home.htm), and Contech® (http://www.contech-cpi.com/stormwater/13). More information on proprietary technologies is available from the Stormwater Equipment Manufacturers Association (http://www.stormwaterassociation.com).

Filters

Filters provide a practical way to remove pollutants from urban runoff prior to the discharge of the runoff to the conveyance system. They are especially useful to improve water quality from highly impervious sites or pollution hotspots, though they provide only very short term storage and minimal hydrologic benefits. Filters are sometimes recommended in conjunction with other BMPs that provide hydrologic control. *Sand filters* involve filtration of runoff through a sand bed or a bed composed of organic media, which can be constructed either at ground level or underground. They are designed to treat only the first flush, which contains the most pollutants, with the remainder of larger storms bypassing the filter.



Hot Spots in the Corpening Creek Watershed

Prefabricated filters can be used to provide pollutant removal at storm drain inlets before runoff enters the conveyance system. These are either inserted in or replace existing inlets. They use either filter media or a specially designed chamber to capture and store pollutants from the first flush. Higher flows exceeding the capacity of the unit are bypassed.

The median construction cost for a perimeter sand filter constructed at grade is approximately $72,000 per impervious acre treated, not including design costs. Sand filters constructed entirely underground are considerably more expensive. Simple inlet filters that fit into existing inlets can be purchased for approximately $600, not including installation. More sophisticated filters that replace existing inlet structures generally cost $15,000 or more installed.

Figure 2.5 Examples of Hot Spot Treatment Filters

2.3 Protect Undeveloped Land

Undeveloped land - including forests, farms, meadows and other open space areas - provide a place for rainwater to absorb into the ground where it can then be discharged to streams in a slow, steady pace. The primarily forested undeveloped areas also discharge cleaner water to streams which helps to dilute polluted water from developed areas. These functions are very important to the health of Corpening Creek, considering that stormwater runoff is one of the major causes of its impairment.

These undeveloped areas also have other benefits to the stream and community. Forests provide shade to cool the stream and leaf litter and downed woody materials, which is food and habitat to aquatic wildlife. Forests protect against erosion and sedimentation. Forests and other open spaces serve as a refuge for all kinds of wildlife – not just fish and aquatic organisms. The forests on Mount Ida and Grants Mountains are also very pretty and help to define Marion's identity as a community 'Where Main Street Meets the Mountains'. There are some undeveloped places that may not be as highly visible but still have ecological and quality of life value. Some are important to existing or planned greenway or park needs.

Photos of Mount Ida, Grants Mountain, and Other Scenic Views from Marion

There is no 'one-best-way' to implement the protection strategy. That being said, it needs to proceed from a base understanding that many of these undeveloped areas are privately owned, and securing their protection will be dependent on the voluntary participation of the landowners (this is true for all of the strategies in this plan). Conversations will need to take into consideration the landowners' preferences or goals for their properties. Yet, the beauty of collaboration is employing creative thought and finding win-win solutions that help the landowner achieve his or her aims while also achieving the broader purpose of this plan to protect these relatively intact forests, meadows and open spaces. The four land protection tools discussed below can be useful in pursuing the protection strategy.

2.3.1 Fee Simple Purchase

Perhaps the simplest way to protect land, though certainly not the easiest, is to purchase the subject property outright. This takes both a willing seller and buyer operating at fair market value. The difficulty lies in raising the money to make the purchase. Options include use of state government conservation trust funds (clean water, parks and recreation, natural heritage), private grants, citizen donors, bonds, or local taxes. Money raised can be stretched further if the seller were willing to entertain a bargain sale.

2.3.2 Conservation Easements

A conservation easement is a legally binding agreement between a property owner and a qualified easement holder in which the owner voluntarily agrees to give up certain rights to the use of the property. Those rights have a financial value, but at a level that is less than fair market value. Conservation easements can be donated or sold. A donation often results in significant federal and state tax advantages for the landowners whereas a sale will provide some income. Sometimes conservation easements can be structured to where they can provide the property owner with both income and tax benefits. Properties identified in this watershed plan as protection priorities would likely qualify for a conservation easement because of the water quality, scenic, habitat or recreational benefits they provide the public.

2.3.3 Low Impact or Conservation Development

Low Impact Development was discussed earlier in this chapter as a means of managing stormwater better. Because protecting green space is a principle of LID, we have included it as a land protection tool as well. Some landowners may have property that is conducive to development and they wish to use their land in that manner. We encourage them and developers to consider the LID or even more protective Conservation Development options to help us protect portions of their properties that we have identified as important to the objectives of this plan. Sometimes, developments such as these can be combined with a conservation easement. Significant land planning and design assistance is required.

2.3.4 Non-Binding Agreements

Another simple way to protect land is through non-binding agreements with landowners. Unlike a fee simple purchase however, there is no transfer of title or anything else prohibiting the landowner from backing away from the agreement in time. For this reason, protection through this mechanism is not permanent. Some may question whether this tool protects land at all. While there is nothing legal to bind the agreement, many landowners who enter into such agreements take their ‘word-of-mouth’ commitments very seriously, and so protection objectives can be satisfied at least temporarily. Sometimes, a non-binding agreement is the first step a landowner will enter into along the way toward later entering into a conservation easement or a fee simple purchase. It can be helpful if the landowner also agrees to inform the Partnership in advance before they sell, to give the Partnership an ability to respond and perhaps secure the property more permanently.

2.4 Rehabilitate Degraded Streams and Riparian Areas

Stream incision and bank erosion are widely documented in Corpening Creek and along many of its tributaries (Appendix A). Residents and business owners have reported problems with bank erosion and would like assistance with solutions (Chapter 1). In addition to the threats to property, degraded stream channels are responsible for sedimentation and contributing to adverse scouring affects on in-stream habitat (DWQ, Equinox).

These problems are due largely to the treatment of these streams when Marion was first developed. Streams were moved out of the way and straightened to make room for houses, businesses, roads, utilities, gardens and yards. Except in very steep terrain, streams are not naturally straight and they will always seek a meandering path. Hence the bank erosion that many property owners see today. If streams cannot get out of their channels during high flows, they will dig in, which creates deeply entrenched and unstable stream environments that act something like funnels during storm events. This process is exacerbated by the growth in upstream impervious surface area from rooftops and parking lots that does not allow rainwater to infiltrate. Instead, the runoff flows through pipes and curb & gutter systems and enters these straightened stream channels much more rapidly than natural.

Unfortunately, this condition is a very difficult problem to fix. In the natural world, streams have to access their floodplains. Yet, it is common for our buildings, roads and yards to be located immediately adjacent to the stream at the top of the bank. Very little room exists for grading back banks to the widths necessary and building a new floodplain for these incised creeks. Very little room exists for planting or enhancing streamside buffers. These restrictions mean that stream rehabilitation is a practical healing strategy in only a few places. Nonetheless, we believe both full stream restoration and stream buffer enhancement to be appropriate solutions given feasible site conditions and landowner circumstances.

2.4.1 Stream Restoration

Where space does exist or where landowners are amenable to significant alterations of their landscape, full stream restoration will benefit the health of Corpening Creek. Meanders will slow streamflow velocities, which will alleviate the stress on creekbanks at the site and downstream. In-stream structures should also slow velocities and provide microhabitat the stream is currently lacking. Streamside vegetation will also help slow the stream, at least during flood events and also provide shade to cool the stream, leaf litter and woody materials to enhance habitat.

Example of Urban Stream Restoration

Such projects in an intensively developed urban area will likely not come cheap however. Nor are they without risk of being overwhelmed by stormwater runoff from upstream areas. The risks and costs involved in these urban stream restoration projects amplify the need for better stormwater management in upstream areas in concert with the stream restoration.

Examples of Urban Stream Restoration

2.4.2 Stream Buffer Enhancement

Stream buffers can be planted essentially anywhere along a stream. Homeowners can do it as a part of their landscaping. The City and County can do it as part of their standard upkeep and maintenance of parks and other public facilities. We recommend that people plant woody vegetation native to western North Carolina and at any width that they feel they can accommodate. Buffers of 25 feet or wider are preferred. Equally as important as putting plants in the ground is refraining from mowing or burning existing creekside vegetation.

Streamside vegetation will usually help hold banks together, though this is not always true in deeply incised streams like is common in the Corpening Creek watershed. In these more severe areas, tall trees can actually become undermined by bank erosion and topple over, becoming a log jam that deflects water into creek banks further exacerbating bank erosion problems. Stream buffer enhancement will generally be more effective on creekbanks that slope more gently to the stream. At these spots, the vegetation will provide the standard benefits of shade to cool the stream, rooting mass to stabilize the bank, and leaf litter and woody materials to nourish the aquatic food chain without the risks described above.

Examples of Stream Buffer Enhancement

2.5 Learn More

We have learned a lot from this watershed assessment and planning effort, and our knowledge gives us a high degree of confidence that the healing strategies we have thus far recommended will help Corpening Creek recover. But these strategies may only be part of the solution. And while we can presume, we cannot accurately predict the unintended consequences of our actions, be they positive or negative. We also don't know how many of these actions will be required or how long it will take before these activities result in a fully functioning watershed. So while we know more than we knew before we undertook this effort, there is still a lot left to learn, and as we implement projects over time we need to monitor and evaluate our work so that we can adapt our approaches to fit facts on the ground.

Several items have been identified as top priorities in the 'Learn More' strategy. This is not an exhaustive list. Other issues may warrant attention as this plan unfolds.

1. Sources of Dry Weather Pollution;
2. Pollution and Stormwater Impacts from Large Industrial and Institutional Facilities;
3. Site Specific and Cumulative Impact Monitoring of Healing Strategies

2.5.1 Dry Weather Pollution Sources

Baseflow nitrate concentrations and conductivity levels are high throughout the upper watershed in and around the downtown areas of Marion. This means that at least some of the pollution in the watershed is coming from other sources than stormwater runoff. Whether the nitrate and conductivity readings are related, and how they may bear on toxicity concerns, is not known.

Additional investigation should be conducted to determine the major sources of baseflow pollution in the Upper Youngs Fork sub-watershed, particularly upstream of Perfect Air Control. At a minimum, this investigation should include an evaluation of the extent and location of sanitary sewer line leakages, illegal discharges, and groundwater contamination.

<u>Sanitary Sewer Leakages</u>

The City of Marion has completed a comprehensive Inflow and Infiltration (I&I) Study of the municipal sewer system. The study focused on three basins of the City's system with the oldest infrastructure. The basins studied were Clinchfield, Cross Mill, and East Marion. The flow was monitored in each basin in multiple locations in order to determine flow variations. Once the data was retrieved and analyzed video camera technology was used to identify areas of compromised infrastructure. The video study uncovered repair areas in each of the three basins. The following repairs were implemented:

- In the Clinchfield basin 1324 ft of existing infrastructure was slip lined using trench-less technology. Several feet of infrastructure and failing manholes were abandoned during the listed improvements.
- In the East Marion basin 9 locations were identified for point repair. Existing failing infrastructure was replaced with new materials at each of the identified locations, including 5 manholes. Several feet of infrastructure and failing manholes were abandoned during the listed improvements.
- In the Cross Mill basin 850 ft of existing failing infrastructure was replaced with new materials. Several feet of infrastructure and failing manholes were abandoned during the listed improvements.

After the completion of the repairs the flow in each of the basins was re-studied to verify that the repairs had eliminated the I&I. The study numbers demonstrated that the improvements did address the I&I. Improved flow numbers were also recorded at the City's Corpening Creek Waste Water Treatment Plant after implementing the improvements. Since the study the City has located and mapped all aerial utility stream crossings and inspects them annually for any maintenance issues. The City does not know of any leaking aerial crossings and has not received any customer complaints about leaking waste water utilities.

The City performs routine inspections of our sewer lines on a regular basis and promptly repairs any problems that are found. In addition, the areas along Corpening Creek are highly populated. The City regularly receives complaints from residents when they observe changes in the creek. Every reported case has been due to industry upstream. Therefore, we have no reason to believe that there are leaking public sewer lines in the downtown area.

There very well could be old buildings with drains connected to the creek or buildings with drains connected to our sewer system.

<u>Illegal Discharges</u>
Illegal discharges may involve direct connections to the storm drain system through sewage cross-connections or straight pipes. Such discharges may involve indirect inputs from activities such as dumping, spills, outdoor washing activity, or flow from non-target irrigation. Discharges may be continuous, intermittent or episodic. The investigation of illegal discharges should consist of a mix of three activities:

- A review of land use and property ownership with reference to sanitary and storm sewer lines;
- Field investigations to identify lines with likely non-storm inputs. This would involve screening and monitoring of assessable stormwater outfalls to identify where in the lines illegal inputs occur.
- Dye testing and site inspections to isolate specific sources of illegal inputs to the sanitary sewer system.

On-site investigations will generally require access to private property. A specific illegal discharge investigation plan would need to be developed in collaboration with the City of Marion. For additional information on assessing illegal discharges, see Brown et al (2004) and NEIWPCC (2003).

<u>Groundwater Contamination</u>
Steps to take to assess the potential for groundwater contamination include:

1. Conduct broad–based conductivity monitoring of upper watershed to confirm surface water contamination;
2. Develop a groundwater monitoring plan for problem areas, based upon a review of the history of land use and industrial operations, regulatory databases and existing conductivity data;
3. Conduct groundwater monitoring at identified locations;
4. Follow up with on-site investigations where warranted.

Steps 3 and 4 will generally require access to private property. Once sources of pollution are identified, strategies for remediating them can be developed.

2.5.2 Industrial/Institutional Site Pollution Contributions & Stormwater Retrofit Potential

There are more than a dozen large facilities (Table 2.2) in the watershed where a hot spot investigation or stormwater retrofit survey was beyond the scope of the present assessment either because of the size of the facility or because of access constraints. Collectively, these facilities represent a substantial portion of the development in the watershed. These facilities need to be assessed for their contributions to the stormwater and pollution problems. A meaningful assessment will require knowledge of operations and access to buildings, so it will be necessary to work collaboratively with facility owners and operators. Several sites, such as Cross Mill and Marion Manufacturing, have ponds on the property that could potentially be retrofitted for stormwater treatment. Its important to remind the reader that although we have listed these properties for further assessment, that does not mean that these properties are contributing pollution to the stream. Due to the area of imperviousness on the property, they are contributors to the stormwater problems in the watershed.

Re-development of large, vacant and unused industrial sites can be a component of a broader economic development strategy for Marion and McDowell County. The USEPA sponsors a brownfields grant program to help with the assessment, remediation and re-development of these types of sites. Re-development of these sites can benefit the local governments' tax base, provide employment, and reduce development pressure on surrounding open space and forest lands. The USEPA reports that brownfield redevelopment enhances nearby residential property values by 2% to 3% and that over $18 is leveraged in other investments for every $1 of EPA brownfield grant dollar invested (epa.gov/brownfields). Anecdotal evidence also seems to be mounting that crime rates go down around recently re-developed brownfield sites. As part of the remediation and redevelopment process, the potential water pollution and stormwater impacts from these sites could be addressed.

Table 2.2 Large Facilities in the Corpening Creek Watershed Recommended for Assessment (Sheet 1 of 2)

Name	Description	Owner	Location
McDowell County Public Works	solid waste handling	McDowell County	off Hwy 226
McDowell County Large Material Collection Transfer Station	solid waste handling	McDowell County	off Hwy 226
Ind. Timber and Land Co, ILT Corp	scrap yard		
McDowell Tech	community college campus	McDowell Tech	SR 1819
Henredon Furniture	furniture distribution	City of Marion	SR 1819/Lake Taylor Rd
Spectrum Textured Yarns, Inc	textile plant	Spectrum Textured Yarns, Inc	Barnes Rd

Table 2.2 Large Facilities in the Corpening Creek Watershed Recommended for Assessment (Sheet 2 of 2)

Name	Description	Owner	Location
England Builders & Aircraft, Inc	builder & air conditioning	Grayson Dean England	260 Barnes Rd
All Mechanical & Construction	construction & mechanics	All Mechanical & Construction	108 Barnes Rd
M&T Warehousing	wood products	M & T Partnership	Hwy 226
WNC Dry Kiln Inc	wood kiln processing	WNC Dry Kiln Inc	Jacktown Rd
Marion Public Works	maintenance depot	City of Marion	off Hwy 221
Marion Manufacturing	old industrial site	Ford Miller Holding Co.	Baldwin Ave
Westwood No 2	industrial	Westwood NC II LLC	Blue Ridge St
Broyhill	wood products	McDowell County Millwork LLC	Lail St
Cross Mill site	industrial	James & Ina McKinney	Webb St

2.5.3 Site Specific and Cumulative Impact Monitoring of Healing Strategies

Many diverse stream improvement projects will be installed throughout the watershed as this plan is implemented. They will range from simple, low-cost behavioral modifications undertaken anonymously by residents to costly and complex engineered solutions in highly visible spaces. Benefits should be detectable first at the site-specific location where a project is undertaken. As a greater number of projects are installed, the benefits should accrue until measurable improvements can be detected at the watershed scale. This theory should hold true as long as watershed conditions do not deteriorate in other ways. We plan to monitor and evaluate the site specific impacts of some of our projects as a standard practice of project development, though we cannot afford to measure the improvements from all of them. We also plan to monitor and evaluate on a routine basis the condition of the watershed, including biological, hydrological and water quality criteria and indicators. The monitoring plan in Chapter 5 provides greater detail.

Chapter 3 It All Comes Down to People

While healing Corpening Creek is the purpose behind our work, it is through the people who live, work and own property in this watershed that we will succeed. The Muddy Creek Restoration Partners' approach has always been to work in a collaborative spirit with willing citizens and landowners who voluntarily choose to participate with us. We are pleased with the results we have generated thus far through this approach and the relationships we have built along the way. Since the decision to change a behavior or host a stream conservation project rests ultimately with 'others', we place a premium on our ability to connect with people and deliver resonant, persuasive messages.

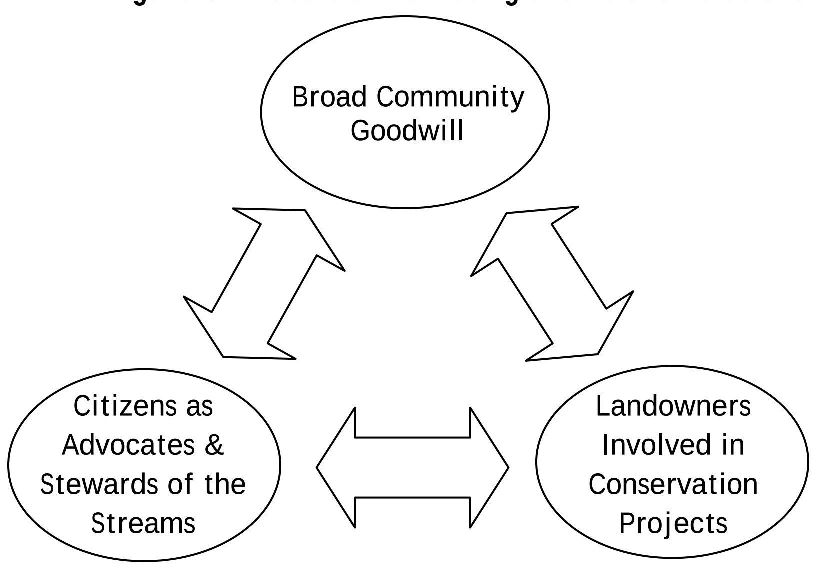
This chapter describes the central guiding concepts from which we will operate while performing marketing and public relations (also known as outreach and education). Specific educational or marketing and public relations activities and the logistical issues involved in implementing them are described in Chapter 4.

3.1 Our Three Core Goals Driving Marketing and Public Relations

We have three goals (Figure 3.1) that we want to accomplish through our marketing and PR efforts. We want to achieve:

1. Community goodwill
2. Participants in our healing strategies
3. Stewards who continuously care for Corpening Creek over the long term

Figure 3.1 Goals of Marketing and Public Relations



These goals are mutually compatible and reinforcing. A positive impression of the Partnership within the community will help produce participants in stream conservation. Satisfied participants will help generate widespread community goodwill. As a greater number of projects are successfully installed and as awareness grows of the effort to restore Corpening Creek, people will emerge as long-term caretakers of this resource. Ultimately, we want word-of-mouth advertising from members of the community saying good things about the Partnership and our work.

3.2 Success is Dependent on Relationships

We believe that these goals are realistic and achievable as long as we maintain a focus on ***relationships***. Good relationships are built on ***trust***. To win trust and sustain it, the Partnership will honor its commitments and conduct its affairs with ***integrity***. Trust is also dependent on ***open, honest and timely communications***. While we have a number of messages that we want to convey throughout the community and to individuals, we know that people naturally have questions, concerns, and a need to be heard. ***Listening*** to people will be a core value.

Patience is vital to effective marketing and public relations because it often takes a great deal of time before a landowner, for example, will elect to participate or a group of people to come around to a different way of thinking. Sometimes, it is us, members of the Partnership and our friends, allies and supporters who may need to come around to a different way of thinking. So disagreements or conflicts, while frustrating, may in all ***humility*** actually prove beneficial as they slow us down and make us consider diverse perspectives. A willingness to ***flex*** and ***adapt*** is essential, receiving and working with what conditions on the ground provide at a given moment in time. ***Persistence*** is also required to keep the marketing and public relations program working when obstacles arise and seem insurmountable. ***Faith*** and ***hope*** in the basic goodness of people and in the goodness of the purpose behind this work will help the Partnership persevere and find the common ground with all types of people that will be needed for this plan to bear much fruit.

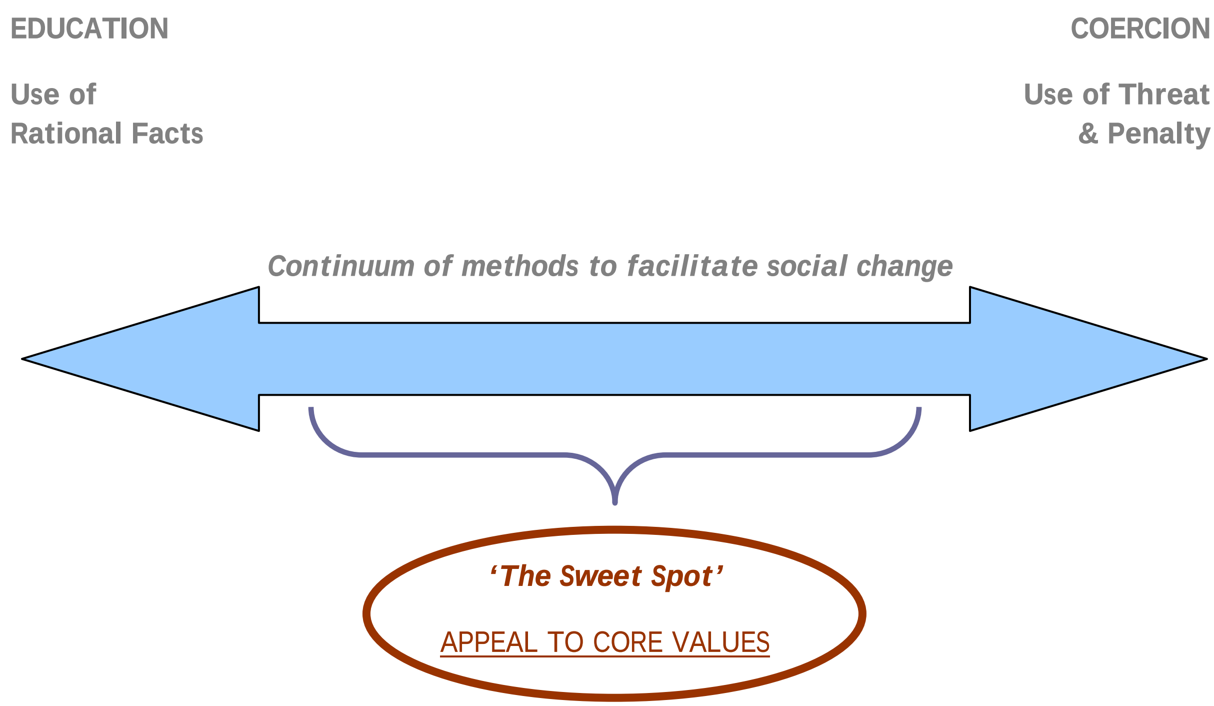
Good relationships are not one-sided affairs based on dependency. The Partnership believes in its value to Marion and McDowell County and will seek to build ***interdependent relationships*** with landowners and the broader community. The Partnership will assume the ***leadership*** role in driving the implementation of this watershed restoration plan, but we will expect others outside of the Partnership to participate and even take a leadership role when circumstances warrant.

3.3 Education is Not Enough

> *'So often people know exactly what they should be doing and why, and they still disregard what their head tells them.'*
>
> *- Jack Wilbur, Utah Dept of Agriculture & Food (2006)*

We prefer to call our outreach efforts 'marketing and public relations' rather than education. Undeniably, the Partnership is undertaking these activities in an effort to facilitate behavioral changes within the community (also known as social change). Education, however, goes only so far in its effectiveness (Wilbur et al. 2006). Behavioral changes may be a desired outcome from education, but its primary purpose is to enhance a person's intellect about a certain subject matter with the hope that once a person understands, s/he will respond in the way that is desired. Marketing, on the other hand, is designed with the express intention to motivate certain actions among a target population. Like education, a marketing approach may appeal to intellect, but it also appeals to emotion. It rests upon an assumption that most people will be more motivated to participate in a stream improvement project or change behaviors to enhance stream health when they feel an urge to do so. The scientific and technical information located throughout this planning document provides us with a great deal of useful intellectual data and information. But messages that are crafted to appeal to peoples' core values are to also be used as a means of facilitating the changes that are desired (Figure 3.2).

Figure 3.2 Appealing to Core Values to Facilitate Social Change



Based on our experience in the watershed over a number of years, we know that 'independence', 'self-reliance', 'local pride', 'taking care of our own', 'mountain culture and heritage', 'craftsmanship', and 'farming' are but a few of the core values of people from McDowell County and Marion. Another core value of most people, regardless of where they are from, is 'self-interest' – or a 'what's in it for me?' attitude. We also know that, in general, this community does not easily or quickly embrace government intervention and regulation (also known as coercion in Figure 3.2). We believe that this plan will likely garner more local support and participation as it is implemented and messages are conveyed in accordance with these core values. In sum – we seek win-win solutions between all parties, and we actively seek ways that we can build bridges between our interests in restoring Corpening Creek and the self-interests or core values of our audience.

'Belief counts for a lot, but belief isn't enough. For people to take action, they have to care.'

Chip & Dan Heath in Made to Stick (2007)

3.4 Messaging Strategy

In its appeals to the community and key individuals, the Partners may find it helpful to think in terms of the audience it is trying to reach, the message(s) that are likely to appeal to that audience, the most appropriate methods for reaching that audience, and the messenger most likely to be well-received by the audience. The Partnership held a brainstorming session using these focusing elements to identify prospective means of obtaining participation in each of the healing strategies. Tables 3.1 and 3.2 illustrate the results from that effort for promoting better management of stormwater and protecting undeveloped properties, respectively.

The messaging strategy is not complete. The Partners are not obligated to all of the ideas generated through this brainstorm. Some ideas appear to be appropriate to the task at hand, while others may not be quite as suitable. Some ideas generated for one healing strategy may prove equally as useful for all of the strategies. The Partners will go through this process yet again to refine the messages they want to convey and the processes to employ for going about that work.

3.4.1 Messaging to Promote Better Management of Stormwater

The primary objective of this messaging strategy is to influence people to host, participate in, or take action on their own stormwater management projects. The Partners have identified the following core audiences that we need to reach with this healing strategy, but the messaging strategy brainstorm depicted in Table 3.1 occurred only for the Business and Residential audiences.

- Businesses – This audience includes a) downtown business owners and owners of commercial properties in downtown Marion; and b) business owners and owners of commercial properties on the Highway 221 corridor.
- Residents – This audience includes a) residents and owners of residential properties in neighborhoods in general; and b) residents and owners of residential properties directly adjacent to streams.
- Government – This audience includes a) McDowell County and b) the City of Marion, both of whom own and manage property in the watershed and also serve on the Partnership. It also includes the c) McDowell County Schools; d) NC Department of Transportation; and e) NC Department of Corrections.
- Students – There are 3 schools in the watershed. This audience needs to be reached because of their ability to help the Partners carry the message forward and be a catalyst to action with their parents and relatives and the schools in which they attend.
- General Public – This audience includes every resident who lives in the Corpening Creek watershed, property owners and non-property owners alike. This group is important for the widespread community goodwill that we need in order to maintain political support and word-of-mouth advertising.
- Other Groups with Common Interests – This audience includes civic groups, church groups, garden clubs, etc. who can be friends, allies, and contributors to our efforts.

Of the different methods of delivery listed in Table 3.1, the Partners have thus far expressed preferences for One on One Outreach and Discussions, Web Page and Social Media Outlets, Speaker Programs at Civic Clubs, and an Awards and Recognition Program for Green Businesses, Neighborhoods, and Residents. These outreach activities are discussed further in Chapter 4.

Table 3.1 Messaging Strategy for Recruiting Business and Home Owners into Stormwater BMP Retrofit Projects

AUDIENCE	MESSAGE TO BE DELIVERED	METHOD OF DELIVERY	MESSENGER
Business Owners	• Your participation is a 'green business' marketing opportunity • These projects can help beautify your property, which = more appeal/attraction to customers and improved property value • These projects can reduce maintenance & repair costs • Projects will possibly help reduce flooding & standing water over the long-term • More trees = more shade = lower energy usage and lower costs • Trees reduce noise • Projects help create open space, which attracts people to downtown and associated businesses • Don't dump your stormwater into the City's stormwater system – it overwhelms us • Let it soak in • Action now could preclude government mandates later (i.e. 'Rain Tax')	• Government TV channels – infomercials • One-on-One outreach & discussions with key individuals • Web page and blog linked to County and City websites • Social Media – U Tube Videos, Facebook, Twitter, DIY • Grassroots – this Partnership as a partner in collaboration with the community not the authority giving directives • 'Green Business' and 'Green Resident' Award • Newspaper • Brochures, Door Hangers, Fliers • Mountain Glory Festival Booth • Other Civic Events • Speaker Programs at Civic Clubs – Rotary, Kiwanis, Lions, Garden Clubs	• Marion Business Association • Chamber of Commerce • McDowell Trails • Master Gardeners • Members of the Partnership • NC Cooperative Extension • EcoVan • Partnership Coordinator • Equinox
Homeowners and Residents	• Let it soak in • Action now could preclude mandatory action later • Take responsibility now – avoid a 'Rain Tax' later • Beautify your property • Rain barrels = Lower water usage and fees from City utility • Other benefits of rainwater versus treated water to the landscape • Reduce lawn and enhance use of native trees and shrubs = time and money savings from less mowing • Redirect downspouts into lawn or wooded landscape • Use swales and berms to divert rooftop and driveway runoff into woods for infiltration • Protect your foundation and basement from water encroachment and mold and mildew		

3.4.2 Messaging to Promote Alleviation of Hot Spots

The primary objective of this messaging strategy is to influence people to change behaviors so that cooking oil, grease, chemicals, and petroleum products are well contained and do not inadvertently find their way to storm drains and creeks during routine work, cleanup and waste disposal. The Partners have identified the following core audiences that we need to reach with this healing strategy:

- Businesses – This audience includes owners or operators of: a) Restaurants; b) Convenience Stores & Gas Stations; c) Automobile Service & Repair Stations; d) Auto Salvage Yards; and e) the Norfolk Southern and CSX Railroads.
- Government – This audience includes maintenance directors and facility managers of: a) McDowell County Solid Waste; and b) City of Marion Wastewater Treatment; c) City of Marion Public Works; d) City of Marion Code Enforcement; and e) NC Department of Transportation complex. Additionally, we feel that f) the NC Cooperative Extension Service could play a role in helping provide technical assistance and instruction about better management practices at some facilities.
- Keep McDowell Beautiful – This audience has much in common with the Partnership, especially regarding waste disposal, and we believe that this group can help in this marketing and PR campaign.
- Students – There are 3 schools in the watershed. This audience needs to be reached because of their ability to help the Partners carry the message forward and be a catalyst to action with their parents and relatives and the schools in which they attend.
- General Public – this audience includes every resident who lives in the Corpening Creek watershed, property owners and non-property owners alike. This group is important for the widespread community goodwill that we need in order to maintain political support and word-of-mouth advertising.

The message(s), method of delivery and messenger remain to be developed for hot spot alleviation.

3.4.3 Messaging to Promote Rehabilitation of Degraded Streams and Riparian Areas

The primary objective of this messaging strategy is to secure participation by private landowners into stream restoration projects or to take efforts on their own to plant and maintain streamside vegetation. Because space is limited for full restoration due to the dense concentration of roads and people's homes, yards, and driveways, marketing for this objective need only occur with landowners at a few specific locations. However, stream buffer enhancement can occur essentially anywhere, and so marketing messages will need to account for the widespread audience that will need to be reached. The Partners have not yet brainstormed the messaging strategy for this effort.

3.4.4 Messaging to Promote Protection of Large Tracts of Undeveloped Land

The primary objective of this messaging strategy is to persuade owners of these open spaces to keep them in their forested, agricultural, or otherwise undeveloped state and if that is not feasible, then to pursue a more environmentally sensitive development pattern such as Low Impact Development or Conservation Development. Another objective is to encourage management of these undeveloped lands in a manner that is consistent with the water quality and community beautification objectives of this plan. Audiences include:

- Landowners of Priority Lands (primarily Mount Ida and Grants Mountain) – This audience includes owners of undeveloped tracts 30 acres or greater. There are owners of smaller tracts that could also be included in this marketing effort.
- Developers and Realtors – This audience includes those people who maintain a pulse on property sales and development activities.

- Utility Companies – This audience includes Duke Energy and Rutherford Electric Association, both of whom are responsible for managing utility rights of way. The audience also includes the CSX and Norfolk Southern railways that operate and maintain rail lines in the watershed.
- Other Groups with Common Interests – This audience includes: a) McDowell Trails Association; b) the Business Community, both of whom will benefit from the protection of scenic and open space values in the Corpening Creek watershed.

Due to the sensitive nature of the land protection strategy, the method of delivery of any message will essentially be one-on-one. The messengers and network of people who can introduce messenger(s) to landowners is critically important.

Table 3.2 Messaging Strategy for Recruiting Property Owners into Protection Projects

AUDIENCE	MESSAGE TO BE DELIVERED	METHOD OF DELIVERY	MESSENGER
Landowners	• Why their land is important to the health of Corpening Creek • Why this land is important to Marion's community identity • Convey our interest in purchasing if circumstances warrant • Our all-voluntary and collaborative approach to conservation • Listen to their goals for their properties • Financial / Tax benefits of conservation easements • Financial advantages of Low Impact Development or Conservation Development versus traditional development	• One on One Conversations	• Marion Business Association • Chamber of Commerce • McDowell Trails • Key Partnership Members • Coordinator of Partnership • Equinox • Foothills Conservancy
Developers & Realtors	• Why this land is important to the health of Corpening Creek • Convey our interest in purchasing if circumstances warrant • Request to be kept in the loop about potential property transactions • Financial / Tax benefits of conservation easements • Financial advantages of Low Impact Development or Conservation Development versus traditional development		
Utilities & Railroads	• Why this land is important to the health of Corpening Creek, scenic integrity of Marion, and recreational needs of the community • Request a management approach to ROWs that is consistent with the objectives of this plan		
McDowell Trails / Business Community	• Why this undeveloped land is important to their self - interests • Request their participation as advocates, friends, allies of our efforts to protect this land • Request certain peoples' participation with us as 'messengers' to other audiences		

Chapter 4 Implementing the Healing Strategies

This plan probably has a life span of 15 years. The healing strategies we recommend are relevant to watershed conditions as we currently understand them. As we implement projects and as Marion grows, changes will occur on the landscape that will both benefit and place more stress on the stream system. Restoration technologies also will change. With monitoring and more study, our understanding of the issues affecting the ecological health of Corpening Creek should improve over time. There are also social, political, and economic changes that will likely occur both inside and outside of the watershed that will have some affect on our work. All of this means that while we may have a vision that might require decades to unfold, we hesitate to outline specific action items to be undertaken beyond 15 years, a timeframe within which we can see into with some degree of confidence. At the 15 year threshold, if not before, an update to this watershed restoration plan will be needed. Until then, there is undoubtedly a lot of good, important work to do right now that will help Corpening Creek begin to recover.

While we have identified a 'manageable' list of five healing strategies in this plan, we have actually generated dozens of site-specific project ideas that fall within the strategies. Those project lists are presented in this chapter along with corresponding maps showing project locations. As projects are implemented, they should produce stream health benefits in and immediately downstream of the project location. As the number of completed projects grows, these site-specific benefits will accumulate and ultimately produce improvements in the health of the Corpening Creek watershed as a whole. We have established a stream monitoring program to document the site specific and cumulative impacts of our watershed restoration efforts over time. Finally, watershed stewardship will be a critical activity necessary to protect the community's investments in restoring the Corpening Creek watershed.

In each project list, we have identified a handful of higher priority projects to undertake. These have been classified as priorities for good reason. We will focus on them, but not to the neglect of other opportunities. We will simultaneously work on an opportunistic basis with landowners and residents of any project site we have identified in our plan who are willing to work with us. We will work with anyone who brings a project opportunity to our attention when it fits within our overall strategy. Our goal in this first 15 years is to be as inclusive as possible while pursuing certain projects that we believe have clear importance. After 15 years perhaps we will have met with such success that we can afford to be more selective with our priorities. For now, any project identified in this plan is a good and meaningful project worthy of the Partnership's attention.

Realistically, we are aware that not all of this plan can be implemented within the next 15 years, particularly if the Partners are required to implement every project. The costs for all of the projects we've identified are prohibitive; there is just not enough grant money out there to pay for all of this. Even if it were feasible to raise revenues from local taxes or fees, we would still likely come up short. Also, coupling our voluntary-and-collaborative approach in developing projects with the sheer number of project ideas we've generated, 15 years does not afford enough time to win the trust and secure the commitments from landowners of each potential project site. All of this underscores the critical importance of the Partners' marketing and public relations (education and outreach) efforts. For us to succeed, our messages must generate numerous individuals who share our commitment to healing the

Corpening Creek watershed and agree to undertake the actions we have identified on their own initiative.

