Parkerson Mill Creek Watershed Management Plan

Table of Contents

Chapter 4: Challenges to the Parkerson Mill Creek Watershed

Chapter 5: Parkerson Mill Creek Watershed Management Alternatives

Chapter 6: Assessment & Sustainability of the Parkerson Mill Creek Watershed Plan

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LIST OF ACRONYMS

ACES – Alabama Cooperative Extension System
ADEM – Alabama Department of Environmental Management
ALNHP – Alabama Natural Heritage Program
API – Alabama Polytech Institute
AWW – Alabama Water Watch
BOD – Biogeochemical Oxygen Demand
BEHI – Bank Erosion Hazard Index
BMP – Best Management Practice
CSW – Constructed Stormwater Wetland
CWP – Clean Water Partnership
EPT – Ephemeroptera/Plecoptera/Tricoptera
EWB - Engineers without Borders
DO – Dissolved Oxygen
HUC – Hydrologic Unit Code
JTU – Jackson Turbidity Unit
LID – Low Impact Development
LA – Load Allocation
MOS – Margin Of Safety
NOAA – National Oceanic Atmospheric Association
NPDES – National Pollutant Discharge Elimination System
NPS – Nonpoint Source
NRCS – Natural Resource and Conservation Service
NTU – Nephelometric Turbidity Units
SOS – Save our Saugahatchee
TMDL – Total Maximum Daily Load
TN – Total Nitrogen
TP – Total Phosphorus
TSS – Total Suspended Solids
USDA – United State Department of Agriculture
USEPA – United States Environmental Protection Agency
USFWS – United States Fish and Wildlife Service
USGS – United State Geological Survey
WLA – Waste Load Allocation
WPCF – Water Pollution Control Facility

EQUATIONS, FIGURES, AND TABLES

Equations

Figures

Tables

CHAPTER 1 EXCUTIVE SUMMARY & INTRODUCTION

EXECUTIVE SUMMARY

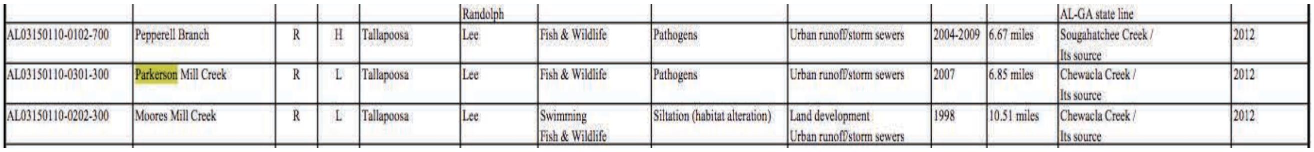
Figure 1. Tallapoosa River Basin – Parkerson Mill Creek Watershed

The Parkerson Mill Creek Watershed is located in Lee County, Alabama in east-central Alabama. The watershed is part of the Chewacla Watershed, in the lower Tallapoosa River Basin. The 9.3 square mile (5981 acres) watershed contains 21,000 m (68,500 ft) of mainstem perennial stream and approximately 86,000 m (282,152 ft) of tributary stream length. The stream network empties into Chewacla Creek, just south of the H.C. Morgan Water Pollution Control Facility (Southside WPCF). The watershed includes the City of Auburn, Auburn University, and surrounding areas. The headwaters of Parkerson Mill Creek are approximately 3000 m (9,845.5 ft) in length and are located on the campus of Auburn University.

Land use in the Parkerson Mill Creek Watershed is unique, containing urbanized, residential (suburban), industrial, and agricultural lands. The urban and suburban areas within this watershed will continue to increase as Auburn University continues to grow.

PROBLEM STATEMENT

The Parkerson Mill Creek Watershed fails to meet the minimum water quality standards for its designated Fish and Wildlife use. In 2007, the Alabama Department of Environmental Management (ADEM) listed Parkerson Mill Creek as impaired on Alabama's 303(d) List of Impaired Waters based on a series of Auburn/Opelika Intensive Fecal Coliform Studies. The 303(d) List is a compilation of impaired waters that require the establishment of a Total Maximum Daily Load (TMDL) under the Clean Water Act (Sec 130.7. See Figure 2). "A TMDL is a calculation of the maximum amount of pollutant that a water body can receive and safely meet water quality standards" (Impaired Waters and Total Maximum Daily Loads, 2010).



					Randolph						AL-GA state line	
AL03150110-0102-700	Pepperell Branch	R	H	Tallapoosa	Lee	Fish & Wildlife	Pathogens	Urban runoff/storm sewers	2004-2009	6.67 miles	Sougahatchee Creek / Its source	2012
AL03150110-0301-300	Parkerson Mill Creek	R	L	Tallapoosa	Lee	Fish & Wildlife	Pathogens	Urban runoff/storm sewers	2007	6.85 miles	Chewacla Creek / Its source	2012
AL03150110-0202-300	Moores Mill Creek	R	L	Tallapoosa	Lee	Swimming Fish & Wildlife	Siltation (habitat alteration)	Land development Urban runoff/storm sewers	1998	10.51 miles	Chewacla Creek / Its source	2012

Figure 2. Excerpt from 2010 Draft 303(d) List of Impaired Waters of Alabama

The Parkerson Mill Creek Watershed has an impaired status due to pathogens from point and nonpoint sources, primarily urban runoff and storm sewer cross connections. The TMDL or loading capacity for pathogens in Parkerson Mill Creek Watershed will be written and released in 2012. A TMDL will determine a load allocation or portion of the loading capacity that can be attributed to point sources (such as municipal and industrial wastewater treatment facilities) and nonpoint sources (such as direct runoff from agricultural lands, urban areas, forested lands, etc) in the watershed. Both point and nonpoint sources are to be examined, in order to reduce pathogen counts.

A source of pathogens for Parkerson Mill Creek is cited on the 303(d) List as urban runoff, a type of nonpoint source or NPS pollution. Nonpoint source pollution is diffuse pollution that cannot be traced to a particular discharge. The best management practices (BMPs) funded by the 319 Program will focus on nonpoint sources.

Point Source vs. Nonpoint Source

The term "nonpoint source" is defined as any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

The term "point source" means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Unlike pollution from industrial and sewage treatment plants, nonpoint source pollution (NPS) comes from many diffuse sources. Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters.

(Excerpt from US EPA – What is Nonpoint Source Pollution? April 2010)

Rainfall moving over the landscape or stormwater runoff is the primary cause of NPS pollution. As runoff moves throughout the landscape it picks up pollutants, depositing them in water bodies. Various pollutants are carried in urban stormwater runoff; examples include sediment, nutrients, metals, oils, and pathogens. Impervious surfaces within the watershed contribute to the intensity and frequency of NPS pollution found in waterbodies such as Parkerson Mill Creek. Future development within this watershed will only increase impervious surfaces, thereby increasing the potential for polluted runoff and further degradation of the stream.

PURPOSE OF A WATERSHED MANAGEMENT PLAN FOR PARKERSON MILL CREEK WATERSHED

The Parkerson Mill Creek Watershed Plan is a comprehensive plan to restore, improve, and protect water quality through the integration of current scientific data and existing plans in cooperation with a multi-sectoral group of stakeholders. This watershed management plan is a long-term effort, with the ultimate goal of attaining the TMDL for Parkerson Mill Creek and restoring the stream to its fish and wildlife use status. This watershed includes the City of Auburn, Auburn University, and a portion of Lee County who are required to be in compliance for stormwater runoff contributions through the Phase II stormwater regulations. The plan will to help those communities by establishing protocol to aid in meeting the minimum requirements of the Phase II program.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S 9 KEY ELEMENTS

All projects that apply for Section 319 funding under the Clean Water Act must include nine key elements in their watershed plans. These items are discussed in the Nonpoint Source Guidance document by US Environmental Protection Agency (US EPA) and are summarized in Figure 3. The key elements are components that will aid in the success of this plan and implementation of its recommendations.

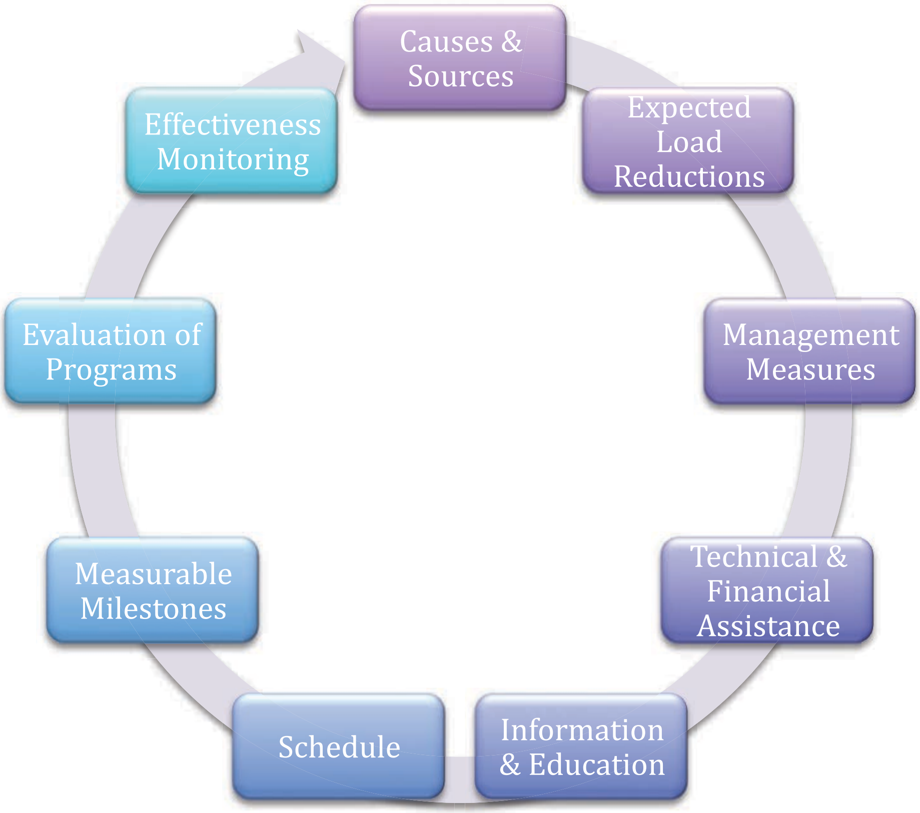


Figure 3. USEPA's Nine Key Elements

STAKEHOLDERS AND COMMITTEES

In the early 2000s, several entities within this watershed were interested in improving the condition of Parkerson Mill Creek. This group of stakeholders formed a committee to address various issues within the watershed, particularly on the portion of the stream located on the campus of Auburn University.

In 2010, various stakeholders including this initial core group, as well as others were invited to participate and guide in the process of developing a Parkerson Mill Creek Watershed Management Plan. This group further divided into three committees, Technical, Resources, and Education & Outreach, which have met monthly from March of 2010 until July 2010. The committee members include: engineers, hydrologists, educators, planners, natural resource managers, ecologists, city and county officials, and other interested stakeholders. The committees provide input to focus the project on specific areas of concern within the watershed. The success of the watershed management plan hinges on the support and approval of all the stakeholders represented.

RESOURCE COMMITTEE

The Resource Committee for the Parkerson Mill Creek Watershed Management Plan is comprised of individuals focusing their efforts on the gathering of historical plans and information and working with the community to provide additional supporting information. The Resource Committee works closely with the Education & Outreach Committee and once implementation of the watershed management plan begins, this committee will merge with the Education & Outreach Committee.

EDUCATION & OUTREACH COMMITTEE

The Education & Outreach Committee is responsible for the majority of the public awareness efforts occurring in conjunction with the watershed management plan. The Education & Outreach Committee creates the outreach publications, will maintain the Parkerson Mill Creek Watershed Plan website post-plan adoption, identifies training needs for monitoring and maintenance personnel, and will be the lead in the search for future funding opportunities. The Education & Outreach Committee will aim to ensure public education is conducted for the proposed best management practices (BMPs) and will help to further education about the sources and impacts of pathogens and other pollutants in the watershed.

TECHNICAL COMMITTEE

Sound scientific data must be the foundation to best determine the impacts that have occurred due to pathogens and the future needs of the Parkerson Mill Creek Watershed. The Parkerson Mill Creek Watershed Management Plan Technical Committee was formed to provide expertise and direction on the research and scientific aspects of the plan including but not limited to water quality sampling, identification of pollution hotspots, assistance with data modeling and determining load reductions, researching and identifying BMPs, and assisting with the development of a monitoring plan for the Parkerson Mill Creek Watershed.

COMMITTEES SUMMARY

Upon a series of initial meetings, these Committees decided the comprehensive watershed management plan for the Parkerson Mill Creek Watershed would provide the framework for the following goals:

- Meet the water quality standards assigned to Parkerson Mill Creek.
- Aid the City of Auburn, Auburn University, and Lee County not only to meet their compliance goals for Phase II communities, but also to be an example for others.
- Restore aquatic habitat and function in Parkerson Mill Creek to support its designated Fish and Wildlife use.
- Protect greenspace in planning for the future.

The Committees recognize and strive to achieve these conditions through the long-term implementation of this living document.

CHAPTER 2 CHARACTERISTICS OF THE PARKERSON MILL CREEK WATERSHED

WATERSHED DESCRIPTION

Parkerson Mill Creek and its tributaries are located in Auburn, Lee County, Alabama in the Lower Tallapoosa River Basin. The Parkerson Mill Creek Watershed includes approximately 9.3 square miles of watershed area and 20,850 meters (68,405 feet) of mainstem perennial stream. The watershed also includes 85,847 meters (281,649 feet) of tributary stream length. Approximately 3,050 meters (10,000 feet) of the mainstem is located on the campus of Auburn University. Parkerson Mill Creek is a subwatershed of the Upper Chewacla Watershed, 12-digit HUC 03150110301. Parkerson Mill Creek Watershed along with Town Creek, Lake Ogletree and Moore's Mill Creek Watersheds make up the sub-watersheds draining to the Chewacla Watershed. The watershed is predominately urban but has agricultural influence on the campus of Auburn University, as well as some rural influences on the perimeter of the watershed.

The Parkerson Mill Creek Watershed has experienced changes in land use, natural features, and hydrology among other watershed characteristics in the last decade. Many of these changes can be attributed to increased urbanization in the City of Auburn area, and the growth of Auburn University.

As the watershed transitions from a more rural and agriculturally dominated landscape to an urban and industrial one, the watershed characteristics change. Some of the changes observed have negative impacts on the water quality found in Parkerson Mill Creek and its tributaries.

Figure 4. Historic Photograph of Parkerson Mill Creek (Auburn University Library Archives, 2010)

CLIMATE

The Tallapoosa River Basin climate is a moist and temperate climate, with annual precipitation ranging between 124.5 and 134.6 cm/yr (49 and 53 in/yr) (Tallapoosa, 2010). There is minimal snowfall in this portion of the state and a dry season occurring from mid-summer to late fall (Tallapoosa, 2010). Rainfall for this region is usually greatest in March and least in October.

The general climate in Auburn, Alabama is that of most southern cities. From January 2009 to January 2010, there has been an average temperature of 19.8℃ (67.8℉) with a low of -3.4℃ (25.9℉) and a high of 36.7℃ (98.1℉) (Weather Underground, 2010). The average humidity 2010 was 77.5%.

The city of Auburn has daily rainfall data dating back to 1976. The 30-year average annual rainfall according to the records from 1979-2009 at the Auburn-Opelika Airport is 132.9 cm/yr (52.31 in/yr). In the last decade an average annual rainfall has been elevated with an average of 142.8 cm/yr (56.23 in/yr). Years 2000, 2007, and 2006 had the lowest annual rainfall at 99.6, 103.1, 103.6 cm/yr, respectively (39.2, 40.6, and 40.8 in/yr). The wet years of the past decade were 2009, 2005, and 2003 with rainfall at 188.2, 177.5, 164.1 cm/yr, respectively (74.1, 69.9, 64.6 in/yr). All of this historical data was collected by the City of Auburn at a gauged location at the Auburn-Opelika Airport.

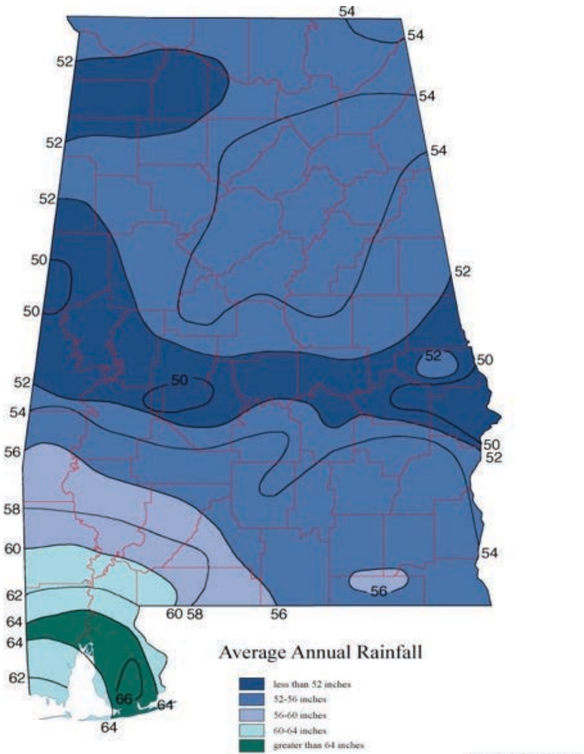


Figure 5. Rainfall in Alabama (Alabama Maps - courtesy of University of Alabama Department of Geography)

TOPOGRAPHY

Auburn, Alabama is located at 32°35’52’’N and 85°28’51’’W. Auburn is located on the Fall Line of the joining of the Piedmont and Coastal Plain of Alabama. Portions of Auburn also lay at the southern most tip of the Appalachian Mountain chain, with some of the final foothills being present in Chewacla State Park, just southeast of the Parkerson Mill Creek Watershed. Most of this region is characterized by rolling plains. Elevation in this area changes from 117 m (386 feet) (Chewacla Creek) to 257.7 m (845 feet) above sea level near the Chambers county line. Variations in elevation for Lee County are shown in Figure 6.

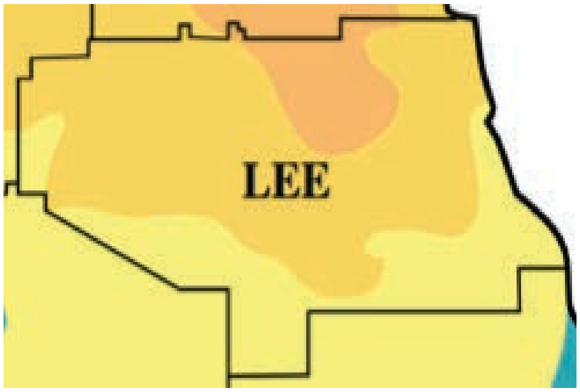
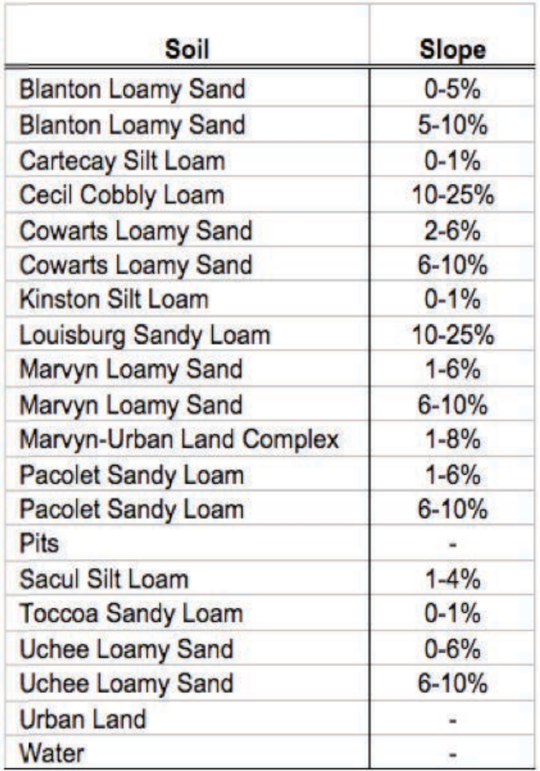


Figure 6. Elevation in Lee County, (Alabama Maps)

SOILS

The predominant soils in this area are the Marvyn Loamy Sand (1-6% slopes) and the Pacolet Sandy Loam (6-10% slopes). The area in the vicinity of Parkerson Mill Creek is primarily made up of loamy sand and sandy loams (Pacolet, Gwinnett, and Hiawassee Soil Series). These soils have moderate infiltration rates, hydrologic soil groups B, and relatively low surface runoff. The majority of the soils have >200 cm (6.5ft) depth to water table. The soil erodibility factor, K, ranges from 0.10 to 0.37 for the soils found within the watershed (Soil Survey Staff, 2010). K represents the susceptibility of the soil to erosion and the rate of runoff. Thirty-five percent of the soils within the watershed are moderately susceptible to detach according to K values. The K values for soils may



Soil	Slope
Blanton Loamy Sand	0-5%
Blanton Loamy Sand	5-10%
Cartecay Silt Loam	0-1%
Cecil Cobbly Loam	10-25%
Cowarts Loamy Sand	2-6%
Cowarts Loamy Sand	6-10%
Kinston Silt Loam	0-1%
Louisburg Sandy Loam	10-25%
Marvyn Loamy Sand	1-6%
Marvyn Loamy Sand	6-10%
Marvyn-Urban Land Complex	1-8%
Pacolet Sandy Loam	1-6%
Pacolet Sandy Loam	6-10%
Pits	-
Sacul Silt Loam	1-4%
Toccoa Sandy Loam	0-1%
Uchee Loamy Sand	0-6%
Uchee Loamy Sand	6-10%
Urban Land	-
Water	-

Figure 7. Soils within Parkerson Mill Watershed Vicinity (Web Soil Survey)

provide insight to some of the erosion and sedimentation experienced within the Parkerson Mill Creek Watershed. Past management or misuse of soil may increase erodibility. Further testing performed by a soil scientist is needed to determine if the soils structure has been destroyed or permeability further reduced.

HYDROLOGY

Figure 8. Hydrology of Parkerson Mill Creek Watershed (city of Auburn GIS)

Parkerson Mill Creek begins at an approximate 188 m (615 foot) elevation near Magnolia Avenue in downtown Auburn, with much of its headwaters located on the highly urbanized campus of Auburn University. The creek continues to flow south for approximately 11 kilometers (seven miles), flowing through Auburn University's campus and the City of Auburn before flowing into Chewacla Creek. Parkerson Mill Creek has eight major tributaries flowing into it including approximately 85,850 m (281,650 ft) of tributary stream length.

Much of the stream alteration that has occurred on Parkerson Mill Creek is due to urbanization. Previous to urbanization, the land was predominately forested with some agriculture. "Natural stream functions in the watershed have been altered by historic changes in watershed land uses channel straightening and relocation, piping, floodplain filling, streambank armoring, stormwater discharges, and loss of riparian vegetation" (Jennings, et al., 2003). The majority of the headwaters portion of the stream is incised down to bedrock. Eroding streambanks, invasive plants, poor aquatic habitat, and degraded water quality are present likely due to the lack of floodplain, incision, and loss of native vegetation. Overall the hydrology of Parkerson Mill Creek has been drastically altered. Some of the primary hydrologic factors affected are flow stability and channel morphology.

LAND USE

Prior to settlement in the 1830's most of the Parkerson Mill Creek Watershed was comprised of old growth forests and rolling plains. Post settlement and up until the middle of the next century forests and farms made up much of the watershed and the ecoregion. The Parkerson Mill Creek Watershed is located on the cusp of the Piedmont and Southeastern Plains ecoregions (Piedmont, Southeastern, 2010). These ecoregions, as defined by the U.S. Geological Survey, are two of the largest ecoregions in the eastern United States (Figure 9). The Southeastern Plains region spans from the Gulf of Mexico up the east coast into southern Maryland, covering approximately 33,614,054 km^2 (12,978,459 mi^2) (Southeastern, 2010). The Piedmont spans over 16, 545,986 km^2 (6,388,441 mi^2), transitioning the Southeastern Plains up to the Appalachian Mountain chain and the Blue Ridge ecoregion (Piedmont, 2010). These regions are made up of cropland, pasture, forest, and wetlands. Because of their long growing season and abundant rainfall, they are rich in natural resources for farming and forests of pine, hickory and oak.

Figure 9. Ecoregions of the Eastern United States (Loveland and Acevedo, 2010)

From 1973 to 2000, the percentage land cover area changed in these regions was 20.4% for Southeastern Plains and 14.5% for the Piedmont, higher than most other eastern United States ecoregions (Southeastern, Piedmont, 2010). The estimated changes in land cover per time interval (normalized to annual rates of change) are shown in Figure 10. The black line in Figure 10, representing the estimated changes in land cover for the Southern Plains ecoregion is in comparison with other regions depicted in gray.

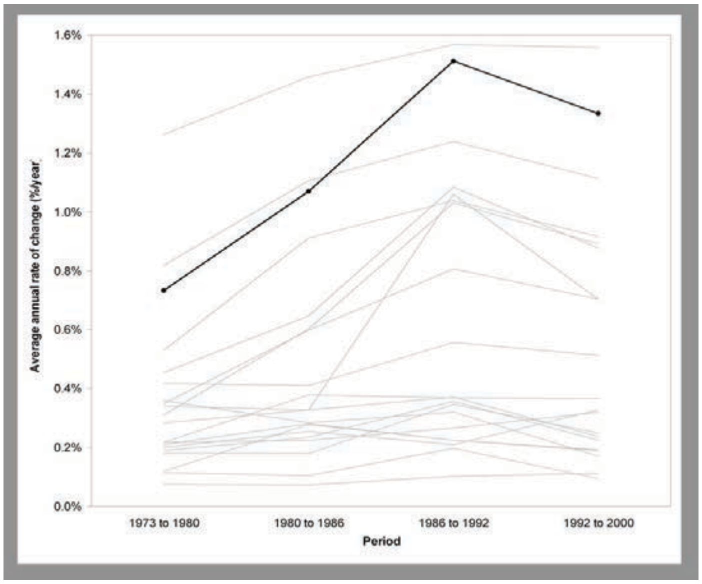


Figure 10. Average Annual Rate of Land Cover Change (%/year) from 1973 to 2000 for the Southeastern Plains

Despite the dramatic changes in land cover as shown in Figure 10, this change reflects a dynamic timber industry true of the ecoregion and the State of Alabama. The five most common land cover conversions for the Southeastern Plains and Piedmont region in 1973 through 2000 include transitions to or from a forested area. Forests transitioning into developed areas, agricultural lands transitioning to forest, and a healthy pattern of forest management are all reflected in this land cover change. The five most common areas changed are represented in Figure 11.

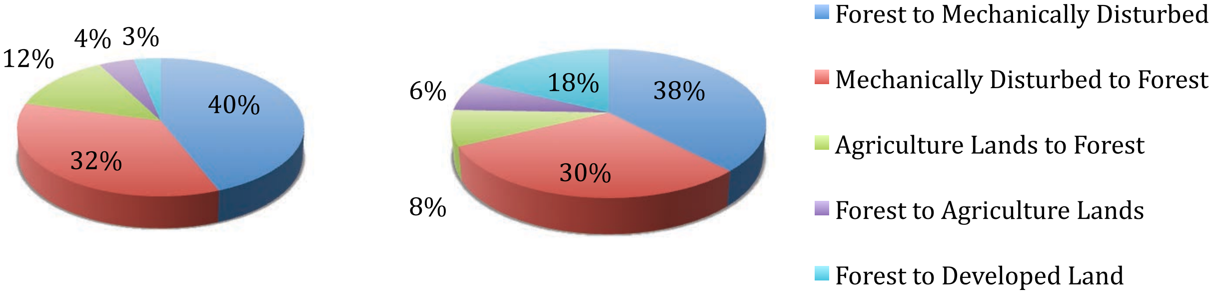


Figure 11. The Five Most Common Land Cover Class Changes from 1973 to 2000 for Southeastern Plains (left) and Piedmont (right) Ecoregions

Similar to the changes experienced in these ecoregions, changes involving the conversion of farmland and forests were experienced specifically in the state of Alabama. Farms covered two-thirds of the State in 1950, as compared to one-quarter of the total land area in 1997. Much of the Parkerson Mill Creek Watershed was historically covered in farms and experienced similar changes as those documented for the entire state. Table 1 depicts the decrease in farmland and forest lands in Alabama form 1950 to 1997.