Our implementation of the Corpening Creek Watershed Plan can be illustrated as follows:

Figure 4.1 Corpening Creek Watershed Management Plan Implementation Flow Diagram

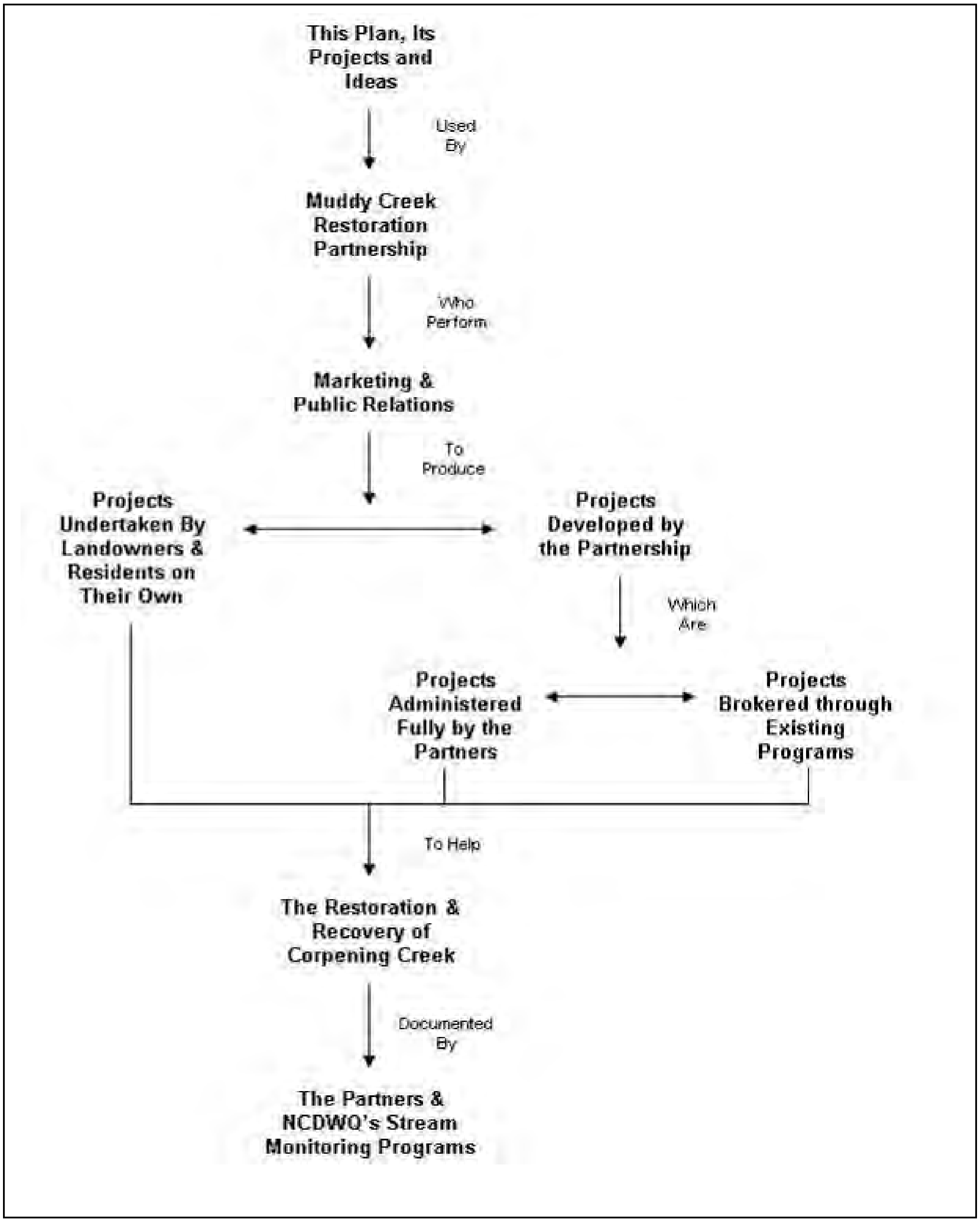


Table 4.1 summarizes our strategies and attempts to quantify to a degree that is practicable the pollutant and stormflow volume reduction benefits that we expect to gain if this plan were fully implemented. These calculations are also intended to help satisfy US EPA's plan element #3.

Table 4.1 Quantified Stressor Reduction Benefits Expected from Management Strategies

Management Strategies	# of Projects / Goal	Stressor Reduction Benefits: StormH2O Volume – Per Event	StormH2O Volume – Annual	Annual Pollution Reductions – N	Annual Pollution Reductions – P	Annual Pollution Reductions – Sed	Annual Pollution Reductions – Tox	Habitats Improved
Manage Stormwater Better								
* Simple BMPs	50% participation in UYF 25% Participation Elsewhere	1.4M Gal	Not Yet Quantified					Not quantifiable but downstream benefits expected
* Engineered BMPs	31 Projects Total 15 Projects in 15 Years	8.9M Gal	77.5M Gal	239 lbs	76 lbs	13.4 tons	Unknown	
* Low Impact Development	No Goal Established 2 Projects in 15 Years	Benefits dependent upon actual sites and design/details. Not quantifiable at this time.						
Fix Hot Spots of H2O Pollution	33 Projects Total 75% Participation in 15 Years	Little or no expected benefit		Unquantifiable at this time. Hot spots are suspected as major contributor of toxins.				Not Applicable
Protect Undeveloped Land								
* Large Tracts >30 Acres	32 Tracts Total 75% Participation in 15 Years	Benefits are difficult to quantify. This strategy is designed to help keep stormwater and pollution problems from getting worse, while also helping to maintain some existing habitat integrity. Some volume benefits might occur as older aged stands of forests mature, which theoretically will help store rainfall.						
* Small Tracts 5 - 30 Acres	64 Tracts Total No Participation Rate Established							
Restore Degraded Streams								
* Engineered Restoration and Stabilization	8 Projects Total 3 - 5 in 15 Years/ After BMPs	Not quantified yet, but some volume benefits expected due to storage		Not quantified yet, but some nutrient reductions expected		2,000 - 8,000 tons annually		>70 score at project sites\ >65 at baseline monitoring sites
* Riparian Reforestation	23 Projects Total 100% Participation in 15 Years							
Learn More * Dry Weather Pollution * Institutional Facilities * ID Specific Toxins * Monitor, Evaluate, Adaptat		These projects will help refine our ability to identify pollutants and their sources with greater specificity and quantify pollutant load reduction estimates						

The need for this plan was established in Chapter 1. Solutions, or healing strategies, to address these needs were discussed in Chapter 2. The findings of our watershed assessment are documented in Appendix A, which we believe substantiate our conclusions about watershed conditions and justify the solutions we recommend. Our Marketing and Public Relations (aka Education and Outreach) approach was illustrated in Chapter 3. Specific projects and implementation ideas are shared here in Chapter 4 and are organized according to healing strategy. As a reminder, the five healing strategies include:

1) Manage Stormwater Better
2) Fix Hot Spots of Water Pollution
3) Protect Undeveloped Land
4) Restore Degraded Streams and Riparian Areas
5) Learn More About How Best to Heal the Stream

The expected benefits of the healing strategies, costs, and implementation targets are discussed. **For convenience, the action plan and implementation schedule tables for each strategy are presented in separate sections (4.8 and 4.9).** The details of our monitoring program are described in Chapter 5.

4.1 Manage Stormwater Better

Managing stormwater better is a foundational healing strategy for two reasons. One, these projects address both of the primary problems that we believe are responsible for the degradation of Corpening Creek – the problem of ***too much pollution*** and ***too much water too fast*** in the creek after storms. Stormwater BMPs offer a way to simultaneously remove pollutants that are poisoning the stream and help reduce storm surges in the creek that are scouring instream habitat, eroding creekbanks, and damaging adjacent property. The second reason is that it will prove very difficult to restore streams and address streambank erosion problems unless the upstream stormwater in the downtown and immediate vicinities, which is largely responsible, is controlled. Citizens owning land adjacent to creeks have voiced complaints about property loss and damage associated with streambank erosion. We want to help these people, but any engineered solution at the problem area is at risk of being overwhelmed by runoff from big storms and ultimately failing. Even if we are successful at temporarily stopping the erosion at the problem site, the problem typically doesn't go away as much as it simply gets transferred to another nearby property owner. This second issue does not mean that we should delay our attempts to restore streams in the lower reaches of the Corpening Creek watershed or its tributaries, but it does mean that we need to weigh the risks before we proceed. Restoration designs in the lower reaches of the watershed must account for high upstream imperviousness and associated high volumes of stormwater runoff. For this reason, managing stormwater in the headwaters of the Corpening Creek watershed should be given high priority.

4.1.1 Simple BMPs

We desire widespread implementation of simple BMPs – in residential neighborhoods, in the downtown area, along the commercial Rutherford Road (US 226/NC 221) corridor, and at industrial and institutional facilities. This solution consists of the following types of projects:

- Downspout Re-routing
- Rain Barrels and Cisterns
- Dry Creek Beds
- French Drains

Generally, these are relatively low-cost solutions that most property owners can implement on their own or with minimal design and construction assistance. Most of the costs will be born by property owners and residents, though we anticipate spending $25,000 on incentive and cost-share programs. That amount is in addition to the extensive amount of education and marketing we plan to undertake.

We have set an ambitious goal of achieving a 50% rate of participation within 15 years at all businesses, homes, and institutional facilities in the headwater reaches of the Corpening Creek watershed. This area is labeled the Upper Youngs Fork subwatershed in Figure A-2. Elsewhere in the watershed our goal is to get 25% of the landowners to participate in installing these BMPs. We have prioritized the upper reaches of the Corpening Creek watershed for greater rates of participation because of location and need. These sites are upstream of most of the stream restoration we recommend and the amount of impervious surface in these areas is extraordinary. To advance our goal, we plan to initiate a comprehensive community outreach campaign focusing on this one strategy. We estimate that this outreach campaign will cost $10,000 in cost-share and incentive programs and part of our coordinator's time specifically devoted to this issue.

Figure 4.2 graphically illustrates the significance of imperviousness in a small catchment within the Upper Youngs Fork subwatershed. This catchment is 285 acres; approximately 36% of the area is covered with impervious surfaces comprised of homes and buildings, sheds and other accessory structures, driveways, parking lots, and roads. Unless rain falls on yards and the few undeveloped properties, it has nowhere to go except into a curb and gutter that transports it rapidly to the stream. If through our BMP outreach campaign we can get 50% of the property owners to help us capture, hold, and provide for infiltration of the 1st inch of rainfall we can reduce stormwater runoff from this subwatershed by 1.4 million gallons per storm event. If this were accomplished over the entire Upper Youngs Fork subwatershed, a significant reduction in peak stream flows would be achieved.

Figure 4.2 Imperviousness of example catchment in Upper Youngs Fork

Catchment Imperviousness Statistics

- 285 acres in size
- 182 acres of grass, forest & other vegetation
- 36% or 103 acres of imperviousness
  1) 34 acres of homes and buildings
  2) 28 acres of roads
  3) 42 acres of driveways & accessory structures
- Treating 1st inch of rainfall from 50% of impervious surface results in 1.4 million gallon reduction in runoff

4.1.2 Engineered BMPs

We have identified 31 stormwater BMP retrofit sites (Figure 4.3; Table 4.2). All of them combined are estimated to cost approximately $2.77 million to implement. The engineered BMPs associated with the sites include:

- Bioretention (aka rain gardens)
- Constructed Wetlands (aka stormwater wetlands)
- Permeable Weirs
- Underground Storage Devices
- Stormwater Sand Filters
- Water Quality Swales
- Rain Barrels

In many of the project sites, we are proposing a treatment train consisting of two or more of these BMPs. The filter and rain barrel solutions also have relevance in other strategies.

Engineered BMP projects will not only moderate stormwater runoff volumes, but they will also remove toxins, nutrients, and sediment from the runoff. Pollutant load reductions we expect to achieve if all recommended engineered BMPs are implemented are shown in Table 4.1.

Table 4.2 Estimated Pollutant Load Reductions from Implementation of Engineered Stormwater BMPs in the Corpening Creek Watershed

Watershed Status	Nitrogen (lbs/yr)	Phosphorous (lbs/yr)	Sediment (tons/yr)	Toxins	Volume
Pre-BMP	18,349	2,853	404	High	High
Post-BMP	18,110	2,777	391	High	High
Total Reduction	239	76	13.4	Low	Low
% Reduction	1.3%	2.7%	3.3%	Low	Low

The pollutant reductions achieved are relatively small considering the amount of pollution that likely enters the stream annually across the entire watershed. However, engineered BMPs will also provide infiltration of stormwater, reducing the volume of runoff that gets into creeks after a storm. This will protect stream habitat against the scouring forces of surges in stream flow and reduce associated streambank erosion. Combined, the pollutant and stormwater volume reductions make the cost per benefit more palatable. The expected low cumulative benefits depicted in Table 4.2 can be discouraging, but we must remember that these projects are only one aspect of one healing strategy. It will take all healing strategies combined to produce the cumulative watershed benefits that will allow Corpening Creek to begin to heal itself. We are also reminded that natural systems like streams do not usually behave in a linear fashion, and we are not yet equipped to predict actual benefits to be gained from our projects. These projects will undoubtedly help us reduce the impacts from stormwater, and many of them are located in areas where they will also help beautify our community.

We want to construct at minimum 1 BMP project per year for each of the next 15 years, which means that we may address only half of the sites on our list. Considering cost and landowner agreements needed, we believe that 15 projects is an ambitious but reachable goal. We have prioritized a handful of projects for the immediate positive impact that they could have as well as their ability to help with aesthetic beautification of the community. Priority locations include: Marion Police Department, McDowell County Jury Parking Lot, McDowell Emergency Management Services, Downtown Church School, Hook and Anchor Seafood Restaurant, and other sites along the US 221 Rutherford Road corridor.

Figure 4.3 Stormwater BMP Retrofit Sites

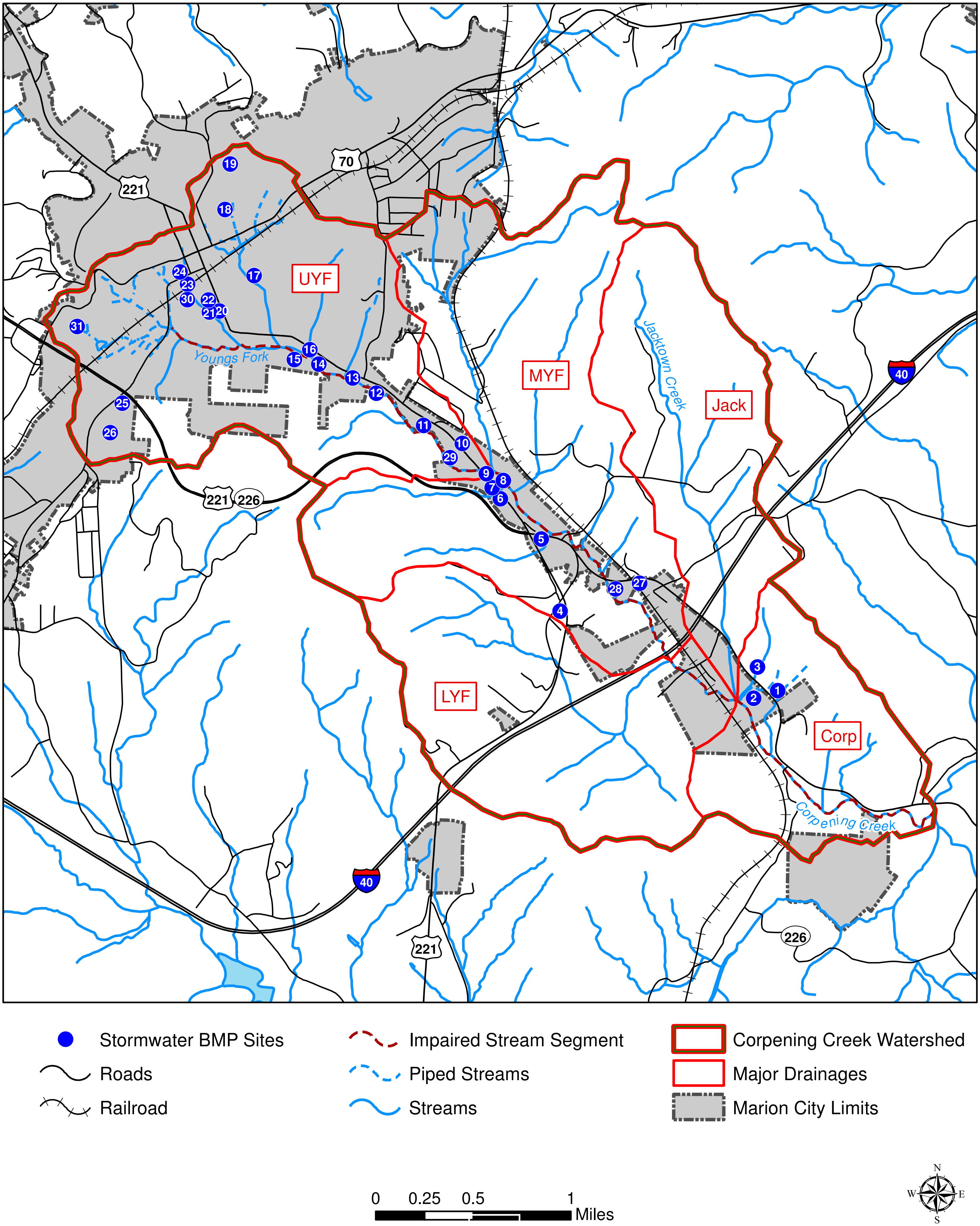


Table 4.3 Engineered Stormwater BMP Site Data (Sheet 1 of 5)

Site ID	BMP ID	Site Name	BMP Surface Area (sq ft)*	BMP Type*	Receives Stormwater from Upgradient BMP ID*	BMP Drainage Area (acres)	Impervious Area Treated (acres)	Impervious Area Treated (%)
1	**site totals**	**NCDOT District Maintenance Facility**	**111,194**			**54.4**	**40.26**	**74%**
	A		2,694	Underground storage, inlet filter		3.9	2.60	66%
	B		2,800	Underground storage, inlet filter		3.4	1.52	44%
	C		758	Underground storage, inlet filter		2.4	1.85	78%
	D		13,637	Bioretention, swale, sand filter		6.7	5.04	76%
	E		7,275	Bioretention, water quality swale		4.8	2.76	57%
	G		2,827	Water quality swale		2.1	0.05	2%
	H		854	Bioretention island		0.7	0.53	76%
	I		8,698	Bioretention		0.8	0.39	47%
	J		4,370	Bioretention		0.3	0.21	63%
	K		4,620	Bioretention		0.7	0.35	48%
	L		*29,438*	*Bioretention, water quality swale*	*H, D & E*	*12.9*	8.56	67%
	M		*111,194*	*Constructed wetland*	*Entire site*	*54.4*	16.38	30%
2	**site totals**	**Marion Waste Water Treatment Plant**	**32,587**			**6.0**	**4.68**	**78%**
	A		17,733	Constructed wetland		2.8	1.87	65%
	B		1,649	Bioretention		0.2	0.24	100%
	C		3,352	Bioretention		0.9	0.90	100%
	D		9,853	Constructed wetland		2.0	1.68	83%
3	**site totals**	**McDowell County Transfer Station**	**27,121**			**53.6**	**3.71**	**7%**
	A		3,455	Constructed wetland		31.6	1.62	5%
	B		5,396	Constructed wetland		13.2	0.00	0%
	C		*27,121*	*Constructed wetland*	*Entire site*	*53.6*	3.71	7%

Table 4.3 Engineered Stormwater BMP Site Data (Sheet 2 of 5)

Site ID	BMP ID	Site Name	BMP Surface Area (sq ft)*	BMP Type*	Receives Stormwater from Upgradient BMP ID*	BMP Drainage Area (acres)	Impervious Area Treated (acres)	Impervious Area Treated (%)
4	**site totals**	**Chapel Hill Baptist Church**	**65,983**			**20.4**	**4.36**	**21%**
	A		3,489	Bioretention		2.9	1.38	47%
	B		*65,983*	*Constructed wetland*	*A*	*20.4*	4.36	21%
5	**site totals**	**Club Fitness Gym**	**5,019**	**Bioretention**		**1.2**	**0.66**	**57%**
6	**site totals**	**Video Advantage**	**2,828**			**0.3**	**0.30**	**93%**
	A		1,137	Bioretention		0.2	0.16	88%
	B		1,691	Bioretention		0.1	0.15	100%
7	**site totals**	**Countryside BBQ**	**6,111**			**0.4**	**0.39**	**100%**
	A		1,088	Bioretention		0.1	0.13	100%
	B		5,023	Bioretention		0.3	0.26	100%
8	**site totals**	**Carolina Interiors**	**4,377**			**1.0**	**0.97**	**96%**
	A		3,170	Bioretention		0.4	0.36	100%
	B		1207	Swale enhancement		0.7	0.61	93%
9	**site totals**	**McDowell Cornerstone Credit Union**	**3,536**			**0.5**	**0.50**	**93%**
	A		2,011	Constructed wetland		0.3	0.31	92%
	B		1,525	Bioretention		0.2	0.20	95%
10	**site totals**	**Toolcraft**	**1,177**	**Bioretention**		**0.7**	**0.62**	**94%**

Table 4.3 Engineered Stormwater BMP Site Data (Sheet 3 of 5)

Site ID	BMP ID	Site Name	BMP Surface Area (sq ft)*	BMP Type*	Receives Stormwater from Upgradient BMP ID*	BMP Drainage Area (acres)	Impervious Area Treated (acres)	Impervious Area Treated (%)
11	**site totals**	**Jalepeno Fresh Grill**	**5,861**			**0.8**	**0.75**	**95%**
	A		1,106	Bioretention island		0.2	0.12	79%
	B		3,537	Bioretention		0.4	0.35	98%
	C		1,218	Bioretention		0.3	0.28	99%
12	**site totals**	**Eddie's Pizza & Pasta**	**4,321**	**Bioretention**		**0.6**	**0.58**	**97%**
13	**site totals**	**Bantam Chef**	**3,596**			**0.5**	**0.41**	**74%**
	A		1,940	Bioretention, swale enhancement		0.4	0.31	84%
	B		*3,596*	*Bioretention*	*A*	*0.5*	0.41	74%
14	**site totals**	**Hook & Anchor Family Seafood**	**7,147**			**2.0**	**1.95**	**99%**
	A		3,508	Bioretention		0.5	0.47	99%
	B		1,635	Bioretention island		0.6	0.56	100%
	C		2,004	Constructed wetland		0.9	0.92	97%
15	**site totals**	**Perfect Air Control**	**62,525**			**6.4**	**5.21**	**81%**
	A		14,638	Bioretention		1.3	1.22	97%
	B		4,197	Bioretention		0.4	0.31	86%
	C		2,565	Bioretention		0.7	0.59	89%
	D		2,840	Bioretention		0.2	0.13	66%
	E		10,335	Bioretention		0.8	0.82	100%
	F		3,834	Sand filter		0.5	0.44	96%
	G		4,765	Bioretention		0.6	0.62	100%
	H		*29,686*	*Constructed wetland*	*E*	*2.9*	1.90	66%

Table 4.3 Engineered Stormwater BMP Site Data (Sheet 4 of 5)

Site ID	BMP ID	Site Name	BMP Surface Area (sq ft)*	BMP Type*	Receives Stormwater from Upgradient BMP ID*	BMP Drainage Area (acres)	Impervious Area Treated (acres)	Impervious Area Treated (%)
16	**site totals**	**KG's Quick Stop**	**5,660**			**7.4**	**2.03**	**27%**
	A		691	Underground storage, inlet filter		5.2	1.16	22%
	B		651	Underground storage, inlet filter		2.2	0.85	39%
	C		*5,660*	*Constructed wetland*	*A & B*	*7.4*	2.03	27%
17	**site totals**	**McDowell County Rescue Squad**	**11,559**	**Constructed wetland**		**2.8**	**1.06**	**38%**
18	**site totals**	**New Manna Christian School**	**18,459**			**6.4**	**6.11**	**95%**
	A		4,517	Extended detention (permeable weir)		1.2	0.43	36%
	B		*13,155*	*Constructed wetland*	*A*	*4.0*	0.90	22%
	C		5,304	Bioretention		5.0	2.17	44%
19	**site totals**	**Eastfield Elementary School**	**9,732**			**25.5**	**3.80**	**15%**
	A		308	Rain barrels		0.3	0.33	96%
	B		1,759	Bioretention		0.2	0.20	99%
	C		*6,734*	*Extended detention (permeable weir)*	*A,B, & F*	*20.2*	2.05	10%
	D		1,160	Extended detention (permeable weir)		2.2	1.21	54%
	E		1,838	Extended detention (permeable weir)		3.0	0.53	18%
	F		1,114	Bioretention		9.8	0.64	6%
20	**site totals**	**McDowell County School District**	**472**	**Underground storage, inlet filter**		**0.3**	**0.31**	**100%**
21	**site totals**	**Nevant Orthodontics**	**1,727**	**Bioretention**		**0.3**	**0.34**	**100%**

Table 4.3 Engineered Stormwater BMP Site Data (Sheet 5 of 5)

Site ID	BMP ID	Site Name	BMP Surface Area (sq ft)*	BMP Type*	Receives Stormwater from Upgradient BMP ID*	BMP Drainage Area (acres)	Impervious Area Treated (acres)	Impervious Area Treated (%)
22	**site totals**	**Marion Police Department**	**7,105**			**2.9**	**2.16**	**75%**
	A		*3,283*	*Bioretention*	*B*	*2.0*	1.48	74%
	B		1,035	Bioretention		0.4	0.27	67%
	C		*3,822*	*Bioretention*	*D*	*0.9*	0.69	79%
	D		1,768	Bioretention		0.3	0.32	94%
23	**site totals**	**The Marion Depot**	**3,273**	**Underground storage, inlet filter**		**2.1**	**2.06**	**100%**
24	**site totals**	**RockTenn Packaging**	**8,367**			**3.4**	**3.34**	**97%**
	A		382	Bioretention		0.2	0.17	100%
	B		7,985	Underground storage		3.3	3.17	97%
25	**site totals**	**US-226 Exit Ramp**	**16,419**	**Bioretention**		**6.5**	**2.12**	**33%**
26	**site totals**	**Mt. Moriah Baptist Church**	**2,635**			**0.4**	**0.31**	**75%**
	A		676	Extended Detention/Bioretention		0.2	0.06	37%
	B		*2,635*	*Bioretention*	*A*	*0.4*	0.31	75%
27	**site totals**	**Vacant Building**	**4,807**	**Constructed wetland**		**1.4**	**1.34**	**99%**
28	**site totals**	**Gurley's Motors**	**1,401**	**Bioretention**		**0.6**	**0.57**	**92%**
29	**site totals**	**Triple M Express Lube**	**11,449**	**Bioretention**		**1.4**	**1.12**	**80%**
30	**site totals**	**Carwash on Railroad & Morgan St.**	**784**	**Bioretention**		**0.2**	**0.23**	**100%**
31	**site totals**	**Crossmill City Park**	**1,410**	**Constructed wetland**		**13.5**	**3.15**	**23%**

*Items in italics are part of a treatment train and receive treated stormwater from an upgradient BMP.

4.1.3 Low Impact Development and Green Roofs

We want to see at least two green roofs and two low impact development projects be implemented within the next 15 years. These types of projects will also help address stormwater runoff problems. The Partnership's role on this project will be primarily educational and advocacy. We do not anticipate incurring other than ancillary costs for literature and time from the coordinator. Costs (and savings) will be born by the developer.

We will encourage the City of Marion and McDowell County to adopt these building practices on any new or refurbished facility construction projects and to include these architectural and site design approaches in their community development planning documents. The Partnership will serve primarily an educational role - helping local government officials, developers, realtors and the owners or lessors of large institutional properties understand both the ecological and economic benefits of these property development techniques. We will explore the feasibility of and encourage, when appropriate, brownfield redevelopment of some of the institutional facilities in the watershed, making use of LID and green roof technologies.

4.2 Fix Hot Spots of Water Pollution

We have identified 33 hot spots of likely water pollution (Figure 4.4; Table 4.3). These are gas stations, restaurants, institutional and industrial properties, farm and garden supply operations, and other commercial facilities where storage and disposal of chemicals and wastes occur directly adjacent to storm drains or streams and containment appears to be inadequate. Fixing hot spots will address the toxicity issues that plague Corpening Creek. Because it is not known exactly what contaminants and at what levels are potentially entering the stream from these sites, we cannot quantify expected pollution reduction benefits from this strategy. We do know that this strategy will compliment the stormwater BMP strategy in terms of addressing toxicity. At most hot spots it's also a relatively simple and straightforward strategy to implement and likely will deliver greater benefit for the buck than any of the other healing strategies.

In some cases, simple behavioral modifications will alleviate the threat of water pollution. In other cases, better catchment and containment mechanisms might be a better solution. Most of the costs associated with implementing this strategy will be born by owners of the sites in question, though we do plan to create a $15,000 cost-share fund to help some owners develop better containment mechanisms. Additionally, the Partners will implement a focused outreach campaign to help the owners of these sites understand the toxicity issues affecting Corpening Creek and persuade them to participate. We are striving for an ambitious 75% participation by land and business owners over the next 15 years.

Several specific facilities should be mentioned because of the obvious potential for water quality impacts or the number of concerns observed:

- McDowell Cement Products (site 28). Piles of sand, gravel, and other materials are stored adjacent to a tributary of Youngs Fork, sometimes to the top of the bank. The piles are not contained, covered, or otherwise managed in such a way as to prevent inputs to the channel. Materials are almost certainly washed into the stream by precipitation and runoff, and may sometimes be spilled into the stream during normal operation of the facility.

- McDowell Technical Community College. A periodic dry weather discharge has been observed coming from a campus building (site 4). Campus officials have suggested that this could be related to a photography class, but this has not been confirmed.
- McDowell County Large Material Collection Transfer Station (site 3). Liquid from trash collects in the loading area and drains untreated into a ditch.
- Loves Travel Stop and adjacent establishments (site 5). The potential for pollutant inputs are high at this site because of the size of this complex and the intensity of vehicular activity.
- Randolph's Garage (site 29) and Marion Tire South (site 21). The review indicated multiple concerns at these sites.

Figure 4.4 Hot Spots in the Corpening Creek Watershed

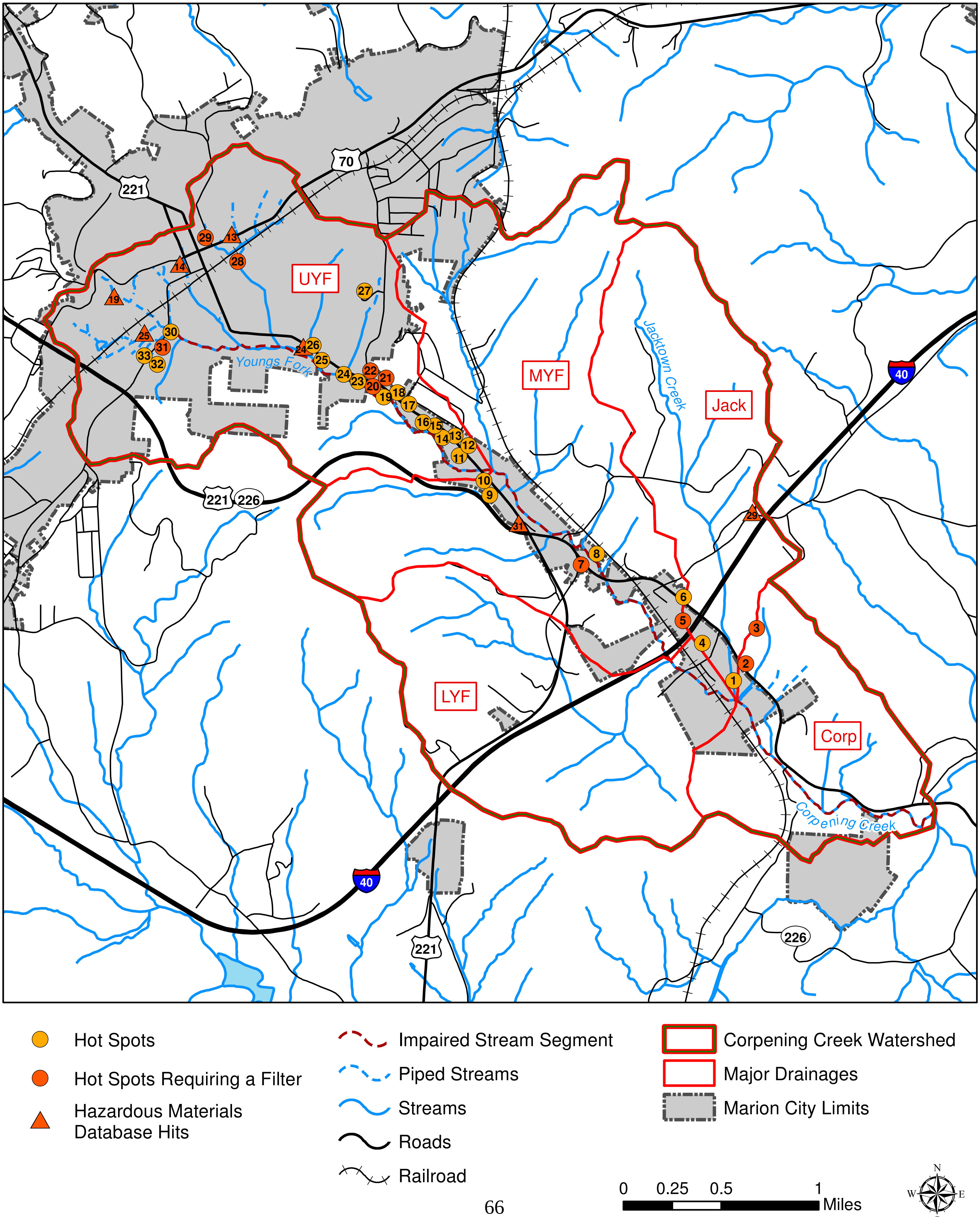


Table 4.4 Corpening Creek Hot Spot Site Data (Sheet 1 of 2)

Hot Spot ID	Facility Name	Facility Description	Concern	Remediation Strategy
1	Industrial Timber & Land Co.	timber plant	Outdoor Materials Storage	Operational Modification
2	McDowell County Landfill	household collection	Outdoor Materials Storage	Filter
3	McDowell County Landfill	large material collection	Other	Filter
4	McDowell Tech	McDowell Tech campus	Other	Operational Modification
5	Love's Travel Stop	gas station, restaurant, car wash	Waste Management	Filter
6	Waffle House	restaurant	Waste Management	Better Containment Mechanism
7	Excel Mart	gas station, store	Waste Management	Filter
8	McDowell Recycling Co.	scrap yard	Debris, Scraps, and Parts Storage	Operational Modification
9	Countryside BBQ	restaurant	Waste Management	Better Containment Mechanism
10	Soapy Suds	car wash	Vehicle Operations	Operational Modification
11	Express Lube	auto lube	Waste Management	Better Containment Mechanism
12	Toolcraft	metal working and machine shop	Outdoor Materials Storage	Better Containment Mechanism
13	J's Discount of Marion	discount grocery store	Waste Management	Better Containment Mechanism
14	Marion Equipment Co.	tractor sales	Debris, Scraps, and Parts Storage	Operational Modification
15	Spencer Hardware Farm & Garden Center	hardware & garden center	Waste Management	Operational Modification
16	Jalepeno Grill	catering	Waste Management	Better Containment Mechanism
17	Pyatt Heating & Air Conditioning	heating &air conditioning	Waste Management	Operational Modification
18	John's Precision Auto Body	auto body work	Waste Management	Operational Modification
19	Eddie's Pizza & Pasta	restaurant	Waste Management	Better Containment Mechanism
20	BP Station	gas station	Vehicle Operations	Filter
21	Marion Tire South	auto tire and service	Outdoor Materials Storage	Filter
22	Summit Motors	car sales	Outdoor Materials Storage	Filter
23	Marion Ag & Garden	garden supply	Debris, Scraps, and Parts Storage	Operational Modification

Table 4.4 Corpening Creek Hot Spot Site Data (Sheet 2 of 2)

Hot Spot ID	Facility Name	Facility Description	Concern	Remediation Strategy
24	Bantam Chef	restaurant	Waste Management	Better Containment Mechanism
25	Hook & Anchor Family Restaurant	restaurant	Waste Management	Better Containment Mechanism
26	KG Quick Stop	gas station, convenience store	Vehicle Operations	Operational Modification
27	Samuel Frady's Used Auto Parts	scrap yard	Debris, Scraps, and Parts Storage	Operational Modification
28	McDowell Cement Products	cement manufacturer	Outdoor Materials Storage	Filter
29	Randolph's Garage	auto repair garage	Outdoor Materials Storage	Filter
30	Shell Station	gas station	Vehicle Operations	Operational Modification
31	Kwik as a Wink	gas station, convenience store	Waste Management	Filter
32	Ingles	shopping center	Waste Management	Operational Modification
33	McDonalds	restaurant	Waste Management	Better Containment Mechanism

4.3 Protect Undeveloped Land

It is probably no exaggeration to say that Corpening Creek would be in far worse condition without the relatively forested conditions prevailing on the east side of Grants Mountain and Mount Ida. These steep lands have thus far made extensive development very difficult. As a result, forests dominate these hillsides. These forests provide crucial hydrological and habitat benefits to the watershed. The rain that falls here can infiltrate the ground as it naturally should. The streams here are shady and cool. The streams have less sediment in them, except where the land has been disturbed. These streams also carry leaf packs and woody material downstream to Corpening Creek, which are valuable food sources for fish and aquatic organisms. Grants Mountain and Mount Ida also serve the unique function of being an important part of Marion's scenic viewshed and civic identity. There are other less visible, forested, undeveloped lands in the Corpening Creek watershed that also serve the valuable functions described above.

4.3.1 Large Tracts Greater than 30 Acres

To keep hydrological problems and resulting stream scour, bank erosion, and habitat deficiencies from getting worse in Corpening Creek, we plan to protect undeveloped forested areas. We have identified 32 tracts of undeveloped private land greater than 30 acres in need of protection (Figure 4.5 and Table 4.4). Most of these are on Grants Mountain and Mount Ida but others are dispersed throughout the headwaters of tributaries that flow into Corpening Creek from the eastern portion of the watershed.

At a minimum, we would like to secure temporary, non-binding protection agreements on 75% of these tracts by the end of the 15 year life span of this plan. We plan to use voluntary agreements to accomplish this goal. We will seek permanent and legally binding protection of these tracts when opportunities arise and it is feasible for us to do so. We will use conservation easements (purchases and donations), fee simple purchases, and low impact development as tools to accomplish this goal. We plan to utilize the Foothills Conservancy of North Carolina as a qualified holder of these conservation properties though this is not an exclusive agreement. Depending upon circumstance, the City of Marion, McDowell County, and McDowell County Soil and Water Conservation District are also qualified to hold easements and properties, and one of those organizations may be the best party for some transactions. To persuade developers to utilize low impact development approaches, we plan to develop educational literature for distribution in the local government planning offices and to local realtors. Outreach with these audiences and the landowners of these properties will be a routine part of the coordinator's job.

We anticipate incurring purchase and transaction costs of $7.13 million associated with protecting these tracts. These cost estimates are very rough and based upon a) easement and fee-simple purchases, based on current fair market value per acre, of six of the more prominently visible tracts on Grants Mountain and Mount Ida; b) transactional costs associated with these six purchases and easement donations on up to six other tracts valued at $2 million in the watershed. These cost estimates are provided to show the magnitude of the dollar investment needed on the protection strategy. The costs of protecting land through low impact development will be incurred by the developers of those properties.

4.3.2 Smaller Tracts

There are 64 of undeveloped tracts between 5 and 30 acres adjacent to the 32 large undeveloped tracts. Due to their small size and the sheer number of these properties, we do not propose trying to protect them other than through landowner goodwill. Owners of these properties will be included in our land protection outreach campaign, so we will invest in coordinator time and materials to perform this service. There are a couple of hundred small tracts less than 5 acres that are still considered forested or open space. We hope to reach owners of these properties through more generic outreach into the broader community.

Figure 4.5 Properties Proposed for Preservation in the Corpening Creek Watershed

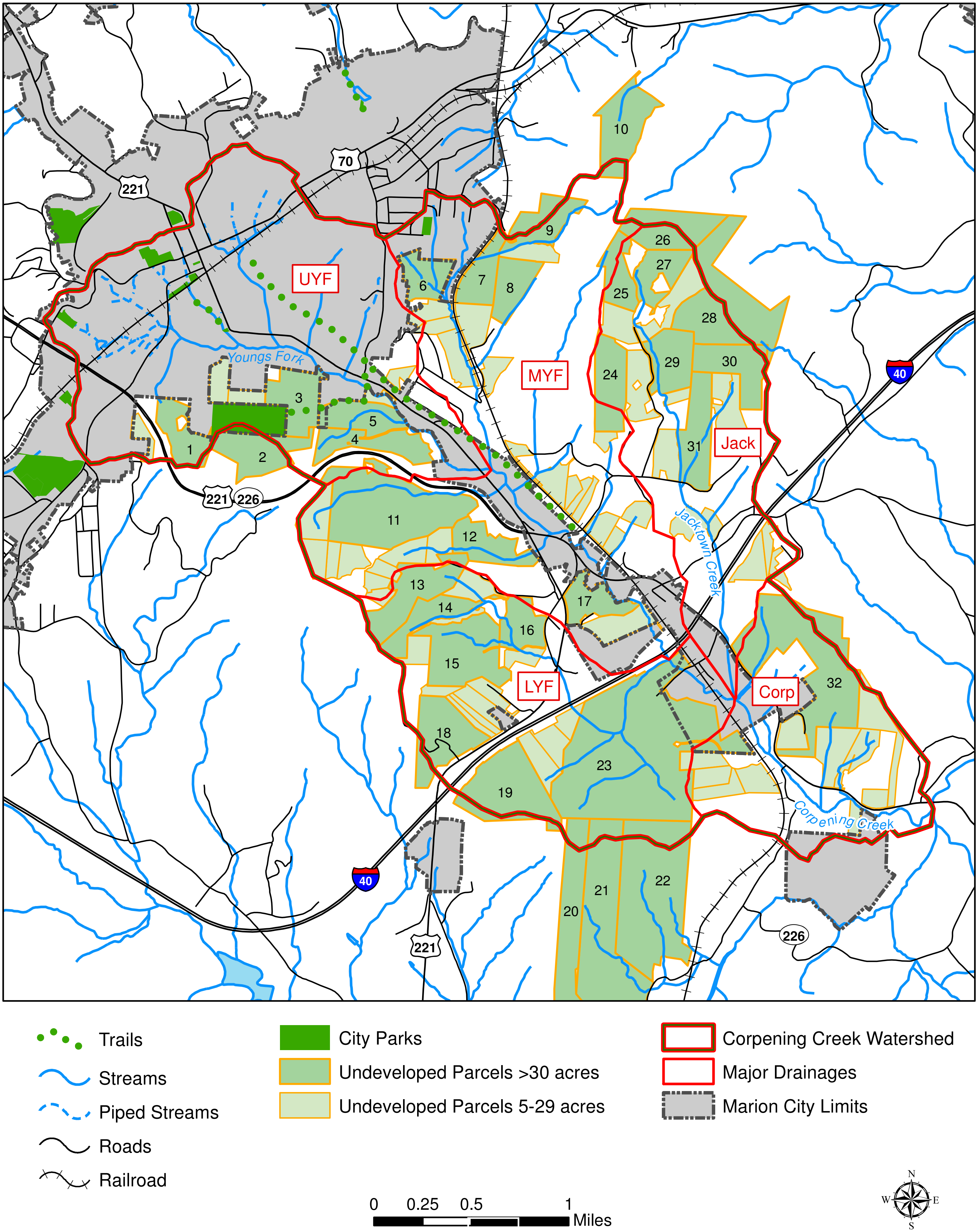


Table 4.5 Parcel Data for Preservation Properties in the Corpening Creek Watershed (Sheet 1 of 2)

Site ID	PIN	Total Parcel Acreage	Site ID	PIN	Total Parcel Acreage
1	1701-52-8953	35.9		9x14291	22.9
2	1701-81-2936	49.7		1711-45-0521	20.5
3	1701-93-1612	45.8		1711-34-6509	20.2
4	1711-12-5299	42.3		1711-91-3935	19.7
5	1701-93-9219	38.5		1711-75-9460	18.1
6	1711-26-9700	31.1		1710-53-7328	18.1
7	1711-46-1523	33.1		1720-43-4769	17.5
8	1711-46-7094	33.6		1710-48-4754	16.7
9	1711-68-0144	39.7		1720-18-5868	15.5
10	1712-81-1221	59.9		1710-29-3204	15.3
11	1711-10-7499	142.2		1711-61-1185	15.0
12	1710-49-2412	39.8		1720-13-6105	14.9
13	1710-28-4348	62.1		1720-24-6300	14.4
14	1710-37-0751	36.2		1700-98-7937	14.1
15	1710-36-7657	79.4		1710-64-1163	13.9
16	1710-57-4290	32.7		1701-73-1800	13.8
17	1710-77-0958	32.3		1711-57-6375	13.8
18	1710-34-1387	63.1		1711-90-7116	13.1
19	1710-42-6728	88.4		1710-09-7194	12.9
20	1619-66-8509	114.5		1710-45-2063	12.5
21	1619-77-5630	160.2		1720-03-3697	12.5
22	1619-89-8111	164.0		1710-39-0473	12.4
23	1720-04-5477	313.8		1711-25-8779	12.4
24	1711-73-7911	47.9		1720-02-5972	12.3
25	1711-76-8591	32.4		1710-26-5529	11.9
26	1711-87-8008	54.1		1720-03-6145	11.5
27	1711-96-0828	33.3		1710-79-3799	11.1
28	1721-15-1545	115.4		1710-45-5319	11.1
29	1711-93-4991	42.9		1711-44-4294	10.8
30	1721-14-2482	49.0		1710-57-4290	9.8
31	1721-02-2627	52.3		1721-03-8574	9.8
32	1720-27-6242	155.0		1711-80-6484	9.7
	1720-53-3464	29.4		1710-65-3442	9.2
	1720-33-7849	27.8		1701-51-2938	8.9
	1711-96-4029	27.5		1701-73-9432	8.6
	1711-84-4159	25.8		1711-35-0327	8.3
	1710-77-6224	25.5		1720-42-8576	7.8
	1721-02-6660	24.6		1710-09-1084	7.6

[1]Parcels with ID numbers are ≥30 acres and are identified on Figure 4.5.

Table 4.5 Parcel Data for Preservation Properties in the Corpening Creek Watershed (Sheet 2 of 2)

Site ID	PIN	Total Parcel Acreage	Site ID	PIN	Total Parcel Acreage
	1710-18-5787	7.0		1710-35-0048	5.8
	1720-19-9547	6.9		1710-18-4036	5.8
	1710-18-3405	6.3		1711-70-0636	5.8
	1720-09-5802	6.2		1720-28-7754	5.8
	1720-43-3123	6.1		1711-51-2987	5.6
	1710-44-0836	6.0		1710-79-7599	5.6
	1711-14-9015	5.9		1710-34-9713	5.6
	1711-13-4379	5.9		1711-72-5368	5.3
	1711-60-6998	5.9		1711-71-0013	5.2
	1710-37-2309	5.9		1711-93-5405	5.1

[1]Parcels with ID numbers are ≥30 acres and are identified on Figure 4.5.

4.4 Restore Degraded Streams and Riparian Areas

We have identified 31 stream and buffer restoration projects (Figure 4.6; Table 4.5). These are sites along the mainstem of Corpening Creek that through field assessments are known to have poor habitat, severe bank erosion, and a degraded riparian buffer. Also included are sites on tributaries, identified through aerial photograph analysis, that have little or no buffer on one or both sides of the creek for at least 500 feet. We plan to address these problem areas through either one of two means: riparian revegetation or stream restoration. At stream restoration sites, a riparian reforestation component will also be included.

Riparian revegetation is a low-cost solution that consists of removing invasive exotic plant species, if needed, and planting native grasses, shrubs, and trees along the creek bank. Native river cane can also be a good option. Restored buffers may vary in width depending on adjacent land use and landowner preferences. Some locations will have space for a narrow 15 foot wide strip while others might accommodate a 35-75 foot wide buffers. At the very least, we want property owners to simply reestablish some vegetative cover along the stream or to stop mowing or burning the creekbank. Streamside vegetation will help slow and filter stormwater runoff and associated pollutants. Where the stream is not terribly incised, vegetation will help to hold banks in place and protect property and the stream from erosion and sedimentation. The plants will also provide leaf litter and woody material, important components of aquatic habitat and that serve as food sources.

Of the sites we have identified, there are 23 where we think that a relatively low-cost riparian revegetation approach is an ample solution. These are streamside areas in upper reaches of Corpening Creek and in upper reaches of tributaries. These projects are priorities because of their location in headwaters areas and low cost. Our goal is to implement every riparian revegetation project over the next 15 years and we expect to invest upwards of $500,000 (Table 4.8.4).

We use the term 'stream restoration' as a broad category to include any kind of engineered technique to remove stress on eroding streambanks and enhance in-stream and riparian habitat. We have not yet conceptualized site-specific restoration solutions, but we suspect that solutions may include natural channel design restoration, bio-engineered bank toe protection or even rip-rap, gabions, or other types of hard structure stabilization approaches. Because of risk, we do not recommend pursuing until later years of the project any stream restoration on the mainstem of Corpening Creek, except in the Upper Youngs Fork sub-watershed. These are likely to be very costly projects and any stream restoration projects built in the lower reaches of Corpening Creek could get overwhelmed by the storm surges so characteristic of this watershed. Once stormwater becomes better managed in downtown and nearby neighborhoods of the UYF watershed, then restoration on the Corpening Creek mainstem can proceed. We plan to implement 3-5 of the stream restoration projects over the next 15 years and these have an estimated total cost of $1.5 million (Table 4.8.4).

Figure 4.6 Proposed Stream Restoration and Riparian Revegetation in the Corpening Creek Watershed

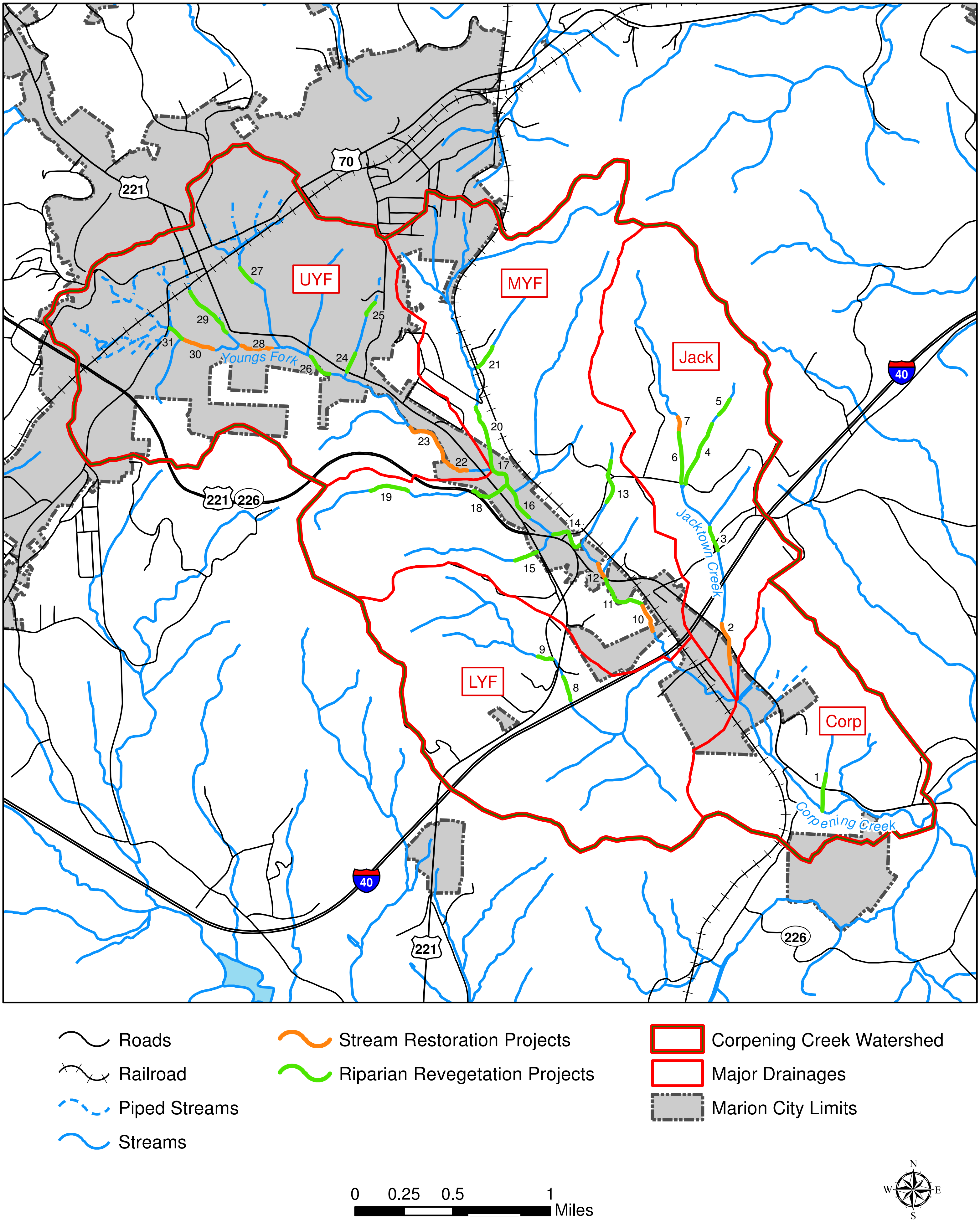


Table 4.6 Site Data for Proposed Stream Restoration and Riparian Revegetation in the Corpening Creek Watershed (Sheet 1 of 2)[1]

Site ID	Major Drainage	Stream	Project Length (ft)	Severe Stream Bank Erosion?	Habitat Score (100)	Impacted Buffer?	Stormwater BMP Adjacent?	Number of Landowners	Restoration Type
1	Corp	Corpening Creek	1,006					1	Riparian Revegetation
2	Jack	Jacktown Creek	1,139	yes	63	yes	no	1	Stream Restoration
3	Jack	Jacktown Creek	659	no	57	yes	no	4	Riparian Revegetation
4	Jack	UT Jacktown Creek	1,795					1	Riparian Revegetation
5	Jack	UT Jacktown Creek	507					2	Riparian Revegetation
6	Jack	Jacktown Creek	1,368					2	Riparian Revegetation
7	Jack	Jacktown Creek	435	yes	33	yes	no	3	Stream Restoration
8	LYF	UT Youngs Fork	652					2	Riparian Revegetation
9	LYF	UT Youngs Fork	405					3	Riparian Revegetation
10	MYF	Youngs Fork	769	yes	79	no	no	3	Stream Restoration
11	MYF	Youngs Fork	1,434	no	75	yes	yes	5	Riparian Revegetation
12	MYF	Youngs Fork	481	yes	78	no	no	3	Stream Restoration
13	MYF	UT Youngs Fork	1,211					6	Riparian Revegetation
14	MYF	Youngs Fork	1,002					5	Riparian Revegetation
15	MYF	UT Youngs Fork	639					1	Riparian Revegetation
16	MYF	Youngs Fork	803	no	90	yes	no	4	Riparian Revegetation
17	MYF	Youngs Fork	932	no	59	yes	yes	4	Riparian Revegetation
18	MYF	UT Youngs Fork	1,003					3	Riparian Revegetation
19	MYF	UT Youngs Fork	1,065					1	Riparian Revegetation
20	MYF	UT Youngs Fork	1,813					5	Riparian Revegetation
21	MYF	UT Youngs Fork	691					1	Riparian Revegetation
22	UYF	Youngs Fork	883	yes	87	no	yes	5	Stream Restoration

[1]Empty cells are indicate reaches that were identified in GIS but were not assessed in the field.

Table 4.6 Site Data for Proposed Stream Restoration and Riparian Revegetation in the Corpening Creek Watershed (Sheet 2 of 2)[1]

Site ID	Major Drainage	Stream	Project Length (ft)	Severe Stream Bank Erosion?	Habitat Score (100)	Impacted Buffer?	Stormwater BMP Adjacent?	Number of Landowners	Restoration Type
23	UYF	Youngs Fork	1,323	yes	71	yes	yes	5	Stream Restoration
24	UYF	UT Youngs Fork	548	-	-	-	-	2	Riparian Revegetation
25	UYF	UT Youngs Fork	410	-	-	-	-	1	Riparian Revegetation
26	UYF	Youngs Fork	733	no	46	yes	yes	3	Riparian Revegetation
27	UYF	UT Youngs Fork	501	-	-	-	-	6	Riparian Revegetation
28	UYF	Youngs Fork	868	yes	55	no	no	12	Stream Restoration
29	UYF	UT Youngs Fork	1,522	-	-	-	-	17	Riparian Revegetation
30	UYF	Youngs Fork	901	yes	59	no	no	12	Stream Restoration
31	UYF	Youngs Fork	441	no	35	yes	no	4	Riparian Revegetation

[1]Empty cells are indicate reaches that were identified in GIS but were not assessed in the field.

4.5 Learn More About How Best to Heal the Stream

The healing strategies and specific projects discussed above are based on best available knowledge of watershed conditions as of June 2011. We need to start somewhere to help Corpening Creek recover its health, and we make these recommendations with high confidence that they will benefit the stream. Yet, there remain some vexing issues that can only be addressed after additional studies are completed. We need to continue refining our understanding about the sources of toxicity and nutrients and the causes of stream scour and habitat decline. It may be that our effectiveness is limited until we gain clarity on these issues.

We operate from the premise that it is also not enough to identify problems, we also want to use this information to craft solutions. None of these studies will be undertaken to assign blame. Our overarching goal remains to help Corpening Creek recover its lost functions and the common thread in our approach remains to work collaboratively with people who voluntarily elect to work with us.

4.5.1 Dry Weather Pollution

Nutrients, fecal coliform bacteria, and conductivity concentrations in the Upper Youngs Fork subwatershed are elevated – even in dry conditions. Why? We do not know the answer to this. We suspect that it is due to one or a combination of the following:

- sanitary sewer leaks
- illicit discharges from commercial and industrial operations
- groundwater contamination

The City of Marion has completed a comprehensive Inflow and Infiltration (I&I) Study of the municipal sewer system. The study focused on three basins of the City's system with the oldest infrastructure. The basins studied were Clinchfield, Cross Mill, and East Marion. The flow was monitored in each basin in multiple locations in order to determine flow variations. Once the data was retrieved and analyzed video camera technology was used to identify areas of compromised infrastructure. The video study uncovered repair areas in each of the three basins. The following repairs were implemented:

- In the Clinchfield basin 1324 ft of existing infrastructure was slip lined using trench-less technology. Several feet of infrastructure and failing manholes were abandoned during the listed improvements.
- In the East Marion basin 9 locations were identified for point repair. Existing failing infrastructure was replaced with new materials at each of the identified locations, including 5 manholes. Several feet of infrastructure and failing manholes were abandoned during the listed improvements.
- In the Cross Mill basin 850 ft of existing failing infrastructure was replaced with new materials. Several feet of infrastructure and failing manholes were abandoned during the listed improvements.

After the completion of the repairs the flow in each of the basins was re-studied to verify that the repairs had eliminated the I&I. The study numbers demonstrated that the improvements did address the I&I. Improved flow numbers were also recorded at the City's Corpening Creek Waste Water Treatment Plant after implementing the improvements. Since the study the City has located and mapped all aerial utility stream crossings and inspects them annually for any maintenance issues. The City does not know of any leaking aerial crossings and has not received any customer complaints about leaking waste water utilities. Ultimately, the Partners would like to expand this study into the Upper Youngs Fork sub-watershed at a future date.

According to our 2008 hazardous materials database search, there are 45 underground storage tanks located in the watershed, and 16 of them have experienced a leaking incident. There are 10 facilities in the watershed that are small quantity generators of hazardous waste. There have also been five reported incidents of groundwater and/or soil contamination. The numbers given indicate only what has been reported. While we only speculate at this time, these data suggest that these sites could be a source of the toxicity in Corpening Creek. This issue needs further investigation; we estimate the cost at $50,000.

4.5.2 Impact of Institutional Facilities

There are 15 of institutional/industrial facilities located in the Corpening Creek watershed, most in the Upper Youngs Fork sub-watershed. These institutional sites occupy large swaths of land and contain large asphalt, concrete or compacted gravel parking lots. Creeks that are on site have typically been piped and built over.

These sites were too large and complex to include in the watershed assessment performed for this plan. We would like to learn more about the sewer system connections, stormwater management systems, and other drain systems (e.g. floor drains) at each of these facilities. Considering the time period and standard practices in place when these structures were built, it is quite possible that drains inside the buildings are piped directly to storm drains or creeks. It is also almost certain that the storm water management systems from these old facilities rely on the conventional pipe and transport approach to move rain water as rapidly away from the site as possible. Considering the sheer size of these impervious areas, this translates into a very significant hydrological impact to adjacent streams and the watershed as a whole.

4.5.3 Identification of Toxic Substances

Previous NCDWQ studies have indicated impacts to biota from toxic substances are likely to be occurring in the Corpening Creek watershed, but specific toxins could not be identified. It is known that sediments containing polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides, and metals (zinc, copper, chromium) have been found in upper Youngs Fork. During streamwalks associated with this plan, pipe outfalls and drainage ditches of unknown origin with high conductivities were identified. Additional sites having soils contaminated with a variety of hazardous substances were identified a search of State and Federal hazardous waste lists. Now that we know where toxic chemicals may be originating, it is time to identify those sites where toxic chemicals are present, identify the specific toxins, and to develop remediation plans that will restore the health of the Corpening Creek watershed. We estimate that $50,000 will be required to complete the initial screening. Because the number and types of chemical tests are unknown at this time, we have not estimated the costs associated with the laboratory testing.

4.5.4 Monitoring, Evaluation, and Adaptation

Our monitoring and evaluation program is another important 'learn more' strategy. Whereas the study designs for the other projects within this strategy still remain unclear, we have developed the monitoring program design, which includes criteria, indicators, and a timeline for achievement. Because we have greater clarity and it is a current project, the monitoring program is discussed separately in Chapter 5.

4.6 Partnership Coordination and the Marketing and Public Relations Program

The Muddy Creek Restoration Partnership itself is an all voluntary organization consisting of citizens, business owners, government and corporate members. Most members are employed elsewhere or have other obligations and responsibilities that compete for their time. Successful implementation of this plan must include a marketing and public relations program. We have identified 15 actions to achieve this goal. Many of these actions will be implemented continuously over the life of the plan, whereas others are more appropriate for implementation at certain stages in the life of the plan or in association with completion of other management measures.

Watershed Coordination

A key element in achieving the management targets laid out in this plan will require the services of a dedicated watershed coordinator. Based on our 12-year track record, we anticipate the need to contract with a local person, preferably from McDowell County, on a ½ - ¾ time basis to perform the following duties:

- Leadership – vision, planning, executing implementation activities
- Meeting Facilitation of the Partnership and its Committees
- Marketing and Public Relations
- Fundraising
- Project Development and Oversight
- Record Keeping and Reporting
- Negotiating Contracts with Sub-Contractors

A breakdown of costs and time investment for each core job responsibility is provided in Table 4.6

Table 4.7 Estimated Costs to Establish a Corpening Creek Watershed Coordinator Position

JOB RESPONSIBILITY	COST	% OF JOB	HRS PER YR	RATIONALE
Estimated Annual Personnel Cost	**$ 40,000.00**	**100%**	**1,250**	**25 hrs/wk * 50 weeks**
Estimated Annual Travel/Phone Cost	**$ 5,000.00**			
Leadership	$ 2,700.00	6%	75	1.5 hrs per week just being/thinking
Meeting Facilitation & Partner Communications	$ 5,004.00	11%	139	16 hrs each qrtr + 1.5 hrs per wk
Marketing & PR	$ 18,000.00	40%	500	10 hrs per week * 50 weeks
Fundraising	$ 5,760.00	13%	160	4 proposals/yr * 40 hrs each
Project Development & Oversight	$ 10,800.00	24%	300	4 projects/yr * 75 hrs each
Record Keeping and Reporting	$ 1,800.00	4%	50	1 hr per wk * 50 wks
Negotiating & Supervising Sub-Contracts	$ 1,152.00	3%	32	as needed
Totals	**$ 45,216.00**	**100.5%**	**1,256**	

We anticipate incurring an annual cash outlay of approximately $45,000 for this service, including travel, phone, and other expenses. A member Partner will furnish office space, equipment and supplies/materials for the contractor. As of this date, the coordinator will be a contract position, which means this person will be responsible for her or his own self employment taxes and benefits.

The job responsibilities bulleted above will be further detailed in a job description. Most of these responsibilities will be paid for from the annual coordinator contract. However, the marketing and public relations program carries some additional costs. For this reason and because of the timeline and detailed activities that we plan to undertake, the marketing and public relations program is described in this chapter in greater detail.

Targeted Outreach Campaigns

To gain participation of landowners and residents in the projects we propose requires a significant amount of outreach and education, marketing and public relations. This will be a standard, routine part of the coordinator's job responsibility and will likely occupy at least 40% of the coordinator's time on an annual basis. In the first three years of this plan implementation we hope to jumpstart three specific outreach campaigns intended to secure significant landowner and resident participation at the end of 15 years in simple BMPs, hot spot remediation and protection projects. This effort will likely consume half or more of the 40% of time the coordinator will devote to marketing and PR over the next three years

We want to secure a 50% rate of participation in simple BMPs by all owners and residents in the Upper Youngs Fork sub-watershed. We want to secure a 100% rate of participation by all property owners on hot spot remediation projects and a 100% rate of participation in non-binding protection projects by all property owners of larger undeveloped tracts. This will require a significant amount of one-on-one conversation and negotiation work, but we also plan to utilize workshops, public service announcements, literature, and social media to compliment the one-on-one effort.

BMP Workshops

We will utilize engineered stormwater BMP projects that we have developed as demonstrations to showcase their function, cost, stream health benefit, and aesthetic qualities (as applicable). Developers and owners of properties that we have identified for projects will be invited to these workshops. We anticipate this marketing and PR project to cost $9,000 all totaled.

Public Service Announcements

We anticipate spending approximately $1,000 over the next 15 years on public service announcements.

Social Media and Website

We plan to create a website to showcase projects and distribute information on watershed conservation practices. We also plan to utilize You Tube to showcase educational stormwater BMP projects in action. Facebook and a blog will likely be a component of our social media engagement. We anticipate incurring no more than $2,000 creating the website. Establishing a Facebook page and blog will be a routine part of the coordinator's job. We will utilize existing videos of stormwater BMPs, which are free.

Annual Green Awards
In each of our outreach campaigns, we plan to reward participants with signage, certificates and other types of recognition. We would like to reward 3 participants annually from each of the BMP, hot spot, and protection project outreach campaigns for a total of 9 awards each year. This is not an inexpensive proposition, as we anticipate the cost for awards coming to $10,000 over a period of 15 years.

Signage for Stream and Buffer Restoration
The signage installation effort is similar to the green awards program. However, a restoration project may involve multiple landowners but we only propose installing a sign at a terminus of the project as a means of informing the community of the restoration activities taking place.

Speaker Programs at Local Clubs \ Annual Booth at Mountain Glory
Many of our Partners are members of or know people who belong to the Master Gardeners, Kiwanis, Rotary, and other civic clubs. Marion is a small town, and we believe these clubs to be integral to helping us network throughout the community and develop projects. The Mountain Glory Festival is a very big community event held every fall where we can also get good exposure. These projects carry essentially no cost except for the coordinator's time and costs for literature. Individual partners of our group will also provide in-kind service in making introductions and arranging the presentation opportunities.

Brochures, Doorhangers, Window Fliers, and Other Literature
We need literature that we can leave with landowners when we perform one on one outreach and to share with the general public at Mountain Glory and civic club presentations. We anticipate spending $4,000 over the next 15 years developing and producing literature on the Partnership, our purpose, and the healing strategies we are trying to implement.

Storm Drain Stenciling Program
Since stormwater is a major culprit behind the degradation of Corpening Creek, we think it is important to create reminders throughout the community of where the stormwater runoff goes. We plan to utilize volunteers to help us stencil all of the storm drains in downtown Marion and surrounding neighborhoods, especially those in the Upper Youngs Fork neighborhood. This is a low cost project, totaling no more than $250, that we plan to undertake early in the implementation of this plan.

EcoVan Curriculum for Schools in the Muddy Creek Watershed
The EcoVan program is a part of the Keep McDowell Beautiful organization. They have an established curriculum for teaching elementary and middle school students about the function of the hydrological cycle. We plan to Partner with the EcoVan program to include education on better means of stormwater management, hot spot remediation, stream and buffer restoration and the role of forests in watershed health. While the annual costs for this program are not extremely expensive, the overall cost of $75,000 over the course of the next 15 years makes it a substantial outlay. The purpose of this activity is to help us develop the next generation of good stewards of the Corpening Creek water resource. A side benefit is that this program is that it will likely reach some of the children of the adults that we need to connect with who own properties where we would like to implement certain projects.

4.7 Tracking Management Plan Achievements

The implementation schedule for each element of the Corpening Creek Watershed Management Plan presents the timeline over when and how much of each management action will be achieved during the plan's 15-year life (see tables in section 4.9). Target numbers for each management action, where possible, were distributed across years based on Partner input. Equally important to carrying out the management actions will be the tracking of what is accomplished. Each implementation schedule is designed to compare actual versus planned accomplishments for each management action. The planned accomplishment numbers will serve as interim milestones against which progress in implementing the management measures will be evaluated. A comparison of the actual accomplishments with the monitoring result will provide an indication of how effective the management actions have been at improving overall watershed conditions such that Corpening Creek can be removed from the State's 303(d) list. Significant deviations from the planned accomplishments, particularly those affecting aquatic habitat and water chemistry, will provide a first indication that the management plan may need revision.

4.8 Management Plan Actions

Table 4.8.1 Corpening Creek Action Plan for Stormwater BMPs (Sheet 1 of 4)

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Simple BMPs								HIGH PRIORITY ACTIVITY
Downspout & Gutter Disconnects	50% owner participation in Upper Youngs Fork; 25% participation in remainder of watershed	McDowell County, City of Marion, Individual Landowners	Continuous over life of the plan	Minimal	Property owner assumes installation; cost to program only for technical assistance; provide incentive funding if possible	Local and State agencies	Technical assistance	Reduced runoff volume to streams
Rain Barrels & Cisterns		McDowell County, City of Marion, Residential& Commercial Landowners	Continuous over life of the plan	$100 per unit installed		Local and State agencies	Installation guidance	Reduced runoff volume to streams
Dry Creek Beds		McDowell County, City of Marion, Residential & Commercial Landowners	Mid- to long-term	Minimal		Local and State agencies	Technical assistance	Reduced runoff volume, nutrients and sediment
French Drains		McDowell County, City of Marion, Residential & Commercial Landowners	Mid- to long-term	Owner installed - $25/foot		Local and State agencies	Installation guidance	Reduced runoff volume, nutrients and sediment

Table 4.8.1 Corpening Creek Action Plan for Stormwater BMPs (Sheet 2 of 4)

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Engineered BMPs								HIGH PRIORITY ACTIVITY
Bioretention (aka Rain Gardens)	78 features at 31 sites, 36.0 acres impervious surface treated	City of Marion, McDowell County, Individual Landowners	Mid- to Long-term	$25,400 per impervious acre treated[1] (unit cost decreases with increased area treated, but increase with feature complexity)	$2,023,378	CCAP, NCDWQ 319, CWMTF, local government, landowner match	Engineering, Landscape Architect Design, Material Supplier	Reduced pollutant loads
Constructed Wetlands (aka stormwater wetlands)	15 wetlands at 12 sites; 56.7 acres impervious surface treated	City of Marion, McDowell County, Other landowners	Mid- to Long-term	$2,900-$9,600 per impervious acre treated[1]	$365,974	CCAP, NCDWQ 319, CWMTF, local government, landowner match	Engineering, Landscape Architect Design, Material Supplier	Reduced runoff volume to streams and reduced pollutant load
Wet Detention Ponds	1 detention structures	City of Marion, McDowell County, Others	Long-term	$3,800 per impervious acre treated[1]	$11,300	CCAP, NCDWQ 319, CWMTF, local government, landowner match	Engineering, Landscape Architect Design, Material Supplier	Reduced stream bank erosion and reduced pollutant load
Permeable Weirs (aka Extended Detention)	5 structures at 3 sites; 6.8 acres impervious treated	Property Owners w/local government assistance	Mid- to Long-term	$7,200 per impervious acre treated	$88,356	CCAP, NCDWQ 319, CWMTF, local government, landowner match	Engineering, Landscape Architect Design, Material Supplier	Reduced stream bank erosion and reduced pollutant load

Table 4.8.1 Corpening Creek Action Plan for Stormwater BMPs (Sheet 3 of 4)

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Underground Storage	8 structures at 5 sites; 13.5 acres impervious treated	Property Owners w/local government assistance	Mid- to Long-term	$12,000 installed for 100' x 60' chamber which treats 10 cubic feet per linear foot of chamber2	$228,909	CCAP, NCDWQ 319, CWMTF, local government, landowner match	Engineering, Landscape Architect Design, Material Supplier	Reduced stream bank erosion and reduced pollutant load
Stormwater Sand Filter	2 structures at 2 sites	Property owners	As retrofit funds become available	$65.00 per cubic foot treated	$25,652	CCAP, NCDWQ 319, CWMTF, local government, landowner match	Engineering, Landscape Architect Design, Material Supplier	Reduced stream bank erosion and reduced pollutant load
Water Quality Swales (Swale Enhancement)	6 swales or enhancements at 3 sites	City of Marion, McDowell County, Others	Mid- to Long-term	$3.50-$8.20 per cubic foot treated; $4.75 nominally used; varies depending on sites conditions	$8,975	CCAP, NCDWQ 319, CWMTF, local government, landowner match	Engineering, Landscape Architect Design, Material Supplier	Reduced runoff volume to streams and reduced pollutant load
Rain Barrels (as part of treatment trains)	0.33 acre impervious surface treated	City of Marion, McDowell County, Others	Mid- to Long-term	$380 per unit	$16,150	CCAP, NCDWQ 319, CWMTF, local government, landowner match	Engineering, Landscape Architect Design, Material Supplier	Reduced runoff volume to streams and reduced pollutant load

Table 4.8.1 Corpening Creek Action Plan for Stormwater BMPs (Sheet 4 of 4)

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Green Roofs	2 structures	Developers	Mid- to Long-term	None	None	Developers	None	Reduced runoff volume to streams and reduced pollutant load
Low Impact Development	2 locations	Developer	As opportunities arise	None	None	Developers	None	No increase in runoff volume to streams; no increase in pollutant load
Permeable Paving	As opportunities arise	Developers; State and Local Governments	As opportunities arise	Unknown	Unknown	Developers; State and Local Governments	Qualified installer information	Reduced runoff volume to streams and reduced pollutant load

Table 4.8.2 Corpening Creek Action Plan for Hot Spot Remediation

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Conscientious Waste Disposal & Dumpster Maintenance	16	Property Owner or Operator	Over life of the Plan	None	None	Property Owner or Operator	Technical Information	Reduced runoff volumes to stream and reduced pollutant load
Filters	10	Property Owner or Operator	Over life of the Plan	None	None	Property Owner or Operator	Technical Information	Reduced pollutant load

Table 4.8.3 Corpening Creek Action Plan for Protecting Undeveloped Land

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Fee Simple Purchase	6 parcels; 361 acres	McDowell County, Local Conservancy, City of Marion	Mid- to Long-Term	$10,000/acre + 15% transaction costs	$4.22 million	CWMTF, Local governments, private donors	None	Water quality and riparian vegetation maintained
Conservation Easements	6 easements; 303 acres	McDowell County, State Agencies, Local Conservancy	Mid- to Long-Term	$8,000/acre + 20% transaction costs	$2.91 million	CWMTF, Local governments, private donors	None	Water quality and riparian vegetation maintained
Low Impact or Conservation Developments	This project discussed already in stormwater management	Developer, local government	Mid- to Long-Term	None	None	Developers	None	Water quality and riparian vegetation maintained
Non-Binding Agreements	32	McDowell County, State Agencies, Local Conservancy	Over life of the Plan	Minimal	Minimal	McDowell County, Federal and State Agencies, Local Conservancy	None	Water quality and riparian vegetation maintained

Table 4.8.4 Corpening Creek Action Plan for Restoring Degraded Streams and Riparian Areas

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Stream Restoration	6,799	Watershed Coordinator	Long-term	$250-300 per stream foot for design, construction & monitoring	$1.5 million	EEP, EQIP, CWMTF, DWQ 319, CCAP, DWQ, NCACSP	Engineering, Landscape Architect Design, Material Supplier	Improved stream channel and aquatic habitat
Stream Buffer Enhancement	36.4 acres	Watershed Coordinator	Mid- to Long-term	$14,000 per acre	$500,000	EEP, EQIP, CWMTF, DWQ 319; CCAP, DWQ, NCACSP	Landscape Architect Design, Material Suppliers	Improved stream channel and aquatic habitat HIGH PRIORITY ACTIVITY

Table 4.8.5 Learn More about Pollutants in the Corpening Creek Watershed

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Dry Weather Pollution Sources	Watershed survey complete	Partnership, Local and State Agencies	Over life of the Plan	N/A	$50,000	NCDWQ	None	Chemical test needs identified
Industrial Site Pollution Contributions & Stormwater Retrofit Potential Identified	Retrofit survey complete; remediation identified	Partnership, Local and State Agencies	Over life of the Plan	N/A	25,000	NCDWQ, CWMTF	None	Pollutant load reductions identified
Identification of Toxic Substances	Screen 76 hazardous waste sites and 20 outfalls with conductivity >100 µS/cm	Partnership, Local and State Agencies	Over life of the Plan	$50,000	$50,000	NCDWQ, Federal Grants	Technical assistance with laboratory testing	Toxic sites and contaminants identified; remediation efforts started
Site Specific & Cumulative Impact Monitoring of Healing Strategies	Complete planned watershed or project monitoring	Partnership, Local and State Agencies	Over life of the Plan	$2,500/year	$37,500	NCDWQ, State and Federal Grants, project funders	None	Observed improvement in aquatic habitat quality

Table 4.8.6 Corpening Creek Action Plan for Marketing & Public Relations (aka Education/Outreach; Sheet 1 of 4)

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Establish a Watershed Coordinator Position	1 part-time position created	Partnership	Immediately	$45,000 annually, including travel, phone & other expenses	$675,000	Grants, State and Local Agencies	None	Position created, contractor selected, plan implemented
Outreach Campaign for Upper Youngs Fork Simple BMPs	50% participation rate	Watershed Coordinator	Immediately	Coordinator time. $10,000 in cost share	$10,000 in cost share funding	Federal, State and Local Agencies and Grants	None	Reduced stormwater volume to creeks
Outreach Campaign to Remediate Hotspots	75% participation rate	Watershed Coordinator	Immediately	Coordinator time. $15,000 in cost share	$15,000 in cost share funding	CCAP, Local, Federal, State Agencies	Technical Assistance	Reduced pollutants and stormwater volumes to creeks
Outreach Campaign to Protect Undeveloped Property	75% participation in non-binding agreements. 6 easements	Watershed Coordinator	Immediately	Coordinator time.	N/A	Local, Federal, State Agencies, Private donors	None	Water quality and riparian buffers protected
BMP Workshops	3 workshops	NCSU, WPCC, McDowell County SWCD, WPCOG, engineering firms	Ongoing	$3,000 per workshop	$9,000	CCAP, DWQ 319, Burke County SWCD	Staff to lead and coordinate	Increased environmental awareness of watershed improvements HIGH PRIORITY

Table 4.8.6 Corpening Creek Action Plan for Marketing & Public Relations (aka Education/Outreach; Sheet 2 of 4)

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Public Service Announcements	15 public service announce-ments	City of Marion, private installers	Ongoing	$0-50 per radio announce-ment[1]	$750	Local and State government.	Video production	Increased environmental awareness of watershed activities HIGH PRIORITY ACTIVITY
YouTube Videos of Stormwater BMPs in Action	Utilize existing videos	WPCOG, City of Marion public access channel	Mid-term	Free	None	N/A	Video production	Increased awareness of stormwater issues and BMPs
Web Page, Facebook, Blog	Create accounts	Watershed Coordinator; web page designer	Immediate; maintain through life of Plan	N/A	$2,000	Grants, Local and State Agencies	Web content, design guidance	Web traffic and usage maintained
Annual Green Business, Green Resident, Green Neighborhood Awards	3 Awards Annually to Participants in BMP, Hot Spot and Protection Projects	Partnership, Watershed Coordinator	Initiate year 3; annually through life of plan	$75 per sign and award.	$10,000	Grants, Local Agencies	None	Number of Nominations