Table 1. A Comparison of Farm and Forest Lands from 1950 to 1997 in Million Acres

	1950	1997
Farm Land	33	<10
Harvesting Crops	6	2
Pasture Land	7	3
Wood Land	6	38750
Forest Land	20-24	23

The most recent land use data specific to the Parkerson Mill Creek Watershed is from 2002. As shown in Figure 12, the headwaters of the watershed are predominately developed with larger areas of forest as the stream moves toward Chewacla Creek. Figure 13 is a bar graph of the acres in each land use classification for 2002.

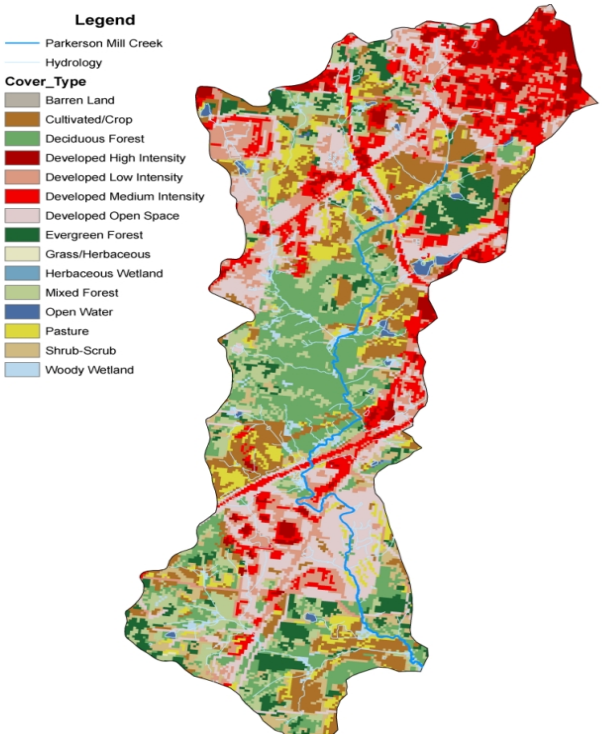


Figure 12. Land Use within the Parkerson Mill Creek Watershed (City of Auburn GIS)

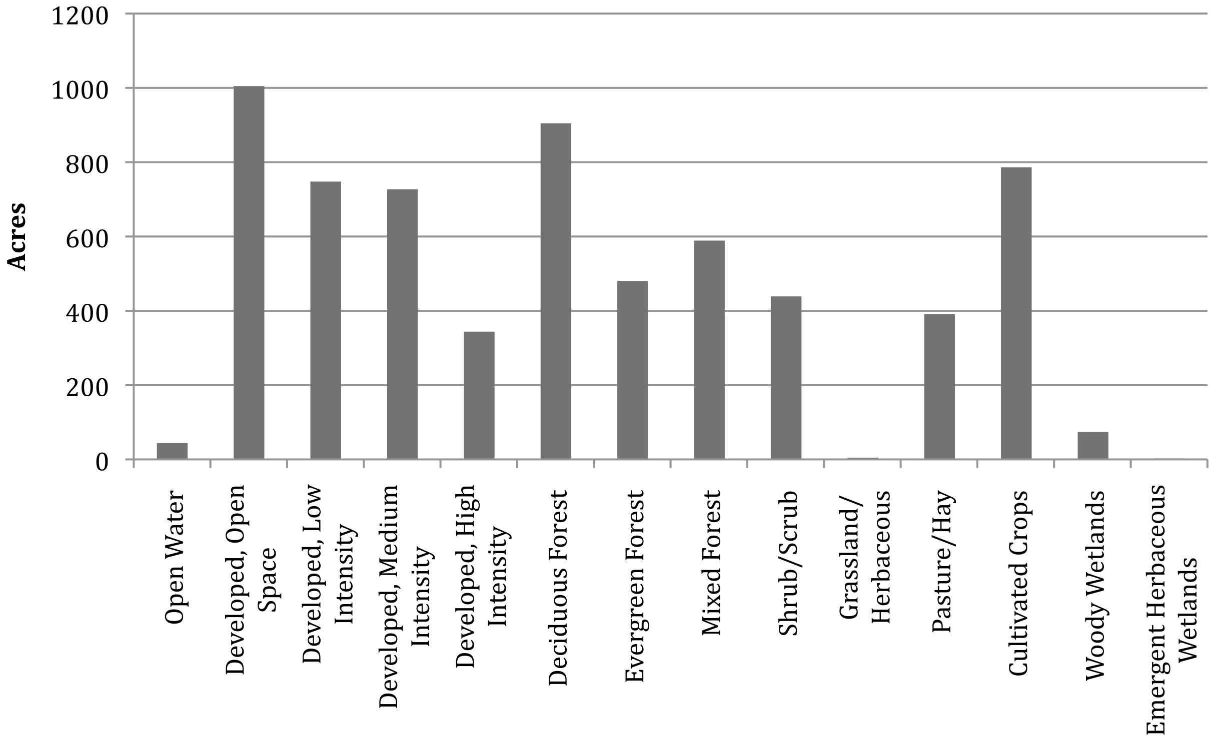


Figure 13. Acreage for each Land Use Classification within the Parkerson Mill Creek Watershed

To better understand the potential sources of pollutants with the watershed, a sound understanding of land use is needed. The most recent land use data for the Parkerson Mill Creek Watershed is shown in Figure 14. Developed land is the most common land use making up 43% of the total watershed. The majority of that development land is developed open space (1005 acres or 36% of total developed land) followed by low and medium intensity development (11.4% and 11.1%). Grasslands, wetlands, and open water comprise the smallest amount of land use categories having only 6 (0.1%), 45 (0.7%), and 79 (1.2%) acres, respectively. Forests make up approximately 30% or almost 2000 acres of the Parkerson Mill Creek Watershed. In the future more development is anticipated, much like the trends experienced from 1997 to 2002. The changes in land use from 1997 to 2002 can be found in Appendix B.

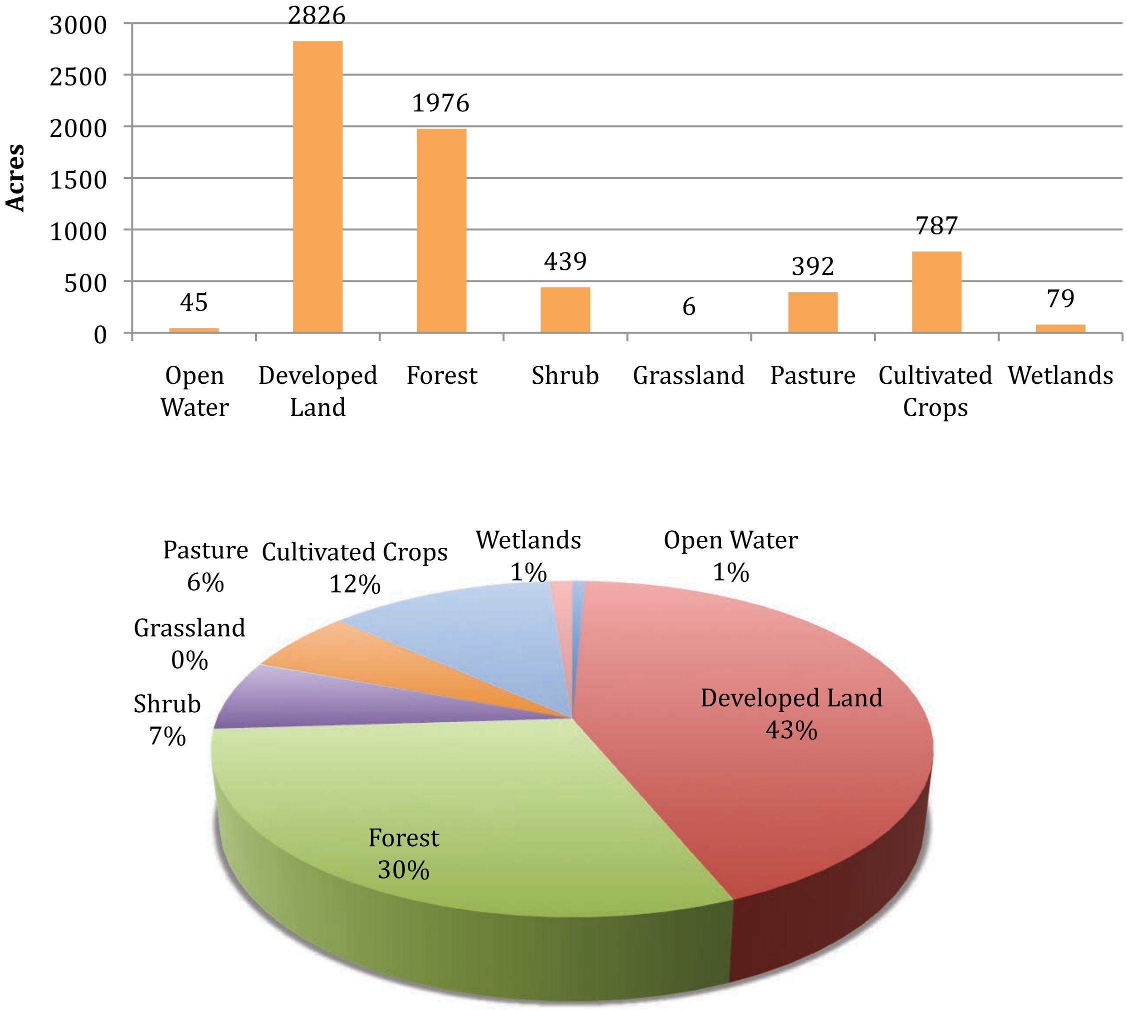


Figure 14. Current Land Use within the Parkerson Mill Creek Watershed

WATERSHED HISTORY

For hundreds of years the Creek Native American Tribe inhabited Auburn and surrounding areas in Lee County. This area was opened to settlement under the Treaty of Cusseta in 1832, which was an agreement established between the Creek Nation and the United States Government. The treaty ceded all Creek lands east of the Mississippi including much of eastern Alabama, and all of Lee County. Post signing of the Treaty of Cusseta, the land that is now called the City of Auburn was settled by a group of individuals from Harris County, Georgia, led by Judge John Harper.

Auburn was incorporated in 1839 and was home to Methodist and Baptist churches and a school. In 1856, a Methodist college for males was established, the East Alabama Male College. Later in 1859, the school became Alabama Polytechnic Institute (API). API all but disappeared during the Civil War and Auburn suffered a prolonged depression for much of the century. In 1892, the college became the first four-year college to accept women in the state of Alabama, helping to restore Auburn's population and economy.

DEMOGRAPHICS

Between 1980 and 2003 the City of Auburn's population grew 65%, much of which can be attributed to the continued growth of Auburn University. The current student enrollment at Auburn University is 25,078 (Dowdle, 2010).

The City of Auburn is currently home to 56,088 people with a population density of approximately 955 people per square mile (United States Census Bureau, 2000).

The City of Auburn has had an estimated 18.7% increase in population between 2000 and 2006, which is 5.5 times the percent increase experienced by the state of Alabama during this time (United States Census Bureau, 2000). The City of Auburn's population increased from 42,987 inhabitants in 2000 to 51,906 in 2006 (United States Census Bureau, 2000). In 2000, 74.1% of the population is persons between the age of 18 and 65. This percent is indicative of Auburn University's population. The US Census of 2000 also recorded that 50.1% of the inhabitants were white persons, 16.8% black persons, 0.2% American Indian and Alaskan Natives, and 3.3% Asian persons.

Figure 15 shows the population for Lee County, Alabama from 1900-2000. Overall, there is a general increase in population for the past century.

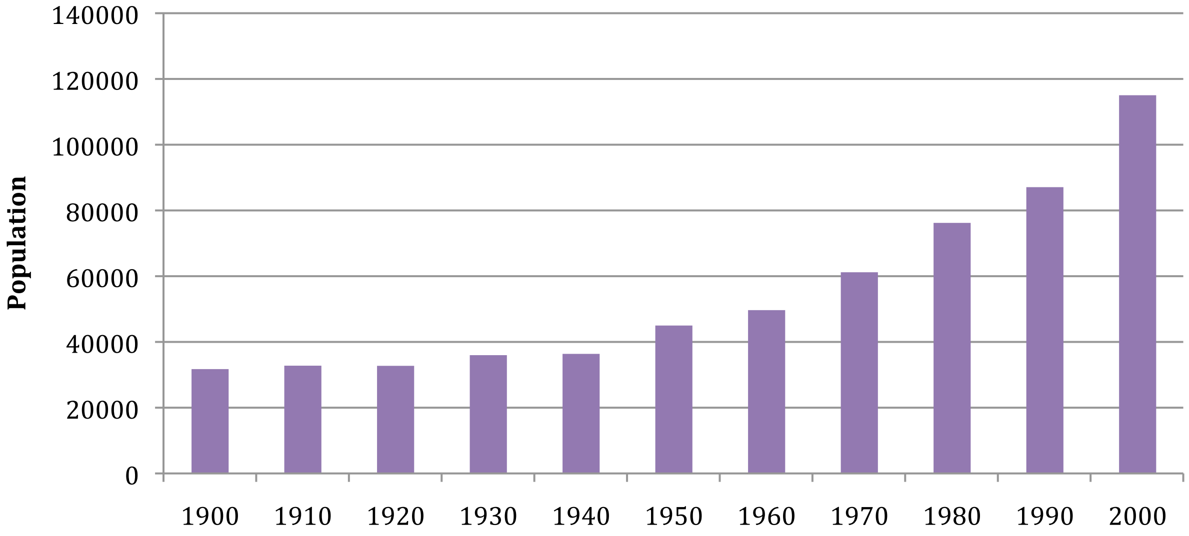


Figure 15. Population of Lee County from 1900-2000

Auburn, Lee County, and the entire state of Alabama, continues to urbanize and become more populated. The projected population for Alabama for the next twenty years is shown in Figure 16.

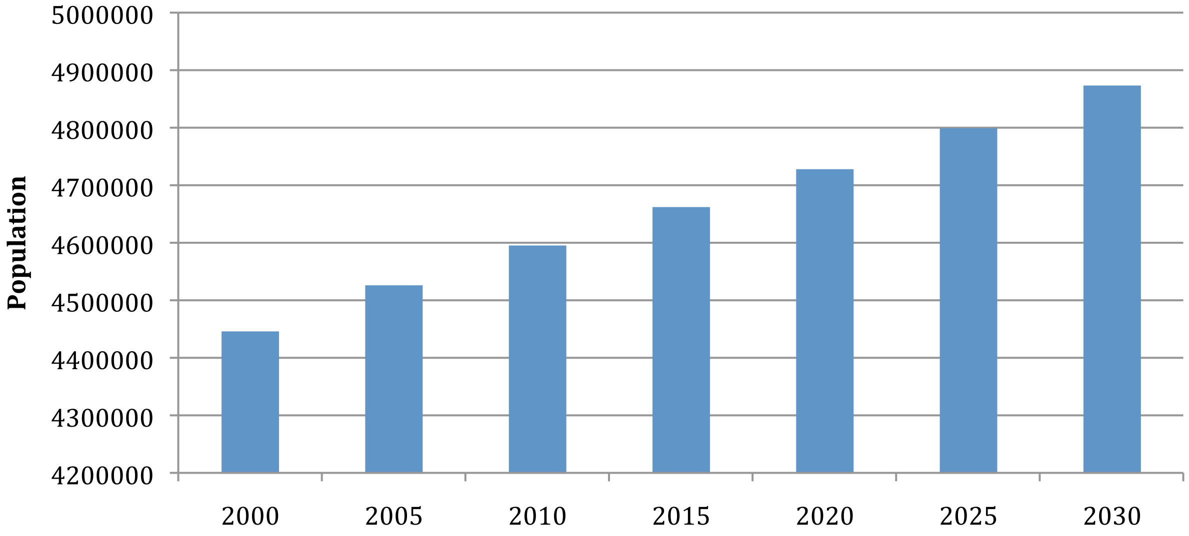


Figure 16. Projected Population of Alabama from 2000-2030 (US Census)

SIGNIFICANT NATURAL FEATURES TO BE PROTECTED

ENDANGERED OR THREATENED SPECIES

The Tallapoosa River Basin is one of the most diverse in the Southeastern United States. The Tallapoosa is home to over 120 native fish species, 31 species of mussel, and 11 species of crayfish that do not occur elsewhere (Tallapoosa, 2010).

The Alabama Natural Heritage Program (ALNHP) aims to provide the best available scientific information on biological diversity within the state. One role of the ALNHP is to collect status and distribution information of species. The ALNHP uses a ranking system developed by the Nature Conservancy (Alabama Natural Heritage Program, 2010). The ranks represented in Tables 2 and 3 are Global and State rankings pertinent to Lee County, Alabama.

Table 2. Global Ranking Descriptions used for Endangered or Threatened Species

Global Rank		
G1	Critically Imperiled	at very high risk of extinction
G2	Imperiled	high risk of extinction
G3	Vulnerable	moderate risk of extinction
G4	Apparently Secure	uncommon but not rare
G5	Secure	common
Q	Questionable Taxonomy	

Table 3. State Ranking Descriptions used for Endangered or Threatened Species

State Rank	
S1	Critically Imperiled in AL
S2	Imperiled in AL
S3	Rare or Uncommon in AL
S4	Apparently Secure in AL
S5	Demonstrably Secure in AL
SX	Presumed Extirpated from AL

**** B and N refer to migratory animals in breeding and non-breeding seasons (refer to the ALNHP 2010 Tracking List for complete descriptions)**

Figure 17 illustrates the number of species within Lee County, 83 total that are listed in the Alabama Natural Heritage Program 2010 Tracking List.

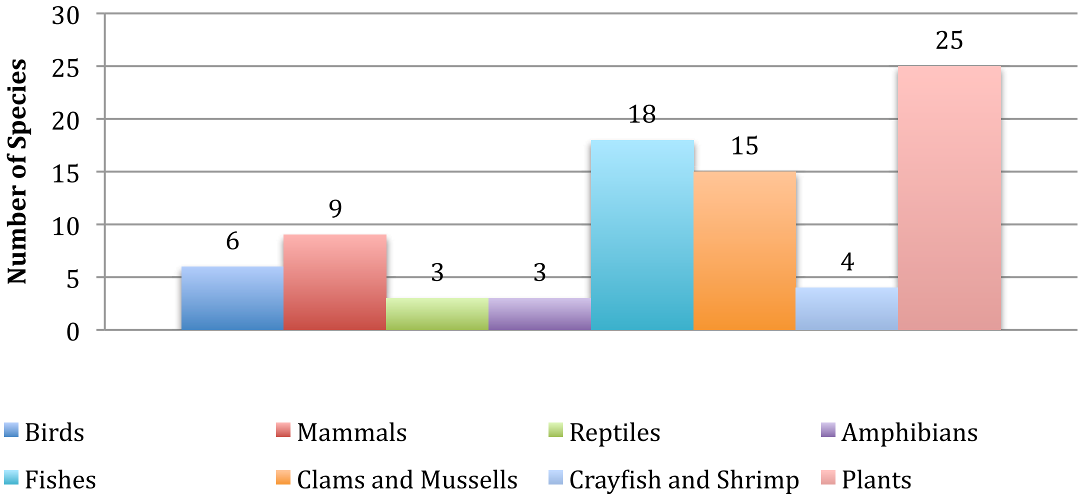


Figure 17. Number of Rare or Endangered Species within Lee County Alabama (ALNHP, 2010)

Several of the species shown on the ALNHP 2010 Tracking List that are imperiled are shown to only have habitat areas in Chewacla Creek, just south of the Parkerson Mill Creek Watershed (Alabama Natural Heritage Program, 2010).

A complete list can be found in Appendix A.

ECOLOGICAL SERVICES

In addition to the importance of habitat for the aforementioned species, undeveloped land provides man ecological services, such as clean air and water, necessary for this watershed and region. According to the current land use data for the Parkerson Mill Creek Watershed, 40% is still undeveloped and available for the use of these desired products, processes and functions.

WATER USE

The United States Geological Survey (USGS) compiles national water-use estimates every five years for each county. The most recent compilation available for Lee County is from

2005. Freshwater use is classified as Surface water and Groundwater uses. The total freshwater use is 21.5 million gallons per day (Mgal/day) (Water Use, 2010).

The USGS study reports 19.28 Mgal/day of surface water are used (Water Use, 2010). Surface water makes up approximately 90% of the total freshwater use in Lee County, Alabama. The primary users of surface water are public supply, industrial and irrigation with 15.53, 2.23, and 1.24 Mgal/day, respectively. The largest withdrawals of surface water are the public suppliers Auburn Water Works Board, Opelika Water Works Board, and Smith Station Water System.

Maintaining surface water quality provides benefit to the Parkerson Mill Creek Watershed. Water treatment is expensive and maintaining natural systems, such as the tributaries to Parkerson Mill Creek, will minimize the cost of future treatment. Surface water flow and quality varies with rainfall events and intensity of an individual event. Extreme weather events have a significant impact on stream flows. The intensity and duration of extreme weather conditions such as flooding or drought alter Parkerson Mill Creek and its tributaries' natural flow regime or flow levels. These drastic changes in flow levels or stress levels affect biodiversity, habitat and pollutant loading, among other stream characteristics. In times of significant drought, such as recent years 2000, 2001, 2007, and 2008, the stream has serious low-flow levels or periods of no-flow. These low levels stress water use capacities, as well as reduce assimilation capacities for point and nonpoint pollution. Subsequently, the opposite is true in times of flood. Sanitary sewer overflows, septic system leachate, and discharges can enter streams. Flood events also create channel erosion due to increased capacity.

According the study of national water-use estimates performed by the United States Geological Survey (USGS) in 2005, Lee County uses approximately 2.23 million gallons per day of ground water, approximately 10% of total freshwater use (Water Use, 2010). "Aquifers in the Lower Tallapoosa River Basin are comprised primarily of unconsolidated sedimentary and alluvial deposits of the Coastal Plain" (CH2MHILL, 2004). Wells in this region are typically capable of flow rates ranging from 20 to 200 gallons per minute

(CH2MHILL, et al., 2004). In the Lower Tallapoosa Watershed (HUC 03150110), approximately 7.83 Mgal/day of groundwater are used, predominately by irrigation (3.85 Mgal/day) and public supply (3.74 Mgal/day). The primary uses of this groundwater within Lee County in million gallons per day are public supply (0.82), residential (0.70), and irrigation (0.36).

It is important that the Parkerson Mill Creek Watershed provide a means of groundwater recharge. Some residents within the watershed area rely on groundwater as their drinking water source as does the agriculture industry for irrigation supply. The mining industry in Lee County relies solely on groundwater.

WETLANDS

Wetlands are transitional lands between terrestrial and deep-water habitats (USFWS, 1998). They provide necessary hydrologic function to efficiently cycle nutrients, while promoting habitat for a biologically diverse plant and animal community.

A few streams in surrounding watersheds, such as Saugahatchee Creek, suffer from organic enrichment from nutrients, such as nitrogen and phosphorus. Natural and constructed wetlands are effective in nutrient, sediment, metals, oils, and greases removal. In addition to pollutant removal, wetlands are beneficial for flow attenuation and reducing peak flow rates of nearby streams. As water moves through the 80 acres of wetlands within the watershed and through native soil and vegetation, there is opportunity for filtration of many pollutants. The Palustrine or freshwater wetlands of the Parkerson Mill Creek Watershed are located in its floodplains.

RIPARIAN AREAS

Vegetation such as shrub and grasslands adjacent to rivers, creeks, and off-line wetlands within the Parkerson Mill Creek Watershed play an important role in

Figure 18. Fallen Pine Tree (Auburn University Campus)

stabilization, filtering pollutants, and erosion control. Preservation of these riparian areas is critical with the future expansion of the City of Auburn and Auburn University. Much of the riparian buffer in the Parkerson Mill Creek Watershed is pine forest. Native grasses such as Little Bluestem (*Schizachyrium scoparium)* are excellent at preventing erosion and persisting in times of periodic droughts or floods. Grassland and shrub lands help to supplement forests that make up the riparian areas within the Parkerson Mill Creek Watershed.

WILDLIFE AND HABITAT DIVERSITY

Alabama is home to many species and a very diverse population. As briefly mentioned before, the Tallapoosa Watershed has 162 species only native to this region. The Ovate and Clubshell mussel can be found in Chewacla Creek and surrounding areas of Lee County in close proximity to Parkerson Mill Creek. This region is critical habitat to both of these mussels as defined by the US Fish and Wildlife Service (USFWS). The middle portion of the Parkerson Mill Creek Watershed with its large research farms and remaining forests are home to much of the wildlife remaining in this urban watershed.

RECREATION

Natural areas that provide hiking, biking, bird watching, hunting, boating, and fishing generate revenue for the local community. A study by Costanza, et al. at University of Vermont shows rivers and lakes worth $3500/ac (Costanza, et al., 1997). Some of the recreation opportunities within the watershed include the Charlotte and Curtis Ward Bike Path, the Donald E. Davis Arboretum, Surfside Water Park, and Auburn Links at Mill Creek. In addition to physical recreation the Parkerson Mill Creek Watershed is also home to a variety of arts facilities and museums including the Jule Collins Smith Museum of Fine Art, the Auburn University Telfair B. Peet Theatre, and the Auburn University Jonathan B. Lovelace Athletic Museum and Hall of Honor. The adjusted budget to maintain parks and recreation for all parks in Lee County for 2010 is over $2 million (City Auburn Parks and Recreation, 2010). With this investment in recreation these areas need to be protected and maintained. The remaining undeveloped areas or natural areas within the Parkerson Mill Creek Watershed need to be conserved and provided prioritized protection.

POINT SOURCES

The National Pollutant Discharge Elimination System (NPDES) permit program, locally enforced through the Alabama Department of Environmental Management (ADEM) and the Alabama Water Pollution Control Act, regulates point source discharges. The term "point source" is defined as any discernible, confined, and discrete conveyance (USEPA, 2010) [see text box in Chapter 1]. The largest point source within the watershed is the H.C. Morgan Water Pollution Control Facility.

The list of permitted point source discharges is dynamic, due to the constant expiration and addition of permits. Figure 19 is a list of permitted discharges in the vicinity of Parkerson Mill Creek, as of June 2010.

FACILITY NAME	STREET ADDRESS	CITY NAME	COUNTY	STATE	ZIP CODE	PERMIT ISSUED DATE	PERMIT EXPIRED DATE
AGRICULTURAL HERITAGE PARK Summary Report	AUBURN UNIVERSITY	AUBURN UNIVERSITY	LEE	AL	36849	SEP-09-2005	JUL-05-2006
AU FORESTRY AND WILDLIFE Summary Report	AUBURN UNIVERSITY FAC DIVISION	AUBURN	LEE	AL	36849	OCT-14-2005	SEP-24-2006
AUBURN UNIVERSITY Summary Report	202 MARTIN HALL	AUBURN	LEE	AL	36849	DEC-09-2003	MAR-09-2008
BEDELL VILLAGE Summary Report	319 W GLENN AVE	AUBURN	LEE	AL	36830	DEC-25-2005	DEC-25-2010
BEEF TEACHING SITE Summary Report	AUBURN UNIVERSITY	AUBURN	LEE	AL	36849	DEC-25-2005	DEC-25-2010
CAMDEN RIDGE SUBDIVISION Summary Report	NORTHWOODS INCORPORATION	AUBURN	LEE	AL	36831	JAN-10-2005	JAN-08-2006
CENTRAL PARK SUBDIVISION Summary Report	CONNER BROS DEVELOPMENT CO INC	OPELIKA	LEE	AL	36830	APR-04-2005	APR-06-2006
COUCH USA READY MIX Summary Report	WEBSTER AND WIRE RDS	AUBURN	LEE	AL	36830	APR-07-2003	APR-06-2004
COUCH USA READY MIX Summary Report	WEBSTER RD AND TEAGUE COURT	AUBURN	LEE	AL	36830	APR-07-2003	APR-06-2004
DISTRICT ENERGY PLANT Summary Report	AUBURN UNIVERSITY	AUBURN	LEE	AL		OCT-20-2004	OCT-19-2005
GARDENS AT GATEWOOD Summary Report	C L AND S SUBDIVISIONS LLC	AUBURN	LEE	AL	36830	MAY-02-2005	MAY-07-2006
HICKORY WOODS ESTATES SOUTH Summary Report	HOWARD WEISSING	AUBURN	LEE	AL	36830	FEB-08-2005	DEC-15-2005
MATTHEW TOLAND Summary Report	118 PRATHERS LAKE DR	AUBURN	LEE	AL	36830	DEC-25-2005	DEC-25-2010
MIKES MERCHANDISE Summary Report	429 MOORES MILL RD	AUBURN	LEE	AL	36830	JUN-29-2004	JUN-28-2005
MUSSELWHITE GROUP INC Summary Report	611 E GLENN AVE	AUBURN	LEE	AL	36830	DEC-25-2005	DEC-25-2010
NORTHLAKES DEVELOPMENT Summary Report	NORTHLAKES INCORPORATION	AUBURN	LEE	AL	36831	APR-04-2005	MAR-16-2006
RENTAL CENTER Summary Report	M AND J ENTERPRISES LLC	AUBURN	LEE	AL	00000	APR-26-2005	APR-27-2006
REXNORD INDUSTRIES LLC Summary Report	1600 PUMPHREY AVE	AUBURN	LEE	AL	36830	OCT-24-2007	SEP-30-2012
RICHLAND ROAD RECONSTRUCTION Summary Report	CITY OF AUBURN	AUBURN	LEE	AL	36832	JUL-18-2005	JUL-18-2006
ROBERT BOSCH TOOL CORPORATION Summary Report	155 ALABAMA STREET	AUBURN	LEE	AL	36832	OCT-01-2007	SEP-30-2012
SOLAMERE SUBDIVISION Summary Report	STEVE CORBETT	AUBURN	LEE	AL	00000	DEC-04-2003	DEC-03-2006
STEEPLE CHASE MOBILE HOME PARK Summary Report	GREENBELT PROPERTIES	AUBURN	LEE	AL	36830	MAR-05-2003	FEB-26-2004
TIM WHITE SUBD LOTS 2 AND 4 Summary Report	TIM WHITE CONSTRUCTION INCORP	AUBURN	LEE	AL	36830	SEP-12-2005	JUL-26-2006
TOWNSEND SUBDIVISION Summary Report	KENNETH HOOD	AUBURN	LEE	AL	36830	MAY-21-2004	MAY-20-2005
WHITE ST MISS BAPTIST CHURCH Summary Report	A G DRE CO INC	AUBURN	LEE	AL	36832	OCT-13-2004	OCT-02-2005
WISTERIA TOWNHOMES CENTRAL PK Summary Report	730 N DEAN RD STE 200	AUBURN	LEE	AL	36830	MAR-15-2005	MAR-09-2006
WOODLAND HILLS SUBDIVISION Summary Report	1449 RICHLAND RD OFC	AUBURN	LEE	AL	36832	FEB-01-2006	JAN-12-2007

Figure 19. Permitted Discharges in the Vicinity of Parkerson Mill Creek (EPA EnviroFacts Website – Envirofacts, 2010)

SEWER SERVICE AREAS AND PRIVATELY OWNED SEPTIC SYSTEMS

The Parkerson Mill Creek Watershed includes households whose waste is treated by publicly owned wastewater treatment plants and those treated by on-site, privately owned septic systems.

According to the Lee County Health Department there are an estimated 1500-2000 active septic systems in the Parkerson Mill Creek Watershed. These systems have a 10-20 year lifespan and need to be properly maintained in order to ensure functionality. It is estimated that approximately 250 septic tanks are currently failing (Hakel, 2010). Failing septic systems have the potential to be major contributors to pathogen loading in the Parkerson Mill Creek Watershed. During rain events, overflows from these failing septic systems can be washed into nearby storm sewers and streams, or systems can leach into the groundwater that feeds the baseflow of the streams.

The majority of the watershed is provided sanitary sewer service by the City of Auburn. The City of Auburn has two wastewater treatment facilities H.C. Morgan or Southside Water Pollution Control Facility and the Northside Water Pollution Control Facility. The City of Auburn maintains over 220 miles of sewer lines, over 5000 manholes, and thirteen lift stations. Over 70% of Auburn's population, approximately 40,000 people, are serviced by the H.C. Morgan Water Pollution Control Facility (Dunn, 2010).

Sewer treatment services within the Parkerson Mill Creek Watershed are provided at the H.C. Morgan Water Pollution Control Facility.

CHAPTER 3 CURRENT CONDITIONS OF THE PARKERSON MILL CREEK WATERSHED

The Parkerson Mill Creek Technical Committee has made an effort to collect all readily available data, in terms of water quality and quantity for the Parkerson Mill Creek Watershed. This collection aims to establish a baseline of current conditions. The efforts include requests to the City of Auburn, Auburn University Office of Risk Management (Stormwater), Alabama Department of Environmental Management, Auburn University Facilities, Alabama Water Watch, Lee County Department of Public Health, and a host of local researchers. In addition to raw data, literature searches were performed to access past published studies. An abundance of studies, datasets, and summaries of relevant data have been obtained; however, the information presented should not be considered completely comprehensive.

WATER QUALITY INDICATORS

Water quality indicators are used as a sign of stream health and water quality. Since Parkerson Mill Creek is listed for impairment due to pathogens *Escherichia coli* (E. coli) and fecal coliform were the primary water quality indicators used to determine stream health. Additional data reflective of water quality were collected including nutrients, turbidity, benthic macroinvertebrates, etc.

The water quality indicators used most often in the study of the Parkerson Mill Creek Watershed include: Pathogens, Nutrients, Sediment, Biological Indicators, and Imperviousness.

PATHOGENS

Pathogens are disease-causing bacteria, viruses, and protozoans. Bacteria and protozoans drive naturally occurring nutrient and carbon cycling. They can exist under a range of physical, chemical, and biological conditions. The waterborne pathogen is one that thrives in water that can be transmitted to humans when they consume untreated or inadequately treated water. Pathogens Giardia and Cryptosporidium, which lead to severe digestive issues, are common waterborne pathogens that are in the news today.

Criteria for Indicator Bacteria for Fish and Wildlife Use (Fresh Water):

Jan-May and Oct-Dec

548 colonies/100 mL E. coli - geometric mean

2,507 colonies/100 mL E. coli – single sample

200 colonies/100mL for fecal coliform – single sample

June - Sept

126 colonies/100mL E. coli – geometric mean

487 colonies/100 mL E. coli – single sample

200 colonies/100mL for fecal coliform – single sample

Pathogen testing is relatively expensive; therefore, indicator bacteria are most-commonly used to gauge water quality. Indicator bacteria, although harmless themselves, have similar sources as do waterborne pathogens and their amounts can serve as indicators of the possible presence of other disease-causing bacteria. As previously mentioned, indicator bacteria E. coli and fecal coliform are the indicator bacteria used in determining the water quality status of the Parkerson Mill Creek Watershed. Indicator bacteria must occur in greater numbers than pathogens and should be at least as resistant to adverse environmental conditions as pathogens (Armon and Knott, 1995). Although sampling for indicator bacteria is a common method for identifying pathogen presence, it is important to note that indicator organisms and monitoring programs are limited in their ability to predict pathogen presence and health risks (Smith and Perdek, 2003). The indicator bacteria used and the time of year for which sampling occurs affect the criterion used to meet water quality standards. If the pathogen impairment is more pronounced in higher flows, the pollutant is associated with wet weather, i.e. stormwater runoff, CSO's and SSO's (USEPA, 2000). The criteria reflect these changes in weather condition but an abnormally high sample in the fall/winter (low flow) months may suggest an infrastructure problem. The criterion for E. coli and fecal coliform established by the Alabama Department Environmental Management for the designated Fish and Wildlife Use is shown in the text box above.

NUTRIENTS

Nitrogen and phosphorus are the primary nutrients of concern in waterbodies impaired for nutrients within Lee County and other urban areas. Both nutrients are essential for all plant growth; they can also be the limiting nutrient in our freshwater systems, meaning that if all of a particular nutrient is used, then plant growth will cease. These excessive amounts of nutrients or eutrophication can lead to the production of large quantities of algae. This increase in algae and subsequent respiration and/or decomposition can deplete the dissolved oxygen in the water, adversely affecting fish and aquatic organisms. Eutrophication can also reduce recreational appeal and the aesthetics of our waterbodies.

SEDIMENT (TURBIDITY)

Sediment is one of the most common impairments of all nonpoint source pollutants. Sediment, particularly fine sediment or silt and suspended solids, may enter waterbodies from surface runoff due to improper land cover or eroding streambanks. Particularly in urban land use settings, improperly managed construction sites can be a source of sediment. Sediment, specifically silt in stream riffles, can affect biodiversity because of reduced oxygen in substrate habitats. Turbidity, or the cloudiness of the water caused by suspended solids like sediments, reduces the amount of light penetration required for some plant species growth. Other potential pollutants such as phosphorus can be adsorbed to sediments, causing increased levels of nutrients from unnaturally high erosion rates. In addition to causing ecological problems, high turbidity levels may inhibit/restrict drinking water purification treatment, leading to higher costs for treatment.

BIOLOGICAL INDICATORS

Benthic macroinvertebrates (visible bottom-dwelling insects) are susceptible to degraded water quality, the physical conditions of the stream or habitat and sediment. Insect diversity indicates good stream quality. The families Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies) populations are used to indicate stream quality. A quantification of the EPT families can serve as an indicator of changes in stream flow, temperature, oxygen, and other alterations that raise the metabolic rates of the insects. Sensitive insect families, such as stoneflies, are most affected by nonpoint source pollution and will not be present in highly impaired stream systems. Various benthic macroinvertebrate assessments using the EPT method have been conducted on Parkerson Mill Creek by an Urban Ecology class at Auburn University, and a five-year assessment performed by the Alabama Department of Environmental Management Field Operations (Appendices E and F).

Fish require aquatic insects for food. The Tallapoosa River Basin has excellent biodiversity of fish species with over 134 species reported throughout the basin (CH2MHILL, et al., 2004). Many of the fishes found in Parkerson Mill Creek and surrounding streams are specific to their watersheds because of local topography and the Fall Line between the Piedmont and Coastal Plain Ecoregions.

IMPERVIOUSNESS

As urban residential, commercial, and industrial land areas increase the result is an increase in impervious surfaces or imperviousness. These surfaces can often be directly connected to the regions that collect and drain runoff to surface waterbodies without the benefit of any water quality treatment. Figure 20 illustrates the changes in infiltration and runoff rates for predevelopment and post development hydrology.

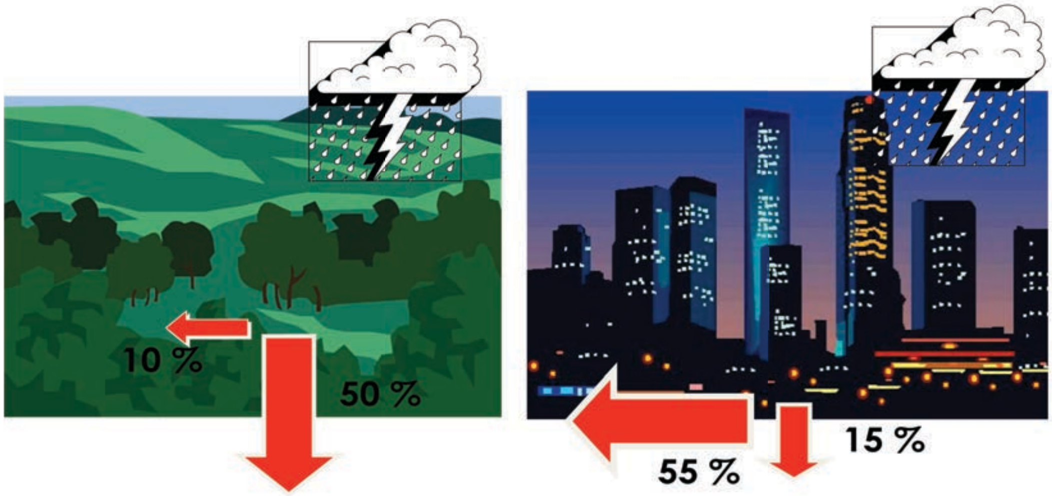


Figure 20. Runoff and Infiltration Percentages for Pre and Post Development Hydrology (NEMO)

As impervious land area increases and becomes the primary area that stormwater comes in contact with before entering streams, streams mitigate with increased flow volumes and velocities. These “flashy” systems impact water quality, as well as have affects on infrastructure and property. Increased volumes and velocities increase streambank erosion. This increased near bank stress applied to stream channels and their banks is a product of mitigating for stream flow regime and capacity. The degradation of stream channels is a reflection of the imperviousness within the watershed.

As the amount of pervious land within the watershed decreases, the ability to infiltrate rainwater is diminished, thus affecting groundwater hydrology. Surface water hydrology is also affected by the reduced infiltration resulting in less baseflow recharge from groundwater, particularly in lakes and streams. Infiltration that occurs on pervious surfaces also promotes the filtering of water, which cannot occur on impervious surfaces. Surface water hydrology is affected by reduced infiltration, resulting in less baseflow recharge for waterbodies, particularly lakes and streams. The impacts of increased surface runoff as a result of increases in imperviousness can also affect aquatic macroinvertebrates and fish habitat, subsequently affecting recreation and ultimately the water quality of drinking water. The impervious area in the Parkerson Mill Creek Watershed was estimated to be 60% of the headwaters in 2003 and has since increased throughout the watershed.

WATER QUALITY STANDARDS

The Water Quality Standards as defined by Alabama Department of Environmental Management in *Alabama Department of Environmental Management Water Division - Water Quality Program Chapter 335-6-10-.09 Water Quality Criteria – Specific Water Quality Criteria* are summarized below for the designated Fish and Wildlife Use (McIndoe, 1991). The Parkerson Mill Creek Watershed plan is tailored to water quality standards relating to the water quality indicators of interest – such as pathogens, pH, temperature, dissolved oxygen, and turbidity. According to the Fish and Wildlife designation:

- pH should not be less than 6 or exceed 8.5
- Water temperature is not to exceed 90℉ (32.2℃)
- Dissolved oxygen is to be greater than 5mg/L
- E. coli should not exceed the geometric mean of 548 colonies/100 mL or maximum of 2507 colonies/100 mL in the months of January – May and October

  - December and should not exceed the geometric mean of 126 colonies/100 mL or maximum of 487 colonies/100 mL from June – September, in any sample from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours
- Turbidity should not exceed 50 NTUs above established background turbidity

The primary goal set forth by the Parkerson Mill Creek Watershed Plan Committees is for Parkerson Mill Creek to meet these standards.

WATERSHED ASSESSMENT

The current condition of Parkerson Mill Creek must be established before developing a process to meet the water quality standard goal. Readily available and relevant water quality data were compiled and summarized in order to illustrate current conditions of Parkerson Mill Creek and its watershed. Although an abundance of data was found, it was discovered that spatial and temporal data for the watershed were limited. Due to the limited datasets, much of the results are informative on a comparative basis. It was also noted that there are significant gaps in data collected over the course of the last decade.

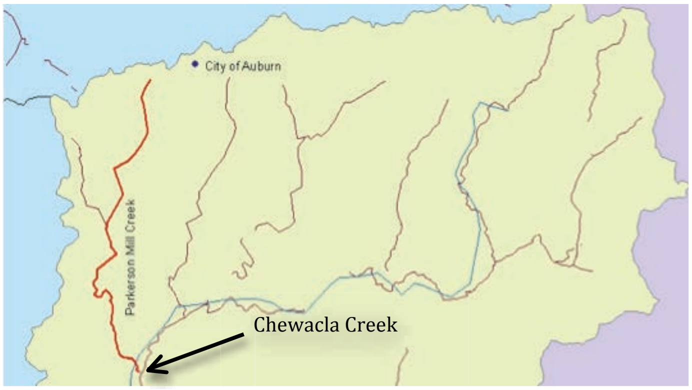


Figure 21. Confluence of Parkerson Mill and Chewacla Creeks

To gain a better perspective on the past and present water quality conditions in the Parkerson Mill Creek Watershed, efforts were made to obtain and review all available and relevant data. On April 1, 2010, the Parkerson Mill Creek Watershed Management Plan Technical Committee met to discuss the existing data collected throughout the watershed and to prioritize reaches of the stream for which more data was to be collected. It was initially decided that there were three main reaches of Parkerson Mill Creek – a reach consisting of primarily the main campus to Shug Jordan Parkway, a reach from downstream of Shug Jordan to the crossing of Parkerson Mill Creek and US Interstate 85, and a reach downstream of US Interstate 85 to Parkerson Mill Creek's confluence with Chewacla Creek

(Figure 21). Upon further review there appeared to be an abundance of data for the watershed and it was suggested further division might be necessary to prioritize the areas for which future monitoring and testing needed to occur, as well as implementation of best management practices to address the increased levels of pathogens found to be in Parkerson Mill Creek.

Due to the abundance of data, the Parkerson Mill Creek Watershed was further delineated into subwatersheds and those subwatersheds categorized into reaches of Parkerson Mill Creek and its tributaries. What was originally the first reach was further divided into three reaches the headwaters/main campus reach, the agricultural research campus reach, and the Vet School/Upper City of Auburn reach. Each of these has very different land use, which was the cause of the division. The second reach was primarily left as is but was renamed the City of Auburn N of 85 reach. The final reach defined initially was split into two reaches, dividing at the H.C. Morgan (Southside) Wastewater Treatment Plant. For each reach, water quality and reach data were summarized. Figure 22 illustrates the forty-one subwatersheds that make up the Parkerson Mill Creek Watershed. The six defined reaches of Parkerson Mill Creek, its tributaries and corresponding subwatersheds are found in Table 4.

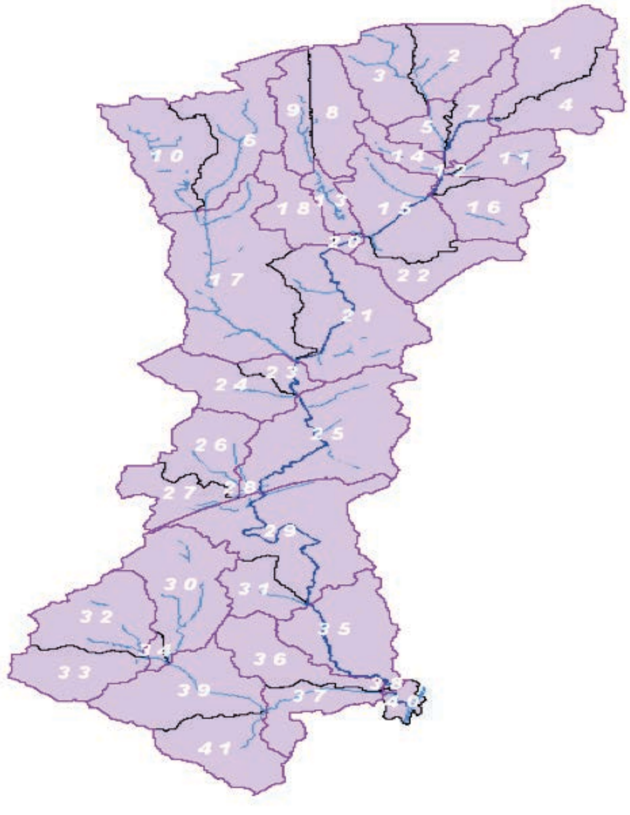


Figure 22. Parkerson Mill Creek Subwatersheds

Table 4. Reaches of Parkerson Mill Creek

Reach		Subwatersheds
1	Headwaters/Main Campus	1, 2, 3, 4, 5, 7, 11, 12, 14
2	Ag Research Campus	8, 15, 16, 22
3	Vet School, Upper City of Auburn	6, 9, 10, 13, 17, 18, 19, 20, 21
4	City of Auburn N of 85	23, 24, 25, 26, 27, 28
5	City of Auburn S of 85 to HC Morgan	29, 30, 31
6	Entering Chewacla	32, 33, 34, 35, 36, 37, 38, 39, 40, 41

PAST DATA AND DATA SUMMARY

The Parkerson Mill Creek Watershed has been studied for the past decade, with the earliest data recorded in late May of 2001 by Alabama Water Watch monitors. There are significant gaps in the data, with a concentration of studies occurring in 2003, 2007, and 2010. Six relevant studies were recorded and made available to date and are shown in Table 5. The Parkerson Mill Creek Watershed Management Plan Technical Committee recognized that the data presented would be primarily used to support projects, practices, and activities within the watershed that would aid in returning the stream to its designated fish and wildlife use. They also noted that portions of Parkerson Mill Creek would need to be prioritized for the proposed phased approach of meeting this goal. The intention was to analyze and summarize data based on stream reach to identify critical areas.

Table 5. Studies Conducted on Parkerson Mill Creek

Study Name	Parties Involved	Study Parameter	Start Date	End Date
Alabama Water Watch Bacteriological Monitoring	AWW	Bacteria	2001	Ongoing
Alabama Water Watch Water Chemistry Monitoring	AWW	Water Chemistry	2003	Ongoing
Parkerson Mill Creek Feasibility Study	Jennings, Calabria, Hunt, Clinton	Restoration Feasibility	May-03	May-03
ADEM Auburn/Opelika Surface Water Bacteria Studies – Part I	ADEM, City of Auburn	Bacteria & Water Chemistry	Feb-07	2008
ADEM Auburn/Opelika Surface Water Bacteria Studies – Part II	ADEM, City of Auburn	Bacteria & Water Chemistry	Oct-07	2008
ADEM Surface Water Study for TMDL Establishment	ADEM, City of Auburn, AU	Bacteria & Water Chemistry	Jun-10	Nov-10

WATER QUALITY STUDIES CONDUCTED ON PARKERSON MILL CREEK

Alabama Water Watch (AWW) is a citizen volunteer monitoring organization that promotes watershed stewardship. The program is coordinated through the Auburn University Department of Fisheries and Allied Aquacultures. The AWW program began in 1992 and currently has close to 260 citizen groups that have monitored 700 waterbodies at over 2,100 sites. In the Tallapoosa River Basin, AWW volunteers monitor 255 sites, 20 of which are within the Parkerson Mill Creek Watershed. Alabama Water Watch is involved in two of the six monitoring studies that have occurred within the watershed.

ALABAMA WATER WATCH BACTERIOLOGICAL MONITORING

There are thirteen sites for which Alabama Water Watch volunteers have monitored bacteria within the Parkerson Mill Creek Watershed. Five Alabama Water Watch groups have monitored bacteria on Parkerson Mill Creek since 2001 (listed in Table 6). The range in E. coli sampled per 100mL varies from 0 to 73,361 for all of the sites in the Parkerson Mill Creek Watershed, monitored by AWW.

Table 6. AWW Groups - Bacteria Sampling

Group Code	Group
07007	Environmental Awareness
07008	Ag Initiative Tallapoosa
07011	Save our Saugahatchee
07012	Chewacla Water Watch
07018	Jake and Donny Water Watch

The monitoring follows the AWW citizen bacteriological monitoring protocol, which can be found at www.aces.edu/dept/fisheries/aww/aww/monitor-resources/publications.php. The air and water temperature along with three replicates of 1 mL sample are collected at each site location. These samples are inserted in to Coliscan™ Easy Gel media and plated on Petri dishes. Once the media is gelled, the plates are incubated between 29-37℃ for 30-48 hours. The results of each sample are determined by counting E. coli colonies after 48 hours. The blue to purple colonies are E. coli – an example is show in Figure 23.

Figure 23. Coliscan™ Easy Gel, courtesy of Weber Scientific

Equation 1 is used to determine the bacterial concentration of a single sample.

$$E / V * 100 = C \qquad \text{Eqn 1.}$$

Where:

E = # E. coli/plate
V = Sample volume (mL)
C = # E. coli/100 mL

AWW collects three samples for each site. If each sample has a value greater than zero the geometric mean is used to calculate the E. coli/100 mL, as shown in Equation 2.

$$\sqrt[3]{S_1 * S_2 * S_3} \qquad \text{Eqn 2.}$$

Where:

S_1= sample 1
S_2= sample 2
S_3= sample 3

If one or more of the three samples has a zero value, the average of the three samples is used to determine E. coli/100mL.

WATER CHEMISTRY MONITORING PERFORMED BY ALABAMA WATER WATCH

Alabama Water Watch also conducts water chemistry monitoring on Parkerson Mill Creek and some of its tributaries. The AWW groups listed in Table 7 monitor seven sites for water chemistry parameters. Monitors sampled for Temperature, pH, Dissolved Oxygen (DO), Hardness, Alkalinity, and Turbidity.

Table 7. AWW Groups - Water Chemistry Sampling

Group Code	Group
07007	Environmental Awareness
07012	Chewacla Water Watch
07018	Jake and Donny Water Watch

TEMPERATURE

Temperature affects the physical and chemical properties of water. Not only does temperature affect aquatic organisms but also affects dissolved oxygen saturation or the amount of oxygen water can contain, affecting nutrient cycling. AWW measures air and water temperature using a thermometer with a centigrade scale (Alabama Water Watch, 2006)

pH

The pH of water is strongly influenced by surrounding soils and may fluctuate daily and seasonally. pH is the measure of the acidity or alkalinity of a particular solution, having a scale of 0 to 14, with 7 being neutral. The optimum range of pH for aquatic organisms is 6.5 to 9 (Alabama Water Watch, 2006). AWW measures pH using a wide range indicator and a pH scale found in the LaMotte Company water quality test kit (Alabama Water Watch, 2006).

DISSOLVED OXYGEN

Dissolved Oxygen or DO is a measure of the amount of oxygen in water (Alabama Water Watch, 2006). Oxygen can enter water when air mixes with water or through the release of oxygen in plant photosynthesis. In streams, the primary source of oxygen entering the water is when water and air mix (Alabama Water Watch, 2006). Oxygen is essential to aquatic animals and plants. A DO value of 5 ppm or higher is needed to sustain life for most aquatic organisms (Alabama Water Watch, 2006). DO decreases with increasing temperature and fluctuates seasonally. The amount of oxygen in the water can also be expressed as a percentage or the Dissolved Oxygen Saturation level, which is also recorded by AWW monitors.

HARDNESS

Hardness is the measure of the amount of dissolved calcium and magnesium. Although these characteristics are not defined as primary water quality indicators, calcium and magnesium are necessary for animal and plant life. Most fish and aquatic organisms live in water with hardness levels between 15 and 500 mg/L and levels outside of this range may limit reproduction of these animals (Alabama Water Watch, 2006).

ALKALINITY

Alkalinity is a measure of the buffering capacity of water or the waters ability to "buffer" against pH changes (Alabama Water Watch, 2006). Alkalinity is often referred to as a stabilizer or indicator of waterbody stability. Alkalinity in unpolluted waters of Alabama is often similar to hardness levels (Alabama Water Watch, 2006). Knowledge of alkalinity levels may indicate how a waterbody will be able to respond to a point source discharge.

TURBIDITY

Turbidity is the measure of water cloudiness caused by suspended matter (Alabama Water Watch, 2006). Turbidity can be a reflection of suspended sediment or plant matter. Turbidity is measured in Jackson Turbidity Units (JTUs) as done by AWW or in Nephelometric Turbidity Units (NTUs) as required by the Water Quality Standard set forth by ADEM. Turbidity can be an indication of soil erosion. High turbidity levels limit sunlight penetration disrupting aquatic ecosystems and inhibiting plant growth (Alabama Water Watch, 2006).

PARKERSON MILL CREEK RESTORATION FEASIBILITY STUDY

In 2003, Jennings, Calabria, Hunt, and Clinton conducted the *Parkerson Mill Creek Restoration Feasibility Study* in response to a request by Auburn University to examine the potential restoration of the creek and its tributaries located on the main campus. The study focused on the upmost 12,000 linear feet of perennial stream covering two square miles of the watershed. The feasibility study divides this portion of the creek into twelve stream reaches (A, B, C, D, E, F, H, I, K, P, Q, R). Figure 24 depicts the *Parkerson Mill Creek Restoration Feasibility Study* boundary. Stream morphology, streambank stability, riparian condition, and stormwater management were all assessed in this study as part of the existing conditions of Parkerson Mill Creek.