Table 4.8.6 Corpening Creek Action Plan for Marketing & Public Relations (aka Education/Outreach; Sheet 3 of 4)

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Signage Associated with Some Stream Improvement Projects	2 per project	Partnership, Watershed Coordinator, Project Funder	At completion of project	$75 per sign	$4,500	Project Funder, Partnership	None	Project visibility
Annual Booth at Mountain Glory Festival	Annually	Coordinator & Marion Business Association	Year 1, annually through life of Plan	Coordinator time	None	N/A	None	Visitation by Public
Speaker Programs at Civic Organizations, Business Associations, Clubs	3 per year	Coordinator & Local Partners Who are Club Members	Continuous through life of Plan	Coordinator time	None	N/A	None	Follow-up conversations and inquiries about Partnership
Brochures, Doorhangers, Window Fliers, Other Literature	Annual distributions	Watershed Coordinator, Volunteers, Partnership	Created in year 1, updated as needed	N/A	$4,000	Local and State Agencies	Content and layout design assistance	Follow-up inquiries about programs and the Partnership

Table 4.8.6 Corpening Creek Action Plan for Marketing & Public Relations (aka Education/Outreach; Sheet 4 of 4)

Management Actions (what)	Targets (how much)	Responsible Party (who)	Schedule for Implementation (when)	Financial Resources (how much)	Estimated Total Costs to Implement (2011 dollars)	Potential Funding Sources	Technical Resources Needed	Qualitative Success Indicators
Storm Drain Stenciling Program	All storm drains in watershed	Partnership, Watershed Coordinator, Volunteers	Years 3-5	N/A	$250	Partnership, Grants	None	Volunteer participation
EcoVan Curriculum for Specific Schools in Muddy & Corpening Watersheds	Program implemented in all selected schools	McDowell County Schools	Year 3, then annually through life of Plan	$5,000 Annually for subcontract with EcoVan	$75,000	McDowell County Schools, Grants	Curriculum development and updating assistance	Number of children participating

4.9 Implementation Schedule

Table 4.9.1 Corpening Creek Watershed Plan Implementation Schedule for Managing Stormwater Better (Sheet 1 of 2)

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	3	5	6	8	10	11	12	14	15	
Simple BMPs												
Downspout Re-Routing	Planned	Ongoing										50% owner participation in Upper Youngs Fork 25% participation in remainder of watershed
	Actual											
Rain Barrels & Cisterns	Planned	Ongoing										
	Actual											
Dry Creek Beds	Planned	Ongoing										
	Actual											
French Drains	Planned	Ongoing										
	Actual											
Engineered BMPs												
Project Sites Completed	Planned											15 of 31 identified sites
	Actual											
Bioretention (aka rain gardens)	Planned											Dependent on sites constructed; individual BMP types will be tracked
	Actual											
Constructed Wetlands (aka Stormwater Wetlands)	Planned											
	Actual											
Wet Detention Ponds	Planned											
	Actual											
Permeable Weirs (aka Extended Detention)	Planned											
	Actual											
Underground Storage	Planned											
	Actual											
Stormwater Sand Filter	Planned											
	Actual											
Water Quality Swales	Planned											
	Actual											
Rain Barrels (as part of treatment trains)	Planned											
	Actual											
	Actual											

Table 4.9.1 Corpening Creek Watershed Plan Implementation Schedule for Managing Stormwater Better (Sheet 2 of 2)

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	3	5	6	8	10	11	12	14	15	
Green Roofs	Planned											2 sites
	Actual				1			1				
Low Impact Development	Planned			1				1				2 sites
	Actual											
Permeable Paving	Planned	Ongoing – as opportunities arise										

Table 4.9.2 Corpening Creek Watershed Plan Implementation Schedule for Fixing Hot Spots

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	3	5	6	8	10	11	12	14	15	
Conscientious Waste Disposal & Dumpster Maintenance	Planned											80% rate of participation
	Actual											
Hot Spot Filters	Planned											10 sites
	Actual											

Table 4.9.3 Corpening Creek Watershed Plan Implementation Schedule for Protecting Undeveloped Land

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	3	5	6	8	10	11	12	14	15	
Non-Binding Agreements	Planned	Ongoing										100% Participation 32 Tracts
	Actual											
Conservation Easements	Planned	Ongoing										6 Tracts, 367 acres
	Actual											
Fee Simple Purchase	Planned	Ongoing										6 Tracts, 303 acres
	Actual											
Low Impact Development	Planned	Already Discussed in Stormwater Management Strategy										See Table 4.9.1
	Actual											

Table 4.9.4 Corpening Creek Watershed Plan Implementation Schedule for Restoring Degraded Streams and Riparian Areas

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	3	5	6	8	10	11	12	14	15	
Stream Buffer Restoration	Planned											36.4 acres
	Actual											
Stream Restoration (bank stabilization)	Planned											3-5 sites; 6,799 feet

Table 4.9.5 Corpening Creek Watershed Plan Implementation Schedule for Learning More

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	3	5	6	8	10	11	12	14	15	
Dry Weather Pollution Sources	Planned				AA		ZZ					Study Completed
	Actual				AA		ZZ					
Industrial Sites – Pollution and Stormwater Retrofit Potential	Planned											Study Completed
	Actual											
Identification of Toxic Substances	Planned											Screening and testing complete
	Actual											
Monitoring of Site Specific and Cumulative Benefits of Projects	Planned	Discussed in Chapter 5										See Chapter 5

Note: AA = Start of activity; ZZ = Completion of Activity

Table 4.9.6 Corpening Creek Watershed Plan Implementation Schedule for Coordination & Marketing and Public Relations

Management Action	Year	Short-Term			Mid-Term			Long-Term				Target
		1	3	5	6	8	10	11	12	14	15	
Establish a Watershed Coordinator Position	Planned	hired	Ongoing									1 ½ - ¾ time contract coordinator
	Actual											
Outreach Campaign for Upper Youngs Fork Simple BMP	Planned	AA	Ongoing						ZZ			
	Actual											
Outreach Campaign to Remediate Hot Spots	Planned		AA	Ongoing						ZZ		
	Actual											
Outreach Campaign to Protect Undeveloped Land (>30 acres)	Planned		AA	Ongoing							ZZ	
	Actual											
BMP Workshops	Planned		1	1		1						
	Actual											
Public Service Announcements	Planned	4	4	4								
	Actual											
You Tube Videos of Stormwater BMPs in Action	Planned											
	Actual											
Web Page, Facebook, Blog	Planned	Continuous; routine; blog every 2 weeks; website constructed by end of Yr2										
	Actual											
Annual Green Awards	Planned		9									
	Actual											
Signage on Stream and Buffer Restoration Projects	Planned	As projects are completed										
	Actual											
Mountain Glory Festival Booth	Planned	Annually in partnership with Marion Business Association										
	Actual											
Speaker Programs at Civic Clubs and the Business Community	Planned	Routine part of coordinator's job; probably 3 presentations per year										
	Actual											
Literature (Brochures, Doorhangers, Window Fliers)	Planned	AA		UD		UD		UD		UD		
	Actual											
Storm Drain Stenciling	Planned		AA	ZZ								
	Actual											
EcoVan Curriculum Partnership	Planned		AA	Continuous, routine, every year								X number of students reached
	Actual											

Note: AA = Year activity started; ZZ = Year activity completed; UD = Year update activity to take place.

Chapter 5 Watershed Monitoring and Evaluation

To determine the effectiveness of management measures being implemented, the ecological, water chemistry, and physical conditions of the Corpening Creek watershed must be monitored routinely (Figure 5.1). Biological communities, water chemistry parameters, and aquatic habitat conditions are expected to improve as projects are completed. Those improvements will be reflected in the health of the benthic macroinvertebrate community, which will serve as the primary ecological indicator of the Corpening Creek watershed. Secondary indicators include decreases total nitrogen, phosphorous and fecal coliform bacteria numbers; improvements in aquatic habitat conditions; and a more diverse fish community. Water chemistry parameters will be monitored to determine trends in pollutant loadings. While these factors will be evaluated on a watershed basis at our baseline monitoring sites (Figure A-2), some site specific monitoring may be required.

Table 5.1 Corpening Creek Monitoring Plan

Parameter	Monitoring Years	Benchmark Levels	Target Levels	Load Reduction Target
Biological				
Benthic Macroinvertebrates	2012, 2017, 2022	Fair to Excellent (IBI scores 6.26-4.30)	Good-Fair or better at all sites (IBI scores >7.48)	Not applicable
Fish Community	2012, 2017, 2022	Fair fish IBI rating at indicator site (Fish IBI score 40)	Good-Fair or better fish IBI rating (Fish IBI score >40)	Not applicable
Water Chemistry				
Total Nitrogen	Annually	Median levels of 2007-2011 samples	Declining trend	Not applicable
Total Phosphorus	Annually	Median levels of 2007-2011 samples	Declining trend	Not applicable
Total Suspended Solids (TSS)	Annually	Median levels of 2007-2011 samples	No increase or declining trend	Not applicable
Conductivity	Annually	Median levels of 2007-2011 samples	Declining trends and decreasing variability (elimination of high conductivity outfalls)	Not applicable
Fecal Coliform Bacteria	2012, 2017, 2022	5 in 30 day sample average = 1,052 cfu/mL	5 in 30 day sample average ≤200 cfu/mL (North Carolina standard)	Not applicable
Physical				
Aquatic Habitat	2012, 2017, 2022	Individual reach scores from 2008 streamwalk – range 33-90 (39 sites)	Minimum reach score ≥65; Improvements in microhabitat criteria scores	Not applicable

5.1 Biological Monitoring

Removal of Corpening Creek from the State's 303(d) list will be based on NCDWQ benthic sampling associated with their basin-wide planning process. To be removed from that list, the benthic community must be rated as Good-Fair or better. Samples will be taken at NCDWQ's four established sites (Figure A-1) during 2012, 2017, and 2022. We anticipate that NCDWQ will perform the benthic macroinvertebrate monitoring as part of their routine statewide biological monitoring program. However, the Partners may also elect to perform benthic monitoring in these locations.

To monitor trends in the ecological health of Corpening Creek and to supplement the NCDWQ data, benthic macroinvertebrates will be sampled annually using the Virginia Save Our Stream (VASOS 2005) method. Samples will be collected at the six baseline sites established in assessments conducted as part of this plan (Figure A-2; Table 5.1). Data collected during 2008-2010 will serve to represent baseline conditions. Total metric scores of 8 or above at all sites will be the target level to be achieved.

Fish community assessments are scheduled every five years in association with NCDWQ's basin-wide planning efforts. One NCDWQ fish sampling is located in the Corpening Creek watershed (Figure A-1) and is scheduled for sampling in 2012, 2017, and 2022 (Table 5.1). Fish IBI data from NCDWQ's 2002 sampling will be used as the benchmark by which to document changes to the fish community over time. Sampling will occur more frequently if aquatic habitat conditions show significant improvements. Fish community sampling may be integrated into specific stream restoration projects to provide before and after evaluation data. A Good-Fair IBI rating is the target for achievement and necessary to qualify the watershed for removal from the State's 303(d) list.

5.2 Water Chemistry Monitoring

Monitoring select water chemistry parameters should provide insight into how the watershed is responding to the implementation of management measures. Nutrients, in particular, have been identified as a likely stressor by NCDWQ in the CAWS study and have been verified as extraordinarily high by the Partners in our watershed assessment. Some of our healing strategies should reduce nutrient pollution. Therefore, water chemistry samples focusing on nutrients will be collected every other year from the six previously established baseline sites in the Corpening Creek watershed. Specific parameters to be monitored include nitrogen, phosphorus, total suspended solids, and conductivity (Table 5.1). Other pollutants may be included if they are identified during additional watershed assessments. The data for each parameter at each site will be examined for trends over time. Water chemistry data collected during 2009-2011 will serve as the benchmark levels for comparison (Figures A-6, A-10, and A-11).

Pollutant identification and monitoring in association with individual outfalls and hotspots also may be necessary to determine the effectiveness of remediation efforts. Monitoring of individual sites will be based on the conditions present and the pollutant of concern. The need for monitoring of these sites will be dependent upon the results of in-depth outfall and hotspot assessments to be completed as part of this plan.

Toxicity is also a major concern in the watershed. We have very little baseline data on toxins. While we are confident that our better management of stormwater and our remediation of hot spots will address some of the sources of toxicity, we will have no direct proof until we gather baseline data. We plan to gather baseline data in a future study and then monitor periodically at our baseline monitoring sites thereafter. We may also institute site specific toxicity monitoring in concert with some of our projects.

Although not known to be a factor directly affecting benthic macroinvertebrate communities, high fecal coliform bacteria levels are often associated with increased nutrient levels that can alter the benthic community. Fecal coliform bacteria sampling should be conducted every 5 years at the six previously established baseline sample locations (Figure A-2) following the NCDWQ 5 samples in 30 days protocols. The geometric mean of bacteria levels (Figure A-14) taken in September 2008 will serve to represent baseline conditions. Target levels of achievement will be to reduce fecal coliform bacteria levels to <200 cfu/mL, the North Carolina standard for surface waters. More frequent sampling may occur if additional efforts are undertaken to identify and eliminate the sources of fecal coliform bacteria in the Corpening Creek watershed.

5.3 Aquatic Habitat Assessments

To document improvements in aquatic habitat conditions at the watershed level, the 39 stream reaches assessed during streamwalks should be repeated during years 2012, 2017, and 2022. The habitat assessments will follow NCDWQ metric scoring protocols (NCDWQ 2006). Individual reach metric scores (range 33-90) taken during January 2008 will serve as the benchmark for aquatic habitat conditions (Figure A-12). A minimum total metric score of ≥65 for each individual reach will be the target level to be achieved (Table 5.1). Additionally, we hope to detect improvements in microhabitat conditions such as riffle embeddedness, pool depth, leaf litter and woody materials. The aquatic habitat assessment data will be compared with fish and benthic macroinvertebrate community data taken in the same years. Correlations among these data will be used as indicators of improving habitat and biological community conditions.

***Watershed stewardship** ensures investments in watershed conservation practices are protected and managed for purposes of maintaining water quality, wildlife habitat, and community awareness.*

5.4 Watershed Stewardship

Stewardship is an important component of the Corpening Creek watershed plan. Watershed improvements, be they physical improvements, stormwater BMPs, riparian re-vegetation, or land protection measures, all require stewardship to ensure they not only maintain their effectiveness over the long term, but to protect the community's investment in improving the Corpening Creek watershed. As management measures are implemented throughout the watershed, it will be necessary to monitor them on a regular basis to ensure structures are functioning properly, lands are being managed appropriately, and that encroachments into areas under legal protection (e.g. conservation easements) are not occurring. It will be the responsibility of the watershed coordinator to oversee stewardship activities.

Appendix A
Watershed Assessment

Appendix A Watershed Assessment

The purpose of the watershed assessment was to identify potential sources of pollution and stream impacts in the Corpening Creek watershed. This Appendix begins by reviewing prior studies of the watershed, which serve as the background to the current assessment. The Appendix then describes the methods employed and presents assessment findings.

The current assessment targeted the key stressors previously identified by the NC Division of Water Quality (NCDWQ), as discussed in Section 1 below. Stressors examined included toxicity, hydromodification, nutrient/organic enrichment, and habitat degradation. For the most part, the assessment focused on identifying potential sources for these stressors, rather than on the collection of data to refine stressor detection.

Based on NCDWQ recommendations to remove Jacktown Creek from the impaired waters list (Section 2), field investigations were focused primarily on Youngs Fork to make the best use of available resources. However, impacts within Jacktown Creek were documented as part of this project.

NCDWQ Bioclassifications and Water Quality Impairment

NCDWQ rates stream fish and benthic macroinvertebrate communities using a five-level Bioclassification scale: Excellent, Good, Good-Fair, Fair, and Poor. Streams rated Fair or Poor are generally classified as *impaired* and are included on the State's official list of impaired waters, referred to as the 303(d) list.

1 Previous Plans and Studies

1.1 Background

The headwaters of Youngs Fork begin in the center of the City of Marion and flow through dense commercial, residential, and industrial lands before being joined by Jacktown Creek from the north. The joining of these two tributaries forms Corpening Creek, which enters North Muddy Creek several miles downstream of Marion. These streams are designated by NCDWQ as 'Class C' waters, which signifies that, among other uses, the waters shall be suitable for aquatic life propagation and maintenance of biological integrity. NCDWQ evaluates whether state water quality standards for biological integrity are met by monitoring the condition of stream fish and benthic macroinvertebrate (primarily stream insects) communities.

The benthic macroinvertebrate community in Youngs Fork was first monitored in 1985, at Secondary Road (SR) 1819 (Henredon Road, now College Drive). This site was rated Fair at that time and on four other occasions between 1990 and 2002 (Table A-1 and Figure A-1). Sampling by NCDWQ in 2007 found the benthic community to be Poor at this site (NCDWQ, 2008b). NCDWQ concluded that this recent decline in the benthic community could be attributed to a combination of reduced habitat due to lower than normal water levels, as well as to worsening water quality. The benthic community in Corpening Creek, below the discharge from Marion's Corpening Creek Wastewater Treatment Plant (WWTP), was sampled on three occasions between 1985 and 2001, receiving ratings of either Fair or Poor.

Table A-1 NCDWQ Benthic Macroinvertebrate Community Sampling Results[1]

Location	Date	Total Number of EPT Taxa[2]	EPT Biotic Index[3]	Biotic Index[3]	Bioclassification
Corpening Creek at Old Glenwood Road (SR 1794)	4/1985	17	4.6	6.6	Fair
	9/1990	8	6.6	7.2	Poor
	4/2001	16	4.2	6.2	Fair
Youngs Fork at Henredon Rd (SR 1819)	4/1985	19	4.8	6.7	Fair
	9/1990	17	5.4	6.1	Fair
	8/1997	16	5.0		Fair
	4/2001	15	4.7	5.4	Fair
	8/2002	22	4.5	5.8	Fair
	7/2007	7	5.9	5.9	Poor
Youngs Creek at Claremont Ave (headwaters)	4/2001	4	6.5	7.5	Poor
Jacktown Creek at NC 226	4/2001	19	3.9	4.9	Not Rated[4]

[1]Compiled from NCDWQ 2004a and 2008b.
[2]EPT= mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera). Generally, the higher the number of EPT taxa, the healthier the benthic community.
[3]The biotic index (BI) indicates the pollution tolerance of the organisms present. A high BI indicates greater dominance by organisms that are pollution and disturbance tolerant. The lower the BI, the healthier the benthic community. The BI can be calculated based on all taxonomic groups, or based only upon EPT taxa (EPT BI). Biotic index values are normally combined with EPT taxa richness ratings to produce a final bioclassification.
[4]Jacktown Creek is too small to receive a formal bioclassification. Small streams are rated as Not Impaired (NI) if they meet the criteria for a Good-Fair or higher rating using the standard qualitative criteria. A stream that is not rated as Good-Fair or higher using standard qualitative criteria is listed as Not Rated (NR).

The 1999 Catawba River Basin Plan (NCDWQ, 1999) indicated that the major concerns in the watershed were probably due to nonpoint source pollution from Marion, including a lack of stormwater management. The plan noted that the WWTP had been experiencing toxicity problems due to discharges into the municipal system, but that the issue had been successfully addressed through City's pretreatment program. The 1999 Plan also noted that there was not enough information available to determine what efforts might be needed to restore Corpening Creek, and recommended that a more in-depth watershed study be conducted.

Stressors and Sources

A *stressor* can be viewed most simply as a cause of impairment or an agent that actually impairs aquatic life. Causes may fall into one of two broad classes: 1) chemical pollutants, such as toxic chemicals, nutrient inputs, or oxygen-consuming wastes; and 2) physical alterations of a stream that degrade habitat, including loss of in-stream structure such as riffles and pools due to sedimentation; or loss of bank and root mass habitat due to channel erosion or incision.

Sources of impairment are the origins of such stressors or the activities that generated them, such as stormwater runoff or wastewater discharges. In some cases, impairment may be caused by the interaction of multiple stressors. (see NCDWQ 2003a). This is common in urban streams.

1.2 The CAWS Study

With funding from the USEPA, NCDWQ initiated this study in 2001. This effort, part of the Collaborative Assessment of Watersheds and Streams Project (CAWS), was completed in 2004 (NCDWQ, 2004a). The goals of the CAWS project were to: 1) identify the most likely causes of watershed impairment; 2) identify major watershed activities and pollution sources contributing to those causes; and 3) outline a general watershed strategy for restoration activities and BMPs to address the identified problems. Data collection included benthic macroinvertebrate sampling; assessment of stream habitat, stream morphology and riparian zone condition; water and sediment sampling to evaluate stream and sediment chemistry and toxicity; and characterization of watershed land use, conditions, and pollution sources.

The CAWS study concluded that multiple stressors associated with urban development heavily impact aquatic organisms in Youngs Fork and Corpening Creek. The study suggested the primary cause of impairment was impacts from toxic pollutants. Other stressors include scour due to hydromodification and nutrient/organic enrichment. Multiple stressors are characteristic of most developed watersheds, although sometimes a single stressor can be identified as being of primary importance in causing impairment. In this watershed, however, the relative contribution of these stressors could not be clearly differentiated based on the available data.

Because of the biological impairment and the highly developed character of the watershed, NCDWQ recognized that accomplishing substantial water quality improvements would require considerable effort. Some of the data collected during the CAWS study are presented later in this Appendix.

2 Current Status of Impairment

North Carolina's 2006 303(d) list included the entire length of Youngs Fork/Corpening Creek (considered to be the same stream) because of impaired biological integrity. Jacktown Creek was also considered to be impaired at that time. However, a re-evaluation of the Jacktown Creek data based on small stream criteria found that the applicable water quality standards are being met. Jacktown Creek was removed from the 303(d) list in 2008. While NCDWQ has collected no additional data on the causes and sources of impairment in the Corpening Creek since completion of the CAWS investigation, additional assessments were conducted prior to developing this management plan. Data from these assessments were aimed at refining the sources of stressors and to use in developing management actions to reduce their impacts. The methods and results of these assessments are presented in the following sections.

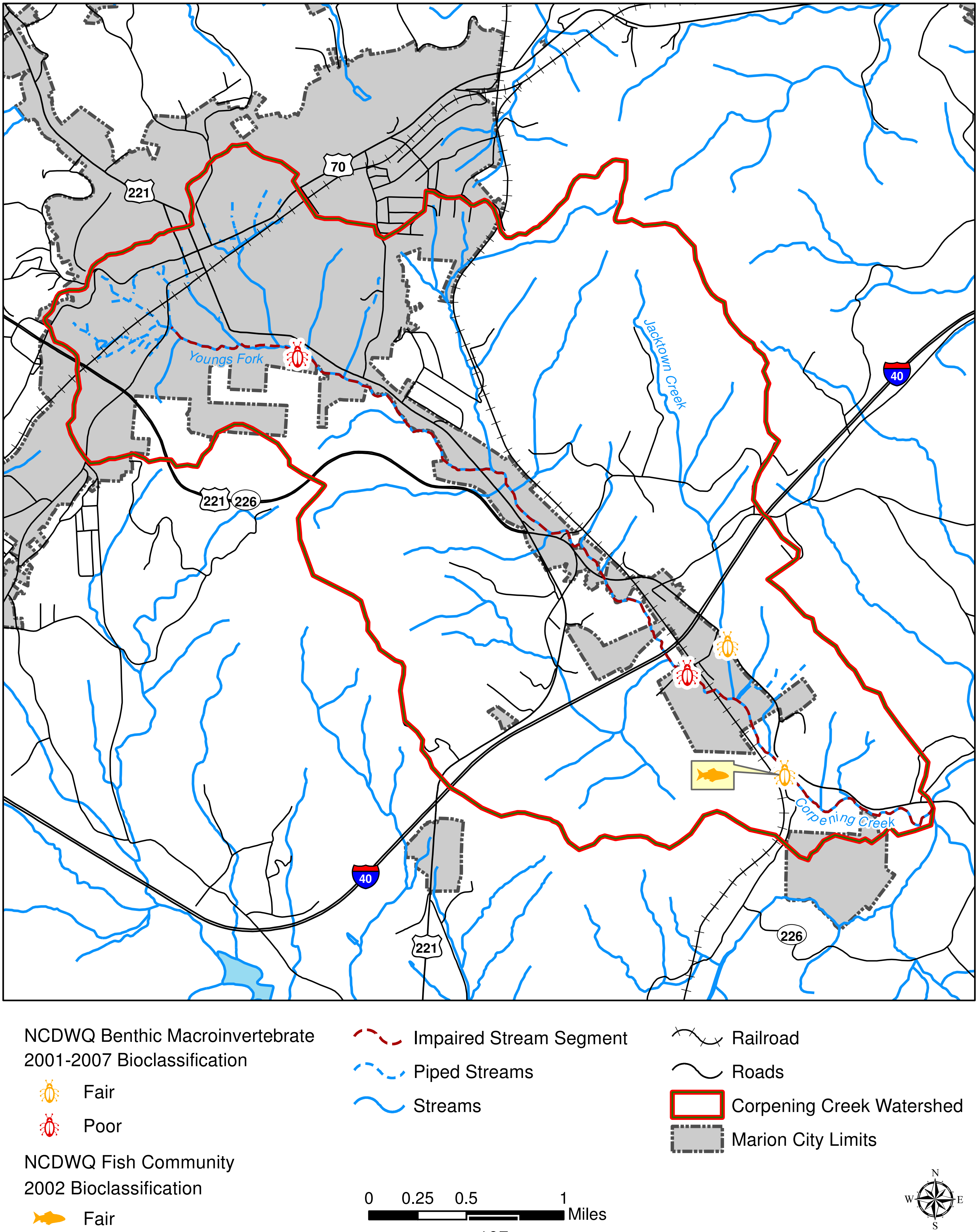
3 Watershed Assessment Methods

Activities conducted for this watershed assessment included:

1. Analysis of existing spatial data sets, such as land cover data;
2. A review of recent aerial photography;
3. Water quality monitoring;
4. Stream assessment (stream walk);
5. Hot spot investigation; and
6. Follow-up monitoring.

The stream walk and hot spot investigation were funded by the NC Clean Water Management Trust Fund. The remaining activities were funded under the current 319 grant.

Figure A-1 NCDWQ Monitoring Sites



3.1 GIS Data and Methods

3.1.1 GIS Data Sources

GIS analyses and data storage were completed using ArcGIS 9.2. The primary GIS datasets used are summarized below.

Aerial photography. April 2005 color orthophotos were used, supplied by the McDowell County office of the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS).

Land cover data. The most recent land cover datasets available were developed by Equinox in 2008 for the Muddy Creek watershed, funded by the N.C. Wildlife Resources Commission. Datasets were developed for two time periods, based upon an interpretation of 1998 and 2005 digital orthophotos (Equinox, 2008a).

Stream channels. The stream dataset developed by the NC Stream Mapping Program was used. This statewide dataset, finalized in the summer of 2007, used Light Detection and Ranging (LIDAR) elevation data to define six-acre minimum catchment areas that were used to delineate the origins of perennial and intermittent streams. This dataset offers more accurate, current, and complete mapping of rivers, streams, and other water bodies than blue line streams mapped by the United States Geological Survey on 1:24,000 scale topographic maps. Equinox corrected the stream data based upon visual assessment of 2005 orthophotography and observations during watershed reconnaissance activities. Streams that did not appear to exist on the ground were eliminated and channels that were piped were so designated in the dataset. These corrections were not based upon a comprehensive stream survey, but incorporate only those corrections Equinox became aware of during the course of the assessment.

Roads. Data on primary and secondary road locations were downloaded from the NC Department of Transportation (NCDOT) web site (http://www.ncdot.org/IT/gis/).

Elevation. LIDAR-based contour data (two-foot intervals) for McDowell County were downloaded from the NCDOT web site (http://www.ncdot.org/IT/gis/).

Local infrastructure and boundaries. The City of Marion Planning and Development Services Department provided data on current city limits, water system lines, and sanitary sewer lines.

Parcels. Land parcel data were provided by McDowell County.

Various GIS datasets were created by Equinox in the course of the assessment, such as watershed and subarea boundary files and the location of various features (monitoring sites, potential hot spots, and other sites of interest) necessary for data analysis.

3.1.2 Estimation of Impervious Cover

Based upon analysis of 2005 aerial photography and literature sources, the percent of impervious cover was estimated for each land cover class in the 2005 land cover data set (Table A-2).

Table A-2 Derivation of Impervious Area by Land Cover Class, Corpening Creek Watershed

Land Cover Class	Number of Acres in Each Class	Estimated Percentage of Impervious Cover in Each Class	Derivation of Impervious Cover Percentages
Commercial	490.7	52%	Based on aerial photo estimates of a sample of commercial polygons.
Mixed Urban	118.2	55%	Based on aerial photo estimates of mixed urban polygons.
Residential	1,096.1	23%	Based on aerial photo estimates of density; 2-3 dwellings per acre (lot size of 0.33 to 0.5 acre) is most typical in Marion, with some denser areas and some areas that would probably be better classified as mixed use. One dwelling per acre is more common out of town, with some areas of lower density. A lot size of 0.5 acre is used as a typical overall value, though this may be low for in-town areas. For this density, CWP (2003) data indicate typical imperviousness of 21%, while Soil Conservation Service data (USDA, 1986) indicate 25%. A value of 23% is used here.
Transportation	135.0	65%	Aerial photo estimates of selected areas. Includes road medians and some grassed roadside areas.
Recreational	5.7	20%	Aerial photo estimate of the only polygon.
Crop land	37.0	2%	Professional judgment based upon photo review. Roads and small structures are present in this land class. This value is consistent with CWP (2003).
Pasture	229.0	5%	Imperviousness of actual pasture is similar to crop land, .but much land in this class is actually open urban land in a variety of uses. Imperviousness here is considerably higher, sometimes >10%. 5% is used here to represent both conditions.
Nursery	0.1	25%	Aerial photo estimate of the only polygon.
Forest	3,179.4	1%	Professional judgment based upon photo review. Very few roads or structures in this land class.
Shrub/Scrub	374.1	3%	Professional judgment based upon photo review. Much of this class is power line tight of way where roads are common (generally unpaved); some roads/structures are present in other areas.
Altered Land	4.1	2%	Professional judgment based upon photo review. Few structures present. Some unpaved roads.
Water	12.9	0%	

3.1.3 Watershed, Subwatershed, and Drainage Delineation

Watershed and subarea boundaries were delineated using the LIDAR contour interval data. The watershed was initially divided into twelve subwatersheds, ranging from approximately 300 to 600 acres in size, in order to facilitate planning of stream walks and other assessment activities. These subwatersheds were then aggregated into five major drainages for subsequent watershed planning purposes (Figure A-2 and Table A-3)

Table A-3 Major Drainages in the Corpening Creek Watershed

ID	Drainage Name	Description	Area (acres)	Area (square miles)
UYF	Upper Youngs Fork	Headwaters to Stumptown Branch	1,495	2.3
MYF	Middle Youngs Fork	Stumptown Branch to I-40	1,656	2.6
LYF	Lower Youngs Fork	I-40 to Jacktown Creek	1,044	1.6
Jack	Jacktown Creek		837	1.3
Corp	Corpening Creek	Downstream from the Confluence of Youngs Fork and Jacktown Creek	650	1.0
		Totals	**5,682**	**8.9**

3.2 Water Quality Monitoring

Monitoring of water chemistry focused primarily on documenting nutrient and fecal coliform bacteria levels in major streams. Additional chemical monitoring to identify toxicants was not planned because such monitoring is extremely expensive and, as discussed below, prior experience has shown that it is unlikely to provide clear answers regarding which substances are the primary causes of toxicity. Although a variety of water column and sediment monitoring was conducted during the CAWS investigation, that study was unable to isolate the specific toxicants of concern in the Corpening Creek watershed. It was the experience of the NCDWQ's Watershed Assessment and Restoration Project (WARP), that specific toxicants could not be clearly linked to impairment of biological communities in urban streams, even with chemical monitoring on a scale considerably more intensive than the CAWS study (see, for example, NCDWQ, 2003a, 2003b, and 2003c). This was the case even where biological community data, midge deformities, and/or bioassay results indicated likely toxic impacts to biota. Given this experience, additional sampling of toxicants in Corpening Creek for purposes of refining our knowledge of the causes of impairment did not seem like a prudent use of available resources.

3.2.1 Baseline Monitoring

Monitoring Overview

Equinox conducted monitoring at six sites in the watershed from December 2007 to May 2011. This monitoring was intended to provide additional information for watershed plan formulation and on which to base changes in watershed condition following implementation of the plan. Monitoring activities included water chemistry sampling, benthic community monitoring, and aquatic habitat assessment. Fecal coliform levels at these sites were measured in September 2008. Sites were located on the mainstems of Youngs Fork, Corpening Creek, and Jacktown Creek (Table A-4 and Figure A-2). The parameters monitored are shown in Table A-5.

Table A-4 Baseline Monitoring Site Locations

Site ID	Stream	Location	Drainage Area (sq mi)
1	Youngs Fork	Claremont Avenue	0.7
2	Youngs Fork	Downstream of US 221 (near Carolina Interiors and Countryside BBQ)	3.2
3	Youngs Fork	Henredon Road/College Drive (SR 1819 at McDowell Tech)	6.5
4	Corpening Creek	Downstream of WWTP (SR 1794at Old Glenwood Road)	8.4
5	Jacktown Creek	Jacktown Road (SR 1737)	0.6
6	Jacktown Creek	US 226	1.3

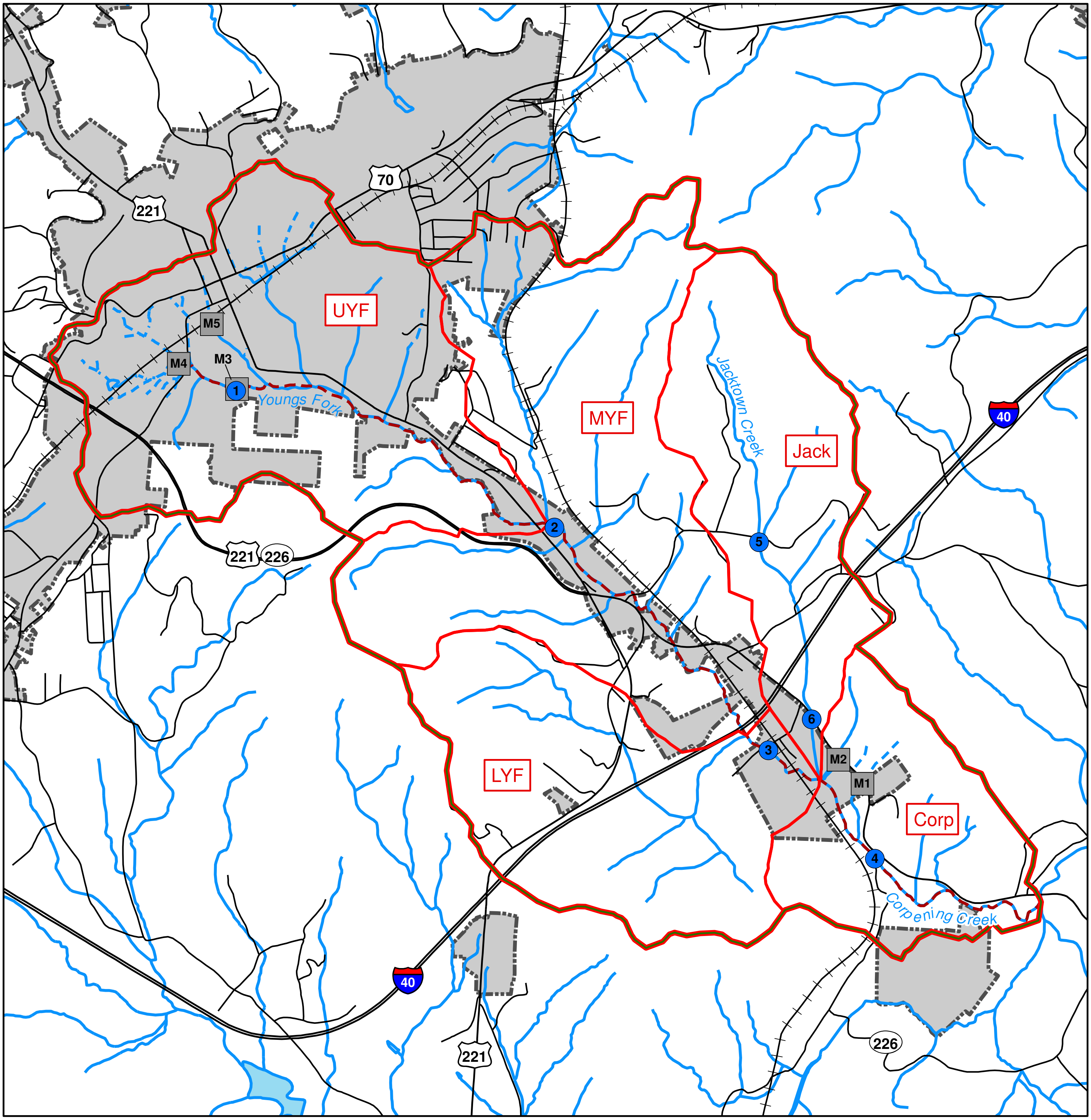
Table A-5 Parameters Monitored at Baseline Sites

Parameter	Units of Measure
Total phosphorus[1]	mg/L
Ammonia nitrogen[1]	mg/L
Nitrite+Nitrate-N[1]	mg/L
Total suspended solids[1]	mg/L
Dissolved oxygen[2]	mg/L
Temperature[2]	°C
Specific conductance[2]	µS/cm
Aquatic habitat[2]	0-100 metric score
Benthic macroinvertebrate community (VASOS)[2]	0-12 metric score
Fecal coliform bacteria[3]	cfu/100 ml

[1]Laboratory measured parameter.
[2]Field measured parameter.
[3]Reported as the geometric mean of 5 samples taken within a 30 day period.

Sampling followed the methods described in the project Quality Assurance Project Plan (QAPP) that was approved by NCDWQ in 2008 (Equinox 2008b). Grab samples were collected at baseflow by Equinox Environmental. Fecal coliform, nutrient, and total suspended solids (TSS) samples were analyzed by the State certified laboratory of the University of North Carolina – Asheville's Environmental Quality Institute (EQI).

Figure A-2 Baseline Monitoring Sites and Metal Sampling Locations



Baseline Monitoring Sites
Metals Sampling Sites
Roads
Railroad
Impaired Stream Segment
Piped Streams
Streams
Corpening Creek Watershed
Major Drainages
Marion City Limits

0 0.25 0.5 1 Miles

N E S W

Nutrient and Fecal Coliform and Nutrient Evaluation Levels

The NC water quality standard for fecal coliform bacteria states that the geometric mean fecal coliform concentrations should not exceed 200 colony forming units/100 ml (cfu/100 ml) and that no more than 20% of the samples should exceed 400 cfu/100ml. This determination must be made based upon at least five samples collected within a 30-day period.

North Carolina does not have applicable nutrient standards for these freshwaters. For purposes of this report, background levels of nutrient parameters are considered to be:

- NH_4^+ (ammonia) - 0.02 mg/L;
- NO_2^-/NO_3^- (nitrite/nitrate) – 0.04 mg/L; and
- TP (total phosphorus) - 0.02 mg/L.