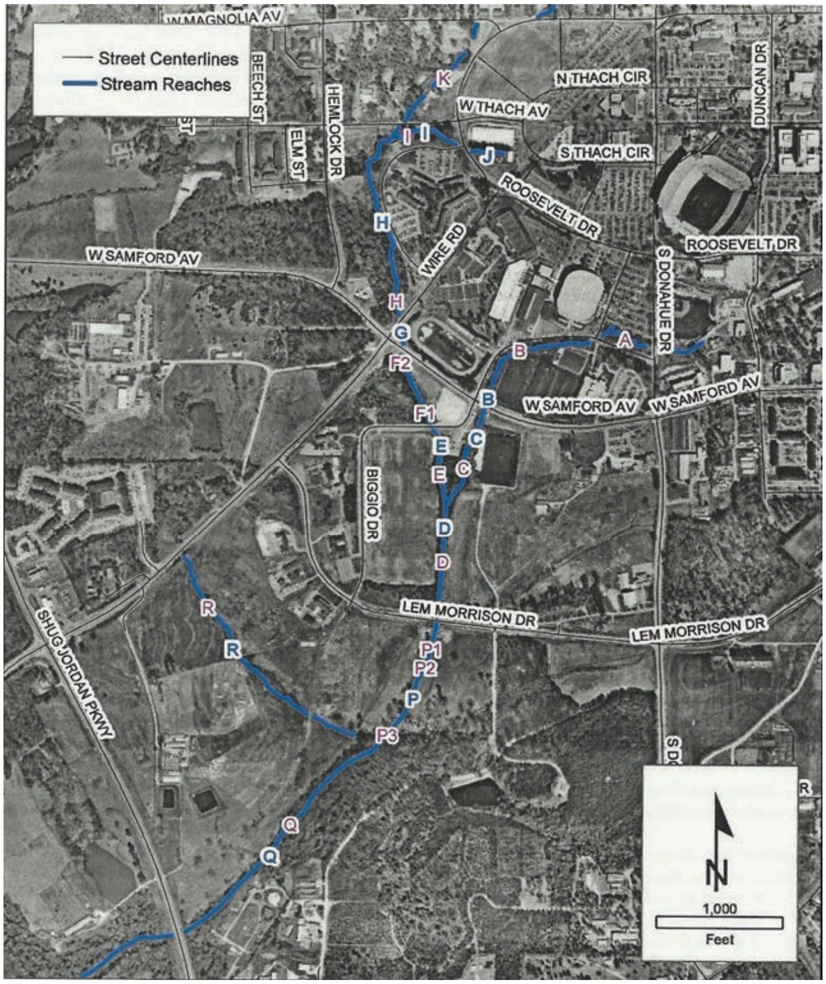


Figure 24. Boundary of *Parkerson Mill Creek Restoration Feasibility Study*, Copied from *Parkerson Mill Creek Restoration Feasibility Study* (Figure 1.1)

AUBURN/OPELIKA SURFACE WATER BACTERIA STUDIES (BACTERIA BLITZ)

In 2007, the Alabama Department of Environmental Management conducted an intensive monitoring study of streams in the Auburn/Opelika area. The focus of the study was to examine indicator bacteria, fecal coliform, at locations on Saugahatchee and Parkerson Mill Creeks that had elevated levels of bacteria in past sampling events. The Alabama Water

Watch Save Our Saugahatchee (SOS) Watershed group performed the past sampling using Alabama Water Watch volunteer sampling methods.

ADEM conducted weekly sampling from January 16, 2007 to February 15, 2007. A total of fifteen sites were identified for sampling, three of which are located on Parkerson Mill Creek. This study is what prompted the listing of Parkerson Mill Creek on the State's 303(d) List of Impaired Waters.

As a follow up to this study, a second study was proposed and was conducted by ADEM. The second study consisted of 19 stations. Bacteria samples were collected weekly for five weeks, in addition to other water quality data. The sampling locations within the vicinity of the Parkerson Mill Creek Watershed included four stations, consisting of the three previous stations, and an additional station located on Chewacla Creek. This study concluded that elevated levels of fecal coliform coincide with rainfall, typically in the fall and winter months.

ADEM SURFACE WATER STUDY FOR TMDL ESTABLISHMENT

A draft TMDL is to be established for the Parkerson Mill Creek Watershed in 2012. A TMDL is the maximum amount of pollutant that a water body can assimilate and safely meet water quality standards for the pollutant of concern (USEPA, 2010). The Pathogen TMDL for Parkerson Mill Creek will determine a wasteload allocation (WLA) for all National Pollutant Discharge Elimination System (NPDES) regulated discharges, a load allocation (LA) for all nonpoint sources, and an explicit and/or implicit margin of safety (MOS).

Four sampling locations were to be monitored monthly by ADEM beginning in April 2010 and continuing through November 2010. In addition to this monthly monitoring, an intensive bacteria study was conducted weekly in June of 2010 and again in August 2010. The data collected in this study will aid in the determination of the TMDL. The Alabama Department of Environmental Management, the City of Auburn Water Resources Management, and the Office of Risk Management at Auburn University executed this sampling in a side-by-side monitoring regime.

Each of these six studies has been beneficial in establishing the water quality conditions of Parkerson Mill Creek and its tributaries. The data for each of these studies is summarized for each of the six reaches defined in the watershed.

PAST STUDIES SUMMARIZED BY REACH

REACH 1

REACH 1 - ALABAMA WATER WATCH BACTERIOLOGICAL MONITORING

Reach 1 is the headwaters of Parkerson Mill Creek, which includes the main campus of Auburn University. Subwatersheds 1-5, 7, 11, 12, and 14 make up Reach 1. Many of the tributaries in Reach 1 are intermittent or only flow during certain parts of the year. The majority of sites sampled on Parkerson Mill Creek are in Reach 1 and Reach 6.

Alabama Water Watch has monitored sixty-three times within Reach 1 from 2007 to 2010. The AWW bacteria monitoring sites, six total for Reach 1, are shown in Figure 25.

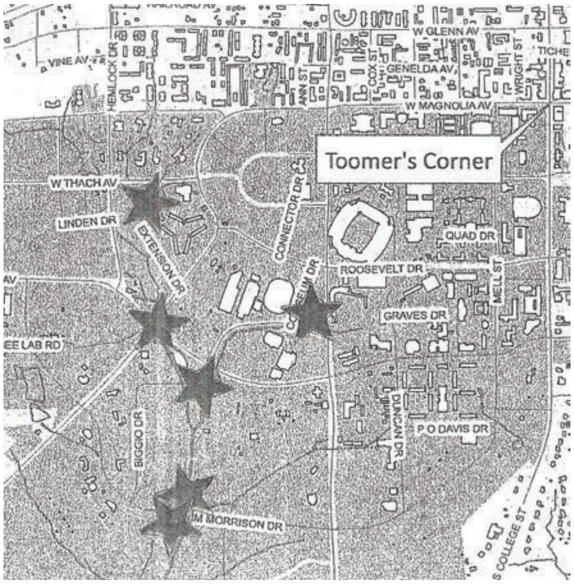


Figure 25. Alabama Water Watch Bacteria Monitoring Sites within Reach 1

Figure 26 illustrates all of the E. coli/100 mL results for each of the sixty-three sampling times. There were four samples greater than 1000 E. coli/100 mL. By removing those data points the distribution of E. coli/100 mL is better illustrated in Figure 27.

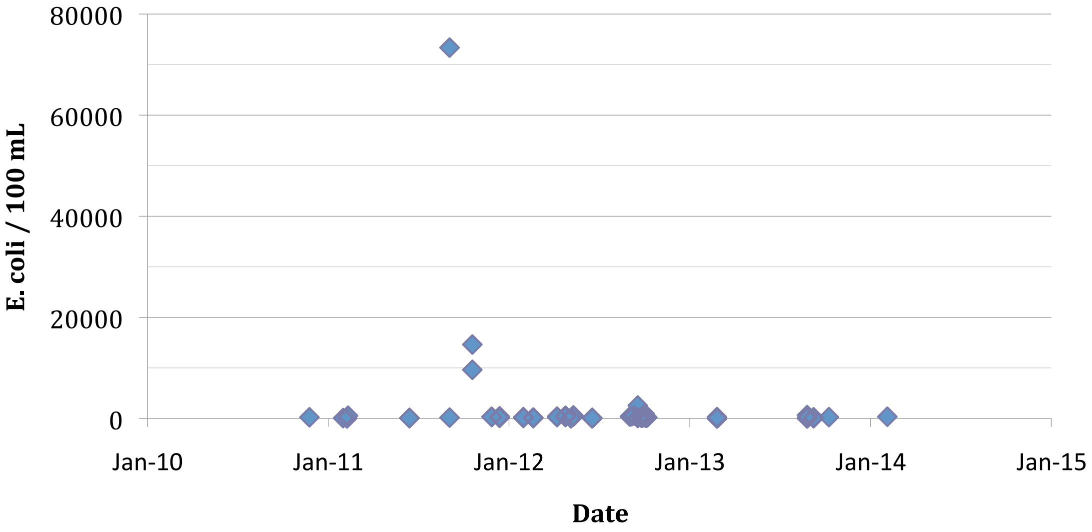


Figure 26. E. coli/100 mL for AWW Bacteriological Monitoring Sites in Reach 1

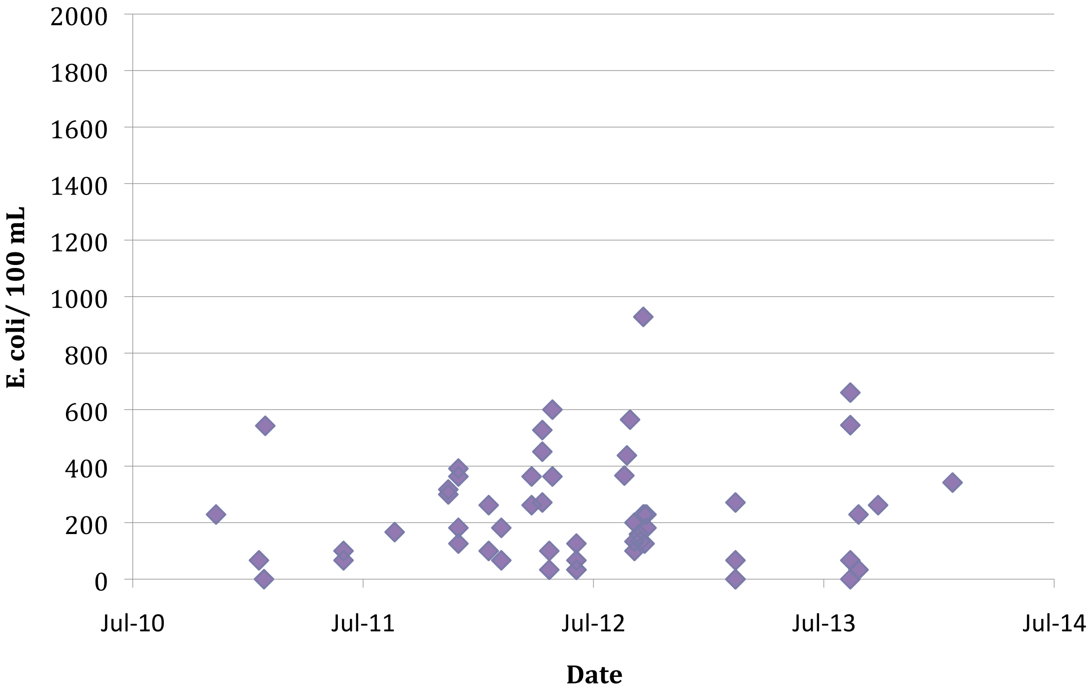


Figure 27. E. coli/100 mL for AWW Bacteriological Monitoring Sites with Counts of 0 to 1000 in Reach 1

The E. coli/100 mL values are highest in 2008. Some of the highest counts for Reach 1 are found in proximity to the Lem Morrison Bridge, as shown in Figure 28.

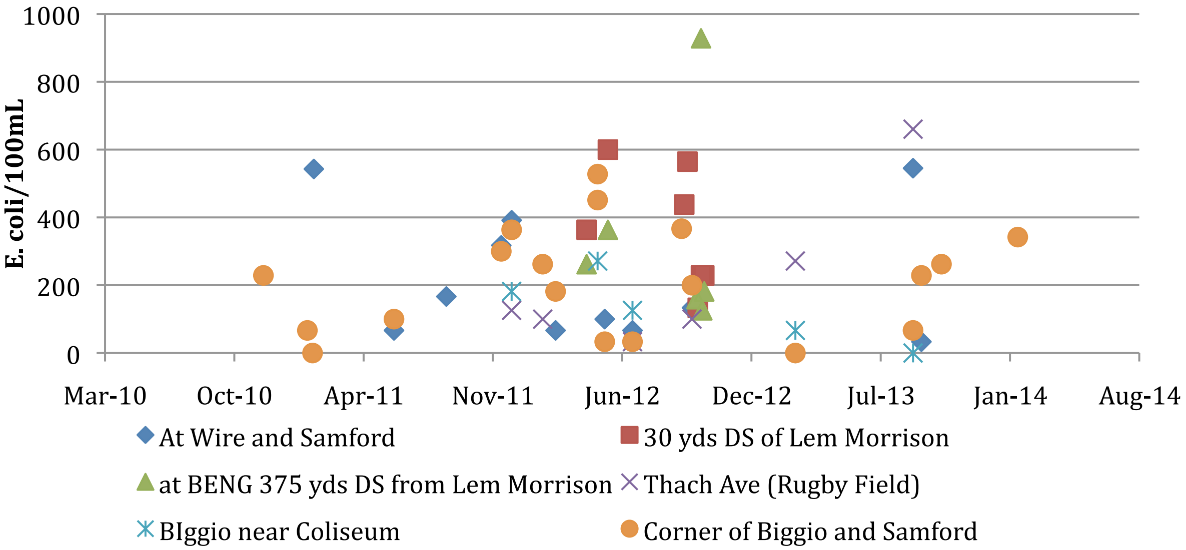


Figure 28. E. coli/100 mL for AWW Bacteriological Monitoring Sites by Location in Reach 1

Bacteriological sites monitored by AWW monitors exceeded the E. coli colonies per 100 mL 32% of the time for Parkerson Mill Creek. Figure 29 depicts the number of exceedances for samples during this monitoring period.

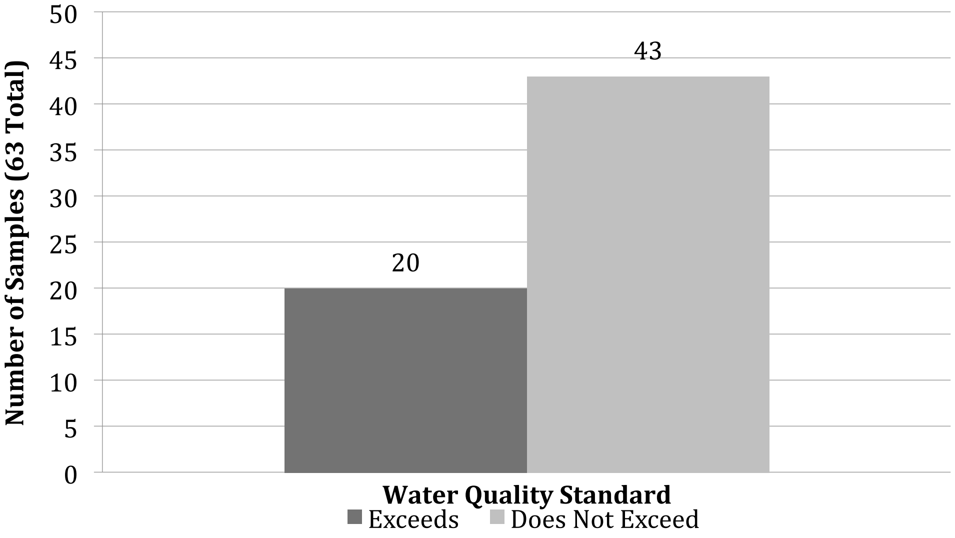


Figure 29. Exceedances in the Water Quality Standard for AWW Bacteriological Monitoring in Reach 1

REACH 1 – ALABAMA WATER WATCH CHEMISTRY MONITORING

AWW sampled for water chemistry 70 different times at two sites within Reach 1 from 2003 to 2010. The two sites documented are the bridge crossing on Lem Morrison Drive and the corner of Biggio and Samford Avenue. At each location the parameters collected are temperature, pH, dissolved oxygen and dissolved oxygen saturation, total alkalinity and total hardness.

Water temperature ranges from 6℃ to 29℃ and air temperature from 4℃ to 41℃. The temperatures recorded are shown in Figure 30. According to the Water Quality Standards (water temperature <32.2℃) Parkerson Mill Creek meets the water quality standard for Fish and Wildlife Use in terms of temperature within Reach 1.

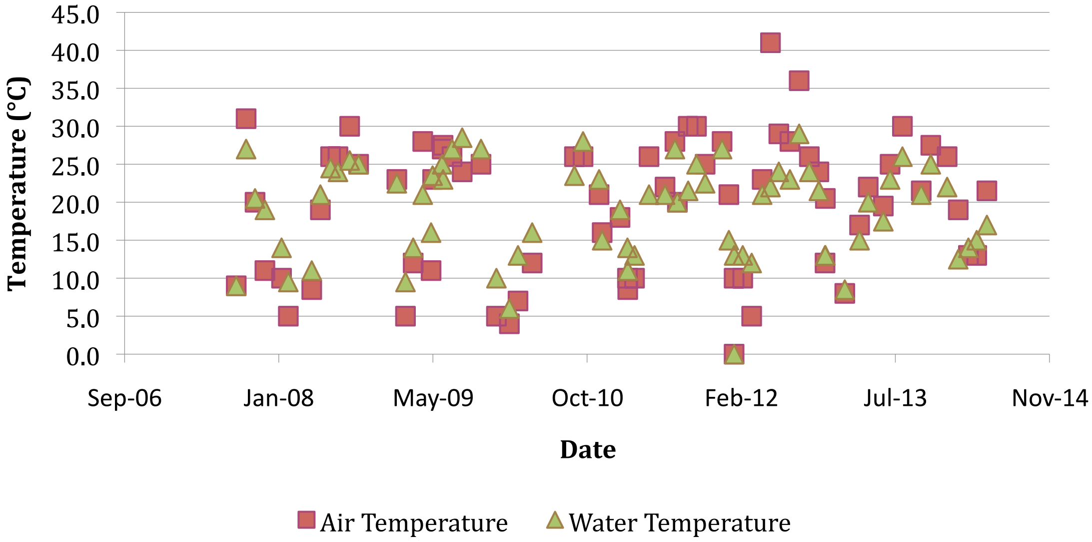


Figure 30. AWW Temperature Data for Reach 1

AWW also tests for pH. The pH in Reach 1 ranges from 7-9 and is pictured in Figure 31. All of the AWW pH measurements meet the water quality standard.

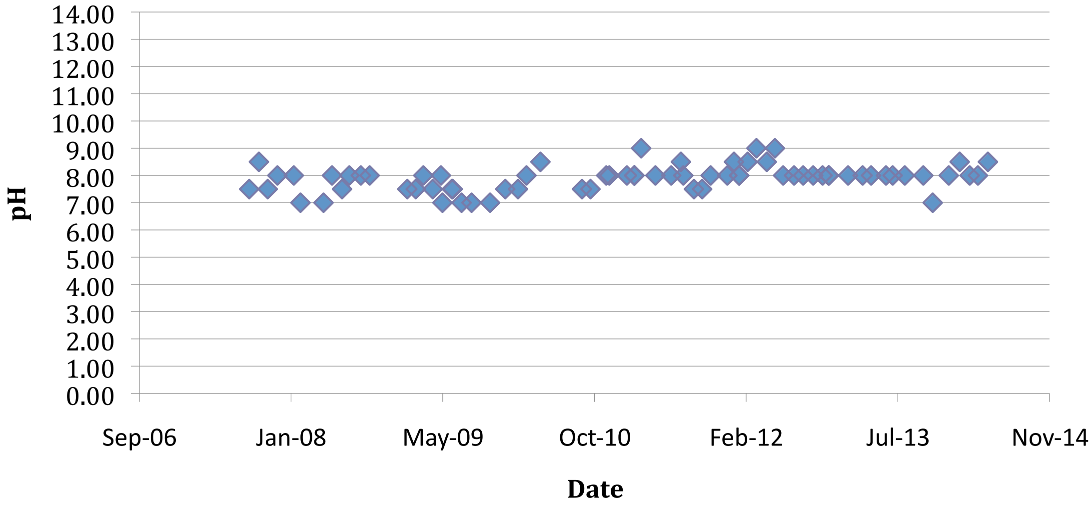


Figure 31. AWW pH Data for Reach 1

Dissolved Oxygen (DO) is important for the respiration of aquatic organisms. In Reach 1, DO ranges from 3.9 to 19.2 ppm with saturation percentages from 40%-100%. Only two samples are lower than the standard of 5 ppm. These samples (3.8 and 4.8) occur in September and October of 2007 and may have been affected by the reduced rainfall experienced that year. Figure 32 illustrates dissolved oxygen data for Reach 1.

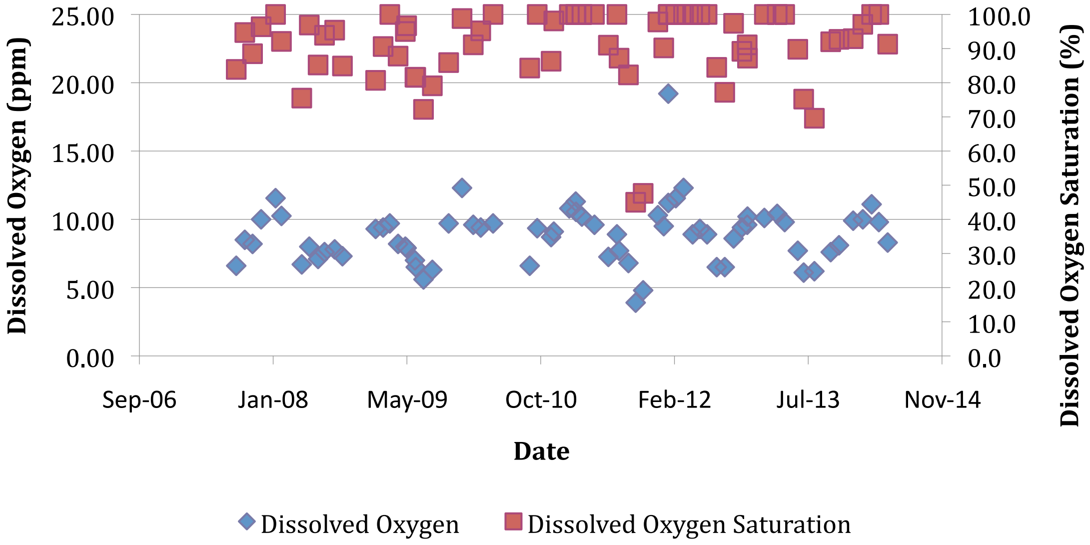


Figure 32. AWW Dissolved Oxygen Data for Reach 1

Total alkalinity, total hardness and turbidity were also measured for Reach 1 and are illustrated in Figures 33 and 34.

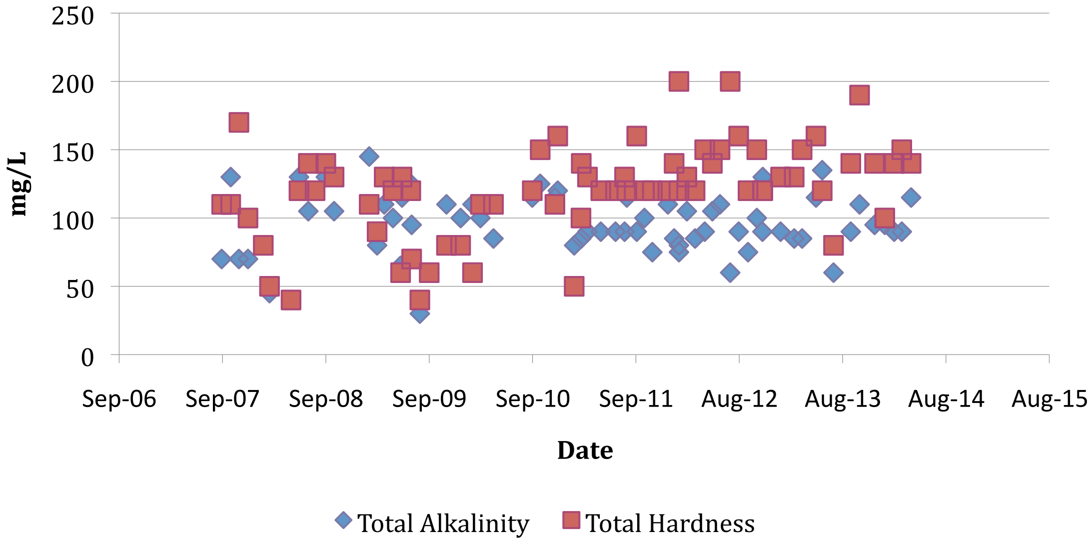


Figure 33. AWW Total Hardness and Total Alkalinity Data for Reach 1

Hardness levels according to the Water Quality Standard for Fish and Wildlife Use are defined as 15-500 mg/L. All hardness and alkalinity measurements fall within this accepted range.

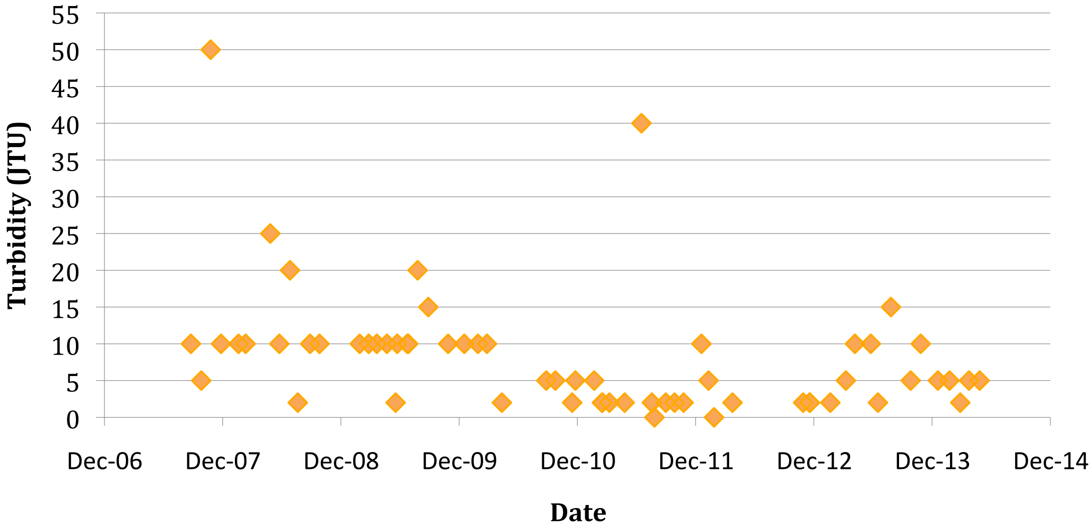


Figure 34. AWW Turbidity Data for Reach 1

Turbidity measurements are all relatively low for Reach 1. The Water Quality Standard states that turbidity measurements should not exceed 50 NTUs in comparison with background. The units for the turbidity data collected by AWW are measured in JTUs and no background data was collected. There is not a direct correlation between JTUs and NTUs.

REACH 1 – PARKERSON MILL CREEK RESTORATION FEASIBILITY STUDY

The second study examined for Reach 1 is the *Parkerson Mill Creek Restoration Feasibility Study* conducted by Jennings, et al. in 2003. Jennings, et al. evaluated stream reaches for their restoration potential by looking at stream channel morphology, and made cost-based recommendations on restoration strategies, riparian buffer enhancement, and stormwater management. Table 8 represents a prioritized list of potential restoration locations based on estimated cost of restoration for study reaches in Reach 1.

Table 8. Prioritized Study Reaches of Reach 1 based on Cost from *Parkerson Mill Creek Restoration Feasibility Study*, 2003

Study Reach	Stream Restoration Estimated Cost	Stormwater Management Estimated Cost	Total Estimated Cost
K	-	-	$-
F	$187.72	$14,000.00	$14,187.72
I	$48,935.00	$40,000.00	$88,935.00
A	$92,224.00	$2,000.00	$94,224.00
H	$99,200.00	-	$99,200.00
E	$186,987.00	$16,000.00	$202,987.00
C	$208,246.00	$15,000.00	$223,246.00
D	$268,816.00	-	$268,816.00
B	$377,093.00	$88,000.00	$465,093.00

In Jennings's study, Reach B is the section of PMC just upstream of Samford Avenue. This portion of stream is highly susceptible to degradation due to the density of development in this area of Auburn University's campus. For this reason, Reach B had the highest estimated restoration and stormwater management costs. As the study moved from the more urbanized areas, the costs for restoration and stormwater practices were reduced.

In addition to pathogens, sediment is a stakeholder concern for Parkerson Mill Creek. It is known that pathogens can bind to sediment and the sediment loading for Parkerson Mill Creek is important in understanding the sources of pathogens. *The Parkerson Mill Creek Restoration Feasibility Study* indicated incision and eroding of the Parkerson Mill Creek stream channel as a source of sedimentation. The incised channels were also listed as an indication of streambank instability. The study evaluated streambank stability using the Bank Erosion Hazard Index (BEHI). BEHI results for Reach 1 range from 25-44 or Moderate to Very High

Bank Erosion Hazard Index

The Bank Erosion Hazard Index or BEHI is one of two bank erodibility estimation tools published by Rosgen in 2001 (Rosgen, 2001a) to estimate annual sediment loads from streambank erosion.