Available data on reference streams in the Southern Appalachians suggest that baseflow concentrations in such streams are likely at or below these levels. Bolstad and Swank (1997), for example, found the following mean concentrations based upon more than 100 baseflow samples in Coweeta Creek, located in southern Macon County: NH_4^+ = 0.003 mg/L, NO_3^- = 0.042 mg/L, and PO_4^{+3}- (orthophosphate) = 0.002 mg/L. In a different stream, Clinton and Vose (2006) found respective mean baseflow concentrations of 0.01 mg/L, 0.007 mg/L, and 0.008 mg/L for thee same three parameters and a mean of 2.8 mg/L for TSS. By way of comparison, Briel (1997) compiled the following median concentrations across all streams in the Blue Ridge Physiographic Province: NH_4^+ = 0.05 mg/L, NO_3^- = 0.23 mg/L and TP = 0.04 mg/L.

Note that total nitrogen concentrations cannot be estimated from the data collected because organic nitrogen was not measured. Organic nitrogen concentrations in urban streams often exceed nitrate concentrations (Burton and Pitt, 2002; Center for Watershed Protection, 2003).

Benthic Community and Habitat Evaluation Methods

While standard NCDWQ benthic community monitoring methods will be used by the State to determine whether the stream should be removed from the 303(d) list, these methods were too resource intensive to use on an ongoing basis for this project. The modified Virginia Save Our Streams (VASOS) rocky bottom benthic monitoring method (VASOS, 2007) was utilized for this project to provide insight into benthic macroinvertebrate community conditions. The VASOS method differs from the NCDWQ standard qualitative method in a number of respects, including the level of taxonomic identification used (NCDWQ methods are more detailed) as well as the habitats sampled. VASOS monitoring is limited to sampling of a single riffle in a reach, whereas the standard qualitative method includes two riffle samples as well as samples of a number of other habitat types.

The VASOS method is comprised of six metrics based on the total number of aquatic organisms collected: percent of mayflies, stoneflies, and most caddisflies; percent common netspinners; percent lunged snails; percent beetles; percent tolerants; and percent non-insects. Individual metric scores can vary from 0 to 2; total metric scores can range from 0 to 12. Samples scoring ≥9 are considered to have an acceptable ecological condition. Those sites scoring <8 are considered to have unacceptable ecological conditions, whereas those sites scoring an 8 are considered to have indeterminate ecological conditions.

The modified VASOS method has been found to yield conclusions about ecological conditions that are very similar to those provided by some more resource intensive methods (Engel and

Voshell, 2002), although the protocol has not been specifically benchmarked against NCDWQ methods. While initially developed for western Virginia, the VASOS method has been applied elsewhere in the southern Appalachians, for example by the Southern Appalachian Man and the Biosphere program (http://samab.org/Focus/Monitor/Watersheds/watersheds.html).

The NC habitat protocol for mountain and piedmont streams (NCDWQ, 2006) was used to assess overall aquatic habitat quality whenever benthic community integrity was monitored. The NCDWQ protocol is widely used in North Carolina to rate overall aquatic habitat quality. The ratings are based on the sum of scores for eight habitat factors relevant to fish and macroinvertebrates. Total scores may range from 0 (worst) to 100 (best).

3.2.2 Metals Monitoring

Monitoring of metals was not originally planned for this assessment due to resource constraints. However, Duke Energy, one of the Muddy Creek Partners, agreed to conduct laboratory analysis for a suite of metals in order to provide additional information at selected sites for a single sampling event. Five sites were selected where high conductivity levels had been measured or where there were potential water quality concerns based upon land uses (Table A-6 and Figure A-2). Baseflow grab samples were collected in December 2008. Samples were collected by Equinox using standard Duke sample collection procedures. Analyses were conducted at the State-certified Duke Energy Analytical Laboratory to determine the total concentrations of seven metals, listed below with laboratory detection limits, followed by the NC freshwater aquatic life standard in parentheses:

- Cadmium - 0.030 mg/L (0.002);
- Chromium - 0.040 mg/L (0.05);
- Copper - 0.0050 mg/L (0.007);
- Lead - 0.090 mg/L (0.025);
- Mercury -0.050µg/L (0.012);
- Nickel - 0.040 mg/L (0.088); and
- Zinc - 0.0050 mg/L (0.05).

Note that detection limits exceed the water quality standard for cadmium, lead, and mercury.

Table A-6 Metals Sampling Sites, December 2008

Site ID	Stream	Location	Notes
M1	UT A Corpening Ck	Downstream of NC DOT facility and NC Dept. of Correction Marion Correctional Institution	Tributary enters Corpening Creek below NC 226
M2	Youngs Fork	Henredon Road/College Drive (SR 1819 at McDowell Tech)	Baseline Monitoring Site 3
M3	Youngs Fork	Claremont Avenue	Baseline Monitoring Site 1. Drains part of downtown Marion
M4	UT A Youngs Fork	Upstream of New West Henderson Street	Drains area of closed Broyhill Plant; drains to Site M3
M5	UT B Youngs Fork	Off of Morgan Street	Drains portions of downtown Marion

3.2.3 Escherichia coli (E. coli) Bacteria Monitoring

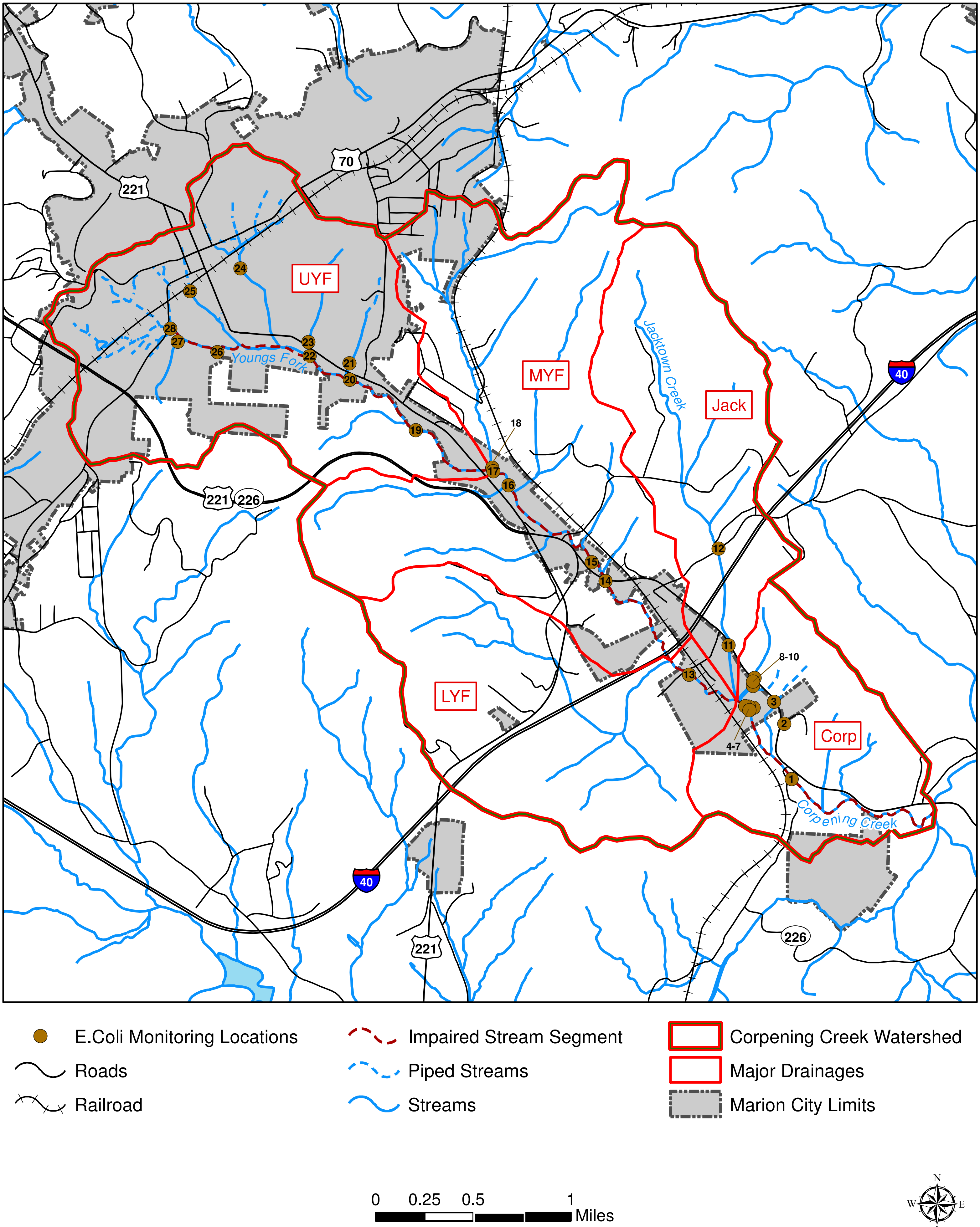
To supplement the fecal coliform data, E. coli monitoring was conducted at 28 locations in the watershed during 2008 (Table A-7 and Figure A-3). While this monitoring was not initially planned, contributions to the project by USEPA Region 4 and Duke Energy made possible several rounds of E. coli monitoring.

- An initial round of monitoring was conducted on April 4, 2008 using 3M™ Petrifilm™ test kits provided by USEPA Region 4. Samples were collected by Equinox and USEPA at 24 sites, selected primarily because of high conductivity levels measured during previous stream walk activities. Incubation and analysis of samples was conducted by Equinox and the UNCA EQI Laboratory, in conjunction with USEPA, using recommended methods (3M; Bruhn and Wolfson, 2007).
- A second round of sampling was conducted by Equinox at six sites on September 30, 2008 with additional 3M™ Petrifilm™ test kits provided by USEPA Region 4. Four of these sites had been sampled in April. Incubation and analysis of samples was conducted by Equinox and the UNCA EQI Laboratory.
- On December 9, 2008, additional E. coli sampling was carried out by Equinox at five locations in conjunction with the metals sampling described above. Laboratory analysis was conducted by Pace Analytical Services with funding provided by Duke Energy. Membrane filtration methods were used.

Table A-7 E. coli Monitoring Sites, 2008

Site ID	Stream	Location and Site Notes	Sampling Times, 2008		
			April	Sept.	Dec.
1	Corpening Creek	Glenwood Road	X		
2	UT Corpening Creek	Small tributary near horse arena	X		
3	UT Corpening Creek	Below DOT facility and Correctional Institution	X		X
4	UT Corpening Creek	Algae present; high conductivity	X		
5	Corpening Creek	Below WWTP		X	
6	UT Corpening Creek	At WWTP outfall	X		
7	Corpening Creek	Upstream of WWTP outfall	X		
8	UT Corpening Creek	Runoff from concrete swale at WWTP	X		
9	UT Corpening Creek	Below Hwy 226, stagnant, orange w/sheen	X		
10	UT Corpening Creek	Wetland	X		
11	Jacktown Creek	DOT restoration site at McDowell Tech	X		
12	Jacktown Creek	Jacktown Creek at Fairview Road, upstream from bridge	X	X	
13	Youngs Fork	Youngs Fork above Jacktown Creek off Henredon Road, baseline monitoring site 3			X
14	Youngs Fork	Mainstem	X		
15	UT Youngs Fork	Drains gas station, carwash	X		
16	UT Youngs Fork	Tributary above confluence by Countryside BBQ	X		
17	Youngs Fork	Youngs Fork at credit union	X	X	
18	UT Youngs Fork	Tributary adjacent at credit union			
19	Youngs Fork	At Ideal Storage	X		
20	Youngs Fork	Lower end of Marion center	X		
21	UT Youngs Fork	Tributary below old textile mill and cemetery	X		
22	Youngs Fork	Youngs Fork at Perfect Air Control, upstream from bridge		X	
23	UT Youngs Fork	Above KG gas station	X		
24	UT Youngs Fork	Below concrete plant	X		
25	UT Youngs Fork	Barbershop	X	X	X
26	Youngs Fork	Claremont Avenue	X		X
27	UT Youngs Fork	Behind Ingles	X		
28	Youngs Fork	Below West Henderson Street, drains Broyhill Plant	X	X	X

Figure A-3 E. Coli Monitoring Locations



3.3 Field Assessment Activities

Field assessments involved walking selected stream channels and evaluating potential pollution hot spots, using methods based on those developed by the Center for Watershed Protection (CWP, 2004a; 2004b).

3.3.1 Stream Walking Approach

Approximately 6 miles of Youngs Fork and Jacktown Creeks were walked to evaluate channel and riparian conditions, to identify potential sources of pollution, and to locate potential remediation opportunities. The area covered by the stream walk included: a) Youngs Fork from approximately New West Henderson Street (below McDowell County Millwork) to its confluence with Jacktown Creek; b) Corpening Creek from Jacktown Creek to Old Glenwood Road; and c) Jacktown Creek from one third mile above Jacktown Road to its mouth.

The methods used were based upon the Unified Stream Assessment approach developed by the Center for Watershed Protection (CWP, 2004a). This approach involves the delineation and walking of specific stream reaches. Observations are made on a variety of stream conditions, and recorded on a series of forms: stormwater outfalls and tributaries (OT); severe and active bank erosion (ER); impacted buffers (IB); utilities in the stream corridor (UT); stream crossings (SC); and dumpsites near or on streambanks (DP). In all, forty three reaches were evaluated.

A synoptic form (RCH) was used to record information on overall reach conditions. Equinox also evaluated aquatic habitat conditions in each reach using the NC habitat protocol for mountain and piedmont streams (NCDWQ, 2006). Stream conductivity and temperature were measured at the beginning and end of each reach, as well as at the mouths of all flowing tributaries and outfalls.

Since bank erosion is common in the watershed, specific eroding areas were recorded during the assessment only when erosion was active and severe. Similarly, removal of riparian vegetation is common. The lack of natural vegetation or presence of lawns was not considered sufficient to merit recording information on specific sites, although general notes on these types of impacts were recorded on the reach forms. Information on specific buffer impacts was recorded only when other significant impacts to the bank area were also present, such as substantial areas of rip-rap or concrete. See Equinox (2008c) for additional information on stream walk methods.

3.3.2 Hot Spot Investigation Approach

All portions of a watershed can produce stormwater pollution. However those areas that pose a risk for higher levels of pollution from spills, leaks, and storm runoff can be considered pollution 'hot spots' (CWP, 2004a) and merit additional scrutiny. In the Corpening Creek watershed, potential inputs of toxic substances and nutrients from these areas are a particular concern.

A watershed-wide Hot spot Site Investigation (HSI) using an approach similar to that developed by the Center for Watershed Protection (CWP, 2004b) was carried out. This approach has been used in other watersheds in North Carolina (Hoyt and Tomlinson, 2005) and represents an affordable method for the assessment of pollution sources.

Equinox conducted an initial site screening via GIS analysis of aerial photographs, supplemented by land parcel data and knowledge of the watershed. Eighty sites, primarily commercial and industrial operations, were identified as meriting additional review. Forty-five of these were inspected in the field (Table A-8). Field observations focused on five areas of operations and management, and their potential for being sources of pollutants:

1. Vehicular operations such as repairing, fueling, washing, etc;
2. Unprotected outdoor materials storage;
3. Waste management;
4. Maintenance and repair of the physical plant, including buildings, outdoor work areas, and parking lots; and
5. Turf/landscaped areas.

See Equinox (2008c) for additional information on hot spot investigation methods.

Table A-8 Types and Number of Potential Hot Spot Operations Inventoried in the Corpening Creek Watershed

Number	Actions and Hot Spot Status
80	Operations Initially Identified (total)
45	Field Inspection Conducted (total)
15	Gas station (n = 7) or other automotive (auto sales, car wash, or repair)
8	Restaurants
7	Industrial
5	Institutional
6	Misc commercial
4	Farm/garden supply and equipment
35	No Field Inspection Conducted (total)
18	No inspection needed based upon nature of operation[1]
4	Vacant/not in operation
2	No access-small facility
11	Large facility - inspection beyond scope of current assessment. Future evaluation

[1]No likely activities meriting inspection. Examples of excluded facilities: churches, banks, and video rental operations. A brief drive-by was conducted for some facilities.

In addition, Equinox retained Environmental Data Resources, Inc. (EDR) to conduct a hazardous materials database search for the watershed (EDR, 2008). Over 50 state and federal databases were searched to identify sites known by the regulatory agencies to contain toxic materials that have the potential to be a source of pollutant. These include databases such as: North Carolina Hazardous Substance Disposal Sites; the NC Petroleum Underground Storage Tank Database; the federal Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS); and federal Resource Conservation and Recovery Act information. These data were received in both text and GIS format and were considered in the initial GIS hot spot inventory. Sites were mapped by EDR where possible. The list of unmapped sites was reviewed to identify those located in the Corpening Creek watershed. Polluted sites reported as being remediated or satisfactorily cleaned up were no longer considered a pollutant threat.

3.4 Other Data Sources

A variety of other data sources was used in the development of this plan.

- Precipitation data from the long-term National Weather Service (NWS) Cooperative Station located in Marion (Station No. 315340) were used. These data are available from the CRONOS Data Base maintained by the N.C. State Climate Office, http://www.nc-climate.ncsu.edu/cronos).
- To provide information on water levels during the period of study, a water level recorder (Global Water Model WL15, www.globalw.com) was installed in Corpening Creek upstream of the lower baseline monitoring site at Old Glenwood Road. This unit, a submersible pressure transducer and data logger, was programmed to record water levels at fifteen minute intervals and was deployed from March 12, 2008 to February 13, 2009. There is no US Geological Survey stream gage in the watershed, though a gage is located on the Catawba River, about two miles northwest of the watershed.
- Discharge monitoring reports from Marion's Corpening Creek WWTP also were reviewed.

3.5 Data Management

All field data collected by Equinox were tracked via the field data sheets completed during monitoring and assessment activities. Field sheets were checked for accuracy and completeness prior to leaving the monitoring station. Data from these forms were entered into Microsoft Excel spreadsheets for permanent electronic storage. Following entry, Equinox data management staff conducted QA/QC checks on all data. Both hard and electronic copies of the field data collected by Equinox are stored at their Asheville office.

Data submitted for laboratory analysis were tracked by sample identification labels and laboratory records. Laboratory results from UNC-Asheville EQI were keyed into Microsoft Excel data files.

All photos were taken and stored digitally. GPS units were used during the field investigation to record the location of key features and activities. Latitude and longitude were uploaded directly from GPS units. Selected data were uploaded from the Excel data files into GIS software (ArcGis 9.2) for mapping and further analysis.

3.6 Estimation of Pollutant Loads

Nutrient and suspended solids loads were estimated using STEPL (Spreadsheet Tool for the Estimation of Pollutant Loads). This is a Microsoft Excel-based tool, developed for the USEPA by Tetra Tech, Inc., that employs simple algorithms to calculate pollutant loads from various land uses. The pollutants included are total nitrogen, total phosphorus, suspended sediment, and 5-day biological oxygen demand (BOD_5). STEPL computes watershed surface runoff, pollutant loads, and sediment delivery for various land uses and management practices. For each drainage defined in the model, the annual nutrient loading is calculated from the runoff volume and the pollutant concentrations in the runoff water, which vary by land use class and management practice. The annual sediment load (sheet and rill erosion only) is calculated using the Universal Soil Loss Equation (USLE) and a sediment delivery ratio. The model can also calculate the load reductions that would result from the implementation of various best management practices (BMPs). The sediment and pollutant load reductions that result from the implementation of BMPs are computed using known BMP efficiencies. For additional details see Tetra Tech (2006).

The model was set up to derive pollution loading estimates for the five major drainage areas in the Corpening Creek watershed. Other model implementation issues are summarized below.

- The 2005 land cover data was used to derive the land cover-based inputs for the model.
- Little of the land in the "pasture" classification is actually active pasture. Most land in this classification is in hay production, managed herbaceous areas such as cemeteries, or large grassy areas adjacent to residences. For this reason the nutrient runoff concentrations in the model for pasture land were reduced to a level closer to urban open space.
- An altered land category was added to the model, to reflect this class in the land cover data set. For altered land, a curve number of 79 and a USLE C Factor of 0.5 were used.
- The number of septic systems in each drainage was estimated based upon a count of residences on the 2005 aerial photographs. Only residences not within the area served by Marion's sewer system were counted. It was assumed that all residences in areas adjacent to sewer lines were served by the Marion system.
- The number and subwatershed location of livestock were estimated by Equinox and personnel of the McDowell County Soil and Water Conservation District.
- Streambank erosion estimates are based upon the 11 severely eroding areas documented during the stream walk. This underestimates total streambank erosion in the watershed since it does not include extensive areas of more moderate bank erosion on the mainstems of Youngs Fork and Jacktown Creek, nor erosion on smaller tributaries.
- Upland erosion estimates do not include gully erosion or erosion associated with unpaved roads or eroding road banks or ditches.

The model focuses primarily on stormwater-related pollution inputs and does not include most dry weather sources of pollution. For example, estimated inputs from septic system failure are included, while sanitary sewer line leaks or overflows are not. Loads from the Marion WWTP are not included in the model. However nutrient loads from the WWTP were estimated separately by multiplying the average annual wastewater discharge (0.78 mgd) by average concentrations of total nitrogen (6.67 mg/L) and total phosphorus (1.39 mg/L), using mean monthly values from the 2007 Discharge Monitoring Reports.

Results of the STEPL model are presented in section 4.2.2. Details of the potential reductions in pollutant loads resulting from implementation of stormwater BMPs are presented in Appendix C.

4 Findings

4.1 Watershed Characteristics

This section provides a brief overview of watershed characteristics, including demographics, land cover, the condition of aquatic communities, and other relevant features.

4.1.1 Socioeconomic Setting

About half of the City of Marion is located within the Corpening Creek watershed, including downtown and many of the older residential areas. Marion is the largest municipality and County seat of McDowell County. The 2007 population was 7,107 persons (N.C. State Data Center -http://www.osbm.state.nc.us/). The population of the watershed in 2007 is estimated at approximately 4,100, predominately within the City. While most of the Corpening Creek watershed (72%) is located outside of the City limits, much of the non-municipal area is sparsely populated.

The city had a vital manufacturing base for much of the twentieth century, including furniture and textile operations, among others. Manufacturing employment has declined substantially over the past several decades, a trend evident in many small municipalities in North Carolina. While manufacturing jobs are still sought by both the City and County, local officials have increasingly explored other approaches to enhancing economic development, including promoting tourism.

Agricultural activity in the watershed is limited and consists primarily of small livestock operations. According to estimates made by Equinox in consultation with the McDowell Soil and Water Conservation District, there are typically about 27 cattle, 9 goats, and 8 horses in the watershed. These are located primarily in the Jacktown Creek, lower Youngs Fork and lower Corpening Creek drainages. Numbers vary over time depending upon economic conditions, especially for cattle.

4.1.2 Precipitation

Precipitation at the NWS station in Marion averages 54 inches per year. Based on data from 1971 to 2000, the NC Climate Office has calculated average monthly precipitation to range from 3.9 to 5.6 inches.

4.1.3 Land Cover and Land Use

In 2005, about one-third of the Corpening Creek watershed was developed, with most of the remainder in forest (Table A-9; Figure A-4). Less than five percent of the watershed was in agriculture, primarily pasture and hay land, including some herbaceous cover in developed areas. Levels of development are highest (63%) in the Upper Youngs Fork drainage, which is the only major drainage located primarily within the Marion city limits. Developed land in the other major drainages is concentrated along the US Highway 221/NC Highway 226 corridor, with commercial uses predominating north of I-40 and institutional uses (McDowell Technical Community College and Marion Correctional Institution, among others) predominating south of the interstate.

Table A-9 2005 Land Cover (acres) in the Corpening Creek Watershed, by Major Drainage

Land Cover Class and Subclass	Major Drainage					Watershed Totals
	UYF	MYF	LYF	Jack	Corp	
Total developed area (acres)	932.5	365.7	179.8	214.0	153.8	1,845.7
Percent of total	62.4%	22.1%	17.2%	25.6%	23.7%	32.5%
Commercial	331.4	105.9	37.1	7.9	8.4	490.7
Mixed Urban	5.3	0.5	15.8	19.5	77.0	118.2
Residential	567.1	206.0	101.6	164.0	57.4	1,096.1
Transportation	23.0	53.3	25.3	22.5	10.9	135.0
Recreational	5.7	0.0	0.0	0.0	0.0	5.7
Total agricultural area (acres)	40.9	89.0	35.1	38.3	62.7	266.0
Percent of total	2.7%	5.4%	3.4%	4.6%	9.6%	4.7%
Cropland	0.0	32.2	0.9	0.3	3.7	37.0
Pasture-herbaceous[1]	40.9	56.8	34.3	38.0	59.0	229.0
Nursery	0.0	0.0	0.0	0.0	0.1	0.1
Total forested areas (acres)	519.7	1,195.9	820.8	583.6	433.5	3,553.5
Percent of total	34.8%	72.2%	78.6%	69.7%	66.7%	62.5%
Forest	459.8	1,111.5	703.1	548.3	356.7	3,179.4
Shrub/Scrub	59.9	84.5	117.7	35.3	76.8	374.1
Total other land cover (acres)	2.2	5.1	8.2	1.5	0.0	17.0
Percent of total	0.2%	0.3%	0.8%	0.2%	0.0%	0.3%
Altered Land	0.0	3.3	0.0	0.7	0.0	4.1
Water	2.2	1.7	8.2	0.7	0.0	12.9
Total acreages	1,495.3	1,655.7	1,043.9	837.3	650.0	5,682.3

[1]In addition to pasture, this category includes land managed for hay production, large managed herbaceous areas such as cemeteries and the like. Little of this land in this category is actually active pasture.

4.1.4 Impervious Cover

Approximately 13% of the Corpening Creek watershed was covered by impervious areas such as buildings, roads and parking areas in 2005 (Table A-10). However, the extent of impervious cover is much higher in the headwaters of the watershed (approx. 22% in the Upper Youngs Fork drainage), declining progressively downstream. Imperviousness in other drainages ranges from about 8% to 12%.

Figure A-4 Land Use in the Corpening Creek Watershed

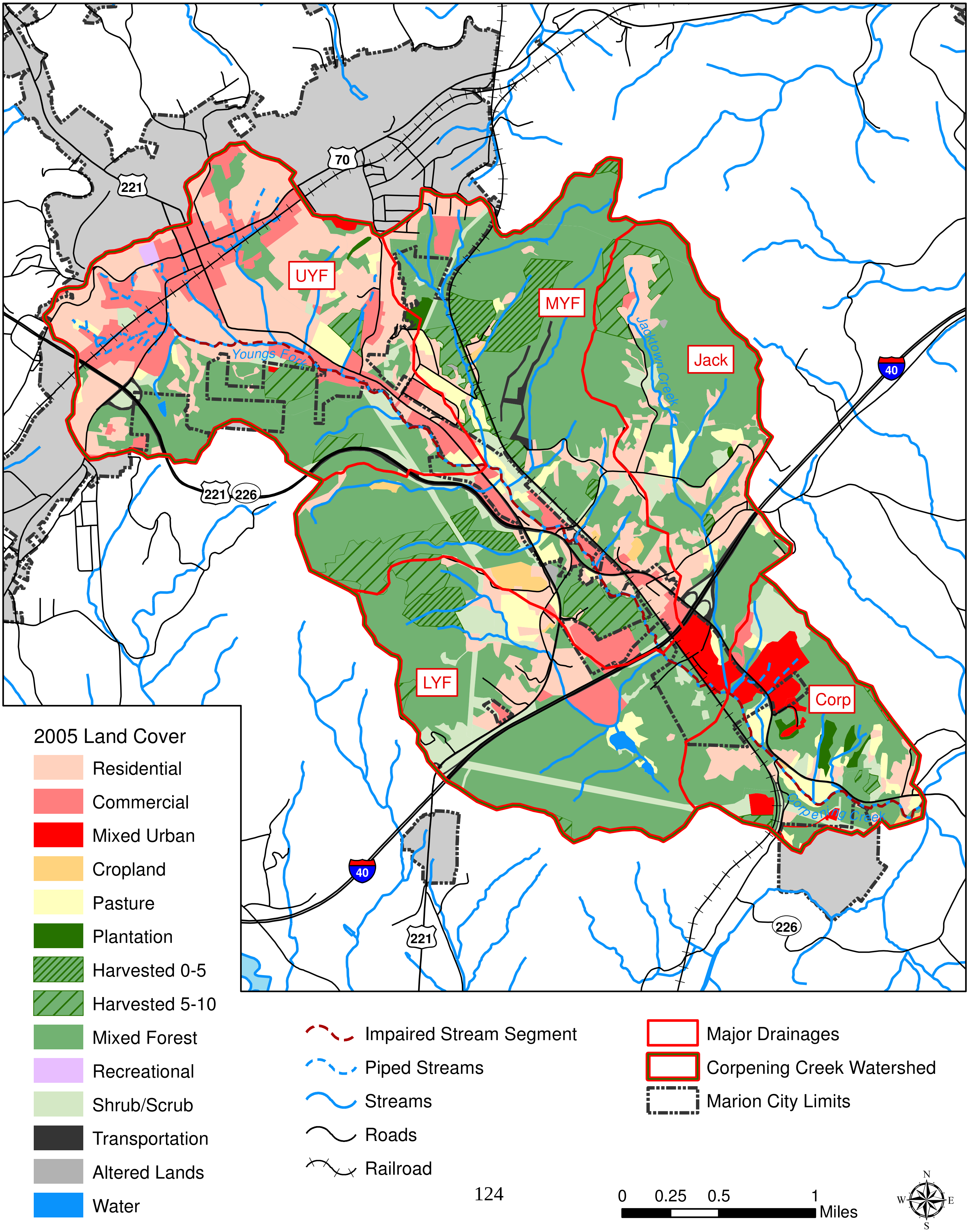


Table A-10 Estimated Extent of Impervious Cover in the Corpening Creek Watershed, 2005[1]

Drainage	Total Area (acres)		Impervious Area (acres)		Percent Impervious	
	Individual Drainage Only	Cumulative Drainage Area	Individual Drainage Only	Cumulative Impervious Area	Individual Drainage Only	Cumulative Impervious Area
UYF	1,495.3	1,495.3	330.2	330.2	22.1%	22.1%
MYF	1,655.7	3,151.0	154.6	484.8	9.3%	15.4%
LYF	1,043.9	4,194.9	80.1	564.9	7.7%	13.5%
Jack	837.3	837.3	75.7	75.7	9.0%	9.0%
Corp	650.0	5,682.3	76.0	716.5	11.7%	12.6%

[1]Cumulative values for a drainage represent cumulative values at the downstream end of the drainage, including estimates for upstream drainages, if any. The cumulative value for MYF also includes UYF; the cumulative value for LYF also includes UYF and MYF; the cumulative value for Corp includes all drainages. Estimates were calculated using percentages of impervious cover, by cover class, as described in Table A-2.

4.1.5 Corpening Creek Wastewater Treatment Plant

The City of Marion's Corpening Creek wastewater treatment facility (NPDES Permit No. NC0031879), located just below the confluence of Youngs Fork and Jacktown Creek, is the only permitted NPDES (National Pollutant Discharge Elimination System) wastewater discharge in the watershed. Since the plant is located near the downstream end of the watershed, any potential impacts of the facility on water quality would be limited to the lower portion of Corpening Creek. The facility is permitted to discharge a maximum of 3 million gallons per day (MGD) of treated wastewater, though typically the plant discharges at less than one-third that rate. Permit requirements and selected discharge characteristics are summarized in Table A-11.

The City of Marion has been actively working to upgrade the capacity of the facility to treat wastewater effectively. Improvements include changing aeration to diffused air, moving the grit removal to before the influent rather than after the influent, a more efficient bar screen, sand filter upgrade, the addition of sulphur dioxide for chlorine removal, rehabilitating the clarifiers, and adding sludge holding capacity. The current facility functions at a 65% efficiency rate at present. The upgrades will take the plant to about an 85-90% efficiency rate.

The facility is currently operating under a Special Order by Consent (SOC). A Special Order by Consent is an agreement that a permit holder enters into with the Environmental Management Commission in order to achieve stipulated actions designed to reduce, eliminate, or prevent water quality degradation (http://h2o.enr.state.nc.us/NPDES/faqs.html#c10). The SOC is intended to allow the city time to address impacts from inflow and infiltration (I&I) into the wastewater collection system. An I&I study conducted by the city in 2007 helped to isolate problems in the collection system. Significant I&I problems located within the Crossmill, Clinchfield, and Baldwin areas of the system have been repaired. The Crossmill area received a new sewer line, and manhole rehabilitation has been completed in the Baldwin area. This is an ongoing program; additional repairs are made as problem areas are located.

Table A-11 Corpening Creek Wastewater Treatment Plant: Summary of Permit Limits and Discharge Characteristics

Characteristic	Permit Limits and Monitoring Requirements
Maximum Permitted Discharge Rate Typical Discharge Rate[1]	• 3.0 Million Gallons per Day • 0.78 Million Gallons per Day
Effluent Quality	• Dissolved Oxygen (DO) = 5 mg/L • Total Suspended Solids = 30 mg/L • BOD_5 = 30 mg/L • Fecal Coliform Bacteria - 200 col./100 ml • pH = 6-9 units • Whole Effluent Toxicity = pass chronic toxicity test • Total Nitrogen (TN) = (no permit limits) • Total Phosphorus (TP) = (no permit limits)
Typical Effluent Nutrient Concentrations	• TN = 6.7 mg/L, TP = 1.4 mg/L
Monitoring Requirements	• Monitoring of effluent for all parameters with a permit limit • Monitoring of effluent for additional parameters (TN, TP, selected metals) • Quarterly bioassay for chronic whole effluent toxicity • In-stream monitoring of temperature, DO, fecal coliform bacteria and conductivity (in Corpening Creek upstream and downstream of the outfall)

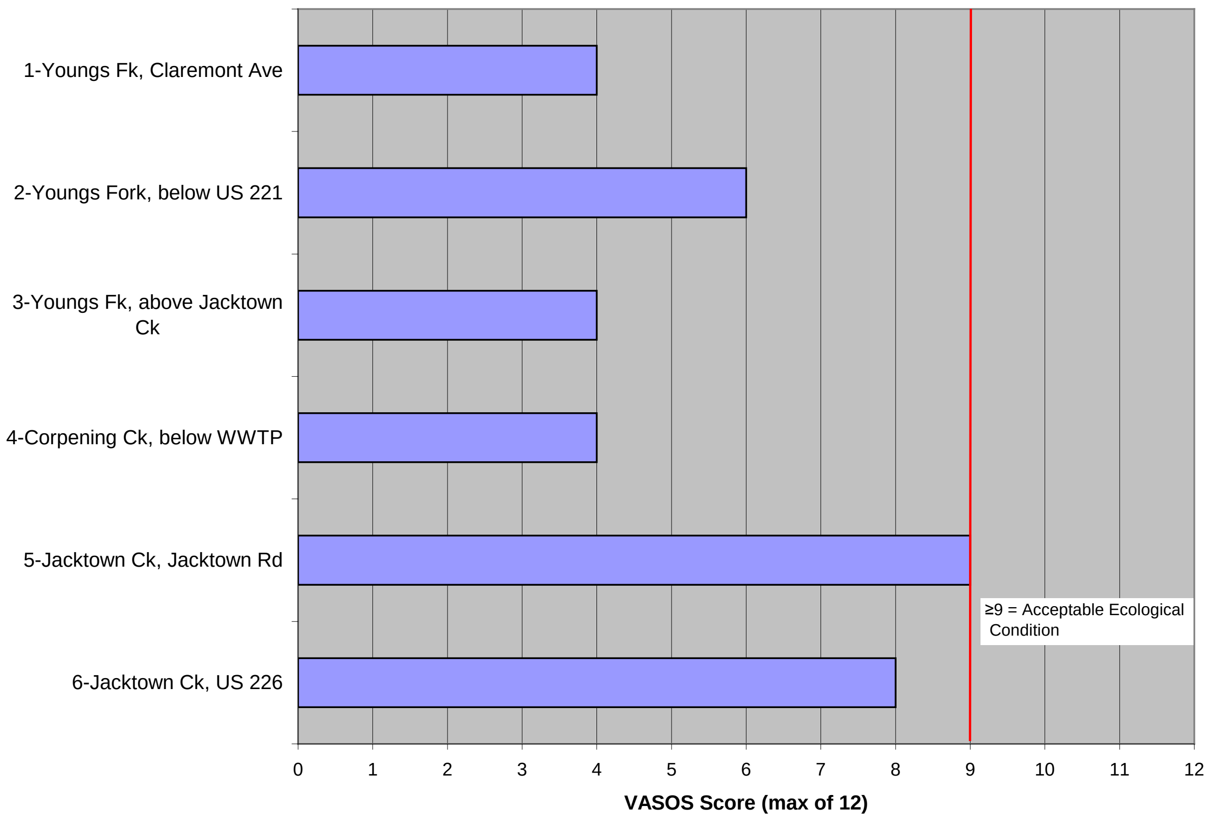
[1]Based upon monthly Discharge Monitoring Reports for 2007, provided by the City of Marion.

In May 2010 the City of Marion took the Catawba River WWTP offline and no longer discharges wastewater into the Catawba River. The approximately 800,000 gallons per day of wastewater handled by the Catawba River WWTP is now being sent to the Corpening Creek plant. The Corpening Creek facility has ample capacity, as Marion has lost much of the industrial base for which the plant was designed to provide wastewater treatment.

4.1.6 Aquatic Biological Communities

NCDWQ's biological community data, summarized in Section 1, indicates impaired benthic communities in Youngs Fork and Corpening Creek. The agency's next scheduled monitoring in the watershed is in 2012. Monitoring of benthos by Equinox using the VASOS protocol was conducted to provide information on trends in the benthic community in the interim. Results of monitoring to date (December 2007-May 2011) indicate that sites on Youngs Fork and Corpening Creek remain highly degraded, while Jacktown Creek is in better condition (Figure A-5).

Figure A-5 Median VASOS Scores At Baseline Sites Based on Monitoring, December 2007-May 2011 (N = 6).



4.2 Evaluation of Stressors and Sources

This section synthesizes the available information on the key stressors examined during the assessment: toxicity, nutrients and organic enrichment, hydromodification, and habitat degradation. The available data on each stressor are summarized and existing information on potential sources is discussed. Additional concerns, such as fecal coliform contamination, are also addressed.

4.2.1 Toxicity

Background

NCDWQ's CAWS investigation of the watershed (NCDWQ, 2004a) concluded that toxicity was probably the primary cause of impairment to the benthic community. This conclusion was based primarily upon biological indicators:

- Analysis of benthic community composition, especially the absence or dominance of certain indicator organisms, pointed to toxic impacts in the headwaters of Youngs Fork (Claremont Avenue) and in Corpening Creek at Old Glenwood Road (SR 1794).
- Deformities in midges collected from Corpening Creek (Old Glenwood Road) were common, indicating likely toxic effects.
- One laboratory bioassay conducted with a baseflow water sample collected at the Corpening Creek site failed, indicating conditions were toxic to test organisms.

> **Toxic Impacts in Urban Streams**
>
> NCDWQ studies (2003a, 2003b, and 2003c) in the State's urban streams indicate that a variety of toxicants are commonly found during storms, including: many metals; pesticides; surfactants (detergent components), and various organic contaminants (e.g. MTBE, or methyl-tertiary-butyl-ether). Metals and organic chemicals are also common in stream sediments, including PCBs (polychlorinated biphenyls), PAHs, and various pesticides.
>
> These studies found that determining the role of specific pollutants in causing toxicity is extremely difficult. This is corroborated by a variety of other research (e.g. Burton and Pitt, 2002). Many pollutants can be present, and concentrations of individual toxicants fluctuate widely. Pollutant interactions are difficult to evaluate, as are the cumulative impacts of multiple pulses of pollution.

Limited chemical monitoring was conducted during that study. Key conclusions can be summarized as follows:

- A variety of potential toxicants were detected in water column samples (including several metals, pesticides, and other organic compounds), but only aluminum was present at levels of concern.
- Sediment analysis found PAHs (polycyclic aromatic hydrocarbons), organochlorine pesticides, and metals (zinc, copper, chromium) at potential levels of concern in upper Youngs Fork (Currier Street). PAHs and aluminum were elevated in Corpening Creek sediments.
- No chemical monitoring was conducted in conjunction with the bioassay failure, though conductivity in that sample was very high (>2,000 µS/cm).