The BEHI assessment tool can be used to determine the erosion potential of a streambank

The assessment assigns points to variables that affect the rate of streambank erosion.

The higher the BEHI index (summation of points) is, the greater potential for erosion.

risk ratings, as shown in Table 9. Study Reaches A – C are located on the mainstem of Parkerson Mill Creek, E –K on an unnamed tributary, and D is located just downstream of the confluence. The BEHI indicates the main stem has a much greater potential for erosion and sedimentation.

Table 9. Bank Erosion Hazard Index for Reach 1 (Study Reaches A-K)

Reach	Bank Height Ratio	Root Depth Ratio	Root Density	Bank Angle	Surf Protection	Adjustment for Soil	BEHI Index	Category
A	7	8	8	6	8	5	42	Very High
B	8	7	8	7	4	7	41	Very High
C	8	8	8	6	6	6	42	Very High
D	7	5	5	6	5	6	34	High
E	8	7	8	6	6	6	41	Very High
F1	7	8	8	8	7	6	44	Very High
F2	6	6	6	7	5	6	36	High
H	3	3	4	3	5	7	25	Moderate
I	6	6	6	5	7	7	37	High
K	3	4	6	6	5	5	29	Moderate

Results from a North Carolina study conducted in 1999 by Patterson et al, measured erosion rates of one ft/yr for the Moderate BEHI category and High to Very High BEHI categories with erosion rates ranging from 1 ft/yr to greater than 10 ft/yr. Applying the results of this study to Parkerson Mill Creek, a moderate rate of 2-ft/yr with approximately 16,000 linear feet of stream in Reach 1 at an average height of six feet, it can be estimated that approximately 192,000 ft3/yr or 4800 tons/yr of sediment erodes from Reach 1.

REACH 1 - ADEM AUBURN/OPELIKA SURFACE WATER BACTERIA STUDIES

The Auburn/Opelika Surface Water Bacteria Study that was began in February 2003 was one of two studies responsible for determining the bacteria problem within the Parkerson Mill Creek Watershed. The initial study, performed by ADEM, included fifteen sampling locations in the Auburn Opelika area, with three on Parkerson Mill Creek, and one in Reach 1. PKML-3, located at the West Samford Avenue crossing of Parkerson Mill Creek (at Lat. 32.59890 and Long. -85.49683), was one of the sites included in this study. In Table 10, Weeks 1 - 3 showed exceedances in the water quality standard for fecal coliform (greater than 200 colonies/100 mL).

Table 10. PKML-3 Data Collected by ADEM in Auburn/Opelika Surface Water Bacteria Studies

	Week 1 (1/18/2007)	Week 2 (1/25/2007)	Week 3 (2/1/2007)	Week 4 (2/8/2007)	Week 5 (2/15/2007)
PKML-3	400	330	5000	190	170

In the follow up study conducted in October of 2003, an additional sampling location PKML-4, was included. PKML-4 is located downstream of the crossing of Lem Morrison Drive and Parkerson Mill Creek. For these locations, the sample on September 17, 2007 at PKML-3 exceeded the single sample limit for fecal coliform. In addition, the geometric mean exceeded the water quality criterion at both sites for all samples except the October 18, 2007 sample at PKML-4. The sampling results from this study are shown in Figure 35. Figure 35 is copied from the study report.

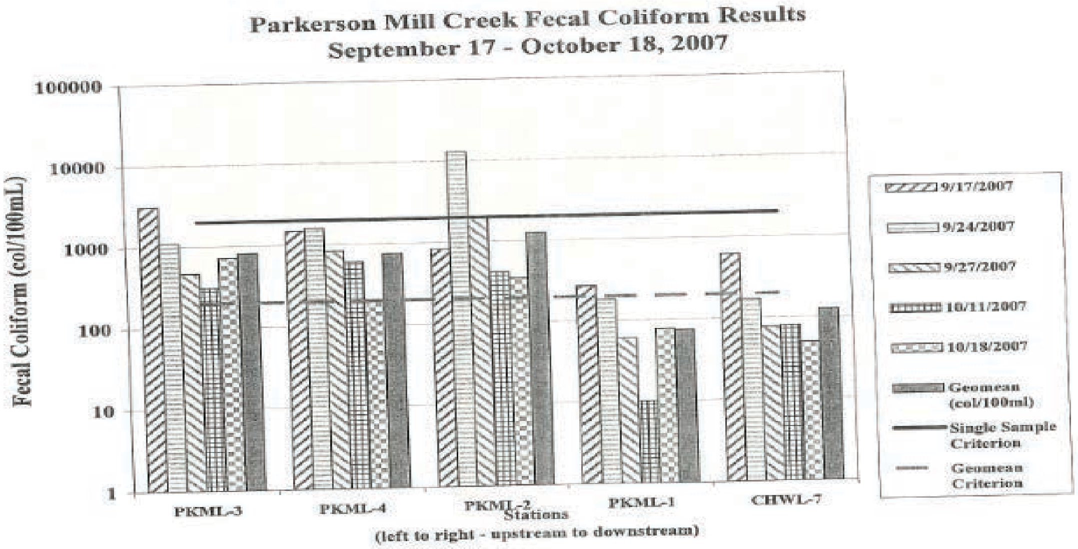


Figure 35. Copied from ADEM *Auburn/Opelika Surface Water Bacteria Studies 2007-2008* (Figure 11).

As a part of the Auburn/Opelika Surface Water Bacteria Studies, on September 5, 2007 the City of Auburn sampled where Parkerson Mill Creek crosses Donahue Drive, Wire Road, and Thatch Avenue for fecal coliform. All of the samples exceeded the 200 colonies /100 mL for fecal coliform. The results can be found in Table 11.

Table 11. Fecal coliform per 100mL for City of Auburn Sampling Sites Donahue Drive, Wire Road and Thatch Avenue in 2007

	Sample 1	Sample 2
Donahue Drive	320	272
Wire Road	930	692
Thatch Avenue	840	784

REACH 1 – ADEM SURFACE WATER STUDY FOR TMDL ESTABLISHMENT

Three sampling sites, LEM, PKML-W and PKML-E were sampled by the City of Auburn and Auburn University in the TMDL sampling of 2010 within Reach 1. LEM is located at the downstream bridge crossing of Lem Morrison Drive. The data for the LEM site is not currently available because of ongoing monitoring. PKML-W is located on the primary unnamed tributary within Reach 1 and PKML-E is located on the mainstem of PMC, just above the confluence south of Samford Avenue and north of Lem Morrison Drive. Auburn University's numbers for fecal coliform for sites PKML–W and PKML-E for the first part of this study can be found in Table 12. All but one of the samples collected on both PKML-W and PKML-E for fecal coliform in this study were found to be higher than the water quality standard.

Table 12. Fecal coliform per 100mL for sites PKML-W and PKML-E for ADEM Surface Water Study for TMDL Establishment

	7-Apr	6-May	8-Jun	14-Jun	21-Jun
PKML-W	162	230	81	2100	636
PKML-E	390	1091	2800	1636	636

For E. Coli samples at sites PKML-W and PKML-E the following data were collected. Two of the samples collected, both on June 14, 2010 exceed the E. Coli single sample criterion.

Table 13. E.Coli per 100mL for sites PKML-W and PKML-E for ADEM Surface Water Study for TMDL Establishment

	7-Apr	6-May	8-Jun	14-Jun	21-Jun
PKML-W	144	180	72	1636	200
PKML-E	340	727	455	1000	100

REACH 2

Reach 2 is made up of subwatersheds 8, 14, 15, and 22. These subwatersheds are primarily used for Auburn University Research. This portion of the watershed contains much of the remaining forests and land used for agriculture.

REACH 2 - ALABAMA WATER WATCH BACTERIOLOGICAL MONITORING

Reach 2 is the second most monitored reach in terms of quantity with 39 bacteriological monitoring events in two locations, both in the proximity of Shug Jordan Parkway. Figure 36 illustrates a distribution of bacteria samples for Reach 2. To better elucidate the distribution, only two points exceeded 5000 and were removed. The results of this distribution are shown in Figure 37.

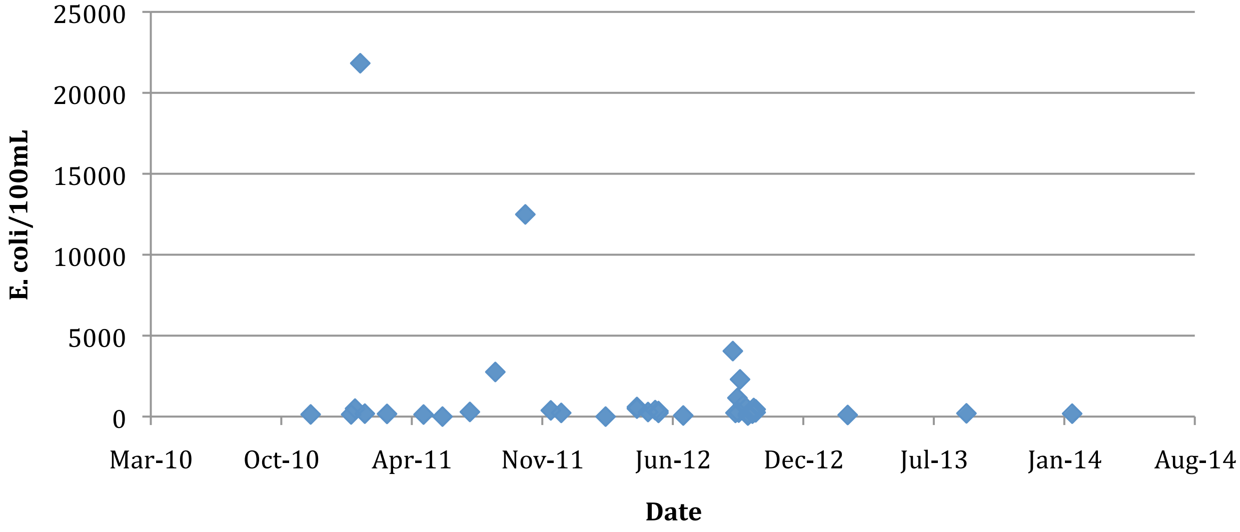


Figure 36. E. coli/100mL for AWW Bacteriological Monitoring Sites within Reach 2

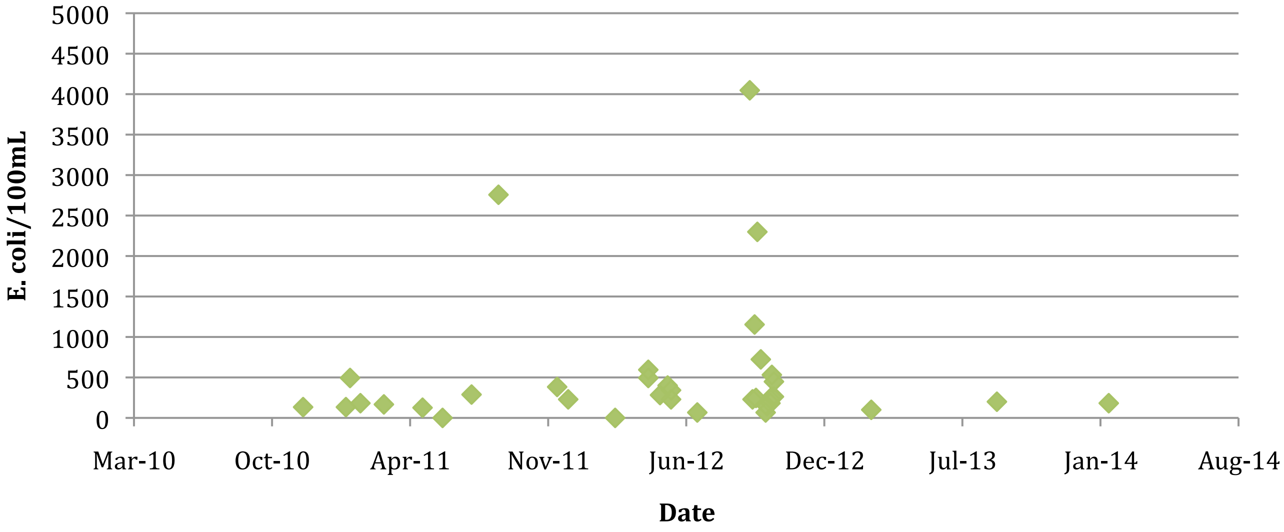


Figure 37. E. coli/100mL with Counts less than 5000for AWW Bacteriological Monitoring Sites within Reach 2

Of the 39 events, 14 of the events exceeded the water quality standard, while 25 samples met the water quality standard, as shown in Figure 38.

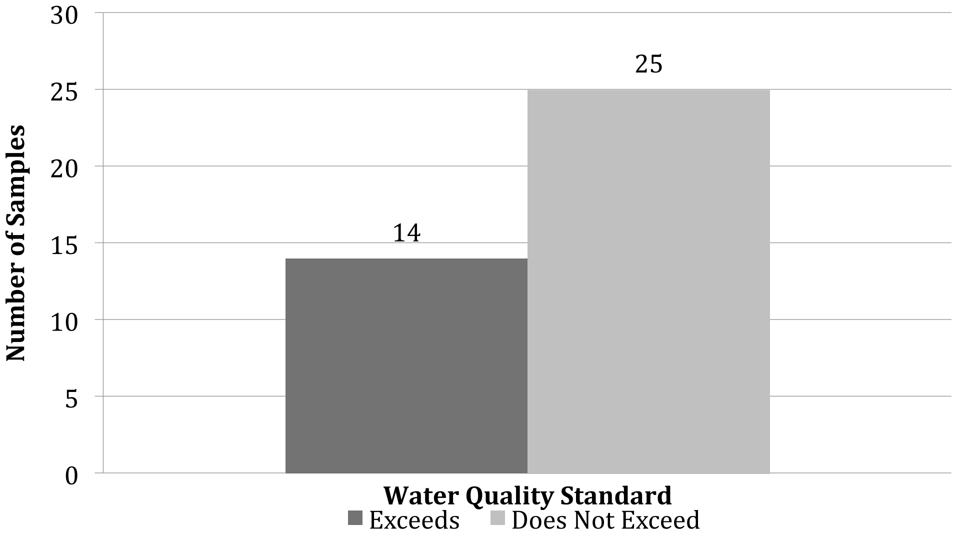


Figure 38. Exceedances in the Water Quality Standard for AWW Bacteriological Monitoring Sites in Reach 2

Figures 39 and 40 show a distribution of bacterial monitoring data for the two locations. Figure 40 is for counts less than 2000 colonies/100 mL.

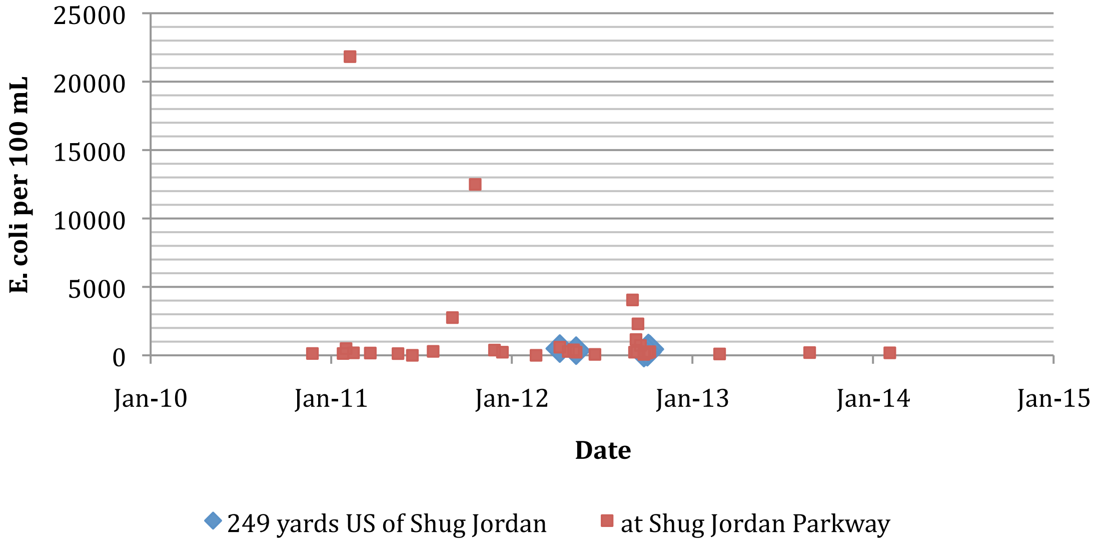


Figure 39. E. coli/100mL for Two Locations within Reach 2

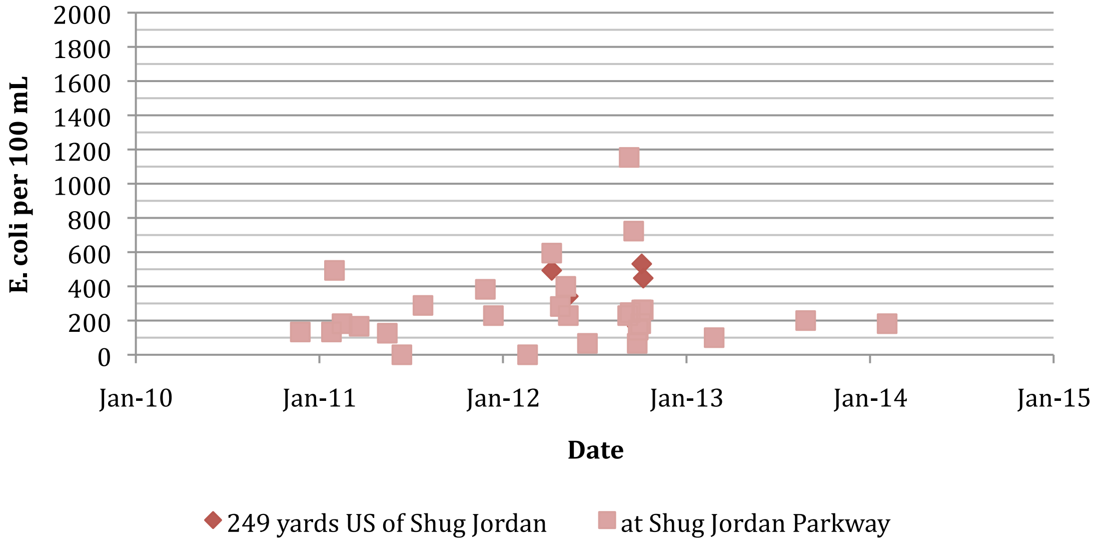


Figure 40. E. coli/100mL with Counts less than 2000 for Two Locations within Reach 2

REACH 2 – ALABAMA WATER WATCH CHEMISTRY MONITORING

AWW sampled for water chemistry at Shug Jordan Parkway 57 times from 2003 to 2010. The water and air temperature at the Shug Jordan location ranged from 3 ℃ to 27 ℃ and are shown in Figure 41. The water temperature measurements within Reach 2 all met the Water Quality Standard for Fish and Wildlife.

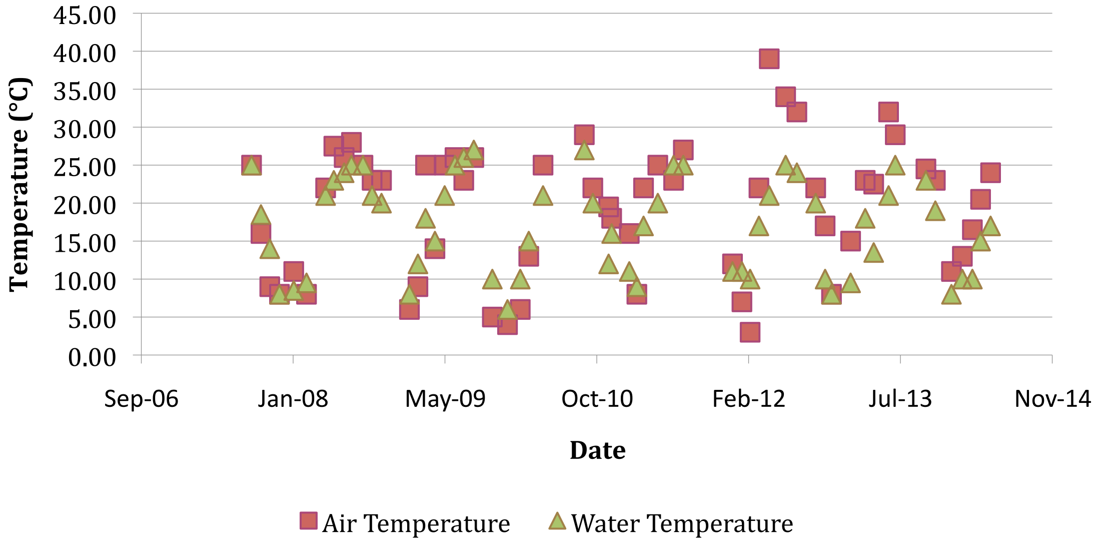


Figure 41. AWW Temperature Data for Reach 2

The pH for Parkerson Mill Creek at Reach 2 remained within 7 to 8.5, which is acceptable for aquatic life and the water quality standard. pH for Reach 2 is shown in Figure 42.

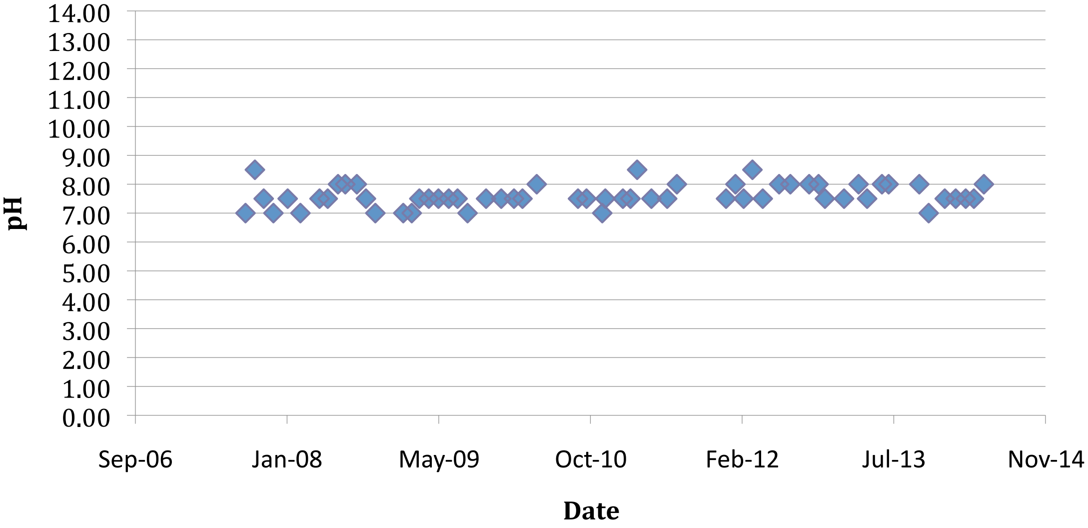


Figure 42. AWW pH Data for Reach 2

Another water chemistry characteristic that is essential to aquatic life is dissolved oxygen (DO). DO ranged from 6 to 16 ppm with saturations between 70-100% for Reach 2, which meets the Water Quality Standard for Fish and Wildlife. A graph of DO is shown in Figure 43.

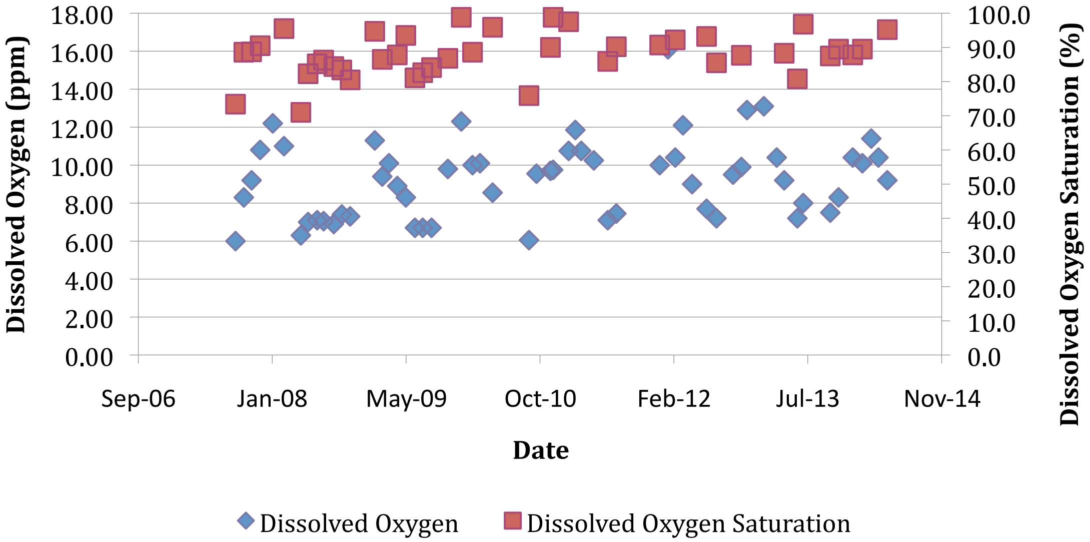


Figure 43. AWW Dissolved Oxygen Data for Reach 2

In addition to these parameters, monitors also sampled for total alkalinity and total hardness with mg/L ranging from 50 to 130 and 40 to 140, respectively (Figure 44). An acceptable range for these parameters according to the Water Quality Standard is 15-500 mg/L, therefore all samples fell within an acceptable range.

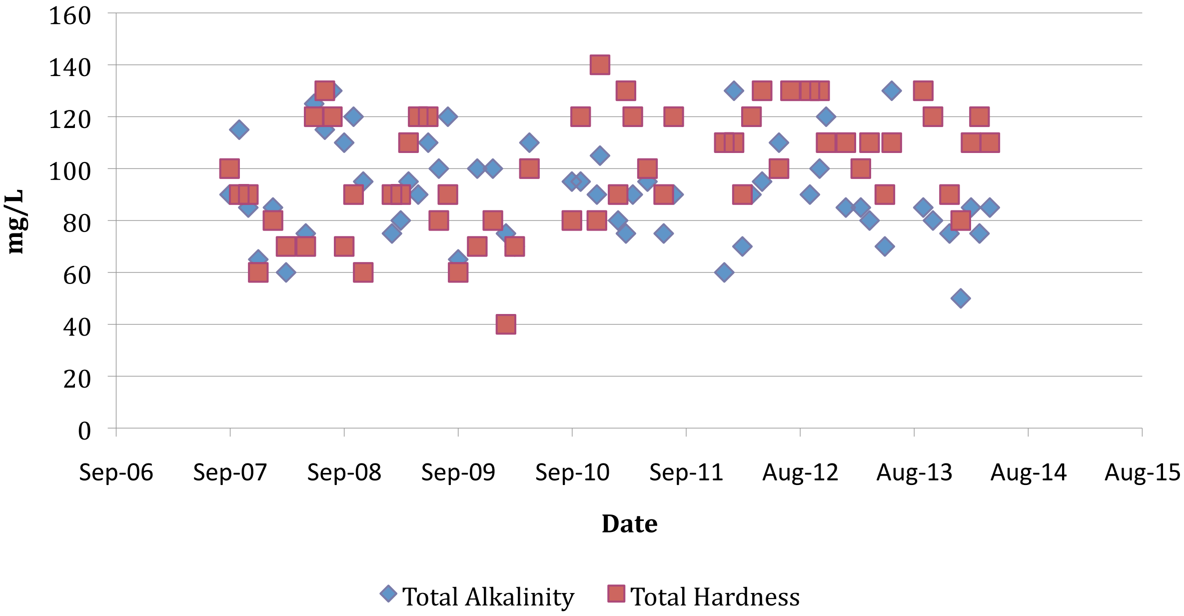


Figure 44. AWW Total Hardness and Total Alkalinity Data for Reach 2

Turbidity measurements for Reach 2 range from 2.5 to 45 JTUs and are illustrated in Figure 45. According to the AWW data available it seems that turbidity in Reach 2 has decreased over time.

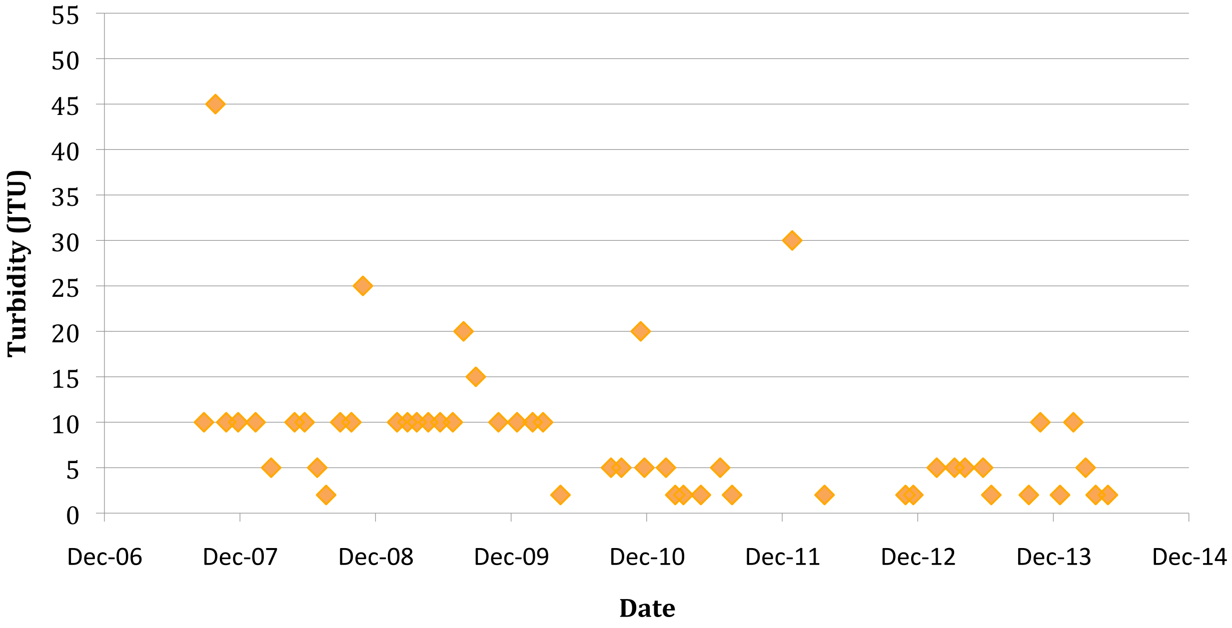


Figure 45. AWW Turbidity Data for Reach 2

REACH 2 – PARKERSON MILL CREEK RESTORATION FEASIBILITY STUDY

Stream morphology, streambank stability, riparian condition, and stormwater management were all assessed as part of the existing conditions of Parkerson Mill Creek in the 2003 *Parkerson Mill Creek Restoration Feasibility Study* conducted by Jennings, et al. The study made cost-based recommendations for reach restoration on Parkerson Mill Creek. Table 14 represents a prioritized list of restoration based on estimated cost of restoration for study reaches in Reach 2.

Table 14. Prioritized Study Reaches within Reach 2 based on Cost from *Parkerson Mill Creek Restoration Feasibility Study*, 2003

Study Reach	Stream Restoration Estimated Cost	Stormwater Management Estimated Cost	Total Estimated Cost
Q	-	-	$-
R	$29,040.00	-	$29,040.00
P	$215,884.00	-	$215,884.00

The *Parkerson Mill Creek Restoration Feasibility Study* indicated incision and eroding of the Parkerson Mill Creek stream channel. The study shows that as a result of the erosion and incision, streambank stability was of concern. The study evaluated streambank stability using the Bank Erosion Hazard Index (BEHI).

BEHI results ranged from 27-35 or Moderate to High risk ratings for Reach 2, as shown in Table 15.

Table 15. Bank Erosion Hazard Index for Reach 2 (Study Reaches P, Q, and R)

Reach	Bank Height Ratio	Root Depth Ratio	Root Density	Bank Angle	Surf Protection	Adjustment for Soil	BEHI Index	Category
P1	5	3	5	5	4	8	30	High
P2	6	5	5	6	5	8	35	High
P3	6	5	5	6	5	8	35	High
Q	5	5	4	4	5	5	28	Moderate
R	3	4	4	5	5	6	27	Moderate

Study reach P, located just below the Lem Morrison Bridge has the highest risk of erosion and is the priority study reach for restoration within Reach 2. Although, the study reaches in Reach 2 are at risk, the potential for erosion in Reach 2 is less than what was found in Reach 1.

REACH 2 - ADEM AUBURN/OPELIKA SURFACE WATER BACTERIA STUDIES

In 2007, the Alabama Department of Environmental Management conducted a study of streams in the Auburn/Opelika area. The focus of the study was to examine indicator bacteria, fecal coliform, at locations on Saugahatchee and Parkerson Mill Creeks that had elevated levels in past sampling. The Save Our Saugahatchee (SOS) Watershed group (with AWW) performed past sampling.

ADEM conducted weekly sampling from January 16, 2007 to February 15, 2007. A total of 16 sites were identified, three of which are located on Parkerson Mill Creek. This study is what prompted the listing of Parkerson Mill Creek on the State's 303(d) list. PKML-2 was included in this study. PKML-2 is located just downstream of the bridge at Shug Jordan Parkway. Each of the samples in this study exceeded the water quality standard. The results of this study for PKML-2 are show in Table 16.

Table 16. PKML-2 Data collected by ADEM in Auburn/Opelika Surface Water Bacteria Studies

	Week 1 (1/18/2007)	Week 2 (1/25/2007)	Week 3 (2/1/2007)	Week 4 (2/8/2007)	Week 5 (2/15/2007)
PKML-2	330	670	3400	6700	480

As a follow up to the ADEM study completed in February, a second was proposed and conducted. The second study consisted of 19 stations. Bacterial samples were collected weekly for five weeks, in addition to other water quality data. The sampling locations within the vicinity of the Parkerson Mill Creek Watershed included four stations, three previously used including a station located on Chewacla Creek and an additional station. This study concluded that elevated levels of fecal coliform coincide with rainfall.

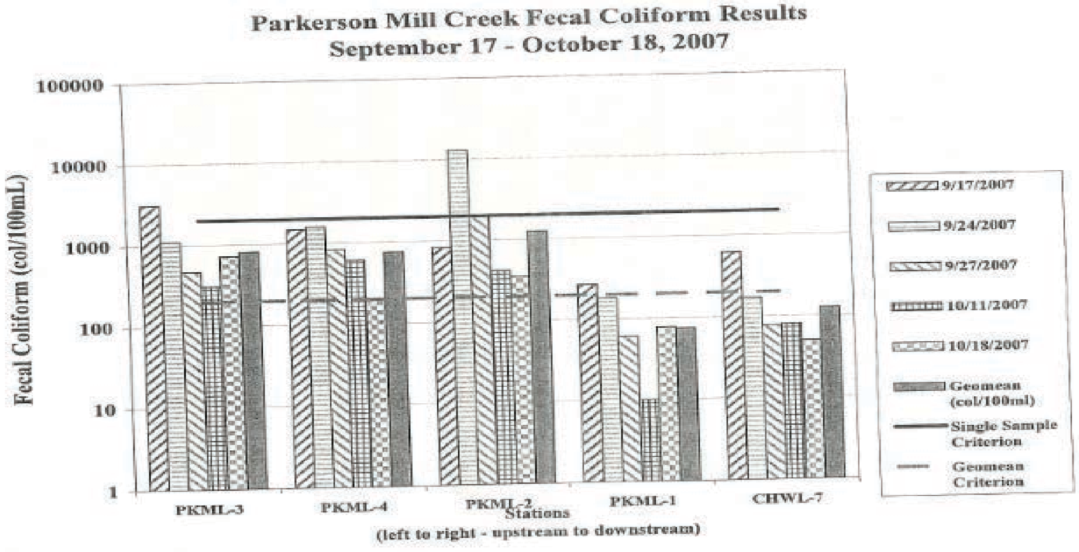


Figure 46. Study Results for ADEM Auburn/Opelika Surface Water Bacteria Studies (Copied)

The exceedances in fecal coliform per sample and all exceedances for this study are in the upper regions of the Parkerson Mill Creek Watershed. The highest geometric mean concentration was 1260 col/100mL and occurred at PKML-2, located downstream of the bridge on Shug Jordan Parkway.

The City of Auburn also has point sample data for fecal coliform at PKML 2 for October 19, 2007. The two samples collected had fecal coliform counts of 2220 and 520 per 100/mL, which greatly exceeds the fresh water criteria of 200 col/100 mL.

REACH 2 – ADEM SURFACE WATER STUDY FOR TMDL ESTABLISHMENT

At the terminus of subwatershed 15, a permanent sampling station for the TMDL sampling of 2010 is established as PKML-2. PKML-2 is just south of the bridge at Shug Jordan Parkway and it was used in initial studies in 2007. As of October 2010, the data collected at PKML-2 by the City of Auburn for the ADEM Surface Water Study for TMDL Establishment is illustrated in Table 18 (modified from City of Auburn Data for ADEM Surface Water Study for TMDL Establishment found in Appendix D). Two samples, collected on 6/8/10 and 8/3/10, exceed the Water Quality Standard for single samples (2,507 colonies/100 mL in Jan-May and Oct-Dec and 487 colonies/100mL in June-Sept).

Table 17. City of Auburn Reach 2 E. coli/100 mL Data for ADEM Surface Water Study for TMDL Establishment

E-Coli					
Date	**PKML-2**	**PKML-5**	**PKML-1**	**PM3**	**HC**
4/7/10	727	144	90	108	
5/6/10	180	180	216	162	
6/8/10	636	153	108	144	
6/14/10	290	350	210	153	
6/21/10	320	455	131	455	
6/28/10	91	171	63	144	
7/6/10	180	135	72	270	
8/3/10	5000	2000	1182	1000	
8/5/10	273	117	45	545	
8/10/10	36	380	9	250	
8/23/10	90	117	45	350	36
8/25/10	315	162	1273	1182	72
8/31/10	182	1000	300	364	90
9/14/10	108	9	9	364	126
10/5/10	364	240	9	144	18

Data collected from sampling events on June 8, 14, 21, 28, and July 6 was used to calculate a geometric mean for PKML-2 (Table 18). The Fish and Wildlife Use fresh water geometric mean criteria for E. coli indicator bacteria are 126 col/100 mL for the months of June through September. The geometric mean for this sampling period was 259.5 col/100 mL, more than double the Alabama Water Quality Criteria.

Table 18. City of Auburn Reach 2 Geometric Mean Study #1

Geometric Mean Study #1 (City)				
	PKML-2	PKML-5	PKML-1	PM3
6/8/10	636	153	108	144
6/14/10	290	350	210	153
6/21/10	320	455	131	455
6/28/10	91	171	63	144
7/6/10	180	135	72	270
Geom. Mean	**249.50**	**223.88**	**106.15**	**208.05**
State WQ Criteria	126	126	126	126

A second geometric mean study was performed for the ADEM Surface Water Quality Study for TMDL Establishment on August 5, 10, 23, 25, and 31. The results for that study are shown in Table 19. The second study geometric mean is not as elevated as that of the first study; however, the geometric mean is still higher than the State Water Quality Criteria of 126 colonies/100 mL.

Table 19. City of Auburn Reach 2 Geometric Mean Study #2

Geometric Mean Study #2 (City)				
	PKML-2	PKML-5	PKML-1	PM3
8/5/10	273	117	45	545
8/10/10	36	380	9	250
8/23/10	90	117	45	350
8/25/10	315	162	1273	1182
8/31/10	182	1000	300	364
Geom. Mean	**138.36**	**242.74**	**93.01**	**459.65**
State WQ Criteria	126	126	126	126

REACH 3

The Auburn University College of Veterinary Medicine and upper portions of the City of Auburn leaving Auburn University's main campus make up subwatersheds 6, 9, 10, 13, 17-20, and 21 of Reach 3. Subwatersheds 6, 10, and 17 make up Parkerson Mill Creek's largest tributary which is approximately 11,250 ft of stream. Only two sampling sites exist on this tributary within Reach 3 for all six studies. Alabama Water Watch monitors these sites. One is monitored for bacteria and the other is used to monitor water chemistry.

REACH 3 - ALABAMA WATER WATCH BACTERIOLOGICAL MONITORING

This bacteriological monitoring site for Reach 3 is located approximately 820 yards downstream of Shug Jordan Parkway. This site was monitored three times in 2008. Only one sample exceeded the water quality standard, as shown in Figure 47 and Figure 48.

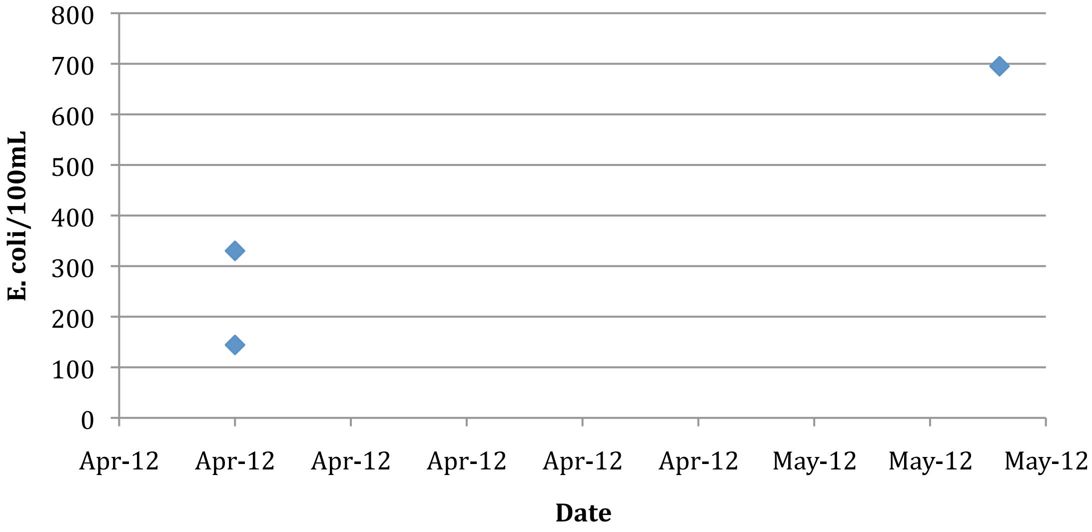


Figure 47. E. coli/100mL for AWW Bacteriological Monitoring Sites within Reach 3

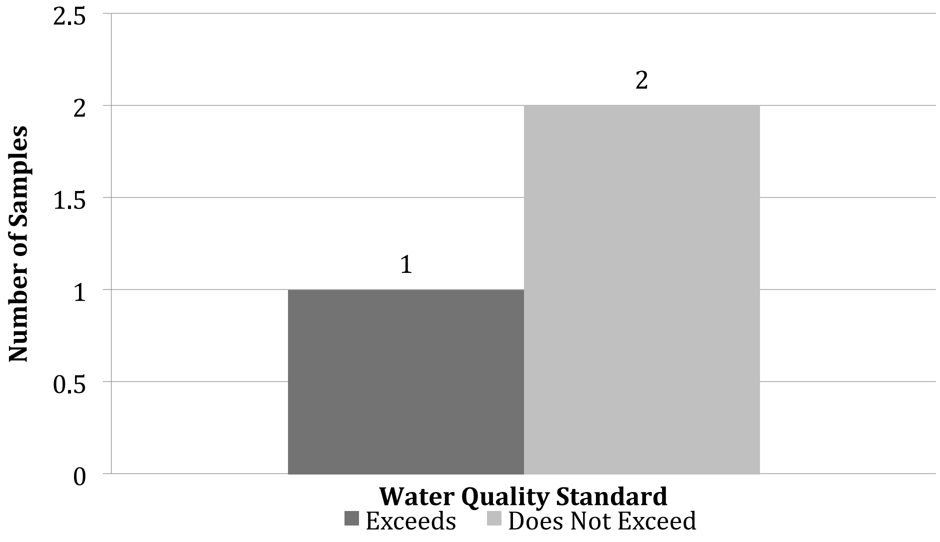


Figure 48. Exceedances in the Water Quality Standard for AWW Bacteriological Monitoring Sites in Reach 3

REACH 3 – ALABAMA WATER WATCH CHEMISTRY MONITORING

AWW monitors one site for water chemistry within Reach 3, which is located at Wire and Webster Roads. Of the fourteen times this site has been sampled, four have incomplete data sets. The following water chemistry data was collected: temperature, pH, dissolved oxygen, total alkalinity, total hardness and turbidity, shown in Figures 49, 50, 51, 52, and 53.

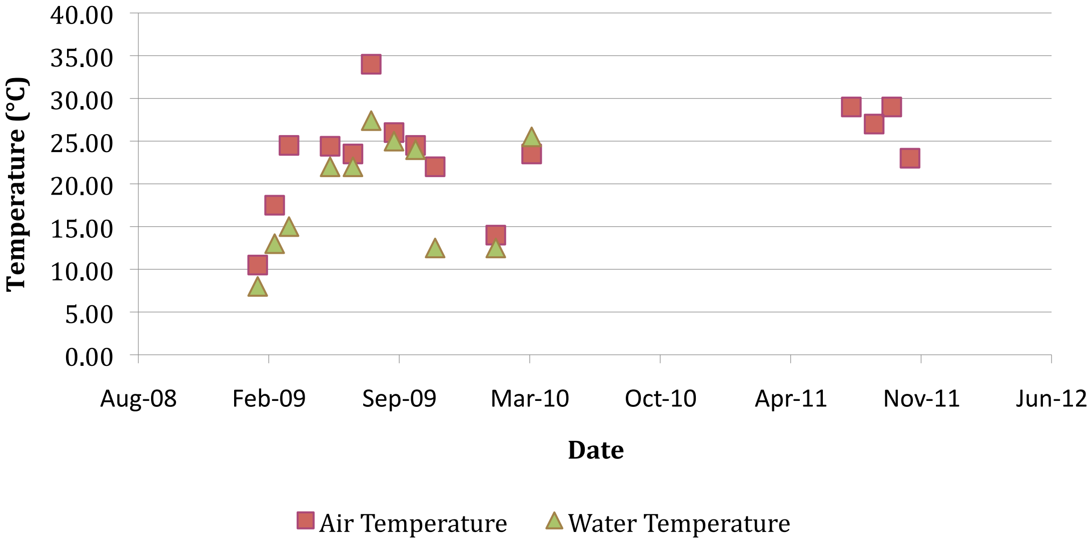


Figure 49. AWW Temperature Data for Reach 3

The temperatures measured in Reach 3 range from 8℃ to 27.4℃ for water and 10.5℃ to 34℃ for air; which are within the Water Quality Standard.

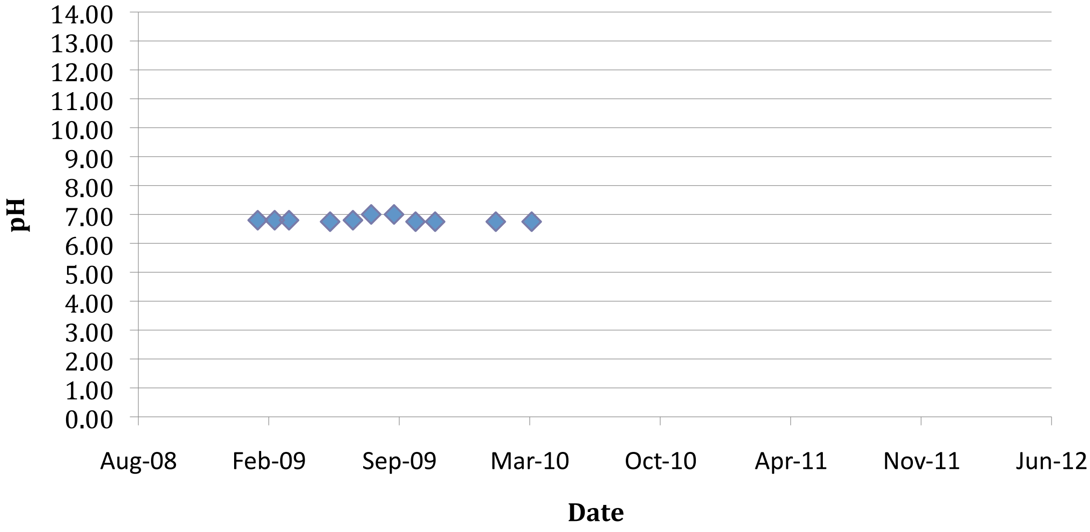


Figure 50. AWW pH Data for Reach 3

The pH for Reach 3 is within the Water Quality Standard range of 6.5 and 9 with values ranging from 6.75 to 7. The pH data collected within Reach 3 was very consistent.

Dissolved oxygen samples for Reach 3 meet the Water Quality Standard criteria of greater than 5 ppm, as shown in Figure 51.

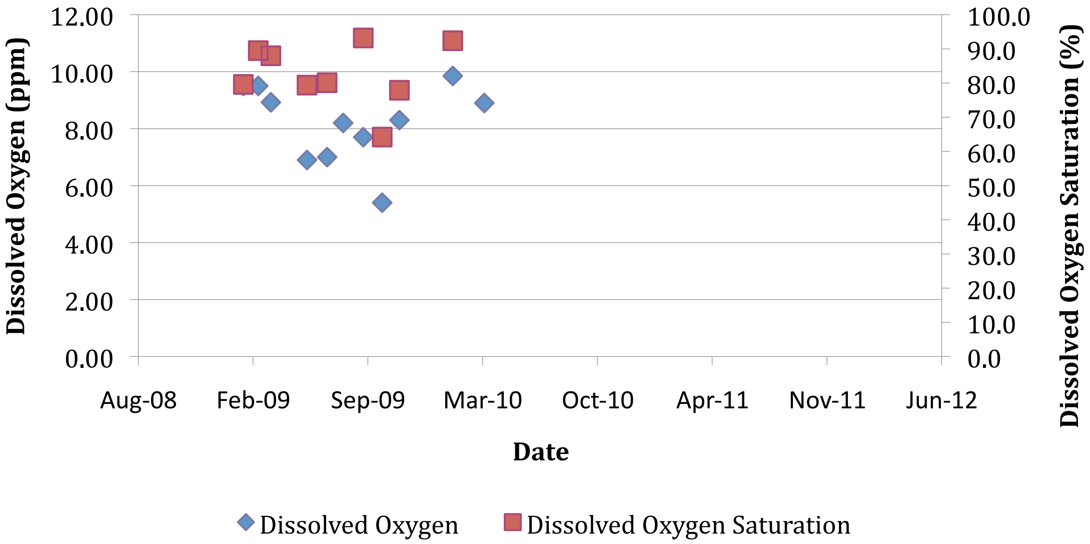


Figure 51. AWW Dissolved Oxygen Data for Reach 3

Total alkalinity and hardness range from 50 to 90 mg/L for locations in Reach 3 monitored by AWW.

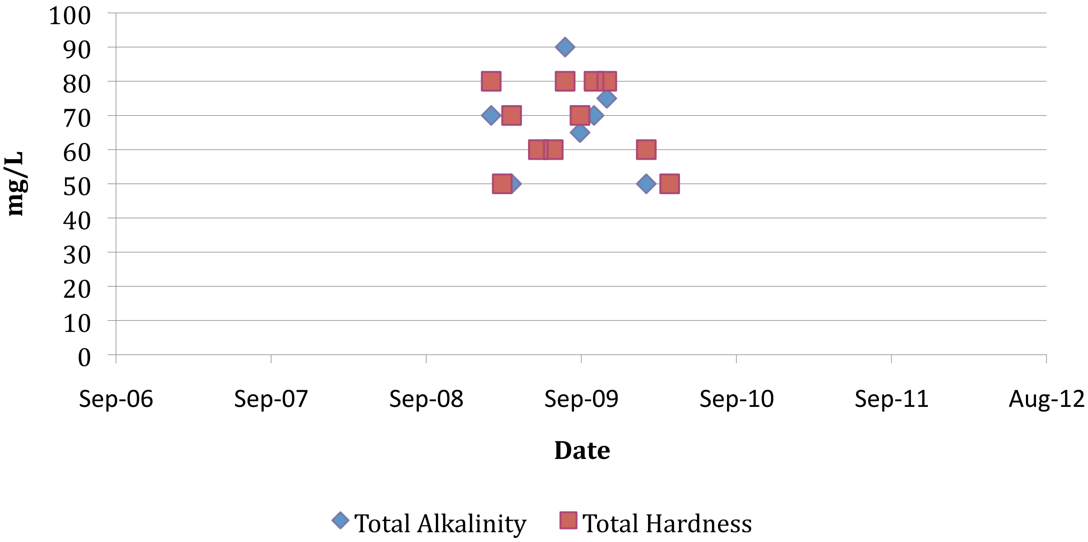


Figure 52. AWW Total Hardness and Total Alkalinity Data for Reach 3

Turbidity values for data collected in Reach 3 are low, ranging from 2 to 5 JTUs.

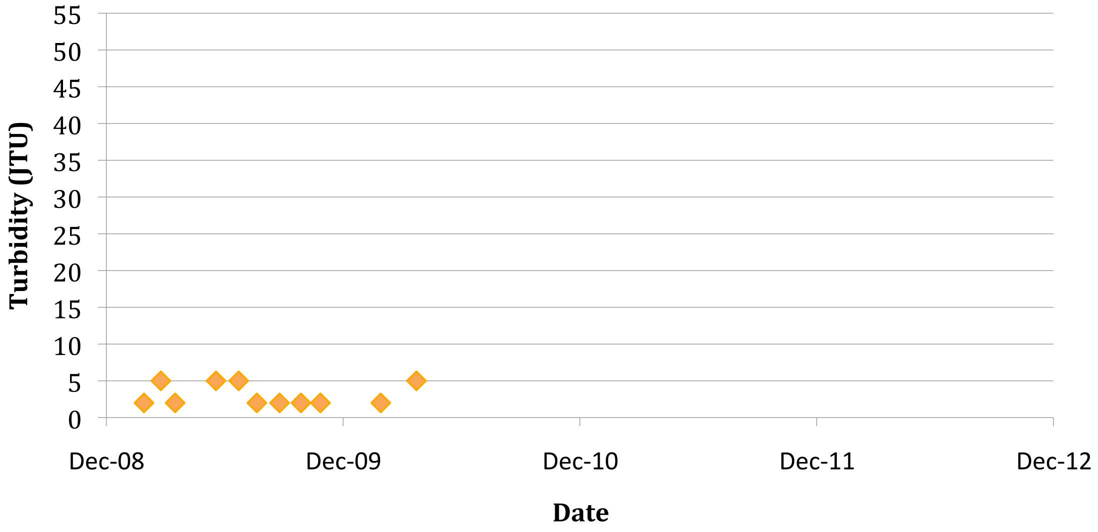


Figure 53. AWW Turbidity Data for Reach 3

The water temperature, pH, dissolved oxygen and hardness data for Reach 3 meet the respective water quality standard for Alabama.

REACH 4

The City of Auburn, north of US Interstate 85 and subwatersheds 23-28, make up Reach 4. This reach of Parkerson Mill Creek makes up the most urban reach with many commercial and industrial land uses.

REACH 4 - ALABAMA WATER WATCH BACTERIOLOGICAL MONITORING

Alabama Water Watch only collected bacteriological data within Reach 4. The seven sampling events took place from 2007-2009 at one location off of Lake Street. The results are shown in Figure 54.

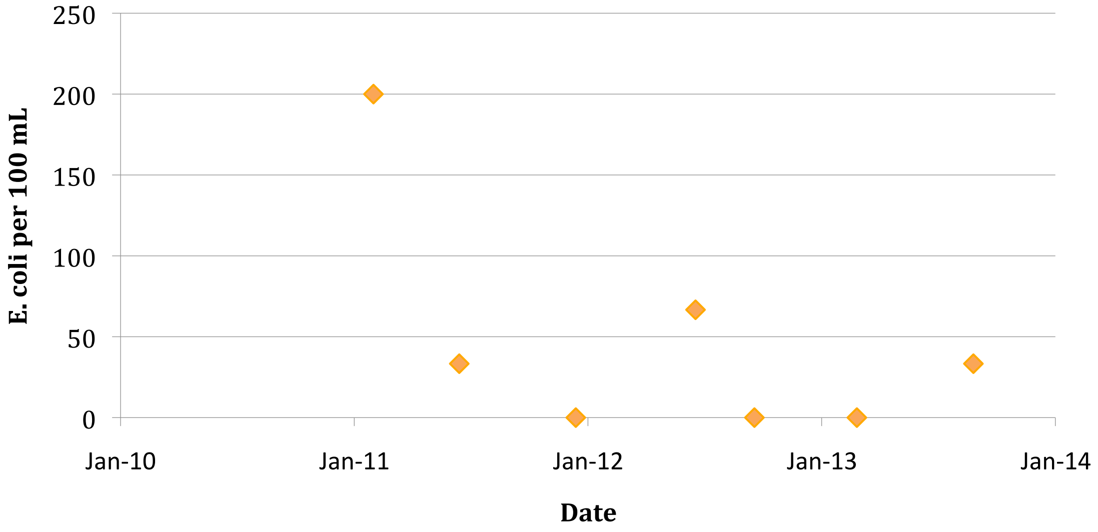


Figure 54. E.coli/100mL for AWW Bacteriological Monitoring Sites within Reach 4

Of the seven events sampled during this time period, no event exceeds the water quality standard, as shown in Figure 55.