Chemical monitoring conducted by NCDWQ was unable to clearly identify specific toxicants responsible for the observed biological impacts (see sidebar). The NCDWQ study was not designed to investigate specific pollution sources in the watershed, but assumed diverse nonpoint source inputs to be the primary source of potential toxicants. The Marion wastewater plant had been passing its required whole effluent toxicity tests and was not considered to be a major factor, although a number of indicators of toxicity were apparent below the discharge.

Assessment Findings

The present assessment of toxicity focused primarily on investigating potential source areas and activities with a high potential for contributing toxic pollutants.

Stream monitoring. Specific conductance (see sidebar) is used as a general measure of overall water quality. Elevated conductivity levels were found at all six baseline monitoring sites (see Figure A-6). Median baseflow values at the uppermost station on Youngs Fork (>140 µS/cm) are over four times background levels for the area (≤30 µS/cm). These values were very consistent, ranging only from 139 to 151 µS/cm over five monitoring events. Conductivity levels progressively decline downstream in Youngs Fork until reaching the Marion WWTP discharge on Corpening Creek. At that point they then spike to >150 µS/cm. This pattern was evident in every monitoring event, indicating a consistent source of nonstorm pollutant inputs in the upper portion of the watershed.

Specific Conductance

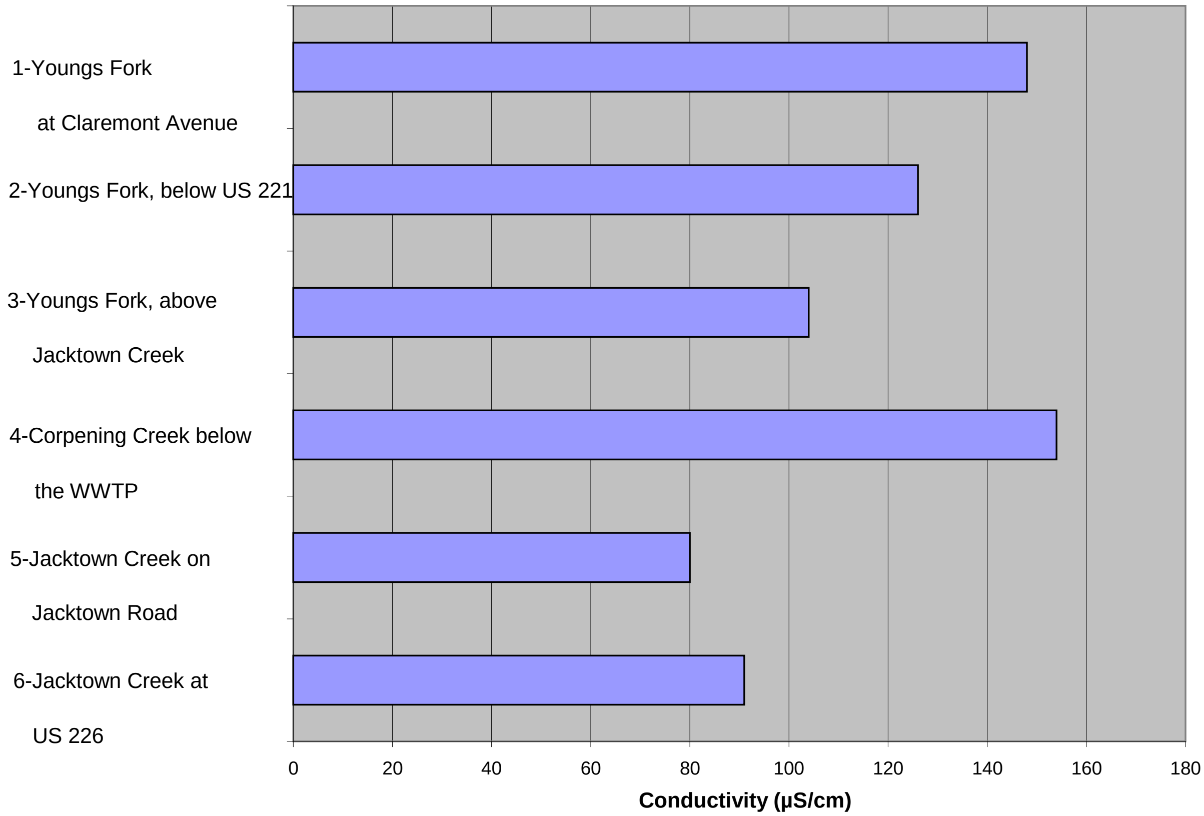
Specific conductance, or conductivity, is a measure of the ability of water to pass an electrical current. Conductivity is affected by the presence of inorganic dissolved solids, and is thus heavily influenced by local geology. Many types of pollutants can raise conductivity above expected levels.

Typical conductivity values for forested sites sampled by the Volunteer Water Information Network (University of N.C., Asheville, Environmental Quality Institute) in the mountain region are ≤30 µS/cm (Maas et al, 2004). Conductivity as low as 34 µS/cm were recorded in undeveloped portion of the Corpening Creek watershed during the present assessment. Levels below 30 µS/cm have been measured elsewhere in the Muddy Creek watershed (Equinox, 2008d). Conductivity is temperature dependent, and values reported here are standardized to 25° C.

Monitoring of conductivity was also conducted widely during stream walking and other watershed reconnaissance activities carried out from January to March 2008. Specific conductance in Youngs Fork and its tributaries above the Claremont Avenue baseline site commonly exceeded 140 µS/cm, and values over 200 were measured at some locations (see Figure A-7). A number of industrial facilities, some now closed, are located in this area. In this part of the drainage, values below 100 µS/cm were observed only in the tributary running behind the Ingles shopping center, which drains a developed area of lower density than most other portions of the upper watershed. Conductivity levels were also high (>150 µS/cm) in several tributaries to Youngs Fork draining downtown Marion. Values >170 µS/cm were often found in small streams adjacent to the Norfolk Southern Railway right-of-way that traverses the upper watershed.

These elevated conductivity levels indicate significant pollutant inputs during nonstorm periods. However, many types of pollutants can raise conductivity, so it is not clear whether these observations are the result of toxic inputs or other contamination. As discussed below, high concentrations of nutrients and fecal coliform bacteria have been observed in some of the same areas where conductivity is elevated. Monitoring for a suite of seven metals did not indicate high baseflow metals concentrations. Most metals were below detection at all five locations for the single monitoring event, although reporting limits exceeded the water quality standard for cadmium, lead, and mercury (see Section 3.2.2). Zinc was found to be above detection limits at four of five sites, but did not exceed the 0.05 mg/L water quality standard. Aside from this limited metals sampling, the potential contribution of toxicants to elevated conductivity levels was not specifically evaluated.

Figure A-6 Median Specific Conductance Values at Baseline Monitoring Sites, December 2007-May 2011[1]



[1]Based upon 5-6 samples per site.

Source overview. Toxic pollutants in urban watersheds can originate from what may be termed common, but generic sources – stormwater runoff from typical urban rooftops, streets, and parking areas. The ultimate sources of such pollution include; automobiles; leaching/corrosion from siding, roofing, and other materials; roadways, atmospheric pollution, and a variety of residential, commercial, and industrial activities (see Table A-12). Urban pollutants also come from 'hot spots' that, by the nature or intensity of on-site activities, have the potential for generating higher concentrations of pollutants than typical urban areas. Potential hot spots include a variety of commercial, industrial, institutional, municipal, or transport-related operations (see below).

Figure A-7 Conductivity Values

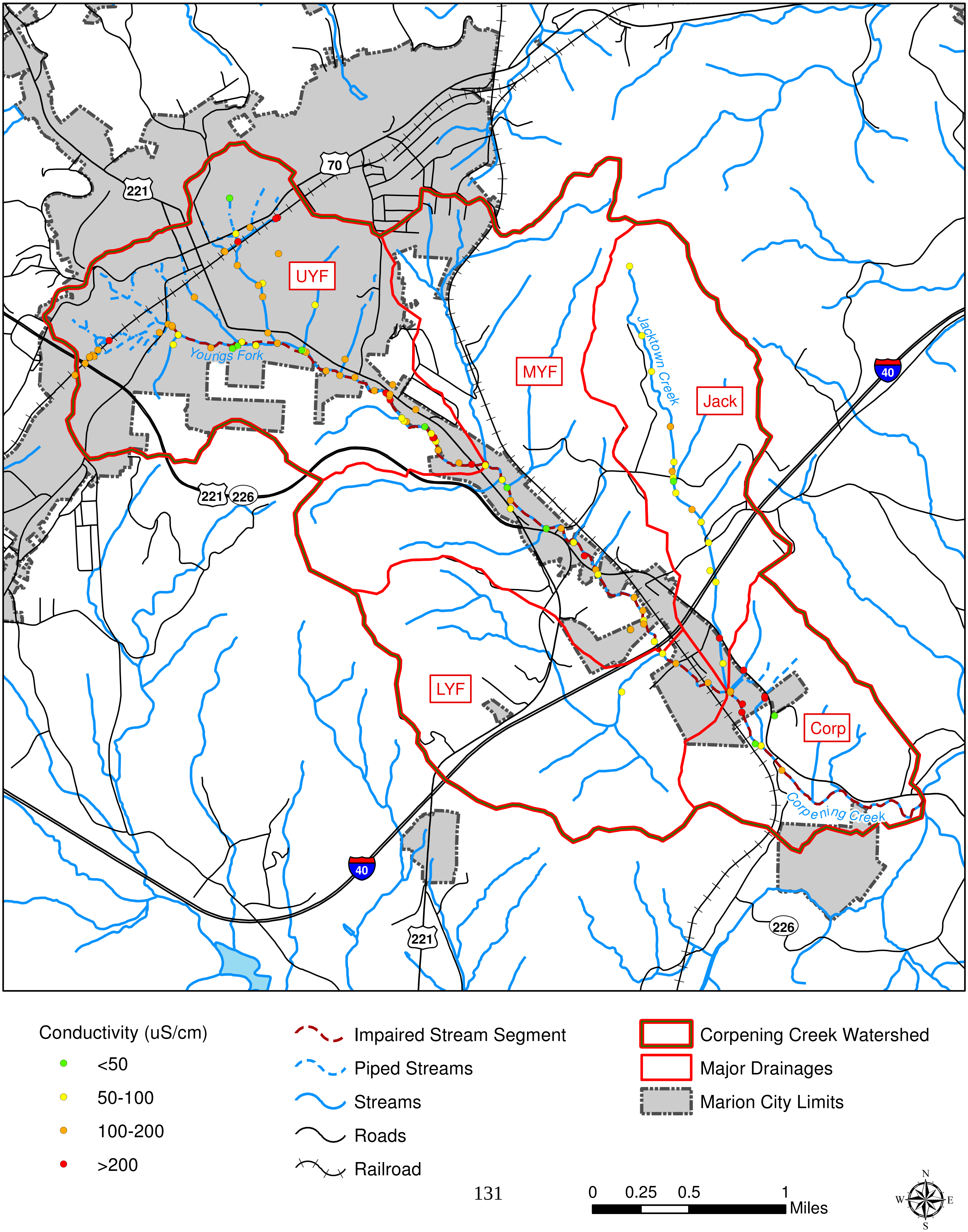


Table A-12 Potential Sources of Selected Toxicants in Urban Areas

Pollutant	Major Sources[1]
Cadmium	Metal corrosion, motor oil
Chromium	Metal corrosion, paint
Copper	Brake linings, fungicides and algicides, metal corrosion, paint
Lead	Tire wear, paints and stains
Zinc	Metal corrosion (galvanized pipes, roofs, and gutters), wood preservatives, paint, tire wear
Hydrocarbons	Vehicles, oil/gasoline spillage, pavement leachate
Pesticides	Application by homeowners, landscape, and pest control contractors

[1]Compiled from Burton and Pitt (2002), CWP (2003); and Schueler and Holland (2000).

Hot spot inventory. Equinox identified approximately 80 potential hot spots based upon analysis of aerial photographs and watershed reconnaissance. A brief field inspection was conducted of 45 of these sites, which included gas stations and other automotive-related establishments, restaurants, and a variety of other commercial and institutional facilities (Figure A-8). A number of large industrial and institutional facilities were not evaluated because of the size and complexity of the operations and/or access restrictions.

Observations suggest that many facilities are well run and maintained, minimizing the potential for water quality impacts. However, a variety of concerns were noted (Table A-13), primarily related to vehicle operations, waste management, and outdoor storage. Among the most common were:

- Potential runoff and spillage from vehicle fueling and other vehicular-related activities (Photo Exhibit 1a);
- Dumpsters that were uncovered or were located (without proper containment) on a stream bank or near a storm drain (Photo Exhibit 1b); and
- Various materials stored uncovered and/or without secondary containment (Photo Exhibit 1c).

Additionally, a considerable amount of impervious cover is present at some of these locations, pointing to a need to also mitigate hydrologic impacts.

Several specific facilities should be mentioned because of the obvious potential for water quality impacts or the number of concerns observed:

- McDowell Cement Products (site 28). Piles of sand, gravel, and other materials are stored adjacent to a tributary of Youngs Fork, sometimes to the top of the bank. The piles are not contained, covered, or otherwise managed in such a way as to prevent inputs to the channel. Materials are almost certainly washed into the stream by precipitation and runoff, and may sometimes be spilled into the stream during normal operation of the facility.
- McDowell Technical Community College. A periodic dry weather discharge has been observed coming from a campus building (site 4). Campus officials have suggested that this could be related to a photography class, but this has not been confirmed.
- McDowell County Large Material Collection Transfer Station (3). Liquid from trash collects in the loading area and drains untreated into a ditch (Photo Exhibit 2a).
- Loves Travel Stop and adjacent establishments (5). The potential for pollutant inputs are high at this site because of the size of this complex and the intensity of vehicular activity (Photo Exhibit 2b).

- Randolph's Garage (29) and Marion Tire South (21). The review indicated multiple concerns at these sites (Photo Exhibit 2c).

Hazardous materials database review. A review of sites listed in federal and state hazardous materials databases (EDR, 2008) provides another perspective on potential pollution sources in the watershed. This review identified numerous potential pollution sources, including:

- 10 sites listed in federal RCRA databases (Resource Conservation and Recovery Act of 1976). The sites listed are primarily classified as small quantity generators of hazardous wastes.
- 45 sites with underground storage tanks, as listed in the NCDENR Petroleum Underground Storage Tank Database. This included 16 leaking underground storage tank incidents.
- 5 additional groundwater and/or soil contamination incidents, as listed in the NCDENR Incident Management Database.

These sites are located primarily in the developed areas of the upper Youngs Fork drainage, with some additional sites located in the NC 221/US 226 corridor to the south, and a few in other portions of the watershed. The extent to which these sites serve as sources of pollution to streams in the watershed has for the most part not been investigated. Most of these incidents were reported in the 1990's. Although many of these sites were remediated or otherwise closed out by NCDWQ, the status of 14 sites is unknown and warrant further investigation to determine their potential as sources of pollutants (Figure A-8). It is important to note that these are only the sites that have been discovered and reported; there are likely more sites in the watershed that could be impacting water quality.

Figure A-8 Hot Spots in the Corpening Creek Watershed

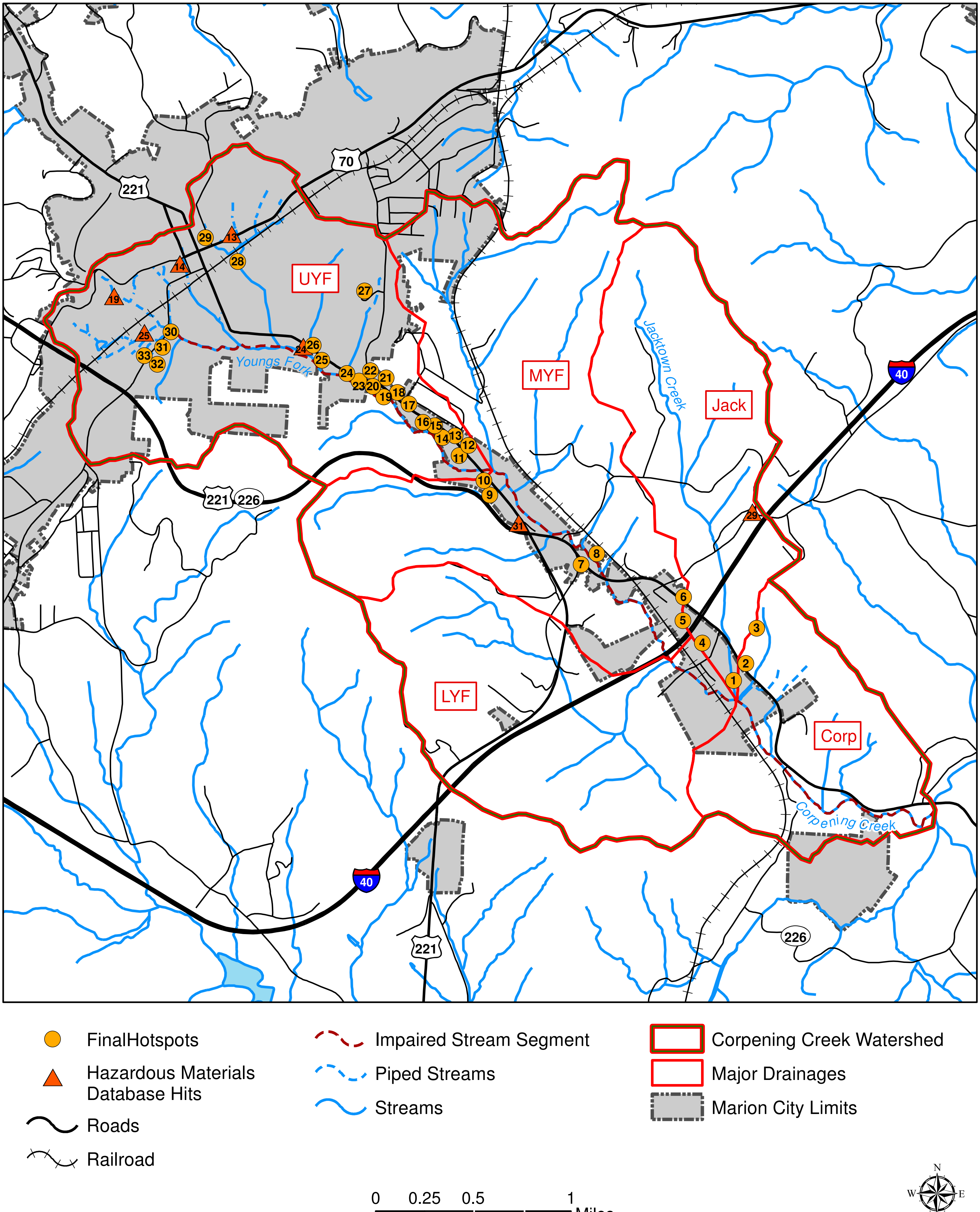


Table A-13 Summary of Primary Hot Spot Concerns in the Corpening Creek Watershed

General Type	Problem	Facility (site identification number[1])
Waste Management	Dumpster/container location on streambank	Hook & Anchor (25) Bantam Chef (24) Eddie's Pizza and Pasta (19) Spencer's Hardware (15)
	Dumpster uncovered (no cover or open lid)	John's Precision Auto Body (18) Countryside BBQ (9) Express Lube (11) J's Discount (13) Pyatt Heating and Air (17) Kwik-as-a-Wink (31) Shopping Center-Ingles (32)
	Evidence of spillage	Jalepeno Grill (16) Loves Travel Stop (5)
	Dumpster near drain or stream, with no diversion or containment	Waffle House (6) Eddie's Pizza and Pasta (19) Shopping Center-Ingles (32) McDonalds (33) Excel Mart (7) Hook & Anchor (25) Pyatt Heating and Air (17)
Outdoor Materials Storage	Lack of cover	Industrial Timber and Land Co. (1) Toolcraft (12) Marion Tire South (21) Summit Motors (22) McDowell Co. Household Waste Collection (2) McDowell Cement Products (28) Randolph's Garage (29)
	Lack of secondary containment	Industrial Timber and Land Co. (1) Toolcraft (12) Marion Tire South (21) Summit Motors (22) McDowell Co. Household Waste Collection (2) McDowell Cement Products (28)
Debris/Scrap/Parts Storage	Located adjacent to stream or subject to uncontrolled runoff	Samuel Frady's Used Auto Parts (27) Marion Ag and Garden (23) McDowell Recycling Inc. (8) Marion Equipment Co. (14) McDowell Co. Household Waste Collection (2)
Vehicle Operations	Fueling or repair areas adjacent to storm grain and/or subject to flow through	KG Quickstop (26) BP Station (20) Shell Station (30) Kwik-as-a-Wink (31) Loves Travel Stop (5) Excel Mart (7) Randolph's Garage (29)
	Spillage/leakage	Randolph's Garage (29) BP Station (20) Kwik-as-a-Wink (31) Loves Travel Stop (5) Excel Mart (7)
	Cars washed outdoors	John's Precision Auto Body (18) Randolph's Garage (29) Soapy Suds (10) Summit Motors (22) Car wash-Excel (7)
Other	Dry weather discharge to storm drainage system	McDowell Tech-dry weather discharge. (4) McDowell Co. Large Material Collection Transfer Station (3)

[1]Facility ID numbers in parenthesis refer to IDs shown on Figure A-8

Photo Exhibit 1: Common Hot Spot Problems

a. Car wash and cleaning area adjacent to storm drain.

b. Example of dumpster draining to storm drain, KFC.

c. Uncovered materials storage at Marion Equipment

Other sources. As discussed above, potential dry weather sources of toxic pollutants are a concern in the upper watershed. Some of the information presented on hot spot operations casts some light on this issue, but there are numerous other potential sources, including: illegal dumping; spillage; outdoor washing activities; cross connections from discharges that should go to the sanitary system; and undocumented groundwater contamination. No data on any of these are available.

Vehicular activity can be an important pollution source (Table A-12). Automobile traffic in the watershed is considerable along major corridors (Table A-14). Although pollution in street runoff, as opposed to vehicle-related hot spot establishments, is particularly difficult to assess and to treat, vehicular activity is likely an important source of pollution in the project area.

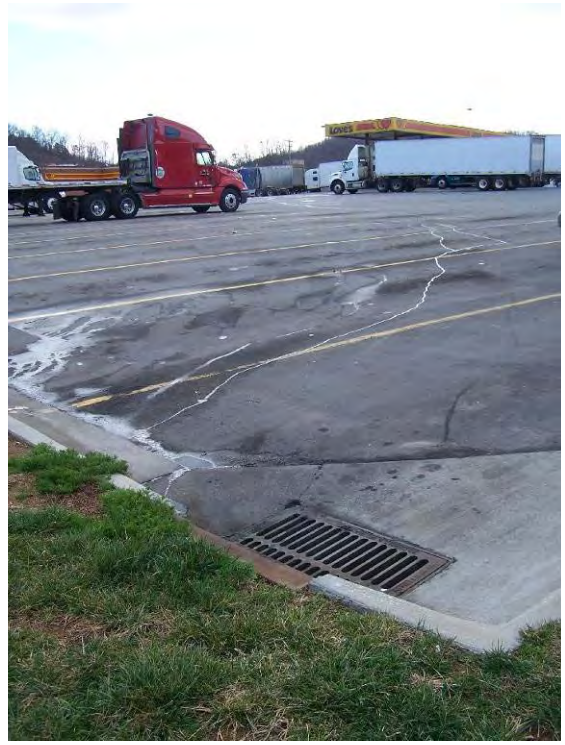
Table A-14 Average Daily Traffic Counts at Selected Locations in the Corpening Creek Watershed, 2007[1]

Vehicles per Day	Location
27,000	I-40 between US 221 and NC 226 interchanges
15,000	US 221/NC 226 Bypass
10,000	US 221/NC 226 Business, south of downtown Marion
13,000	Main Street, north of downtown Marion
12,000	Henderson Street, west of downtown Marion

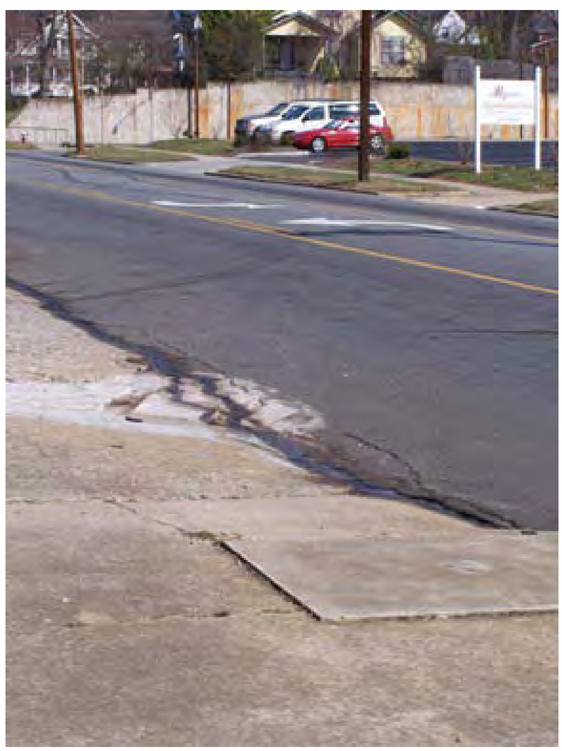
[1]Source: Traffic Volume Maps developed by the NCDOT Traffic Survey Group (http://www.ncdot.org/it/img/DataDistribution/TrafficSurveyMaps/)

Photo Exhibit 2: Hot Spots of Concern

a. Dry weather runoff from McDowell County



b. Dry large area with intensive vehicular activity,



c. Dry weather runoff from Randolph's Garage.

The Marion WWTP also discharges potentially toxic pollutants into Corpening Creek. While the location of the discharge precludes any impact on conditions in Youngs Fork, impacts on receiving waters in the lower watershed are possible. Though the discharge of individual toxic pollutants has not been quantified, NCDWQ data (NCDWQ, 2008d) show that the facility passed all of its quarterly whole effluent toxicity tests during the 2003-2007 period, indicating that the effluent should not be toxic to aquatic organisms.

4.2.2 Nutrient Enrichment

Background

The CAWS investigation (NCDWQ, 2004a) concluded that elevated levels of nutrients and organic inputs were an important stressor to stream organisms. Nutrients were elevated in Corpening Creek at (Old Glenwood Road), the only site at which they were monitored (Table A-15). The study found that nutrient enrichment did not appear to be lowering dissolved oxygen concentrations to problematic levels and were probably not sufficient to cause impairment alone. The CAWS study did not find dissolved oxygen concentrations below 6 mg/L.

NCDWQ did find that enrichment worked in combination with other stressors to cause impairment. Biological community indicators support this conclusion at several sites:

- Benthic community indicators of enrichment were observed in the headwaters of Youngs Fork (Claremont Avenue);
- Fish community enrichment indicators were observed in Corpening Creek at Old Glenwood Road (SR 1794).

Stream Enrichment

Organic material in the form of leaves, sticks, and other materials provides a food source for aquatic microbes and serves as the base of the food web for many small streams. However excessive amounts of organic matter from human or animal waste can adversely impact streams. Oxygen-consuming wastes and nutrients, particularly phosphorus and nitrogen, can increase microbial activity to levels that deplete dissolved oxygen. Adequate dissolved oxygen is essential to aquatic communities, and few organisms can tolerate low oxygen levels. Excessive organic materials also serve as food for certain aquatic invertebrate groups that can dominate the invertebrate community

Nutrients were assumed to be originating from a diversity of urban land cover types as well as the WWTP, which is located above the chemical monitoring station.

Table A-15 Nutrient Data Collected for the CAWS study, Corpening Creek at Old Glenwood Road[1]

Parameter	Baseflow Median (n = 4) (mg/L)	Storm Median (n = 4) (mg/L)
Ammonia	0.02	0.02
Total Nitrogen	1.65	1.27
Total Phosphorus	0.24	0.24

[1]NCDWQ 2004a

Assessment Findings

As noted earlier (Section 4.2.1), conductivity in upper Youngs Fork and its tributaries is elevated at a number of locations. The pollutants responsible for this situation have not been determined, but excessive nutrient inputs are one possibility.

Stream Nutrient Data. Data taken at baseflow from the six baseline monitoring sites (Figures A-9 and A-10) indicates that ammonia and nitrate concentrations are generally above levels typically found in the Blue Ridge Physiographic Province (Briel, 1997). This is especially true for nitrate. The pattern in median nitrate concentrations mirrors the pattern shown earlier for conductivity - very high levels in the headwaters of Youngs Fork (median of 1.50 mg/L), a gradual decline in concentration to 0.5 mg/L further downstream in Youngs Fork, and then a sharp increase below the WWTP discharge (median of 1.30 mg/L). Total phosphorus concentrations (Figure A-11) also exceed regional median concentrations, although at most sites the difference is not as dramatic as for nitrate. The exception is Corpening Creek below the WWTP, where phosphorus concentrations are much higher than elsewhere in the watershed. Nitrate concentrations in Jacktown Creek are the lowest in the watershed, but ammonia levels there are very high (median of 0.1 mg/L).

Figure A-9 Median Ammonia Concentrations at Baseline Monitoring Sites, December 2007-May 2011

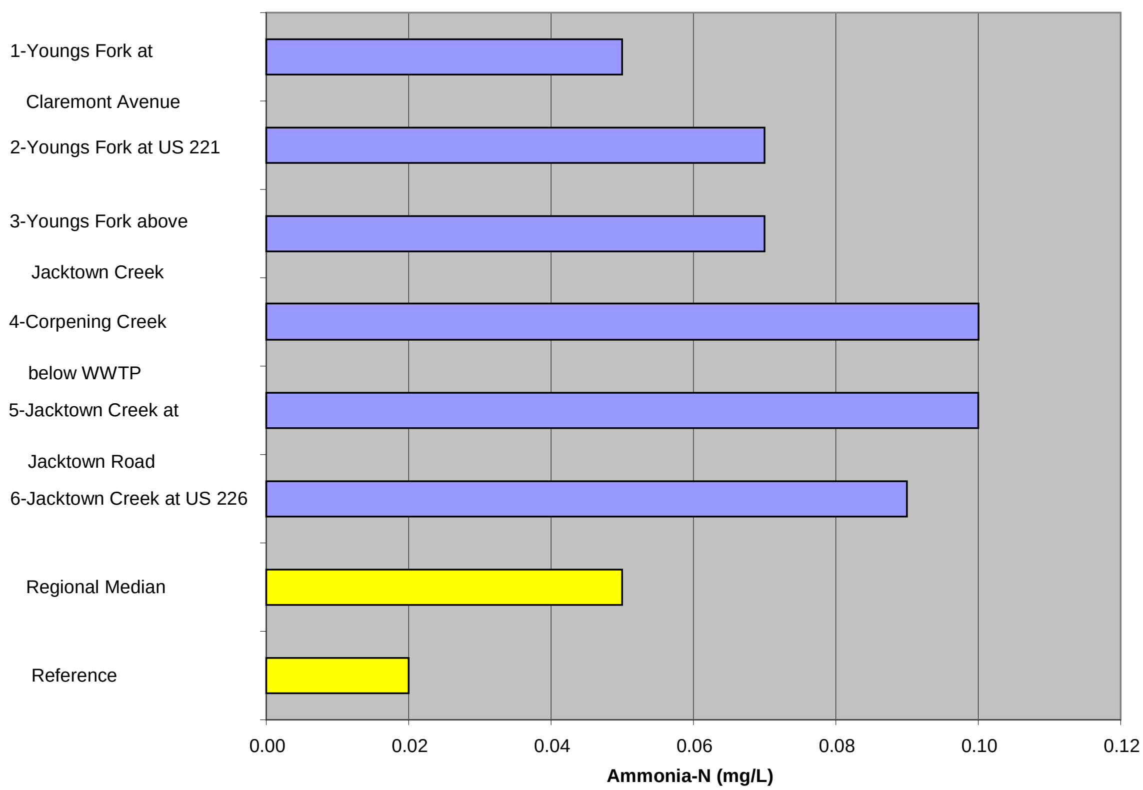


Figure A-10 Median Nitrate Concentrations at Baseline Monitoring Sites, December 2007-May 2011

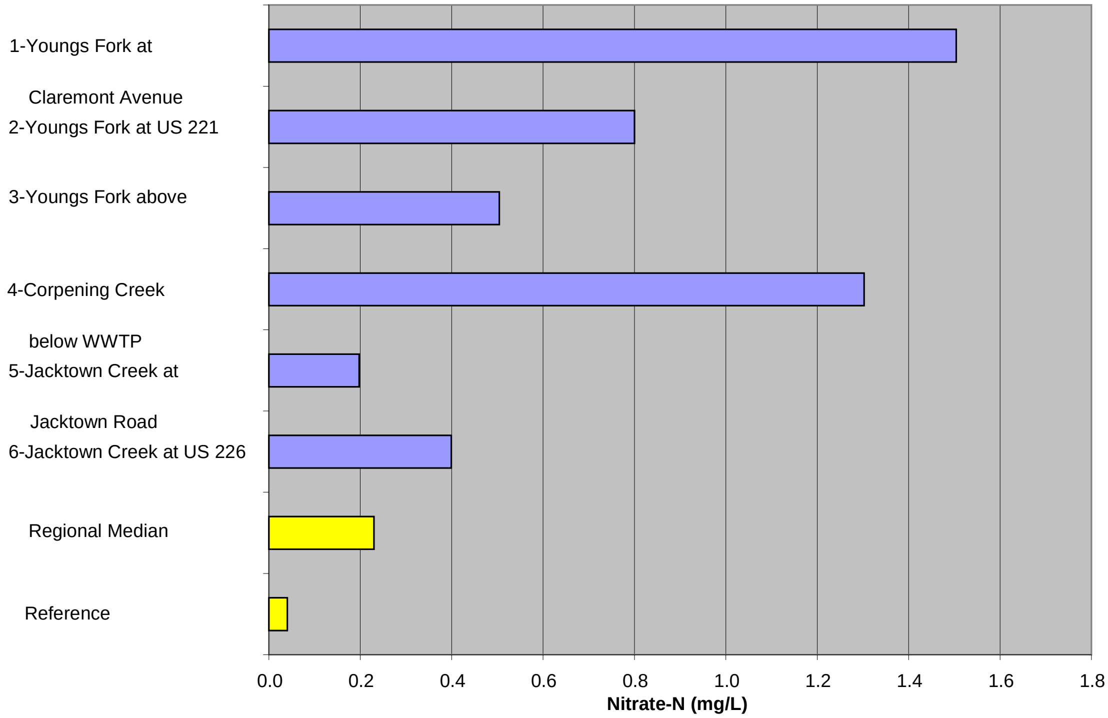
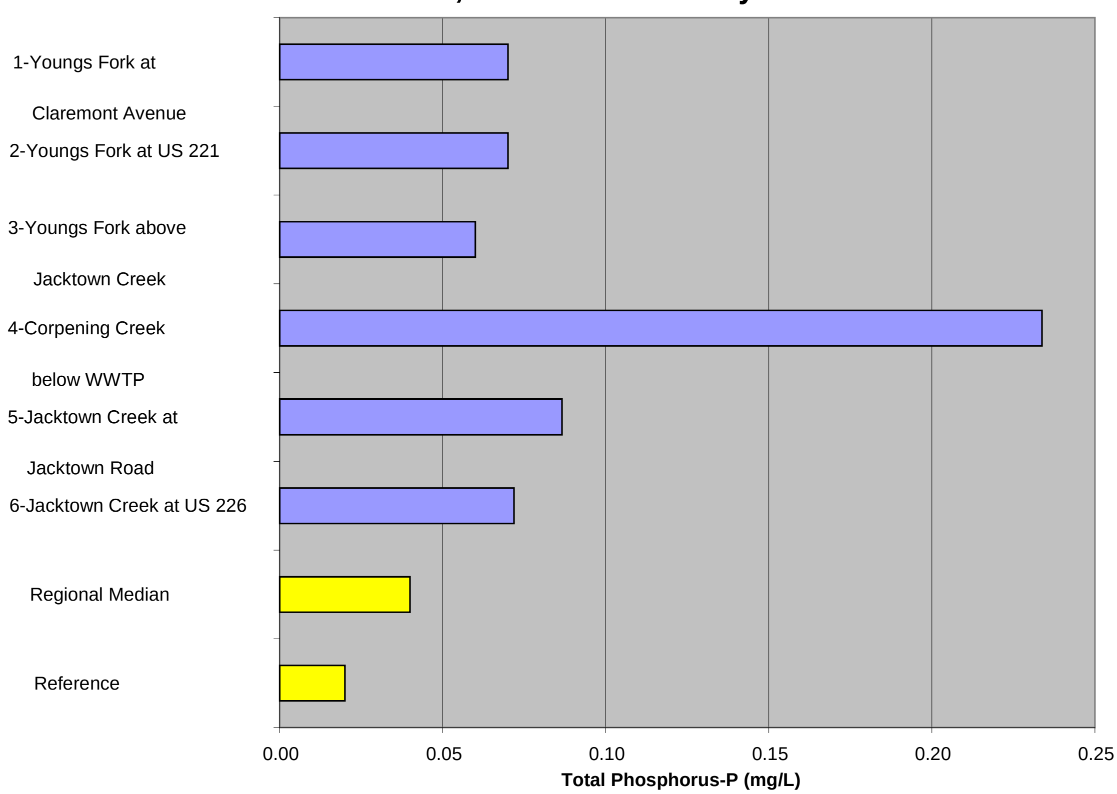


Figure A-11 Median Total Phosphorus Concentrations at Baseline Monitoring Sites, December 2007-May 2011



Enrichment Sources. Nutrient sources in developed areas can be quite diverse (CWP, 2003). Dry weather sources include septic systems, leaking sanitary sewer lines, and illegal discharges. Illegal discharges include both direct dumping into streams and illicit connections to the storm sewer system. Sources contributing to nutrients in storm runoff include:

- Fertilizer;
- Pet waste;
- Organic matter (e.g. leaves, mulch, grass clippings);
- Erosion (both upland and stream banks); and
- Atmospheric deposition (e.g. deposited pollutants from fossil fuel combustion),

Monitoring data at the baseline sites clearly indicate that the upper portion of the Youngs Fork watershed is an important source of baseflow nitrates. Leaking sanitary sewer lines and/or illegal connections of wastewater to the stormwater collection system or to streams seem the most likely nutrient sources in the Youngs Fork drainage during nonstorm periods. There are few, if any, livestock in this area, and septic systems are an unlikely source in this portion of the watershed, which is served by the Marion wastewater system.

Each year, Marion WWTP staff walk the sewer lines to identify any evident problems with the lines. In 2007, staff also cleared the right-of-ways and access lines for the sewer system. While very useful, these activities may not identify problems in much of the upper watershed, where inspection is difficult.

Sewer service was recently extended to the Eastfield area, located at the headwaters of a Youngs Fork tributary east of downtown Marion, through a $6 million sewage expansion project. The sewer expansion likely addressed some of the suspected nutrient enrichment and bacterial contamination from faulty septic systems in this tributary.

Elsewhere in the watershed, the Marion wastewater discharge is a significant source of both nitrogen and phosphorus to lower Corpening Creek. Possible sources of baseflow nutrients in Jacktown include livestock and faulty septic systems. Several sites where livestock have stream access were documented along Jacktown Creek. This drainage is unsewered except for a small area near its confluence with Youngs Fork.