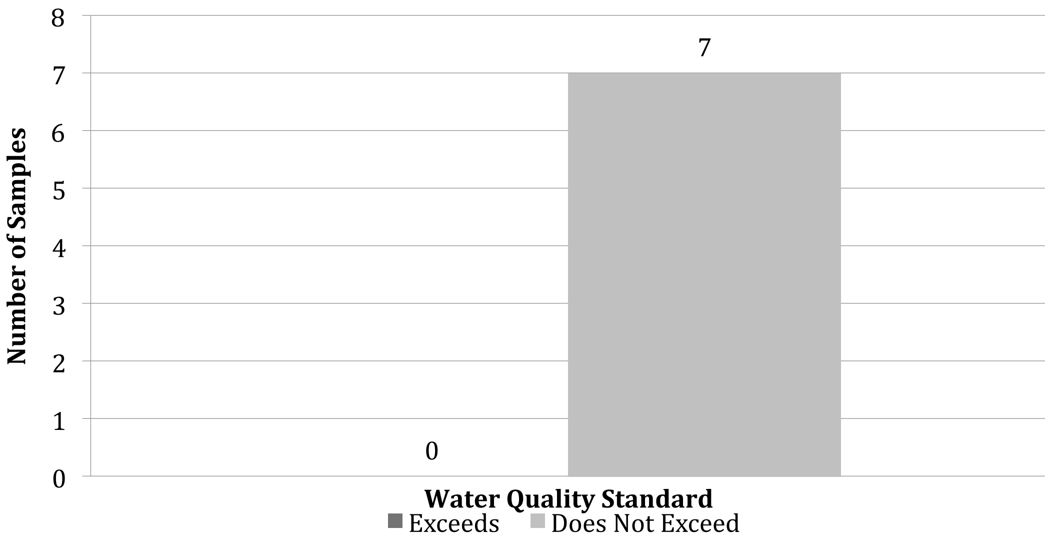


Figure 55. Exceedances in the Water Quality Standard for AWW Bacteriological Monitoring in Reach 4

REACH 4 – ADEM SURFACE WATER STUDY FOR TMDL ESTABLISHMENT

PKML-5, which is located off of Veterans Boulevard upstream of the first bridge, is one of five permanent sampling sites monitored by Alabama Department of Environmental Management and City of Auburn for the 2010 TMDL monitoring study. Two sampling events (8/3/2010 and 8/31/10) at PKML-5 exceeded the single sample limits for the Fresh

Water Criteria for Fish and Wildlife Use (Table 21). As of October 2010, the data collected at PKML-5 by the City of Auburn for the ADEM Surface Water Study for TMDL Establishment is illustrated in Table 20 (modified from City of Auburn Data for ADEM Surface Water Study for TMDL Establishment found in Appendix D).

Table 20. City of Auburn Reach 4 E. coli/100mL Data for ADEM Surface Water Study for TMDL Establishment

E-Coli					
Date	**PKML-2**	**PKML-5**	**PKML-1**	**PM3**	**HC**
4/7/10	727	144	90	108	
5/6/10	180	180	216	162	
6/8/10	636	153	108	144	
6/14/10	290	350	210	153	
6/21/10	320	455	131	455	
6/28/10	91	171	63	144	
7/6/10	180	135	72	270	
8/3/10	5000	2000	1182	1000	
8/5/10	273	117	45	545	
8/10/10	36	380	9	250	
8/23/10	90	117	45	350	36
8/25/10	315	162	1273	1182	72
8/31/10	182	1000	300	364	90
9/14/10	108	9	9	364	126
10/5/10	364	240	9	144	18

The results of the two Geometric Mean Studies conducted as part of the ADEM Surface Water Quality Study for TMDL Establishment are shown in Table 21 and 22. Both studies show exceedances greater than 126 colonies/100mL at PKML-5.

Table 21. City of Auburn Reach 4 Geometric Mean Study #1

Geometric Mean Study #1 (City)				
	PKML-2	**PKML-5**	**PKML-1**	**PM3**
6/8/10	636	153	108	144
6/14/10	290	350	210	153
6/21/10	320	455	131	455
6/28/10	91	171	63	144
7/6/10	180	135	72	270
Geom. Mean	**249.50**	**223.88**	**106.15**	**208.05**

Table 22. City of Auburn Reach 4 Geometric Mean Study #2

Geometric Mean Study #2 (City)				
	PKML-2	PKML-5	PKML-1	PM3
8/5/10	273	117	45	545
8/10/10	36	380	9	250
8/23/10	90	117	45	350
8/25/10	315	162	1273	1182
8/31/10	182	1000	300	364
Geom. Mean	**138.36**	**242.74**	**93.01**	**459.65**

REACH 5

Reach 5 is the smallest of the six reaches, made up of subwatersheds 29, 30, and 31. This reach includes the Auburn Technology Park 4 and the Auburn Water Park.

REACH 5 – ALABAMA WATER WATCH CHEMISTRY MONITORING

The only data collected within Reach 5 is Alabama Water Watch data for water chemistry. There are no sampling stations within Reach 5 for any other study. All of the AWW data was collected at the crossing of Parkerson Mill Creek and South College Street. The data was collected from this site from 2003 to 2010. The temperature data is shown in Figure 56. All water temperature data complies with the Water Quality Standard and is no greater than 32.2 °C.

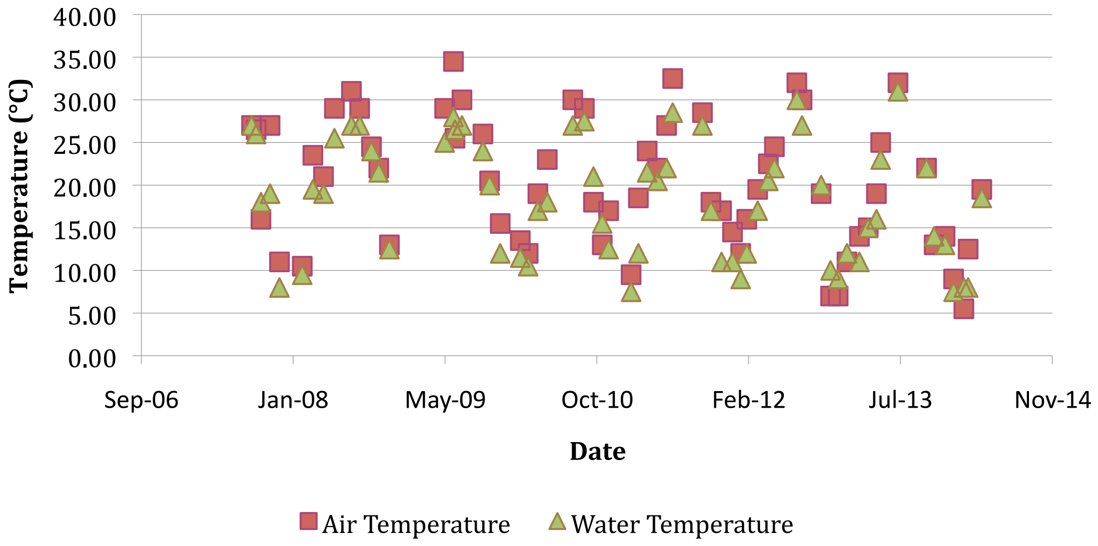


Figure 56. AWW Temperature Data for Reach 5

The range for pH for Reach 5 is stable with values ranging from 7 to 8.5 (Figure 57). The data for pH are suitable for Fish and Wildlife.

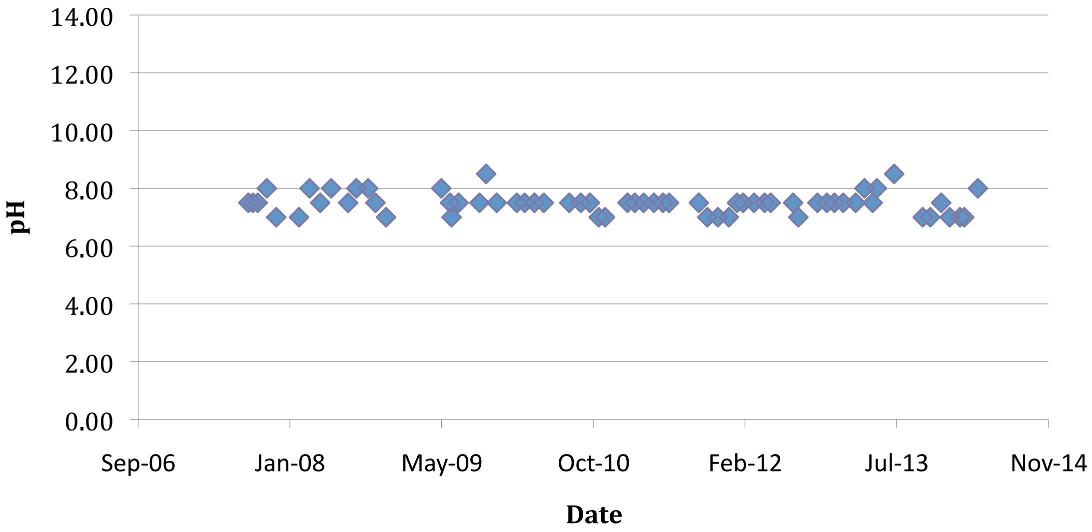


Figure 57. AWW pH Data for Reach 5

Dissolved oxygen for Reach 5 varies from 6.10 to 12.05 ppm with saturation percentages of 83% and higher. Figure 58 illustrates both the dissolved oxygen and dissolved oxygen saturation data for Reach 5.

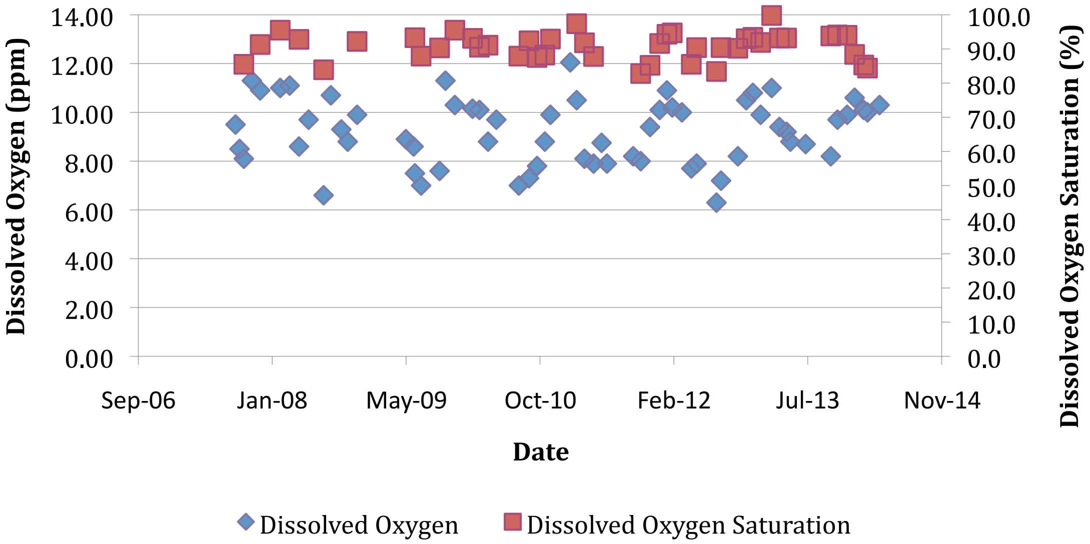


Figure 58. AWW Dissolved Oxygen Data for Reach 5

Total alkalinity and total hardness levels for Reach 5 are shown in Figure 59. All measured values are within the Water Quality Standard of 15 to 500 mg/L.

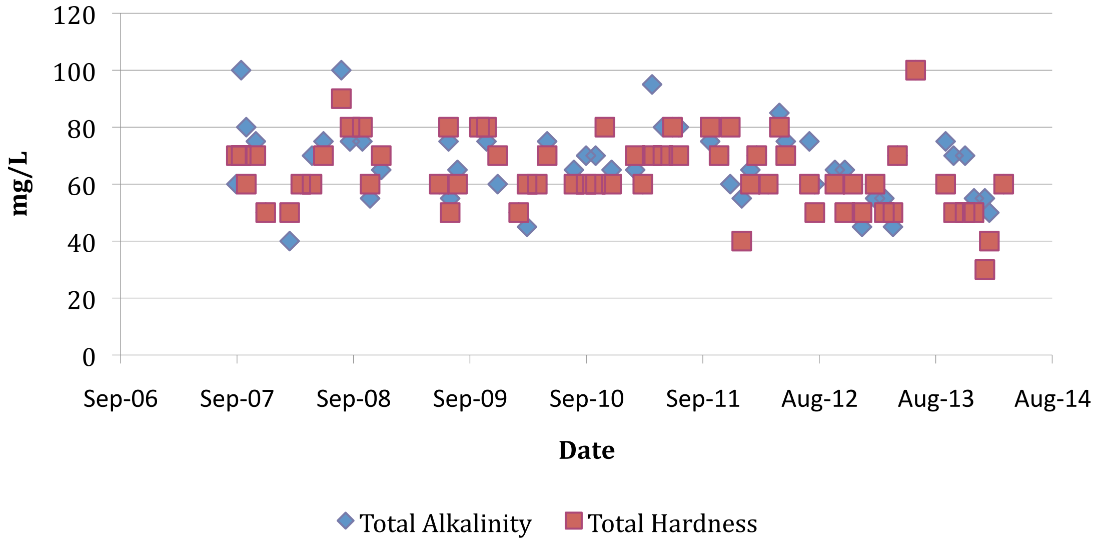


Figure 59. AWW Total Hardness and Total Alkalinity Data for Reach 5

Overall, the turbidity samples for Reach 5 ranges from 0 to 120 JTUs (Figure 60).

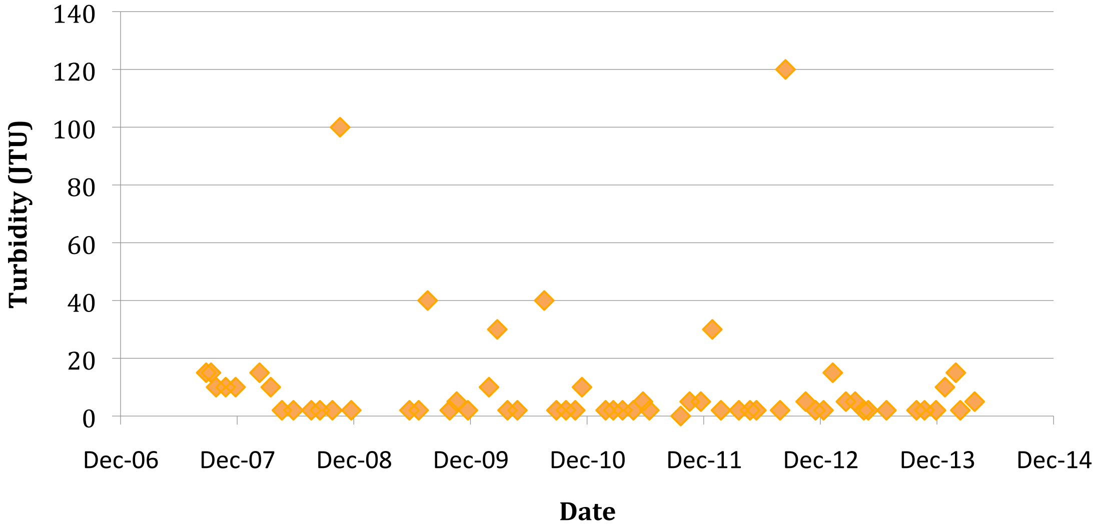


Figure 60. AWW Turbidity Data for Reach 5

REACH 6

Reach 6 is the largest section, containing subwatersheds 32-41. The H.C. Morgan WPCF, or Southside facility, is located within subwatershed 36.

REACH 6 - ALABAMA WATER WATCH BACTERIOLOGICAL MONITORING

Alabama Water Watch collected both bacteriological and water chemistry data within Reach 6. Bacteriological data was collected at two locations – one just south of the discharge from the H.C. Morgan (Southside) Water Pollution Control Facility and the other is just upstream from of the bridge off of Sandhill Road, which is used in later studies and identified as PKML-1.

There were twelve samples collected between 2007-2009 for bacteria. These samples are shown in Figure 61.

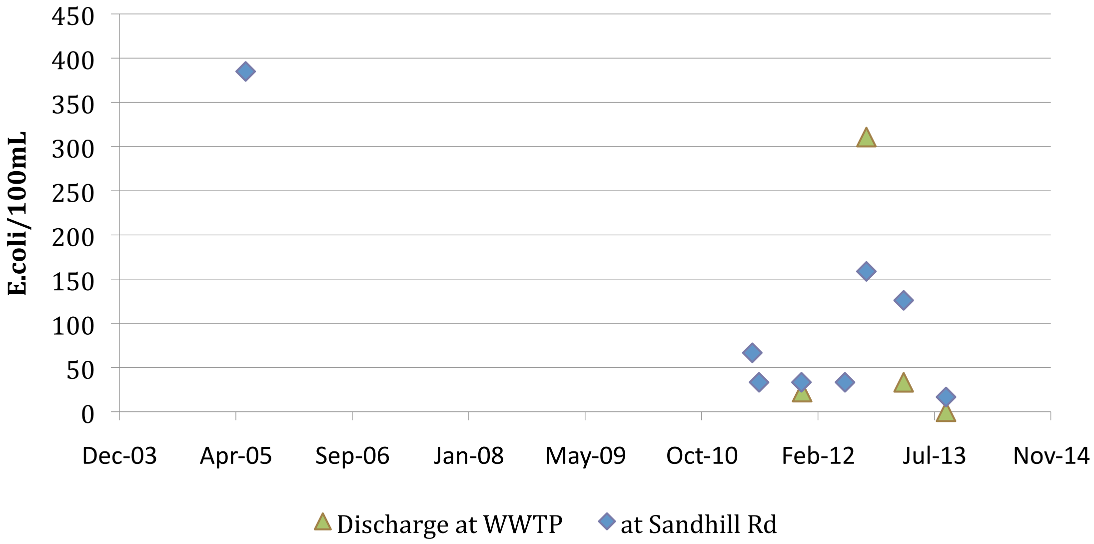


Figure 61. E. coli/100mL for AWW Bacteriological Monitoring Sites within Reach 6

Of these 12 samples, only two events exceed the water quality standard (Figure 62).

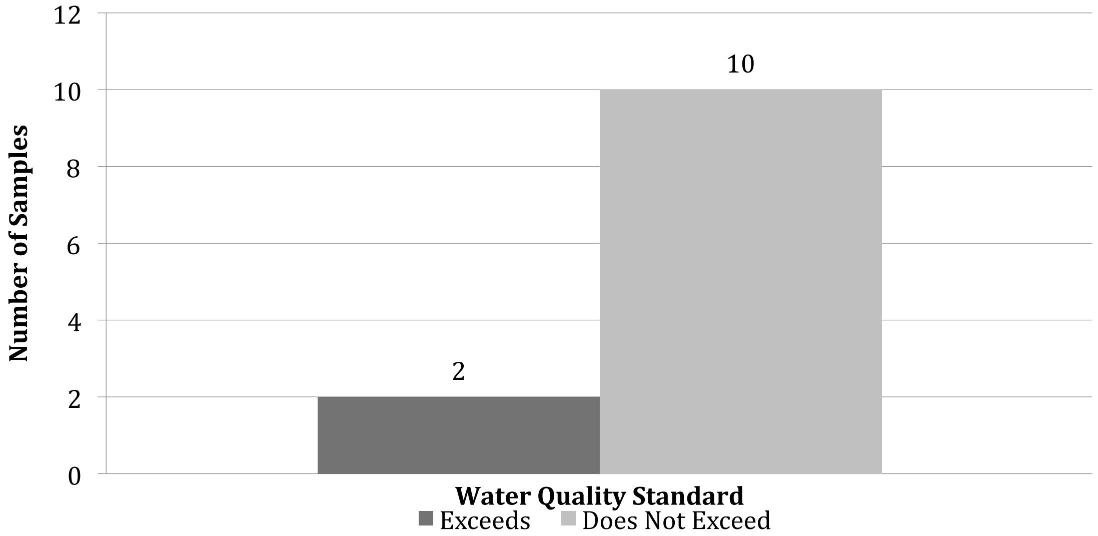


Figure 62. Exceedances in the Water Quality Standard for AWW Bacteriological Monitoring Sites within Reach 6

REACH 6 - ADEM AUBURN/OPELIKA SURFACE WATER BACTERIA STUDIES

In the 2007 ADEM Auburn/Opelika Surface Water Bacteria Study, one site was located within Reach 6. PKML-1 is included in this study. PKML-1 is located off of Sandhill Road (Lee Co. Road 10) at Latitude 32.53744 and Longitude -85.50601 just upstream of the bridge. The results for PKML-1 are shown in Table 23.

Table 23. PKML-1 Data collected by ADEM in Auburn/Opelika Surface Water Bacterial Studies

	Week 1 (1/18/2007)	Week 2 (1/25/2007)	Week 3 (2/1/2007)	Week 4 (2/8/2007)	Week 5 (2/15/2007)
PKML-1	130	190	1400	64	620

In the follow up to the 2007 study by ADEM, a second study was proposed and conducted. Bacterial samples were collected weekly for five weeks, in addition to other water quality data. Neither single sample nor the geometric mean exceeded the criterion for samples collected at PKML-1 during this follow up study (Figure 63).

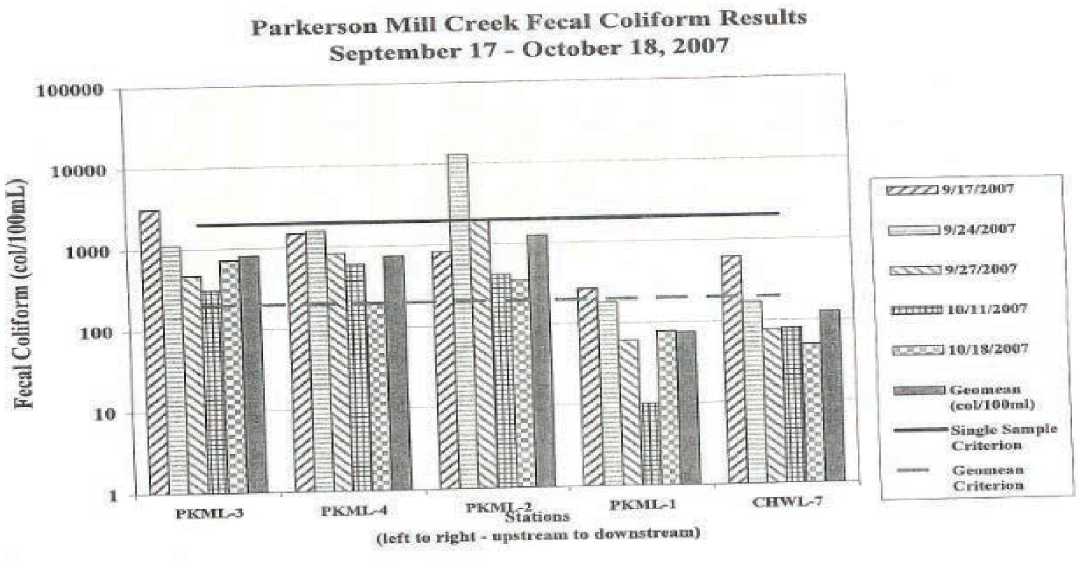


Figure 63. Results from ADEM Auburn/Opelika Surface Water Bacteria Studies

REACH 6 – ADEM SURFACE WATER STUDY FOR TMDL ESTABLISHMENT

In the 2010 follow up study by ADEM, two monitoring locations used in the side-by-side monitoring for the TMDL are located in Reach 6. The locations are PKML-1 and PM-3, both of which were used in previous studies. PM-3 is approximately 0.25 miles downstream of H.C. Morgan Wastewater Treatment Plant and is located approximately 1,500 feet upstream of the confluence with Chewacla creek. As of October 2010, the data collected at PKML-1 and PM-3 by the City of Auburn for the ADEM Surface Water Study for TMDL Establishment are illustrated in Table 24 (modified from City of Auburn Data for ADEM Surface Water Study for TMDL Establishment found in Appendix D). Five samples, two at PKML-1 on 8/3/10 and 8/25/10 and three at PM-3 on 8/3/10, 8/5/10 and 8/25/10 exceeded the water quality sample single sample criterion of 487 colonies/100 mL.

Table 24. City of Auburn Reach 6 E. coli/100mL Data for ADEM Surface Water Study for TMDL Establishment

E-Coli					
Date	**PKML-2**	**PKML-5**	**PKML-1**	**PM3**	**HC**
4/7/10	727	144	90	108	
5/6/10	180	180	216	162	
6/8/10	636	153	108	144	
6/14/10	290	350	210	153	
6/21/10	320	455	131	455	
6/28/10	91	171	63	144	
7/6/10	180	135	72	270	
8/3/10	5000	2000	1182	1000	
8/5/10	273	117	45	545	
8/10/10	36	380	9	250	
8/23/10	90	117	45	350	36
8/25/10	315	162	1273	1182	72
8/31/10	182	1000	300	364	90
9/14/10	108	9	9	364	126
10/5/10	364	240	9	144	18

Data collected from sampling events on June 8, 14, 21, 28, and July 6 was used to calculate a geometric mean for PKML-1 and PM-3 (Table 25). The Fish and Wildlife Use fresh water geometric mean criteria for E. coli indicator bacteria are 126 col/100 mL for the months of June through September. The geometric mean was not exceeded during this study for PKML-1; however, the geometric mean for PM-3 was 208.05, exceeding the Water Quality Standard.

Table 25. City of Auburn Reach 6 Geometric Mean Study #1

Geometric Mean Study #1 (City)				
	PKML-2	**PKML-5**	**PKML-1**	**PM3**
6/8/10	636	153	108	144
6/14/10	290	350	210	153
6/21/10	320	455	131	455
6/28/10	91	171	63	144
7/6/10	180	135	72	270
Geom. Mean	**249.50**	**223.88**	**106.15**	**208.05**

A second geometric mean study was performed for the ADEM Surface Water Quality Study for TMDL Establishment on August 5, 10, 23, 25, and 31. The results for that study are shown in Table 26. Similarly to the first geometric mean study conducted as part of the ADEM Surface Water Quality Study for TMDL Establishment, the City of Auburn had samples that exceeded the water quality standard for PM-3 but geometric means for the second study did not exceed 126 colonies/100 mL for PKML-1.

Table 26. City of Auburn Reach 6 Geometric Mean Study #2

Geometric Mean Study #2 (City)				
	PKML-2	PKML-5	PKML-1	PM3
8/5/10	273	117	45	545
8/10/10	36	380	9	250
8/23/10	90	117	45	350
8/25/10	315	162	1273	1182
8/31/10	182	1000	300	364
Geom. Mean	**138.36**	**242.74**	**93.01**	**459.65**

ADDITIONAL STUDIES ON PARKERSON MILL CREEK

ADEM BENTHIC MACROINVERTEBRATES & WATER QUALITY ASSESSMENT

In 1997, ADEM conducted a water quality assessment of Parkerson Mill Creek. Much of the purpose of this study was due to the NPDES permit (AL0050237) or the permit held by City of Auburn to discharge wastewater from the H.C. Morgan WPCF into Parkerson Mill Creek.

Both Aquatic macroinvertebrates and chemical sampling were conducted beginning on October 15, 1997. Four sampling sites were used including PM-1 (the control for this study), PM-3, PM-1a (located just downstream of the effluent mixing zone), and HCR-1 (located on Hurricane Creek upstream of the bridge on an unnamed gravel road off of Alabama highway 77). HCR-1 is also an ecoregional reference site identified by ADEM Field Operations Division. Toxicity testing and 24-hour composite sampling was also conducted at the Southside Treatment Facility as part of this study.

Parkerson Mill Creek below the H.C. Morgan WPCF was slightly impaired compared to the upstream control station (PM-1) used in this 1997 study. The results also indicated a slight impairment of the control (PM-1), which suggested impact further up in the watershed.