Estimated Pollutant Loading. The STEPL model estimates of pollutant loading (Table A-16) indicate that runoff from urban portions of the watershed accounts for most of the land-based nutrient loading in the watershed - 82% for nitrogen, and 68% for phosphorus. These estimates emphasize stormwater-related pollution inputs and do not include most dry weather sources of pollution (see Section 3.6). Due to the highly developed nature of the area, the Upper Youngs Fork drainage accounts for almost half of the land-based nutrient load (45% for nitrogen and 43% for phosphorus) and over 70% of the sediment loading. Loads from the wastewater treatment plant are also substantial, though these are discharged toward the lower end of the watershed.

Table A-16 Estimated Annual Pollutant Loads by Source for Corpening Creek Watershed[1]

Sources	Total Nitrogen			Total Phosphorus			Suspended Sediment		
	Lb/yr	% of Model Total	% of WS Total	Lb/yr	% of Model Total	% of WS Total	Tons /yr	% of Model Total	% of WS Total
Urban	18,349	81.8%	48.0%	2,853	68.1%	38.2%	404	38.1%	38.0%
Crop Land	330	1.5%	0.9%	65	1.6%	0.9%	20	1.9%	1.9%
Pasture-herbaceous Land	1,170	5.2%	3.1%	134	3.2%	1.8%	18	1.7%	1.7%
Forest	1,315	5.9%	3.4%	650	15.5%	8.7%	21	2.0%	2.0%
Altered Lands	15	0.1%	0.0%	6	0.1%	0.1%	4	0.4%	0.4%
Septic Systems	155	0.7%	0.4%	61	1.5%	0.8%	0	0.0%	0.0%
Streambank Erosion	1,089	4.9%	2.9%	419	10.0%	5.6%	592	55.8%	55.6%
Model Subtotal	22,423	100.0%		4,188	100.0%		1,060	100.0%	
WWTP	15,785		41.3%	3,289		44.0%	5		0.4%
Watershed Totals	38,208		100.0%	7,477		100.0%	1,065		100.0%

[1]Estimated from STEPL model (see Section 3.6), except Corpening Creek WWTP load (estimated from 2007 Discharge Monitoring Reports). Model estimates emphasize stormwater runoff pollution and do not include most dry weather pollutant inputs. Streambank erosion estimates include only a small number of severely eroding areas and do not cover large areas of more moderate bank erosion. Components may not add to totals due to rounding.

Much of the estimated urban nutrient loading (37% to 43%, depending upon the pollutant) comes from residential areas (Table A-17). Loading from runoff originating in commercial areas and major transportation corridors also comprises a substantial portion of the total load from urban runoff.

Table A-17 Distribution of Nutrient Loading from Urban Runoff, by Land Use[1]

Land Use	Total Nitrogen	Total Phosphorus
Total Commercial, Industrial & Institutional	41.4%	33.7%
Commercial	24.1%	15.5%
Industrial	9.0%	9.3%
Institutional	8.3%	8.9%
Transportation	21.9%	23.4%
Residential	36.6%	42.8%
Other	0.1%	0.1%
Total Load from Urban Areas	100.0%	100.0%

[1]STEPL model estimates. Transportation includes only major corridors (I-40, US 221 and NC 226). Secondary roads are included as part of the other land cover classifications.

4.2.3 Hydromodification

Background

The CAWS investigation (NCDWQ, 2004a) concluded that channel scour from increases in stream flow during storm events was contributing to the impaired condition of biological communities in Youngs Fork. The importance of scour appears to have been inferred from the physical condition of the stream, including the degree of incision, the extent of bank erosion, and the fact that the channel has cut down to bedrock in places.

Assessment Findings

Hydromodification-related impacts are most likely to be associated with two factors:

1. Concentrations of impervious cover, especially in areas served by storm sewers, which contribute to elevated stormwater runoff volume and velocities;
2. Direct modification of stream channels, such as relocation and bank hardening.

The most significant contributing area in terms of storm runoff volume is the upper Youngs Fork drainage, where levels of imperviousness are highest (22%). This level of impervious cover is clearly high enough that hydrologic impacts to stream channels and biota would be expected (CWP, 2003; Schueler et al., 2009).

> **Hydromodification**
>
> Hydromodification, or hydrologic modification, is defined as changes in a river or stream channel resulting either in an increase or decrease in the usual supply of water flowing through the channel, or in a change to the usual physical characteristics of the channel (USEPA, 2007). Hydromodification can be caused either by direct alteration of a channel, for instance by straightening or dredging, or by changes in watershed hydrology, such as upstream development or dam construction.

Upper Youngs Fork constitutes only about a quarter of the watershed, but contains almost half (46%) of the impervious area (Table A-10). Farther downstream, commercial, industrial, and institutional operations in the NC 226 and US 221 corridors also contain substantial impervious cover. Importantly, most of the upper watershed is served by curb and gutter storm drain systems, which facilitates the collection of runoff from impervious areas as well as its delivery to streams. Farther downstream, the stormwater delivery system is not as well developed.

Though the watershed is ungaged, a stage recorder deployed in Corpening from March 2008 to February 2009 provides some data on stream hydrology. During this period Corpening Creek experienced seven storm events with a rise in stream stage of 2 feet or more, with a maximum storm rise of 4.2 feet on January 7, 2009. On several occasions, the stream experienced a rise of two feet within approximately one hour. The area draining to this site is about 13% impervious. Stage recorders were not installed upstream in the more densely developed portion of the watershed, but changes in stream stage during storms were undoubtedly more dramatic at these locations.

Watershed development leads to loss of channel length as small streams are routed underground or replaced by the storm sewer system (CWP, 2003). While increased imperviousness results in additional storm runoff, alteration of the channel network increases transport efficiency and reduces opportunities for water storage, further contributing to increased peak flows and velocities. Field reconnaissance conducted during this assessment found that about 20,000 feet of mapped streams in the watershed have been piped. Most of these (17,700 feet) are located in the upper Youngs Fork drainage, where 20% of the streams are now underground.

Existing evidence on the impacts of hydromodification on stream communities is largely indirect. However, given channel conditions and levels of impervious cover in the upper watershed, it is likely that stormwater volume impacts on biota are important in the Upper Youngs Fork and Middle Youngs Fork drainages.

4.2.4 Habitat Degradation

Background

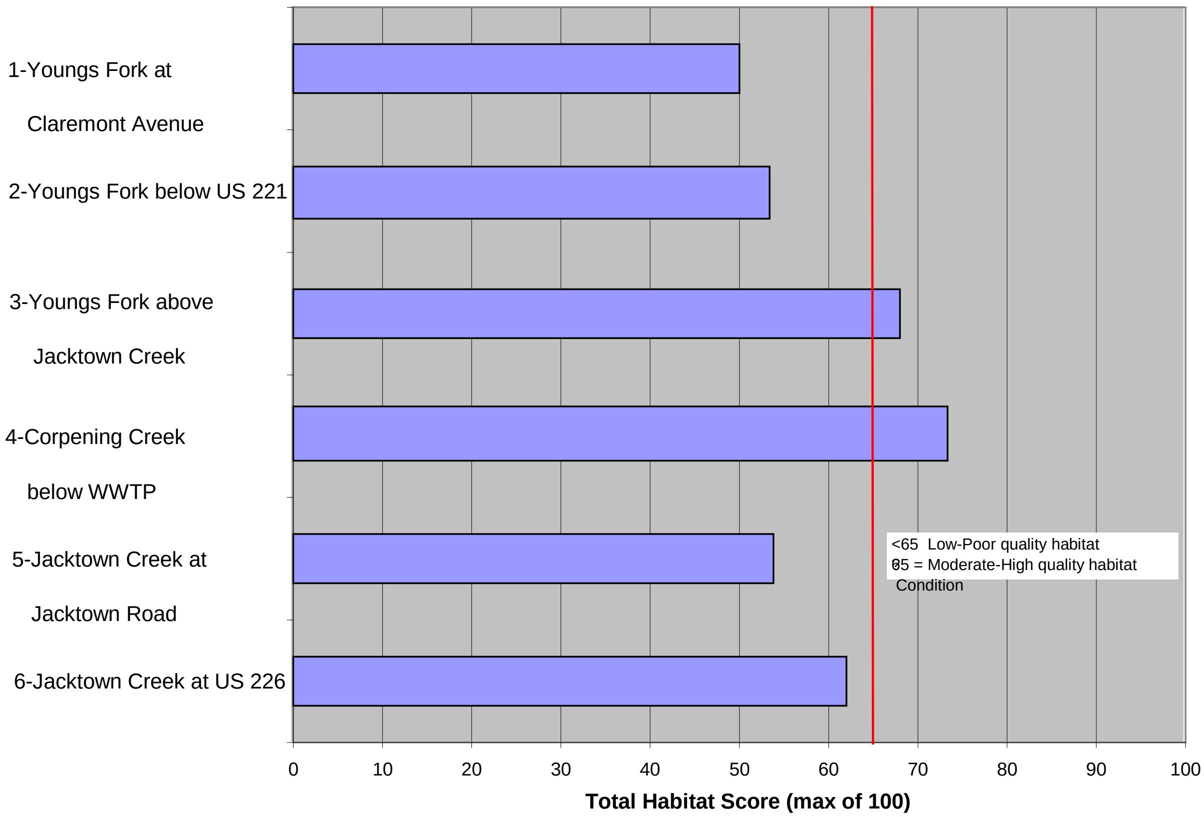
The NCDWQ concluded that habitat degradation due to a lack of microhabitat is a contributing stressor, but probably not a significant cause of impairment (NCDWQ, 2004a). NCDWQ assessments conducted at biological community monitoring sites during the CAWS study found overall aquatic habitat was good in Corpening Creek (score of 70 of 100 at SR 1794) and very good in lower Youngs Fork (90 at SR 1819). Only in the Youngs Fork headwaters was overall habitat in poor condition (score of 53). NCDWQ uses a score of 65 as the cut off between ‘moderate to high’ habitat quality and ‘low to poor’ quality (NCDWQ, 2008b). NCDWQ concluded that, overall, habitat degradation is not major factor in impairment, but that organic microhabitat ranges from very limited to only moderate. Sedimentation is evident in many pools, but riffles do not appear to be highly embedded.

Assessment Findings

Habitat assessments at the six baseline monitoring sites found habitat to be degraded, though not extremely poor (median scores between 50 and 53), in the upper and middle portions of Youngs Fork, and in Jacktown Creek (Figure A-12). Habitat in lower Youngs Fork and in Corpening Creek was of moderate quality (median scores of 68 and 73, respectively). The major habitat deficiencies are associated with the lack of riparian vegetation and the prevalence of sedimentation (riffle embeddedness). Some of the monitoring was conducted during a period of drought, and flushing of sediments may have been more limited than in periods of normal discharge. Despite some sediment impacts, overall microhabitat scores (indicating the diversity and extent of habitat area for stream organisms) were adequate (median scores ranged from 14-16 out of 20). At least at the lower Youngs Fork site, which is NCDWQ’s long-term monitoring site, and in Corpening Creek, habitat is adequate to support a more diverse assemblage of macroinvertebrates than exists. Habitat quality at these sites should support a benthic community that is not impaired.

Habitat evaluations conducted during the stream walk-provided a more extensive look at habitat on the Youngs Fork and Jacktown Creek mainstems. Results from the 39 reaches evaluated confirm that habitat is most degraded in the Upper Youngs Fork drainage (median = 55), while better conditions were observed farther downstream (see Photo Exhibit 3). The median habitat score was 75 in middle and lower Youngs Fork, and 69 in the portion of Corpening Creek that was assessed.

Figure A-12 Median Aquatic Habitat Scores At Baseline Monitoring Sites, December 2007-May 2011 (N = 6)



4.2.5 Other Concerns

Bank Erosion

Watershed reconnaissance indicated that stream bank erosion is widespread in Youngs Fork and Jacktown Creek and on a number of tributaries. This is common in many urban watersheds. For this reason, only the most active and severe erosion was recorded during the stream survey. The location of over 2,100 linear feet of such erosion was documented on the Youngs Fork mainstem (primarily on upper Youngs Fork) and about 540 feet on Jacktown Creek (Figure A-13).

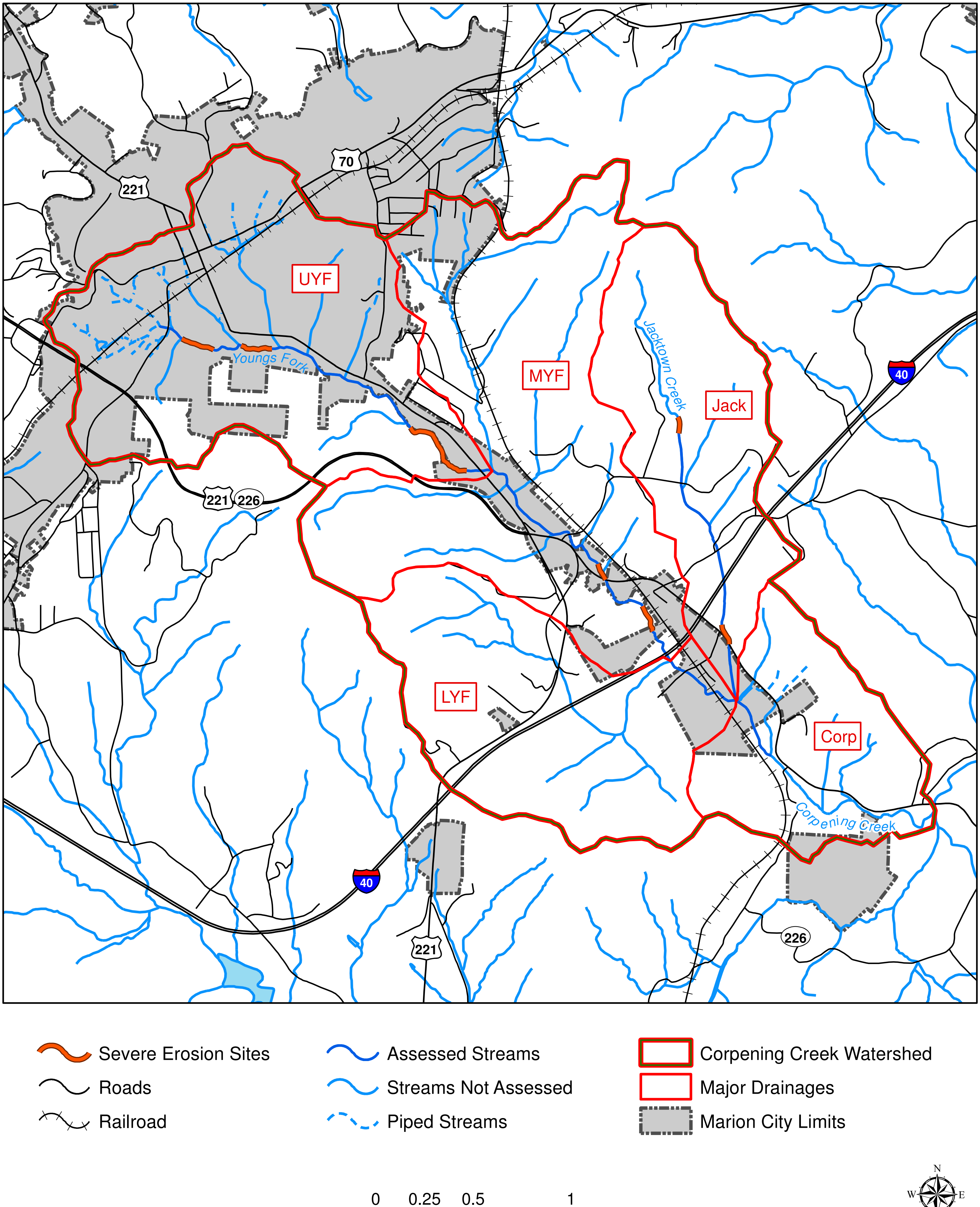
Photo Exhibit 3: Typical Habitat Conditions

a. Upper Youngs Fork

b. Lower Youngs Fork

c. Corpening Creek

Figure A-13 Severe Erosion Sites on Youngs Fork and Jacktown Creek



Riparian Impacts

A zone of woody riparian vegetation along streams is critical for a number of reasons, including: the maintenance of adequate shading; stream bank stability; the removal of pollutants from storm runoff; the supply of woody material and other organic material for stream habitat; and as a food supply for aquatic organisms. Riparian zone impacts were not evaluated quantitatively for this assessment, but stream walk activities and watershed reconnaissance indicate these impacts are common in many parts of the watershed, especially in Upper Youngs Fork and its tributaries, as well as in Jacktown Creek. Woody riparian vegetation has often been removed where streams flow through commercial and residential areas. Buildings and paved areas have been constructed near the stream and banks have been hardened in some areas. Woody riparian vegetation is often limited to a single line of trees. The situation improves in lower Youngs Fork and Corpening Creek, where the stream is more often not adjacent to developed areas.

Bacterial Contamination

The available data indicate elevated levels of fecal coliform and *Escherichia. coli* (*E. coli*) bacteria. These groups are used as indicators of the potential presence of pathogens, since testing for specific pathogenic microorganisms is impractical. Fecal coliform bacteria are the indicator of bacterial pollution commonly used by NCDWQ to evaluate the safety of freshwaters for recreational activity. This bacterial group is abundant in human or animal intestinal tracts, though it is also present in soils and elsewhere in the environment. Its presence in surface water is an indication of recent sewage or animal waste contamination. *E. coli* is a member of the coliform group that is almost exclusively of fecal origin and commonly found in the intestinal tracts of warm-blooded animals. Its presence thus provides stronger confirmation of fecal contamination than does the overall fecal coliform concentration. Though recommended by USEPA, *E. coli* is not used to assess recreational safety in North Carolina. As is the case with fecal coliform bacteria generally, most *E. coli* strains are not pathogenic. Their presence indicates, however, that pathogenic microorganisms posing a threat to human health from recreational activities may be present.

Water Quality Standards for

Bacterial Indicators

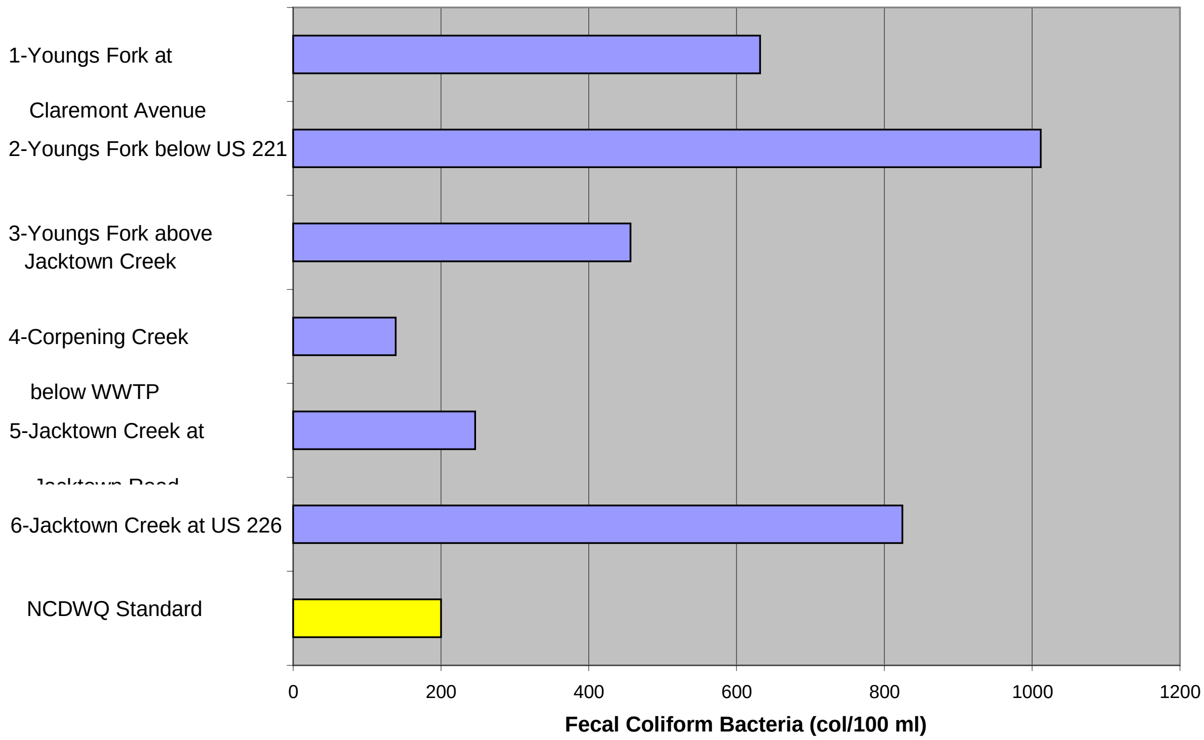
The NC standard for fecal coliform bacteria in fresh waters specifies that the geometric mean should not exceed 200 colonies per 100 ml, nor should more than 20% of the samples exceed 400 colonies per 100 ml. This must be determined based upon at least five consecutive samples collected within a 30-day period.

USEPA freshwater criteria for *E. coli* specify that the geometric mean should not exceed 126 colonies per 100 ml, based upon at least five samples over a 30-day period (USEPA, 1986). The allowable levels for single samples vary with the intensity of use (e.g. 235 col/100 ml for designated beach areas and 406 col/100 ml for lightly used areas). North Carolina has not adopted *E. coli* standards.

Monitoring conducted by Duke Energy as part of the Muddy Creek Monitoring Project (Equinox 2008d) documented violations of the NC standard for fecal coliform bacteria in Youngs Fork just above its confluence with Jacktown Creek and in lower Jacktown Creek at NC 226. The sampling, conducted annually in Youngs Fork using the 5- in-30-day protocol, found geometric mean concentrations well in excess of the NC standard of 200 col/100 ml in two of the three years. The Duke monitoring showed >500 col/100 ml in 2006 and >350 col/100 ml in 2007. Geometric mean concentrations in Jacktown Creek exceeded 700 col/100 ml in 2006, the only year in which Duke monitored this stream.

As part of the current assessment, 5-in-30-day fecal coliform bacteria monitoring was conducted at the six baseline sites in September 2008. Geometric mean fecal coliform bacteria levels were well above the standard at all three Youngs Fork sites, as well as in lower Jacktown Creek (Figure A-14). Concentrations met the state standard only in Corpening Creek, where residual chlorine from the WWTP may be reducing bacterial levels.

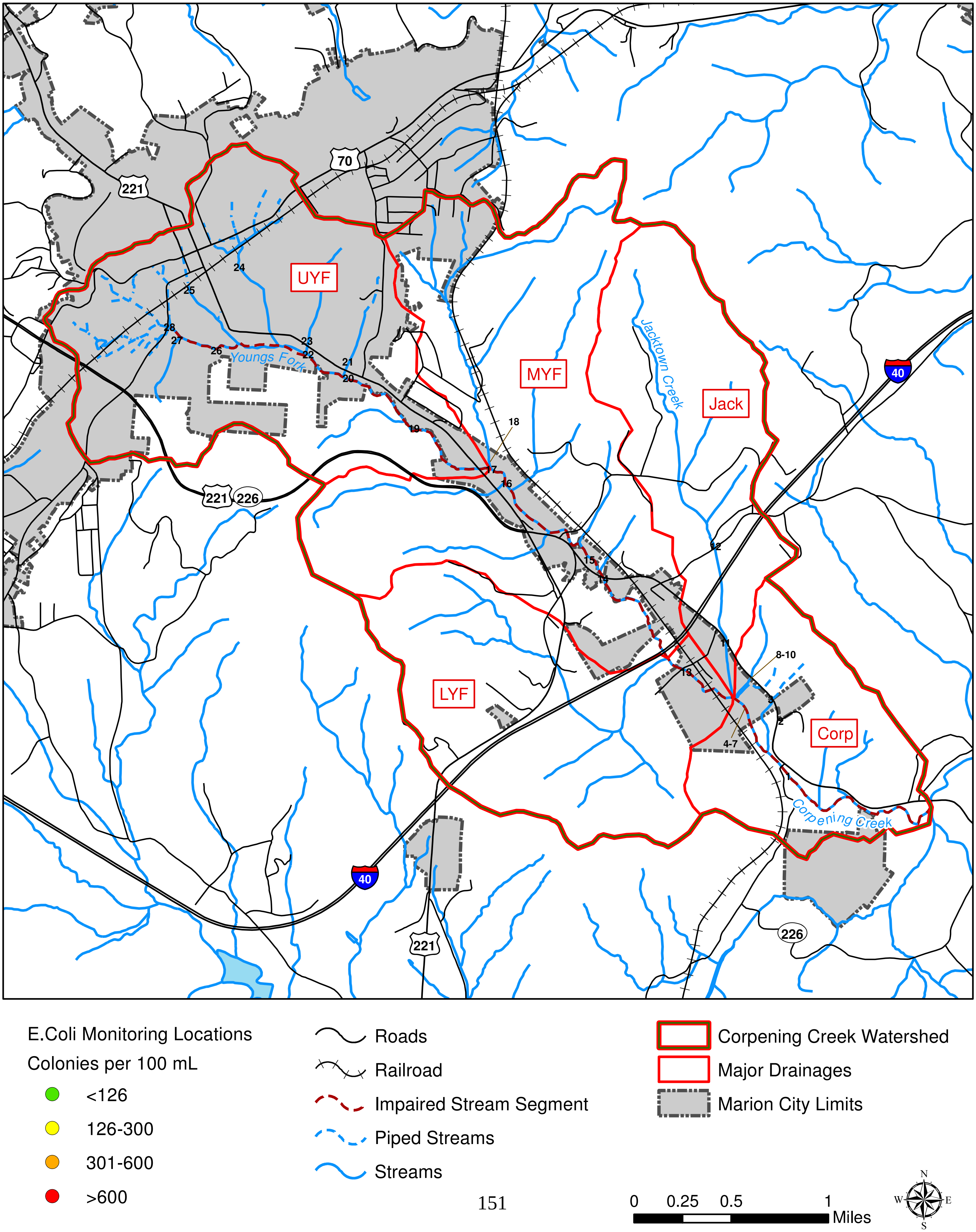
Figure A-14 Geometric Mean Fecal Coliform Bacteria Concentrations at Baseline Monitoring Sites, September 2008



E. coli sampling at 25 sites during a single monitoring event in April 2008 confirmed that contamination of fecal origin is widespread (Figure A-15). Concentrations in excess of the USEPA geometric mean criterion of 126 col/100 ml were found at 13 of the 25 locations, located primarily in the Upper Youngs Fork drainage. Four sites in this area exceeded the USEPA single sample criterion of 406 col/100ml for lightly used waters. Subsequent *E. coli* monitoring was limited, but *E. coli* was detected in nine of the 11 samples collected in September and December 2008. In September, *E. coli* levels exceeded 3,000 in both Jacktown Creek (Fairview Road) and Youngs Fork (at baseline site 2).

Leaking sanitary sewer lines, illegal connections of wastewater to the stormwater collection system, or both seem the most likely sources in the Youngs Fork drainage. There are relatively few septic systems or livestock in this area, and high bacteria levels occur even in upper Youngs Fork, where these other sources are unlikely to be present. Sources in Jacktown include livestock and septic systems. Several sites where livestock have stream access were documented along Jacktown Creek. This drainage is unsewered except for a small area near the mouth of the creek.

Figure A-15 Results of E. Coli Monitoring



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Appendix B
Stormwater Management

Appendix B Stormwater Management

This Appendix describes the methods and results of a search for potential stormwater retrofit opportunities and estimated costs and pollutant load reductions associated with construction of the recommended stormwater BMPs.

1 Stormwater Retrofit Survey

1.1 Methods

An inventory of potential stormwater retrofit locations was conducted to address both site-specific concerns as well as cumulative urban stormwater impacts. This inventory involved three steps, the first two were funded by a Clean Water Management Trust Fund (CWMTF) grant:

1. An initial Geographic Information System (GIS)-based screening to identify potential retrofit sites for further evaluation;
2. A field evaluation of identified sites; and
3. Advanced site analysis using GIS and AutoCAD to develop preliminary BMP characterizations where construction of BMPs were judged to be feasible.

1.1.1   Initial GIS Screening

Equinox began the inventory by conducting a GIS analysis using spatial data layers such as aerial photography and parcel information to search for potential retrofit locations. This screening emphasized the identification of areas of impervious cover with adjacent vegetated areas that could potentially be used to locate BMPs. Forty-two potential stormwater retrofit sites were identified for further evaluation.

1.1.2 Field Evaluation

Sites identified in the screening were evaluated in the field to determine the feasibility of installing BMPs, to identify potential constraints such as utilities and other infrastructure, and to collect information to support BMP characterization such as documenting existing site drainage patterns. Eighteen additional sites, not initially flagged in the GIS screening, were identified during the field survey.

Of the 60 sites surveyed, Equinox identified 31 where BMPs appear feasible (Figure 4.3). These sites were assigned to one of four tiers of projects:

I. Projects representing substantial opportunities for improvement, subject to minimal or moderate constraints;
II. Simple enhancement projects with minimal constraints and modest benefits;
III. Projects with more severe constraints or complexity; and
IV. Sites where additional investigation is needed to before the type and nature of BMPs can be determined.

1.1.3 Site Analysis and Characterization

Once field reconnaissance was completed, Equinox conducted additional analyses to characterize potential BMP opportunities at each site. These characterizations were intended to describe potential stormwater management measures at each site and are not BMP designs. Each of the 31 Tier I-Tier III sites was evaluated using AutoCAD/GIS to determine the appropriate type and location of BMPs for the site. Possible treatment train opportunities also were identified at some sites. These are situations were the outflow from at least one upgradient BMP is routed, along with additional drainage, through a second downgradient BMP.

GIS data and aerial photographs were then used to estimate the following for each BMP:

- *Total area draining to the BMP*;
- *Impervious cover draining to the BMP.* This is the portion of the area draining to the BMP that is covered with impervious surfaces such as rooftops or pavement, based on analysis of aerial photographs; and
- *The area available to construct a BMP.* The maximum area on the site that is available to construct the BMP, considering factors such as slopes, drainage patterns, and existing infrastructure.

Treatment areas and estimated costs to install the various types of BMPs were calculated as described below. Treatment trains were accounted for in these calculations – area and cost estimates were made for both the upgradient and downgradient BMPs.

A. *Percent Impervious Area*. The percent of the drainage area for each BMP that is impervious was calculated as follows:

$$\text{\% Impervious Area} = \left(\frac{\text{Area of impervious cover draining to BMP}}{\text{Total area draining to BMP}} \right) \times 100$$

B. *Treatable Area Drainage Calculation.* In calculating the amount of drainage that can be treated it was assumed that a BMP's surface area must be at least 5% of the contributing drainage (i.e. an individual BMP cannot treat more than 20 times its surface area). This area was calculated as follows:

$$\text{Maximum treatable drainage area per BMP} = \frac{\text{Maximum area available for BMP}}{0.05}$$

The actual size of the BMP will be determined during the design process. Rules of thumb for calculating preliminary estimates vary. For example, the Center for Watershed Protection suggests that proposed treatment areas should generally be either 3-5% or 5-10% of the contributing impervious area, depending upon the size of the site (CWP, 2007).

C. *Treatment Drainage Area Calculation*. The *approximate drainage area to be treated* was estimated as the lesser of (1) the *total area draining to the BMP* or (2) *the maximum treatable drainage area* calculated in (B).

D. *BMP Surface Area Calculation.* The *approximate BMP surface area* is calculated as either (1) *the area available to construct a BMP* or (2) 5% of the *total area draining to the BMP*. If all of the drainage area cannot be treated, the entire area available for a BMP is used to treat as much as possible. If the potential BMP site is larger than needed to treat the entire drainage area, all of the BMP location will not be used and the actual BMP will be sized at 5% of the drainage area.

E. *Impervious Surface Area Treatment Calculation*. The *impervious area treated* by the BMP was calculated by applying the *impervious area percentage* calculated in (A) to the *total drainage area treated* calculated in (C).
F. *Estimating Base Construction Costs.* Bioretention, constructed wetlands, sand filters, swales, and extended detention basins costs were calculated using typical costs compiled by either the Center for Watershed Protection (CWP, 2007), the Water Environment Research Foundation (WERF, 2009), or North Carolina State University (Hathaway and Hunt, 2007). Base construction costs for permeable weirs, underground storage, and vegetative enhancement are Equinox' estimates of likely contractor costs. Inlet filter costs are based upon manufacturer estimates. Best professional judgment was used in atypical situations. See Table B-1 for a summary of cost values used.
G. *BMP Design Costs*. Design costs were estimated as 10%, 15%, 25%, or 32% of construction costs depending on BMP type (CWP, 2007).
H. *Contractor Mobilization Expenses* – To cover these costs, $3,000 was added to the estimates for each site (not each BMP), assuming all BMPs are installed at one time. An additional $3,000 must be added to the costs for each additional construction event when subsets of BMPs are installed at each site.
I. *Total Design and Construction Costs*. Total costs for each BMP were estimated as the sum of items F, G, and H. **These estimates cover design and construction for typical installations. More complex situations (e.g. where utilities must be moved, or where more extensive grading or excavation is necessary) will involve additional expense. Costs for other activities - such as landowner outreach and education, and land acquisition - are not included**.
J. *Inflation Adjustment*. Since most base data used for cost estimates were at least three years old, the costs calculated in I were increased by 11.45% to account for *inflation*. This increase was calculated using the change in the Consumer Price Index between October 2006 and May 2011 (from US Bureau of Labor Statistics at ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt).

Tables B-2 and B-3 show the results of the calculations for each site.

Table B-1 Summary of Base Construction Costs

BMP Type	Base Construction Cost	Source
Bioretention	$25,400 per impervious acre	CWP, 2007
External Bioretention	$10.50 per cubic foot treated	
Internal Bioretention	$30.00 per cubic foot treated	
Constructed wetland	$38,400 per impervious acre	CWP, 2007
Extended detention - drainage largely impervious	$11,400 per impervious acre	CWP, 2007
Extended detention – drainage largely pervious	$3,000 per acre of total drainage	WERF, 2009
Perimeter sand filter	$72,000 per impervious acre	CWP, 2007
Permeable weir	$9,440 per weir	Equinox estimate
Underground storage	$7,420 per 100 linear feet	Equinox estimate
Inlet filters	- Simple bag filter insert: $1,200 installed - Advanced filter: $17,000 installed	Manufacturer estimate
Swales	$1.24 per sq foot of swale ($1.74 if turf reinforcing mat is used). A swale width of 8 ft was assumed.	Hathaway and Hunt, 2007
Vegetative enhancement	- $7,625 per 1,000 sq feet for trees and shrubs - $3,813 for only trees or only shrubs	Equinox estimate
Flow splitter	$5,000 per structure	Equinox estimate
Rain barrel	$380 per barrel, installed	Hathaway and Hunt, 2007

Table B-2 Stormwater BMP Treatment Area Data Details (Sheet 1 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	Receives Stormwater from Upgradient BMP ID*	BMP Surface Area (sq ft)	BMP Drainage Area (sq ft)	Impervious Area Treated (sq ft)	Impervious Area Treated (% of Drainage Area)
1	**NCDOT District Maintenance Facility**	**Corp**	**site totals**			**111,194**	**2,376,718**	**1,753,589**	**74%**
			A	Underground storage, inlet filter		2,694	170,785	113,197	66%
			B	Underground storage, inlet filter		2,800	149,515	66,150	44%
			C	Underground storage, inlet filter		758	103,646	80,683	78%
			D	Bioretention, swale, sand filter		13,637	290,939	219,677	76%
			E	Bioretention, water quality swale		7,275	209,701	120,114	57%
			G	Water quality swale		2,827	93,219	2,323	2%
			H	Bioretention island		854	30,120	23,005	76%
			I	Bioretention		8,698	36,168	17,039	47%
			J	Bioretention		4,370	14,917	9,342	63%
			K	Bioretention		4,620	32,177	15,291	48%
			L	*Bioretention, water quality swale*	*H, D & E*	*29,438*	*560,965*	*373,044*	67%
			M	*Constructed wetland*	*Entire site*	*111,194*	*2,376,718*	*713,726*	30%
2	**Marion Waste Water Treatment Plant**	**Corp**	**site totals**			**32,587**	**261,846**	**203,968**	**78%**
			A	Constructed wetland		17,733	124,287	81,294	65%
			B	Bioretention		1,649	10,392	10,384	100%
			C	Bioretention		3,352	39,296	39,296	100%
			D	Constructed wetland		9,853	87,872	72,994	83%
3	**McDowell County Transfer Station**	**Corp**	**site totals**			**27,121**	**2,340,702**	**161,772**	**7%**
			A	Constructed wetland		3,455	1,378,440	70,599	5%
			B	Constructed wetland		5,396	576,043	0	0%
			C	*Constructed wetland*	*Entire site*	*27,121*	*2,340,702*	*161,772*	*7%*

Table B-2 Stormwater BMP Treatment Area Data Details (Sheet 2 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	Receives Stormwater from Upgradient BMP ID*	BMP Surface Area (sq ft)	BMP Drainage Area (sq ft)	Impervious Area Treated (sq ft)	Impervious Area Treated (% of Drainage Area)
4	**Chapel Hill Baptist Church**	**MYF**	**site totals**			**65,983**	**889,890**	**189,895**	**21%**
			A	Bioretention		3,489	127,509	60,311	47%
			B	*Constructed wetland*	*A*	*65,983*	*889,890*	*189,895*	*21%*
5	**Club Fitness Gym**	**MYF**	**site total**	Bioretention		**5,019**	**51,026**	**28,848**	**57%**
6	**Video Advantage**	**MYF**	**site totals**			**2,828**	**14,253**	**13,272**	**93%**
			A	Bioretention		1,137	7,886	6,906	88%
			B	Bioretention		1,691	6,366	6,366	100%
7	**Countryside BBQ**	**MYF**	**site totals**			**6,111**	**17,173**	**17,171**	**100%**
			A	Bioretention		1,088	5,683	5,681	100%
			B	Bioretention		5,023	11,490	11,490	100%
8	**Carolina Interiors**	**MYF**	**site totals**			**4,377**	**44,219**	**42,240**	**96%**
			A	Bioretention		3,170	15,600	15,600	100%
			B	Swale enhancement		1207	28,619	26,640	93%
9	**McDowell Cornerstone Credit Union**	**MYF**	**site totals**			**3,536**	**23,488**	**21,813**	**93%**
			A	Constructed wetland		2,011	14,522	13,316	92%
			B	Bioretention		1,525	8,966	8,496	95%
10	**Toolcraft**	**UYF**	**site total**	Bioretention		1,177	**28,529**	**26,927**	**94%**

Table B-2 Stormwater BMP Treatment Area Data Details (Sheet 3 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	Receives Stormwater from Upgradient BMP ID*	BMP Surface Area (sq ft)	BMP Drainage Area (sq ft)	Impervious Area Treated (sq ft)	Impervious Area Treated (% of Drainage Area)
11	**Jalepeno Fresh Grill**	**UYF**	**site totals**			**5,861**	**34,407**	**32,558**	**95%**
			A	Bioretention island		1,106	6,764	5,377	79%
			B	Bioretention		3,537	15,520	15,142	98%
			C	Bioretention		1,218	12,122	12,039	99%
12	**Eddie's Pizza & Pasta**	**UYF**	**site total**	Bioretention		**4,321**	**25,781**	**25,132**	**97%**
13	**Bantam Chef**	**UYF**	**site totals**			**3,596**	**23,951**	**17,823**	**74%**
			A	Bioretention, swale enhancement		1,940	16,217	13,674	84%
			B	*Bioretention*	*A*	*3,596*	*23,951*	*17,823*	*74%*
14	**Hook & Anchor Family Seafood**	**UYF**	**site totals**			**7,147**	**86,364**	**85,075**	**99%**
			A	Bioretention		3,508	20,489	20,343	99%
			B	Bioretention island		1,635	24,497	24,466	100%
			C	Constructed wetland		2,004	41,379	40,266	97%
15	**Perfect Air Control**	**UYF**	**site totals**			**62,525**	**281,032**	**227,024**	**81%**
			A	Bioretention		14,638	54,799	53,060	97%
			B	Bioretention		4,197	15,686	13,439	86%
			C	Bioretention		2,565	29,242	25,916	89%
			D	Bioretention		2,840	8,553	5,617	66%
			E	Bioretention		10,335	35,597	35,597	100%
			F	Sand filter		3,834	20,013	19,303	96%
			G	Bioretention		4,765	27,022	27,022	100%
			H	*Constructed wetland*	*E*	*29,686*	*125,717*	*82,667*	*66%*

Table B-2 Stormwater BMP Treatment Area Data Details (Sheet 4 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	Receives Stormwater from Upgradient BMP ID*	BMP Surface Area (sq ft)	BMP Drainage Area (sq ft)	Impervious Area Treated (sq ft)	Impervious Area Treated (% of Drainage Area)
16	KG's Quick Stop	UYF	site totals			**5,660**	**324,163**	**88,430**	**27%**
			A	Underground storage, inlet filter		691	225,495	50,648	22%
			B	Underground storage, inlet filter		651	94,081	36,984	39%
			C	*Constructed wetland*	*A & B*	*5,660*	*324,163*	*88,430*	*27%*
17	McDowell County Rescue Squad	UYF	site total	Constructed wetland		**11,559**	**122,364**	**46,216**	**38%**
18	New Manna Christian School	UYF	site totals			**18,459**	**278,845**	**266,105**	**95%**
			A	Extended detention (permeable weir)		4,517	52,907	18,828	36%
			B	*Constructed wetland*	*A*	*13,155*	*176,527*	*38,995*	*22%*
			C	Bioretention		5,304	217,002	94,727	44%
19	Eastfield Elementary School	UYF	site totals			**9,732**	**1,113,407**	**165,534**	**15%**
			A	Rain barrels		308	15,203	14,554	96%
			B	Bioretention		1,759	8,787	8,675	99%
			C	*Extended detention (permeable weir)*	*A,B, & F*	*6,734*	*882,457*	*89,385*	*10%*
			D	Extended detention (permeable weir)		1,160	98,085	52,882	54%
			E	Extended detention (permeable weir)		1,838	132,865	23,267	18%
			F	Bioretention		1,114	429,234	27,812	6%
20	McDowell County School District	UYF	site total	Underground storage, inlet filter		**472**	**13,505**	**13,506**	**100%**
21	Nevant Orthodontics	UYF	site total	Bioretention		**1,727**	**14,927**	**14,889**	**100%**

Table B-2 Stormwater BMP Treatment Area Data Details (Sheet 5 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	Receives Stormwater from Upgradient BMP ID*	BMP Surface Area (sq ft)	BMP Drainage Area (sq ft)	Impervious Area Treated (sq ft)	Impervious Area Treated (% of Drainage Area)
22	**Marion Police Department**	**UYF**	**site totals**			**7,105**	**124,892**	**94,210**	**75%**
			A	*Bioretention*	*B*	*3,283*	*87,297*	*64,345*	*74%*
			B	Bioretention		1,035	17,748	11,971	67%
			C	*Bioretention*	*D*	*3,822*	*37,596*	*29,865*	*79%*
			D	Bioretention		1,768	14,728	13,857	94%
23	**The Marion Depot**	**UYF**	**site total**	Underground storage, inlet filter		**3,273**	**89,869**	**89,581**	**100%**
24	**RockTenn Packaging**	**UYF**	**site totals**			**8,367**	**149,418**	**145,486**	**97%**
			A	Bioretention		382	7,462	7,462	100%
			B	Underground storage		7,985	141,956	138,024	97%
25	**US-226 Exit Ramp**	**UYF**	**site total**	Bioretention		**16,419**	**284,062**	**92,462**	**33%**
26	**Mt. Moriah Baptist Church**	**UYF**	**site totals**			**2,635**	**17,873**	**13,365**	**75%**
			A	Extended Detention/Bioretention		676	7,189	2,680	37%
			B	*Bioretention*	*A*	*2,635*	*17,873*	*13,365*	*75%*
27	**Vacant Building**	**MYF**	**site total**	Constructed wetland		**4,807**	**59,236**	**58,501**	**99%**
28	**Gurley's Motors**	**MYF**	**site total**	Bioretention		**1,401**	**26,728**	**24,723**	**92%**
29	**Triple M Express Lube**	**UYF**	**site total**	Bioretention		**11,449**	**60,911**	**48,977**	**80%**
30	**Carwash on Railroad & Morgan St.**	**UYF**	**site total**	Bioretention		**784**	**10,110**	**10,110**	**100%**
31	**Crossmill City Park**	**UYF**	**site total**	Constructed wetland		**1,410**	**588,519**	**137,098**	**23%**

Table B-3 Stormwater BMP Construction Costs Estimates (Sheet 1 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	BMP Surface Area (sq ft)	Base Construction Cost	Design Cost	Total Cost	Total, with Inflation Adjustment
1	**NCDOT District Maintenance Facility**	**Corp**	**site totals**		**111,194**	**$373,229**	**$113,751**	**$489,981**	**$546,084**
			A	Underground storage, inlet filter	2,694	$28,861	$7,215	$39,076	**$43,550**
			B	Underground storage, inlet filter	2,800	$26,761	$6,690	$36,451	**$40,625**
			C	Underground storage, inlet filter	758	$22,233	$5,558	$30,791	**$34,316**
			D	Bioretention, swale, sand filter	13,637	$33,211	$10,628	$46,839	**$52,202**
			E	Bioretention, water quality swale	7,275	$22,482	$7,194	$32,676	**$36,418**
			G	Water quality swale	2,827	$1,366	$205	$4,571	**$5,094**
			H	Bioretention island	854	$46,474	$14,872	$64,345	**$71,713**
			I	Bioretention	8,698	$34,423	$11,015	$48,438	**$53,984**
			J	Bioretention	4,370	$18,872	$6,039	$27,911	**$31,107**
			K	Bioretention	4,620	$30,890	$9,885	$43,775	**$48,787**
			L	*Bioretention, water quality swale*	*29,438*	$60,141	$19,245	$82,386	**$91,819**
			M	*Constructed wetland*	*111,194*	$47,516	$15,205	$65,721	**$73,246**
2	**Marion Waste Water Treatment Plant**	**Corp**	**site totals**		**32,587**	**$54,164**	**$17,332**	**$74,496**	**$83,026**
			A	Constructed wetland	17,733	$5,412	$1,732	$10,144	**$11,305**
			B	Bioretention	1,649	$20,979	$6,713	$30,692	**$34,206**
			C	Bioretention	3,352	$22,913	$7,332	$33,246	**$37,052**
			D	Constructed wetland	9,853	$4,860	$1,555	$9,415	**$10,493**
3	**McDowell County Transfer Station**	**Corp**	**site totals**		**27,121**	**$51,211**	**$16,388**	**$70,599**	**$78,682**
			A	Constructed wetland	3,455	$15,559	$4,979	$23,538	**$26,233**
			B	Constructed wetland	5,396	$0	$0	$3,000	**$3,344**
			C	*Constructed wetland*	*27,121*	$35,652	$11,409	$50,061	**$55,793**
4	**Chapel Hill Baptist Church**	**MYF**	**site totals**		**65,983**	**$24,444**	**$7,822**	**$35,266**	**$39,304**
			A	Bioretention	3,489	$11,802	$3,777	$18,578	**$20,705**
			B	*Constructed wetland*	*65,983*	$12,642	$4,046	$19,688	**$21,942**

Table B-3 Stormwater BMP Construction Costs Estimates (Sheet 2 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	BMP Surface Area (sq ft)	Base Construction Cost	Design Cost	Total Cost	Total, with Inflation Adjustment
5	**Club Fitness Gym**	**MYF**	**site total**	Bioretention	**5,019**	**$16,821**	**$5,383**	**$25,204**	**$28,090**
6	**Video Advantage**	**MYF**	**site totals**		**2,828**	**$7,739**	**$2,476**	**$19,215**	**$21,415**
			A	Bioretention	1,137	$4,027	$1,289	$8,315	**$9,267**
			B	Bioretention	1,691	$3,712	$1,188	$7,900	**$8,805**
7	**Countryside BBQ**	**MYF**	**site totals**		**6,111**	**$34,689**	**$11,100**	**$48,789**	**$54,375**
			A	Bioretention	1,088	$11,477	$3,673	$18,150	**$20,228**
			B	Bioretention	5,023	$23,212	$7,428	$33,639	**$37,491**
8	**Carolina Interiors**	**MYF**	**site totals**		**4,377**	**$31,934**	**$10,148**	**$45,082**	**$50,244**
			A	Bioretention	3,170	$31,515	$10,085	$44,599	**$49,706**
			B	Swale enhancement	1207	$419	$63	$3,482	**$3,881**
9	**McDowell Cornerstone Credit Union**	**MYF**	**site totals**		**3,536**	**$18,051**	**$5,776**	**$26,827**	**$29,899**
			A	Constructed wetland	2,011	$887	$284	$4,170	**$4,648**
			B	Bioretention	1,525	$17,164	$5,493	$25,657	**$28,595**
10	**Toolcraft**	**UYF**	**site total**	Bioretention	1,177	**$2,641**	**$845**	**$6,485**	**$7,228**
11	**Jalepeno Fresh Grill**	**UYF**	**site totals**		**5,861**	**$116,546**	**$21,048**	**$140,593**	**$156,691**
			A	Bioretention island	1,106	$10,863	$3,476	$17,339	**$19,324**
			B	Bioretention	3,537	$30,590	$9,789	$43,379	**$48,346**
			C	Bioretention	1,218	$24,321	$7,783	$35,103	**$39,123**
12	**Eddie's Pizza & Pasta**	**UYF**	**site total**	Bioretention	**4,321**	**$50,772**	**$4,249**	**$58,022**	**$64,665**

Table B-3 Stormwater BMP Construction Costs Estimates (Sheet 3 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	BMP Surface Area (sq ft)	Base Construction Cost	Design Cost	Total Cost	Total, with Inflation Adjustment
13	**Bantam Chef**	**UYF**	**site totals**		**3,596**	**$37,744**	**$12,078**	**$52,822**	**$58,870**
			A	Bioretention, swale enhancement	1,940	$1,739	$556	$5,295	**$5,901**
			B	*Bioretention*	*3,596*	$36,005	$11,522	$50,527	**$56,312**
14	**Hook & Anchor Family Seafood**	**UYF**	**site totals**		**7,147**	**$93,204**	**$29,825**	**$126,029**	**$140,459**
			A	Bioretention	3,508	$41,097	$13,151	$57,248	**$63,803**
			B	Bioretention island	1,635	$49,426	$15,816	$68,242	**$76,056**
			C	Constructed wetland	2,004	$2,681	$858	$6,539	**$7,287**
15	**Perfect Air Control**	**UYF**	**site totals**		**62,525**	**$163,163**	**$51,091**	**$217,254**	**$242,129**
			A	Bioretention	14,638	$30,940	$9,901	$43,840	**$48,860**
			B	Bioretention	4,197	$27,148	$8,688	$38,836	**$43,283**
			C	Bioretention	2,565	$35,696	$11,423	$50,119	**$55,858**
			D	Bioretention	2,840	$11,348	$3,631	$17,979	**$20,037**
			E	Bioretention	10,335	$20,757	$6,642	$30,399	**$33,879**
			F	Sand filter	3,834	$16,013	$4,003	$23,017	**$25,652**
			G	Bioretention	4,765	$15,757	$5,042	$23,799	**$26,524**
			H	*Constructed wetland*	*29,686*	$5,504	$1,761	$10,265	**$11,440**
16	**KG's Quick Stop**	**UYF**	**site totals**		**5,660**	**$49,606**	**$12,814**	**$65,420**	**$72,911**
			A	Underground storage, inlet filter	691	$25,914	$6,478	$35,392	**$39,445**
			B	Underground storage, inlet filter	651	$17,805	$4,451	$25,256	**$28,148**
			C	*Constructed wetland*	*5,660*	$5,887	$1,884	$10,771	**$12,004**
17	**McDowell County Rescue Squad**	**UYF**	**site total**	Constructed wetland	**11,559**	**$3,077**	**$19,995**	**$26,071**	**$29,057**

Table B-3 Stormwater BMP Construction Costs Estimates (Sheet 4 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	BMP Surface Area (sq ft)	Base Construction Cost	Design Cost	Total Cost	Total, with Inflation Adjustment
18	**New Manna Christian School**	**UYF**	**site totals**		**18,459**	**$60,944**	**$19,502**	**$83,446**	**$93,000**
			A	Extended detention (permeable weir)	4,517	$3,112	$996	$7,108	**$7,922**
			B	*Constructed wetland*	*13,155*	$2,596	$831	$6,427	**$7,163**
			C	Bioretention	5,304	$55,235	$17,675	$75,911	**$84,603**
19	**Eastfield Elementary School**	**UYF**	**site totals**		**9,732**	**$74,276**	**$20,870**	**$98,146**	**$109,384**
			A	Rain barrels	308	$13,173	$1,317	$14,490	**$16,149**
			B	Bioretention	1,759	$17,525	$5,608	$26,134	**$29,126**
			C	*Extended detention (permeable weir)*	*6,734*	$14,774	$4,728	$22,502	**$25,079**
			D	Extended detention (permeable weir)	1,160	$8,741	$2,797	$14,538	**$16,202**
			E	Extended detention (permeable weir)	1,838	$3,846	$1,231	$8,077	**$9,001**
			F	Bioretention	1,114	$16,217	$5,189	$24,406	**$27,201**
20	**McDowell County School District**	**UYF**	**site total**	Underground storage, inlet filter	**472**	**$12,833**	**$2,046**	**$17,879**	**$19,927**
21	**Nevant Orthodontics**	**UYF**	**site total**	Bioretention	**1,727**	**$30,079**	**$2,768**	**$35,847**	**$39,952**
22	**Marion Police Department**	**UYF**	**site totals**		**7,105**	**$107,112**	**$34,276**	**$144,388**	**$160,921**
			A	*Bioretention*	*3,283*	$37,520	$12,006	$52,526	**$58,540**
			B	Bioretention	1,035	$24,184	$7,739	$34,923	**$38,921**
			C	*Bioretention*	*3,822*	$17,415	$5,573	$25,987	**$28,963**
			D	Bioretention	1,768	$27,994	$8,958	$39,952	**$44,527**
23	**The Marion Depot**	**UYF**	**site total**	Underground storage, inlet filter	**3,273**	**$17,545**	**$0**	**$20,545**	**$22,898**

Table B-3 Stormwater BMP Construction Costs Estimates (Sheet 5 of 5)

Site ID	Site Name	Major Drainage	BMP ID	BMP Type	BMP Surface Area (sq ft)	Base Construction Cost	Design Cost	Total Cost	Total, with Inflation Adjustment
24	RockTenn Packaging	UYF	site totals		**8,367**	**$33,075**	**$9,324**	**$45,399**	**$50,597**
			A	Bioretention	382	$15,075	$4,824	$22,899	**$25,521**
			B	Underground storage	7,985	$18,000	$4,500	$25,500	**$28,420**
25	US-226 Exit Ramp	UYF	site total	Bioretention	**16,419**	**$53,915**	**$13,479**	**$67,394**	**$75,110**
26	Mt. Moriah Baptist Church	UYF	site totals		**2,635**	**$27,442**	**$8,782**	**$39,224**	**$43,715**
			A	Extended Detention/Bioretention	676	$443	$142	$3,585	**$3,995**
			B	*Bioretention*	*2,635*	$26,999	$8,640	$38,639	**$43,063**
27	Vacant Building	MYF	site total	Constructed wetland	**4,807**	**$3,895**	**$1,246**	**$8,141**	**$9,073**
28	Gurley's Motors	MYF	site total	Bioretention	**1,401**	**$14,416**	**$4,613**	**$22,029**	**$24,552**
29	Triple M Express Lube	UYF	site total	Bioretention	**11,449**	**$28,559**	**$9,139**	**$40,698**	**$45,358**
30	Carwash on Railroad & Morgan St.	UYF	site total	Bioretention	**784**	**$20,424**	**$6,536**	**$29,960**	**$33,391**
31	Crossmill City Park	UYF	site total	Constructed wetland	**1,410**	**$9,127**	**$2,921**	**$15,048**	**$16,771**

2 Stormwater BMP Pollutant Load Reductions

2.1 General Approach

Equinox estimated the pollutant load reductions anticipated from BMP implementation using the loads calculated by the STEPL model (see Appendix A) as a pre-BMP baseline, and reducing those loads to account for expected pollutant removal. The STEPL model (Tetra Tech, 2006), estimated existing pre-BMP pollutant loads for each land use class within each of the five major drainages in the Corpening Creek watershed (Figure A-2). Classes of developed land specified in the model include uses such as: commercial, industrial, institutional, multi-family residential, and single-family residential. For each land cover class, STEPL estimated loads for four pollutants: total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), and biochemical oxygen demand (BOD). Post-BMP loads were estimated for all pollutants except BOD.

The general procedure for calculating load reductions can be summarized as follows:

1. For each land use class, estimated pre-BMP loads, calculated as pounds per year were converted to a per-acre basis (lb/acre per year).
2. For each drainage, Equinox calculated the total area of each land use class that would be treated by a recommended BMP. Since pollutant removal efficiencies vary by BMP type, this was done separately for each BMP type. For example, in the Upper Youngs Fork drainage, Equinox calculated the number of commercial acres treated by constructed wetlands, the number of commercial acres treated by bioretention, and so on for each BMP type and each land use.
3. The pollutant load per acre from these treated areas was calculated by reducing the pre-BMP per acre load to reflect expected pollutant removal by the BMPs.
4. Total post-BMP loads for treated areas were calculated by multiplying the per-acre load by the number of acres treated. Loads for areas untreated by BMPs were unchanged..
5. BMP load reductions were determined by subtracting the post-load estimated from the pre-load estimate.

Note that because of the structure of the STEPL model, load reductions were not calculated for individual BMPs. Rather BMPs of a given type draining areas of a particular land use were grouped together within each drainage. For example, all bioretention areas treating runoff from institutional areas in the UYF drainage were grouped together. Additional details on various steps in the load estimation process are discussed further below.

2.2 Synopsis of BMP Type and Location

The types of stormwater BMPs implemented or recommended, as described in Section 2 of this report, include:

- Bioretention;
- Constructed wetlands;
- Extended Detention (Dry);
- Underground storage;
- Grass swales;
- Inlet and sand filters; and
- Oil-grease separators.

Load reductions were calculated only for bioretention, constructed wetlands, and extended wet detention features, which comprise the majority of BMPs. Since permeable weirs and underground storage are both detention approaches, they were considered to operate as extended wet detention features for purposes of load calculations.

Load reductions were not calculated for oil-grease separators, which generally have low nutrient removal efficiency, nor for grass swales, since most swales recommended are enhancements of existing swales. Treatment train approaches, where the outflow of one BMP is routed into a second BMP, were recommended at some sites. To make the calculations manageable, the approach used here does not attempt to capture the impacts of the multiple treatment approaches used, but estimates pollutant removal only from the last BMP in the treatment train.

Table B-2 provides a profile of each BMP site. Site information was then aggregated by land class and major drainage (Table B-4). The BMPs recommended at some sites will manage runoff from several different land uses. To simplify calculations, Equinox assumed that all runoff treated by a BMP was from the dominant land use at a site.

2.3 Pollutant Removal Rates

The pollutant removal efficiencies recommended by STEPL (Table B-5) were used by Equinox to estimate load reductions. Several other compilations of removal efficiency data were also reviewed (CWP, 2007; NCDWQ, 2007; Wossink and Hunt, 2003).

Table B-4 Summary of Area Treated by Drainage, Land Use, and BMP Type[1]

Major Drainage	Dominant Land Use Treated[2]	BMP Type[3]	Area Treated by BMPs (acres)[4]		
			Total by Major Drainage	Total by Land Use Class	Total by BMP Type
Jacktown			8.60		
	Institutional			8.60	
		Constructed Wetland			8.60
Corpening			37.61		
	Institutional			37.61	
		Bioretention			1.14
		Constructed Wetland			36.47
Middle Youngs Fork			21.63		
	Commercial			0.72	
		Bioretention			0.72
	Residential (single family)			19.10	
		Constructed Wetland			19.10
	Institutional			1.80	
		Bioretention			1.80
Upper Youngs Fork			27.98		
	Commercial			8.13	
		Bioretention			5.20
		Constructed Wetland			2.93
	Industrial			6.45	
		Bioretention			3.11
		Constructed Wetland			2.89
		Underground Storage			0.46
	Institutional			13.39	
		Bioretention			3.39
		Constructed Wetland			6.78
		Permeable Weir			3.01
		Underground Storage			0.22
Watershed Total			95.82		
	Institutional			61.40	
	Commercial			8.86	
	Industrial			6.45	
	Residential (single family)			19.10	

[1]Includes BMPs implemented during project and recommended BMP retrofits.
[2]For each drainage, only land uses with at least one BMP are listed.
[3]Final BMP in treatment train.
[4]Total is area treated by all BMPs of specified type and may include multiple sites.

Table B-5 Pollutant Removal Efficiencies Used in Load Reduction Calculations

BMP Type	N	P	TSS
Bioretention	43%	81%	60%
Constructed Wetlands	20%	44%	78%
Extended Wet Detention[1]	55%	69%	86%

[1]Includes permeable weirs and underground storage.

2.4 Pollutant Load Reduction Calculations

The general form of the post-BMP load calculation for each pollutant and land use class within a major drainage is as follows:

$$L_{post} = [L_{pre}(\% \text{ of LU with no BMPs})] + [L_{pre}(\% \text{ of LU with } BMP_1)(1 - BMP_1 \text{ removal efficiency})] + [L_{pre}(\% \text{ of LU with } BMP_2)(1 - BMP_2 \text{ removal efficiency})] + [L_{pre}(\% \text{ of LU with } BMP_3)(1 - BMP_3 \text{ removal efficiency})]$$

Where:

L_{pre} = total pre-BMP pollutant load (lb/yr) for a land class within a specific drainage;
L_{post} = total post-BMP pollutant load (lb/yr) for a land class within a specific drainage;
LU = land use class;
Removal efficiency = percentage of pollutant removed by the BMP type;
BMP_1 = bioretention;
BMP_2 = constructed wetlands; and
BMP_3 = extended wet detention

The load reduction resulting from BMP implementation was calculated as the difference between the pre- and post-BMP loads for that cell. Results by urban land use class are summarized in Table B-6.

2.5 Discussion

The actual reduction in pollutants from any BMP depends on the final design features of the practice, actual site characteristics (including characteristics of the land draining to the BMP), maintenance practices, and other factors. The percent of the load removed by a BMP is also dependent on the influent concentration: it is easier to remove a high percentage of incoming pollutants if the inflow is ‘dirty’ than if it is ‘clean’. Though a percent removal approach has historically been the most common method of estimating pollutant reductions from stormwater BMP implementation, the limitations of this approach have been increasingly recognized in recent years (Kosco and Singelis, 2008; and Jones et al, 2008).

Although this approach remains a straightforward and readily understood method to obtain rough estimates of potential pollutant reductions, it must be understood that there is considerable uncertainty associated with any estimate of potential pollutant reductions, especially where design of the BMPs has not yet been undertaken.

However, there is reason to believe that the estimates presented here substantially underestimate the load reductions likely to occur from the construction of the recommended BMPs because:

- Load reductions were not calculated for some practices, including swales and filters. This is probably a minor factor, given the small acreage impacted by these practices.
- The estimates may not fully account for runoff volume reductions likely to occur as part of these projects (e.g. a reduction in impervious cover will occur at some sites);
- Treatment trains (BMPs built in series) are proposed at about half of the sites, including five of the six sites treating the largest areas. Pollutant calculations reflect the impact of the last BMP in the train only. No attempt was made to account for cumulative pollutant removal of treatment trains.

Table B-6 Pre-BMP Load, Post-BMP Load and Estimated Load Reductions, by Urban Land Use Class for the Corpening Creek Watershed

Pollutant Load Characteristic	Land Use Class									
	Commercial	Industrial	Institutional	Transportation	Multi-Family Residential	Single-Family Residential	Urban-Cultivated	Vacant	Open Space	Totals
Total Nitrogen										
Pre-BMP Load (lb/yr)	4,423	1,657	1,519	4,012	400	6,316	0	0	21	18,349
Post-BMP Load (lb/yr)	4,381	1,628	1,375	4,012	400	6,294	0	0	21	18,110
Reduction (lb/yr)	42	29	145	0	0	23	0	0	0	239
% Reduction	0.9%	1.8%	9.5%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	1.3%
Total Phosphorus										
Pre-BMP Load (lb/yr)	442	265	253	669	73	1,148	0	0	2	2,853
Post-BMP Load (lb/yr)	434	255	205	669	73	1,139	0	0	2	2,777
Reduction (lb/yr)	8	10	48	0	0	9	0	0	0	76
% Reduction	1.8%	3.8%	19.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	2.7%
Total Suspended Sediment										
Pre-BMP Load (tons/yr)	82.9	39.8	28.3	100.3	9.1	143.6	0.0	0.0	0.5	404.4
Post-BMP Load (tons/yr)	81.5	38.3	19.8	100.3	9.1	141.5	0.0	0.0	0.5	391.0
Reduction (tons/yr)	1.5	1.5	8.5	0.0	0.0	2.0	0.0	0.0	0.0	13.4
% Reduction	1.8%	3.7%	29.9%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	3.3%

3 References Cited

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Appendix C
Estimation of Pollutant Load Reductions from Stormwater BMP Implementation

Appendix C Estimation of Pollutant Load Reductions from Stormwater BMP Implementation

This Appendix describes the estimation of pollutant load reductions expected to accrue from the stormwater BMPs constructed during this project as well as the identified BMPs recommended for implementation.

1 General Approach

Equinox estimated the pollutant load reductions anticipated from BMP implementation by using the loads calculated by the STEPL model (see Appendix A) as a pre-BMP baseline, and reducing those loads to account for expected pollutant removal. The STEPL model (Tetra Tech, 2006), estimated existing pre-BMP pollutant loads for each land use class within each of the five major drainages in the Corpening Creek watershed. Classes of developed land specified in the model include uses such as: commercial, industrial, institutional, multi-family residential, and single-family residential. For each land cover class, STEPL estimated loads for four pollutants: total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), and biochemical oxygen demand (BOD). Post BMP loads were estimated for all of these pollutants except BOD.

The general procedure for calculating load reductions can be summarized as follows:

6. For each land use class, estimated pre-BMP loads, calculated as pounds per year were converted to a per-acre basis (lb/acre per year).
7. For each drainage, Equinox calculated the total area of each land use class that would be treated by a recommended BMP. Since pollutant removal efficiencies vary by BMP type, this was done separately for each BMP type. For example, in the Upper Youngs Fork drainage, Equinox calculated the number of commercial acres treated by constructed wetlands, the number of commercial acres treated by bioretention, and so on for each BMP type and each land use.
8. The pollutant load per acre from these treated areas was calculated by reducing the pre-BMP per acre load to reflect expected pollutant removal by the BMPs.
9. Total post-BMP loads for treated areas were calculated by multiplying the per-acre load by the number of acres treated. Loads for areas untreated by BMPs were unchanged..
10. BMP load reductions were determined by subtracting the post-load estimated from the pre-load estimate.

Note that because of the structure of the STEPL model, load reductions were not calculated for individual BMPs. Rather BMPs of a given type draining areas of a particular land use were grouped together within each drainage. For example, all bioretention areas treating runoff from institutional areas in the UYF drainage were grouped together. Additional details on various steps in the load estimation process are discussed further below.

2 Synopsis of BMP Type and Location

The types of stormwater BMPs implemented or recommended, described in detail in the main text of this report, include:

- Bioretention;
- Constructed wetlands;
- Permeable weirs;
- Underground storage;
- Grass swales;
- Inlet and sand filters; and
- Oil-grease separators.

Load reductions were calculated only for bioretention, constructed wetlands and extended wet detention, which comprise the majority of practices. Since permeable weirs and underground storage are both detention approaches, they were considered to operate as extended wet detention for purposes of load calculations.

Load reductions were not calculated for oil-grease separators, which generally have a low nutrient removal efficiency, and for grass swales, since most swales recommended are enhancements of existing swales. Treatment train approaches, where the outflow of one BMP is routed into a second BMP, were recommended at some sites. To make the calculations manageable, the approach used here does not attempt to capture the impacts of the multiple treatment approaches used, but estimates pollutant removal only from the last BMP in the treatment train.

Table C-1 provides a profile of each BMP site. Site information was then aggregated by land class and major drainage (Table C-2). The BMPs recommended at some sites will manage runoff from several different land uses. To simplify calculations, Equinox assumed that all runoff treated by a BMP was from the dominant land use at a site.

3 Pollution Removal Rates

The pollutant removal efficiencies recommended by STEPL (Table C-3) were used by Equinox to estimate load reductions. Several other compilations of removal efficiency data were also reviewed (CWP, 2007; NCDWQ, 2007; Wossink and Hunt, 2003).

Table C-1 Selected Data for Individual BMP Project Sites

Site ID	Site Name	Location (Major Drainage)	Dominant Land Use	Total Area Treated (acres)	Treatment Train Used[1]	BMP Type[2]
Recommended Retrofit Survey Sites						
1	NCDOT, Marion Correctional Institute	Corp	Institutional	25.25	X	Constructed Wetland
2	City of Marion WWTP site	Corp	Institutional	3.97		Constructed Wetland, Bioretention
3	McDowell County Landfill	Corp	Institutional	8.39	X	Constructed Wetland
4	Chapel Hill Baptist Church	MFY	Single Family Residential	19.10	X	Constructed Wetland
6	Video Advantage	MFY	Commercial	0.33		Bioretention
7	Countryside BBQ	MFY	Commercial	0.39		Bioretention
11	Jalepeno Grill - Spencers Hardware	UYF	Commercial	0.79		Bioretention
12	Eddies Pizza and Pasta - BP Station	UYF	Commercial	0.59		Bioretention
13	Bantam Chef- Big Daddy's Minute Mart	UYF	Commercial	0.55	X	Bioretention
14	Hook & Anchor Restaurant	UYF	Commercial	1.98		Constructed Wetland, Bioretention
15	Perfect Air Control	UYF	Industrial	6.45	X	Constructed Wetland, Bioretention, Underground Storage
16	KG Quickstop	UYF	Commercial	1.98		Constructed Wetland
17	McDowell County EMS	UYF	Institutional	2.81		Constructed Wetland
18	New Manna Christian School	UYF	Institutional	6.40	X	Constructed Wetland, Bioretention
19	Marion Elementary School	UYF	Institutional	3.01	X	Permeable Weir
20	McDowell County Schools	UYF	Institutional	0.22		Underground Storage
21	Dr Nevant DDS	UYF	Commercial	0.34	X	Bioretention
22	Marion Police Department	UYF	Commercial	1.90	X	Bioretention
27	Mt Moriah Baptist Church	UYF	Institutional	0.41	X	Bioretention
Project BMPs under construction						
-	McDowell Tech	Jack	Institutional	8.60		Constructed Wetland
-	Eastfield Elementary School	MYF	Institutional	1.80		Bioretention
-	Jury Parking Lot	UYF	Institutional	0.55		Bioretention

[1]Indicates that treatment train is used on at least a portion of the site.
[2]Specifies last BMP type in treatment train (downgradient BMP), as well as individual BMPs not part of train. Upgradient BMPs flowing to downgradient BMP are not listed, as pollutant reductions for these practices were not estimated.

Table C-2 Summary of Areas Treated by Project BMPs, by Land Use and Drainage[1]

Major Drainage	Dominant Land Use Treated[2]	BMP Type[3]	Area Treated by BMPs (acres)[4]		
			Total by BMP Type	Total by Land Use Class	Total by Major Drainage
Jacktown					8.60
	Institutional			8.60	
		Constructed Wetland	8.60		
Corpening					37.61
	Institutional			37.61	
		Bioretention	1.14		
		Constructed Wetland	36.47		
Middle Youngs Fork					21.63
	Commercial			0.72	
		Bioretention	0.72		
	Residential (single family)			19.10	
		Constructed Wetland	19.10		
	Institutional			1.80	
		Bioretention	1.80		
Upper Youngs Fork					27.98
	Commercial			8.13	
		Bioretention	5.20		
		Constructed Wetland	2.93		
	Industrial			6.45	
		Bioretention	3.11		
		Constructed Wetland	2.89		
		Underground Storage	0.46		
	Institutional			13.39	
		Bioretention	3.39		
		Constructed Wetland	6.78		
		Permeable Weir	3.01		
		Underground Storage	0.22		
Watershed Total					95.82
	Institutional			61.40	
	Commercial			8.86	
	Industrial			6.45	
	Residential (single family)			19.10	

[1]Includes BMPs implemented during project and recommended BMP retrofits.
[2]For each drainage, only land uses with at least one BMP are listed.
[3]Final BMP in treatment train.
[4]Total is area treated by all BMPs of specified type and may include multiple sites.

Table C-3 Pollutant Removal Efficiencies Used in Load Reduction Calculations

BMP Type	N	P	TSS
Bioretention	43%	81%	60%
Constructed Wetlands	20%	44%	78%
Extended Wet Detention[1]	55%	69%	86%

[1]Includes permeable weirs and underground storage.

4 Load Reduction Calculations

The general form of the post-BMP load calculation, for each pollutant and land use class within a major drainage, is:

L_{post} = [L_{pre}(% of LU with no BMPs)] +
[L_{pre}(% of LU with BMP_1)(1 — BMP_1 removal efficiency)] +
[L_{pre}(% of LU with BMP_2)(1 — BMP_2 removal efficiency)] +
[L_{pre}(% of LU with BMP_3)(1 — BMP_3 removal efficiency)]

Where:
L_{post} = total post-BMP pollutant load (lb/yr) for a land class within a specific drainage
L_{pre} = total pre-BMP pollutant load (lb/yr) for a land class within a specific drainage
LU = land use class;
Removal efficiency = percentage of pollutant removed by the BMP type;
BMP_1 = bioretention;
BMP_2 = constructed wetlands; and
BMP_3 = extended wet detention

The load reduction resulting from BMP implementation was calculated as the difference between the pre- and post-BMP loads for that cell. Results by urban land use class are summarized in Table C-4.

5 Discussion

The actual reduction in pollutants from any BMP depends on the final design features of the practice, actual site characteristics (including characteristics of the land draining to the BMP), maintenance practices, and other factors. The percent of the load removed by a BMP is also dependent on the influent concentration: it is easier to remove a high percentage of incoming pollutants if the inflow is 'dirty' than if it is 'clean'. Though a percent removal approach has historically been the most common method of estimating pollutant reductions from stormwater BMP implementation, the limitations of this approach have been increasingly recognized in recent years (see Kosco and Singelis, 2008; and Jones et al, 2008).

Although this approach remains a straightforward and readily understood method to obtain rough estimates of potential pollutant reductions, it must be understood that there is considerable uncertainty associated with any estimate of potential pollutant reductions, especially where design of the BMPs has not yet been undertaken.

However, there is reason to believe that the estimates presented here substantially underestimate the load reductions likely to occur from the construction of the recommended BMPs because:

- Load reductions were not calculated for some practices, including swales and filters. This is probably a minor factor, given the small acreage impacted by these practices.
- The estimates may not fully account for runoff volume reductions likely to occur as part of these projects (e.g. a reduction in impervious cover will occur at some sites);
- Treatment trains (BMPs built in series) are proposed at about half of the sites, including five of the six sites treating the largest areas. Pollutant calculations reflect the impact of the last BMP in the train only. No attempt was made to account for cumulative pollutant removal of treatment trains.

Table C-4 Pre-BMP Load, Post-BMP Load and Estimated Load Reductions, by Urban Land Use Class for the Corpening Creek Watershed

Pollutant Load Characteristic	Land Use Class									
	Commercial	Industrial	Institutional	Transportation	Multi-Family Residential	Single-Family Residential	Urban-Cultivated	Vacant	Open Space	Totals
Total Nitrogen										
Pre-BMP Load (lb/yr)	4,423	1,657	1,519	4,012	400	6,316	0	0	21	18,349
Post-BMP Load (lb/yr)	4,381	1,628	1,375	4,012	400	6,294	0	0	21	18,110
Reduction (lb/yr)	42	29	145	0	0	23	0	0	0	239
% Reduction	0.9%	1.8%	9.5%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	1.3%
Total Phosphorus										
Pre-BMP Load (lb/yr)	442	265	253	669	73	1,148	0	0	2	2,853
Post-BMP Load (lb/yr)	434	255	205	669	73	1,139	0	0	2	2,777
Reduction (lb/yr)	8	10	48	0	0	9	0	0	0	76
% Reduction	1.8%	3.8%	19.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	2.7%
Suspended Sediment[1]										
Pre-BMP Load (tons/yr)	82.9	39.8	28.3	100.3	9.1	143.6	0.0	0.0	0.5	404.4
Post-BMP Load (tons/yr)	81.5	38.3	19.8	100.3	9.1	141.5	0.0	0.0	0.5	391.0
Reduction (tons/yr)	1.5	1.5	8.5	0.0	0.0	2.0	0.0	0.0	0.0	13.4
% Reduction	1.8%	3.7%	29.9%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	3.3%

[1]Total Suspended Solids (TSS)

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Appendix D
Methods for Identifying Stream Restoration and Riparian Buffer Enhancement Opportunities

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Methods for Identifying Stream Restoration and Riparian Buffer Enhancement Opportunities

This Appendix describes the methods used to identify stream restoration and riparian revegetation projects. In the context of this plan, stream restoration refers to engineered techniques that remove stress on eroding stream banks and enhance in-stream habitat. These techniques may include, but are not limited to natural channel design, bioengineered bank toe protection, and rip-rap, gabion, or hard structure stabilization. Riparian buffer enhancement consists of planting native trees, shrubs, and grasses adjacent to the stream for a minimum of 15 feet.

1 Methods

Potential projects were identified using a combination of watershed assessment data (Appendix A) and GIS analysis. Severe stream bank erosion sites, sites with impacted buffers, and stream reaches with low aquatic habitat scores identified in the watershed field assessment were located in GIS. Because sites that exhibit severe stream bank erosion are major contributors of sediment to streams, these sites were flagged for engineered stream restoration opportunities. Further investigation of these sites may find that there are too many site constraints or that engineered techniques are not feasible. In these cases, riparian buffer enhancement opportunities may be explored.

Because only the mainstem of Youngs Fork and Jacktown Creek were assessed during the watershed assessment, tributaries were investigated through a GIS search of 2010 aerial photos. Stream reaches having less than a 30 foot buffer on one or both banks in the aerial photos and are at least 500 feet long were flagged as potential riparian revegetation locations. Field verification of these reaches was not conducted.

2 Results

Eight stream reaches totaling 6,799 feet were identified for engineered stream restoration. Six of the eight reaches occur along Youngs Fork, while two are on Jacktown Creek. All stream reaches occur within highly urbanized areas of downtown Marion and along the US-221 corridor. Because reaches identified for stream restoration flow through developed areas without much space for natural channel design, channel stabilization and other engineered techniques will need to be employed. Further investigation of these sites may find that there are too many site constraints or that engineered techniques are not feasible. In these cases, riparian buffer enhancement opportunities may be explored.

The search for riparian buffer enhancement opportunities yielded 23 potential sites for riparian revegetation along 21,141 feet of stream. Eleven of these reaches occur within Marion City Limits, while 12 reaches are located farther upstream, i.e. in the upper reaches of the contributing drainage area. Land use adjacent to identified reaches are primarily residential and agriculture, although several reaches flow through commercial land in downtown Marion. Further investigation of identified sites and landowner outreach will determine the feasibility for riparian buffer enhancement and the most appropriate vegetation to be planted at individual sites. For more details on implementing stream restoration and riparian buffer enhancement, refer to Section 4.4.