AUBURN UNIVERSITY BEEF TEACHING UNIT

Muntiferring, et al. conducted a study on the Auburn University Beef Teaching Unit to study water quality and livestock in 2008. The study site is located on the western edge of Auburn University's campus. This study set up six 0.75 acre "watershed cells" to observe ecosystem processes at the soil-water-plant-animal interface. The results from this study are inconclusive.

KREB'S *PARKERSON MILL CREEK STERAM RESTORATION FUNDING OPTIONS*

As a follow up to the Parkerson Mill Creek Restoration Feasibility Study, Krebs Architecture and Engineering created a report entitled Parkerson Mill Creek Stream Restoration Funding Options. This report suggested that some level of self-funding by using restoration projects could be used as a form of compensatory mitigation.

DATA SUMMARY

The data presented within the highlighted studies on Parkerson Mill Creek provide a baseline of past and current conditions. These results are primarily informative on a comparative basis, not a completely comprehensive one.

In comparing study results the following were noted and summarized:

- For reaches that Alabama Water Watch monitored for bacteria (Reaches 1, 2, 3, 4, and 6) Reach 4 was the only Reach with no exceedances in the water quality standard for pathogens.
- Reach 1 and Reach 2 had the highest number of exceedances with 20 and 14, respectively.
- Of the samples collected by AWW, Reach 1 and Reach 2 have exceedances 32-36% of the time.
- In each Reach, AWW Water Chemistry Data collected meets the water quality standard for
  - Water Temperature,
  - pH,
  - Dissolved Oxygen,

    - Hardness,

with the exception of two samples in Reach 1 for dissolved oxygen, which may have been affected adversely by drought during that year (2007).

- There are no water quality standards for dissolved oxygen saturation or alkalinity, however data collected appears to be within ranges that are suitable for aquatic life.
- Turbidity samples, measured in Jackson Turbidity Units (JTUs), were found to have low values for turbidity. There is no correlation to the water quality standard, measured in Nephelometric Turbidity Units (NTUs), since different sampling protocol was used.
- *The Parkerson Mill Creek Restoration Feasibility Study* indicated the incision and erosion of Parkerson Mill Creek is indicative of an unstable stream channel.
- Study Reach B, located in Reach 1, is most susceptible to degradation and is prioritized for restoration.
- The total estimates for cost of restoration, including both stream restoration and stormwater management of Parkerson Mill Creek within Reach 1 and 2 was approximately $1.6 Million in 2003. Study Reach B had the highest cost estimate of $465, 093.00
- In the initial (February) ADEM Auburn/Opelika Surface Water Bacteria Study all samples exceeded the geometric mean criterion. All single samples for sample site PKML-2 exceeded the single sample limit.
- In the follow up ADEM Auburn/Opelika Surface Water Bacteria Study (September-October), the geometric mean is exceeded at three of four sampling locations. PKML-1 located in Reach 6 did not have a single sample or the geometric mean for which the water quality standard criterion was exceeded.
- In the ADEM Surface Water Study for TMDL Establishment, sites are located in Reaches 1, 2, 4, and 6. Auburn University was the only entity that collected data in Reach 1 as part of this study.
- Only the City of Auburn and Auburn University made data available from this study for report in the Parkerson Mill Creek Watershed Management Plan. These data are from April to October of the study. The data from ADEM are not

currently available because the data have not been quality-assured. Once the data are available, they will be added to this plan.

- Three samples within Reach 1 collected by Auburn University: one for fecal coliform and two for E. coli exceed freshwater criteria for Fish and Wildlife use. Both E. coli samples occur on June 14, 2010.
- The City of Auburn's E. coli data exceeded standards at each sampling location on 8/3/2010.
- All locations for data collected by the City of Auburn have at least two exceedances in the E. coli criterion.
- Two geometric mean studies were conducted (five week studies) one beginning in June and one in August.
- The City of Auburn geometric mean was exceeded in both studies for all locations except PKML-1 (below H.C. Morgan WTCF).
- 45 of 65 (69%) of fecal coliform samples collected by the City of Auburn for the ADEM Surface Water Study for TMDL Establishment exceeded single sample criterion; yet 10 of 65 (15%) of E. coli samples collected exceeded single sample criterion.

PHASE II

The Phase II stormwater regulations contained within the National Pollutant Discharge Elimination System (NPDES) created by USEPA requires communities greater than 50,000 inhabitants to develop, implement, and enforce a stormwater management program. Regulated communities or entities involved in this stormwater-permitting program were developed by NPDES in two phases. Phase I communities or large and medium-sized Municipal Separate Storm Sewer Systems (MS4's) located in incorporated places and counties with populations greater than 100,000 were required to comply beginning in the early 1990's. Phase II, implemented in the late 1990's, included MS4's not regulated under Phase I that have populations greater than 50,000 and small construction activity disturbing greater than one acre. The Phase I and Phase II areas in Alabama, as defined by the 2000 census, are shown in Figure 64.

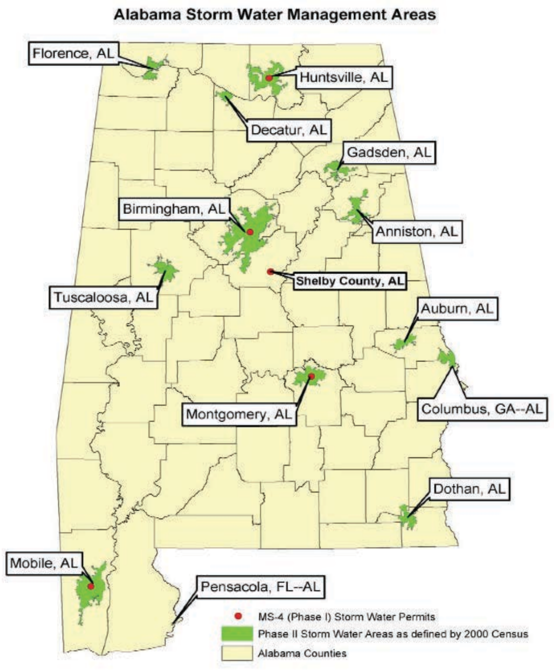


Figure 64. Phase I and Phase II Communities of Alabama (2000 census)

The City of Auburn, Auburn University, and Lee County are defined as Phase II communities and are required to have stormwater management plans (SWMP) to be in compliance. The USEPA has set forth six minimum measures that should be included in the SWMP's. The six minimum measures are:

1. Public Education and Outreach
2. Public Participation and Involvement
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post Construction Runoff Control
6. Pollution Prevention/Good Housekeeping

CHAPTER 4: CHALLENGES TO THE PARKERSON MILL CREEK WATERSHED

CHALLENGES

The Parkerson Mill Creek Watershed is unique in that there are so many involved in the watershed management planning process. This planning not only gives stakeholders the opportunity to assess the current conditions of the watershed but also gives them a chance to picture the watershed potential. As with many watershed management plans, the future of Parkerson Mill Creek if status quo is maintained, is not what the Committees and citizens of the Parkerson Mill Creek Watershed desire.

In a meeting held on May 5, 2010, the Technical Committee began to identify the potential causes of the degraded conditions of Parkerson Mill Creek, as well as their sources and other potential threats. The Technical Committee developed a list to begin to prioritize activities and efforts.

DESIGNATED AND DESIRED USES

The primary criterion for water quality is whether a waterbody meets its designated uses, according to ADEM and the USEPA. The designated uses are those water uses recognized and established by state and federal water quality programs for each specific waterbody.

Ultimately, the goal is to have all streams in Alabama meet their designated uses. The designated water use classifications, according to ADEM's Chapter 335-6-10 Water Quality Criteria are as follows:

1. Outstanding Alabama Water
2. Public Water Supply
3. Swimming and Other Whole Body Water Contact Sports
4. Shellfish Harvesting
5. Fish and Wildlife
6. Limited Warm water Fishery
7. Agricultural and Industrial Water Supply

Parkerson Mill Creek's only designated use is Fish and Wildlife, see Figure 65.

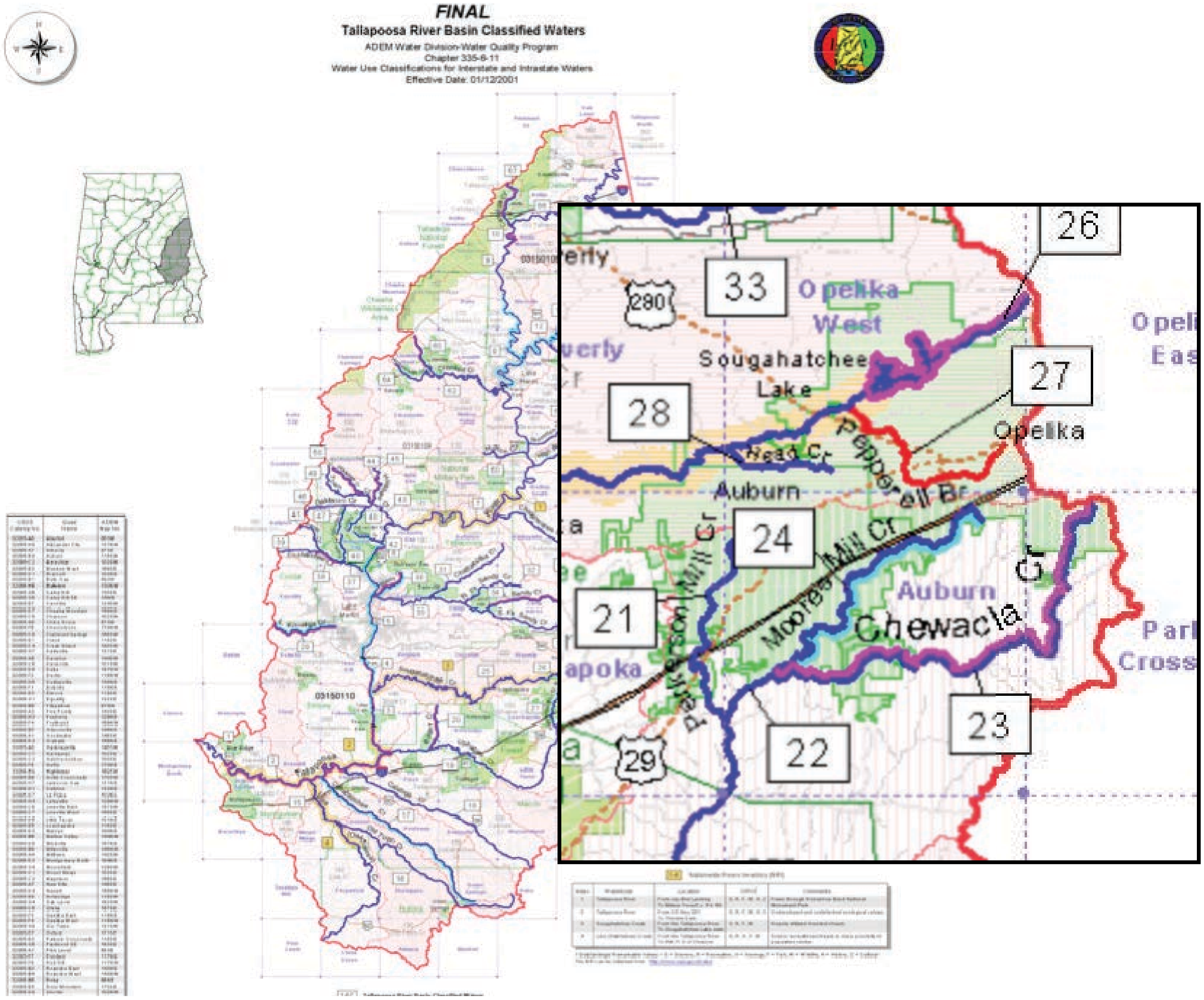


Figure 65. Alabama Department of Environmental Management Water Quality Standards Map of the Tallapoosa River Basin – Excerpt Parkerson Mill Creek

It is the assumption of the Parkerson Mill Creek Watershed Committees that if the community, City of Auburn, Auburn University, Lee County, and other groups take action toward Parkerson Mill Creek meeting its designated Fish and Wildlife Use, improvements and restoration of the Parkerson Mill Creek Watershed can be achieved. Taking action and measuring progress toward this goal will be an iterative process. The goals and actions need comparison with results of regular monitoring, at both the subwatershed and watershed scale, to determine reasonable and steady progress toward long-term goals, related water quality standards, and designated/desired uses.

The initial goals established by the Technical Committee are:

- Meet the water quality standards.
- Restore aquatic habitat and designated Fish and Wildlife use.
- Protect green space.

In addition to these goals, the Committee also established additional desired uses of the Parkerson Mill Creek Watershed to include:

1. **Water Quality and Quantity Functions of Natural Features**
   To protect and enhance streams, floodplains and wetlands in order to prevent flooding and mitigate for erosion and sedimentation.

2. **Coordinated Development**
   To coordinate planning and development of communities, specifically City of Auburn and Auburn University, in order to promote and achieve environmental and economic benefits.

3. **Open Land and Agricultural Lands**
   To protect and preserve these landscapes and functions of these lands.

4. **Recreation**
   To establish and maintain existing trails and access to Parkerson Mill Creek and its tributaries where desired and feasible.

5. **Education**
   To continue to promote the education of stakeholders on using practices and workshops within the Parkerson Mill Creek Watershed and to use Parkerson Mill Creek as an outdoor classroom.

It is the intent of the Parkerson Mill Creek Watershed Management Plan Committees that future decisions and actions place equal emphasis on these desired uses and their consideration along with it aforementioned designated uses and restoration of the water quality.

POLLUTANTS, THREATS, SOURCES, & CAUSES

The diversity in landscapes and land uses throughout the Parkerson Mill Creek Watershed creates a variety of challenges in terms of pollutants and threats to the waters of the Parkerson Mill Creek Watershed. It is the intention of the Parkerson Mill Creek Watershed Committees to address all of these pollutants and threats in the long term with a series of targeted programs. The Parkerson Mill Creek Technical Committee has been careful to identify and attempt to prioritize the most pressing concerns so that resources can be spent cost-effectively and in a phased approach. The pollutants, threats as well as their sources, causes and impacts are discussed and summarized in this chapter.

LEAKING INFRASTRUCTURE/UNCONTROLLED SOURCES OF BACTERIA

Primary sources of bacteria in the Parkerson Mill Creek Watershed include failing on-site sewage disposal, or septic systems, and illicit discharge of sanitary waste from sewer service infrastructure. According to the Lee County Department of Public Health approximately 15% of the septic systems in the watershed are failing. In addition, the headwaters of the Parkerson Mill Creek Watershed is made up of an older urban area and has the potential to discharge sanitary waste, due to the age of existing infrastructure.

Stakeholders are also concerned about the influence of the temporary population increase due to football games. Auburn University Tigers fans often in RVs arrive in Auburn beginning on Thursday before football game day and stay until Sunday for at least six home games a year. Fans increase the number of people in Auburn by one and a half times normal population every game day. Subsequently, these fans increase the stresses on existing infrastructure. As the data suggests increases in counts for data collected in Reach 1 and Reach 2 are higher in the fall. Additional data that are being collected will be used to confirm any trends relating the population increase to bacterial counts.

Pets, livestock and waterfowl wastes can be sources contributing to bacteria in Parkerson Mill Creek, but the ability to measure the magnitude of these is difficult compared to those mentioned above. However, the increase in homes and a subsequent increase in pets, increases in waterfowl habitat adjacent to detention and on practice and playing fields, the presence of animals on the Veterinary School properties, as well as agricultural research suggests that there could be an increase in pathogens from these sources. Public health concerns over bacteria or pathogens in Parkerson Mill Creek increase the loss in recreational activity and the opportunity to use Parkerson Mill Creek as an outdoor classroom.

LAND USE CHANGES

One of the greatest concerns for the Parkerson Mill Creek Watershed is the water quality degradation due to the land use change into a more developed landscape. As the intensity and density of development increases, water quality and quantity can be negatively impacted. Increases in velocities and flow rates, increased pollutants, as well as decreases in natural areas leads to sedimentation, stream bank erosion, loss of wildlife habitat, increases in water temperature, decreased dissolved oxygen, and many other impacts. The remaining threats and pollutants, erosion and sedimentation, loss of natural features, and excess nutrients are all related to this land use change concern.

EROSION AND SEDIMENTATION

Land use changes are one of the primary contributors to increased soil erosion and sedimentation in Parkerson Mill Creek. Sediments washed from parking lots and streets throughout the watershed also serve as a source into Parkerson Mill Creek. Soil erosion from construction sites in particular, in the more rapidly developing portions of the watershed is of concern. The resources to regularly inspect a enforce erosion and sediment control within the watershed are stretched in terms of managing all sites currently under construction. Additionally a general lack of understanding of installation of construction BMPs and their maintenance is a stakeholder concern.

Sedimentation from runoff, increased urbanization, and construction site runoff are not the only sources of sediment entering Parkerson Mill Creek. Parkerson Mill Creek is currently channelized and lacking in native vegetation, and increased stormwater flows will further scour soils and destabilize stream banks. This instability will only increase over time as streambanks start to fail. The downcutting of Parkerson Mill Creek is primarily due to increased development and subsequent increase in impervious surfaces. The agricultural lands within the watershed may also be a source of sediment concern if improperly maintained. The habitat degradation and nutrients bonded to sediment from an agricultural setting can have detrimental impacts to Parkerson Mill Creek.

THREAT OF LOSS OF NATURAL FEATURES

In addition to sedimentation impacts, land use changes and increased development often causes the loss of natural features. Natural Features such as - groundwater recharge areas, wetlands, woodlands, permeable soils, vegetative buffers, and slope changes – provide functions within the landscape that protect water quality, reduce water quantity, and provide wildlife habitat. When replaced, the natural hydrologic functions of infiltration, storage, and evaporation cannot be replaced. If measures or practices that have functions of infiltration, detention, or restoration are not used to replace a portion of these areas, nearby water resources can be severely impacted. Protecting and restoring the riparian corridor is of particular importance to Parkerson Mill Creek.

Only about 80 acres of wetlands remain in the Parkerson Mill Creek Watershed. The loss of wetlands has the potential to contribute to increased flooding, loss of property value, water pollution, and fragmented, diminished wildlife habitat.

EXCESS NUTRIENTS

The presences of excess nutrients within Parkerson Mill Creek, its tributaries, and other waterbodies within the watershed, may lead to an imbalance, favoring certain organisms, and altering their function in the waterbodies. In the Parkerson Mill Creek the nutrients of concern are nitrogen (N) and phosphorus (P). Due to the Saugahatchee Creek Watershed, just north of Parkerson Mill Creek being impaired due to excess nutrients, stakeholders are aware of and concerned with the potential of excess nutrients within the watershed.

These nutrients are often the limiting growth factor for nuisance plants, such as algae. Excess amounts can encourage accelerated growth, subsequently reducing dissolved oxygen and light and creating an unsuitable habitat. These nutrients also have the ability to adsorb to soil particles and can use eroded soils as transport into Parkerson Mill Creek. Not only does this imbalanced plant growth aesthetically displeasing but also it can eventually limit recreational activities within the watershed.

MONITORING PROGRAMS AND DATA

An established, an integrated, and coordinated water quality monitoring program is needed for the Parkerson Mill Creek Watershed. In the review and summarizing of the available and relevant data for this watershed, it became evident that the data set; although it is robust, it is incomplete. In some cases, studies and data significant to water quality decisions did not include the entire watershed or even additional priority areas of concern. In other cases, existing datasets are too incomplete to be used for as the basis for a watershed decision. Other datasets including sediment contamination, agricultural practices, septic system failures, and illicit discharge detection are nearly non-existent or not currently accessible.

The concerns of the Auburn community need to be identified and maintained in order to ensure appeal, involvement and sustainability of practices, projects, and activities within the Parkerson Mill Creek Watershed. Community concerns were assessed at the Parkerson Mill Creek Watershed Technical Committee meeting on May 5, 2010. Table 27 lists concerns brought up at the meeting.

Table 27. Stakeholder Concerns, Potential Causes, Assessment Ideas, Watershed Goals and Measured Progress

Concern	Potential Causes	Assessment Ideas	Watershed Goals	Measured Progress
Illicit Discharge	Incorrect Installation	Smoke/Dye Testing	Cross Connections Eliminated	Construction of projects
Illegal Dumping	RV's		Provide dump stations	
			Maps of dump stations	
			Storm Drain Marking	
Agricultural Practices				
Fertilizer Misuse				
Automobile Discharge				
Urban Runoff	Urbanization/ More Asphalt		Rainwater collection downtown	
			Education	
Sediment	Excess Runoff	Channel Erosion	Reduce Impervious Surfaces	Measure stream flow volumes and patterns
Pathogens	Aging University Infrastructure	E. coli Monitoring	Dump Station	E. coli Levels - Monitoring
Pathogens	Illicit Discharge	E. coli Monitoring	Fix Old Infrastructure	E. coli Levels - Monitoring
Illicit Discharge	Old Infrastructure/ Sanitary Sewer cross connection	Dye/Smoke Test		
Urban Wildlife	Habitat Fragmentation /Clustering	Urban Wildlife Quantification		Source Tracking
RV Waste Discharge	Lack of Education	Surveys		
Stormwater	Impervious Surfaces	Percentage of Impervious Surfaces	Stormwater Infiltration	
Illicit Discharge (Pathogens)	Aging Infrastructure	E. coli Monitoring	Decrease in Pathogens	E. coli Levels - Monitoring
Sediment	Stormwater Management	Stream Morphology Study	Stable, healthy streams	Linear feet of stream restored
	Stream Instability			
	Construction			

This list of concerns became the starting point for identifying concerns. Upon further review, a more general prioritized list of watershed concerns, shown in Table 28, was developed.

Table 28. Watershed Concerns

Concern	Concern/Need
Hydrology Stream Quality	
Water Quality	Nonpoint source pollution
	Sewage in streams
	Loss of biodiversity
	Increased water temperatures
Stream Characteristics	Flooding/Developed Floodplains
	Degraded habitat
	Flashy Runoff
	Low base flow
	Log jams
	Unstable channels
Sedimentation	Eroding streambanks
Development	
Urban Sprawl	Increased development
	Lawn care
	Inadequate infrastructure
	Erosion and runoff from development
Planning	Lack or coordinated planning and development
	Lack of land use plans
	Poor site design impacts on hydrology
Sewer and Water	Failing septic systems
	Overtaxed municipal systems
	Illegal sewage connections
	Water and sewer access
Urban Runoff	Metals, oils, gas, and greases
Habitat and Wildlife	
	Loss and degradation of habitat and forests
	Loss and degradation of riparian buggers
	Loss and degradation of wetlands
	Mismanagement of invasive species
	Mismanagement of deer and other wildlife populations
Agriculture	
	Loss of farmland
	Lack of Agricultural practice maintenance
Recreation	
	Recreation corridors and impacts on riparian corridors
	Lack of public access to creek and riparian areas

The most cost and outcome-effective uses of resources were examined once the concern and their sources were identified. A multi-layered/staged methodology was developed with this prioritized list in mind, to determine critical areas and management practices that will address watershed needs and ultimately return the surface water within the Parkerson Mill Creek Watershed back to its intended and designated uses.

TMDL

Looking to the future, one of the greatest challenges within the Parkerson Mill Creek Watershed is the development of the Pathogen TMDL. Once a waste load allocation (WLA) is assigned, updates to this management plan will be made to reflect the goals or reductions required by the TMDL.

CHALLENGE SUMMARY

In summary, the future of the Parkerson Mill Creek Watershed is positive. The potential to address pollutants within the watershed, specifically pathogens is greater since the pollutants have been identified and their sources and causes recognized. The Parkerson Mill Creek Watershed Management Plan Committees aim to return Parkerson Mill Creek to its designated use and pursue the desired uses of its stakeholders through the implementation of various management alternatives.

CHAPTER 5: PARKERSON MILL CREEK WATERSHED MANAGEMENT ALTERNATIVES

EXISTING POLICIES AND PROGRAMS

Having assessed the current conditions of the Parkerson Mill Creek Watershed and identified critical protection areas, it is also necessary to assess the existing management approaches being used within the watershed. The management strategies and current management programs provide a starting point and framework for the recommendations of the Committees developing this plan.

The efforts to restore and protect Parkerson Mill Creek and its watershed are driven by the numerous programs that are active on the creek. Table 29 is a description of the current programs on Parkerson Mill Creek.

Table 29. Existing Policies and Programs within the Parkerson Mill Creek Watershed

Policies			
City of Auburn Buffer Ordinance		Protects and maintains riparian buffers and their management	
City of Auburn Conservation Subdivision		Provides preservation and conservation options for developers	
Programs		**Efforts**	**Pollutant Addressed**
AWW			
	Environmental Awareness	Monitoring	Nutrients, Sediment, Pathogens
	Ag Initiative Tallapoosa	Monitoring	Pathogens
	Save our Saugahatchee	Monitoring	Pathogens
	Chewacla Water Watch	Monitoring	Nutrients, Sediment, Pathogens
	Jake and Donny Water Watch	Monitoring	Nutrients, Sediment, Pathogens
	Engineers without Borders	Monitoring	Pathogens
Auburn University Master Plan		Planning for LID Practices	
IMPACT		Cleanup, Preservation, Invasives Removal	Trash, Sediment
City of Auburn Stormwater Management (Phase II)		Planning, Management	
Auburn University Stormwater Management (Phase II)		Planning, Management	
Alpha Phi Omega		Clean up	Trash
USCG Auxiliary Eagle Detachment			
Auburn University		Clean up	Trash
The BIG Event		Clean up, Invasives Removal	Trash, Sediment

PROPOSED BEST MANAGEMENT PRACTICES: DESCRIPTION AND PERFORMANCE

Management alternatives that address the sources and causes of the water quality problems are called Best Management Practices, or BMPs. BMPs vary in size, cost, feasibility, and effectiveness because the cover a broad range of activities that have complex factors. A stormwater BMP is a technique or structure that is used to manage the quantity and improve the quality of stormwater entering the system. Structural BMPs are engineered systems such as bioretention or constructed stormwater wetlands and are designed to treat stormwater pollution; whereas educational or pollution prevention practices are designed to limit generated stormwater by preserving and protecting natural features that are non-structural stormwater BMPs. The USEPA recognizes over 150 BMPs at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/ (Menu of BMPs, 2008).

No one BMP can address all stormwater problems. Site-specific factors in addition to constraints such as land space, cost, and pollutant removal efficiency need to be considered. In order to determine which BMPs are the most effective in meeting the Parkerson Mill Creek Watershed Management Plan goals, the Technical Committee brainstormed and created this list of BMPs based on the following 1) best at addressing priority area, 2) feasibility, and 3) cost.

When planning to implement BMPs one consideration brought forth by the Committee was to phase or sequence BMPs based off implementation feasibility. It is the goal of the Parkerson Mill Creek Watershed Management Plan Committees that a stage or phase be indicated for each proposed BMP.

STRUCTURAL PRACTICES

The physical systems designed and constructed for new or existing development that reduce stormwater impacts by trapping or filtering pollutants, and/or reducing runoff velocities are called structural BMPs. Structural BMPs can be designed to meet a variety of goals. Structural BMPs need to be designed by an engineer or design professional to ensure they meet the requirements of proper treatment. Monitoring inflow and outflow of these systems will aid in quantitatively measuring their effect. Pollutant removal efficiencies of various BMPs adopted by the City of Auburn are listed in the proposed practice description.

Homeowner BMPs or BMPs installed at a specific residence that are not designed by an engineer or design professional are also helpful in meeting watershed management plan goals. Homeowner BMPs are often variable and have uncertain pollution removal rates; however their importance is not to be discounted. Vegetated, structural homeowner BMPs such as rain gardens, as well as rain water harvesting to reduce stormwater quantity entering the storm sewer system are the primary focus of homeowner BMPs in the Parkerson Mill Creek Watershed.

NON-STRUCTURAL PRACTICES

Non-structural BMPs include educational and regulatory practices that prevent pollutants from entering runoff or reduce volume of stormwater requiring management. These include educational programs, land use planning, signage, regulation, natural resource protection, and operation and maintenance. These practices are often difficult to measure quantitatively in terms of pollutant reduction; however research demonstrates that these BMPs have impacts on changing policy, enforcing standards, and changing public awareness. These BMPs target source control – which is also cost-effective. These BMPs should not be overlooked and should be emphasized.

No single BMP is ideally suited for every situation and with it brings various performance, maintenance and environmental advantages and disadvantages.

PROPOSED PRACTICES

A list of proposed best management practices can be found in Table 30 and their descriptions below.

Table 30. Proposed Best Management Practices for the Parkerson Mill Creek Watershed

BMP	BMP Category
Bioretention	Structural
Bridges/Access Points	Structural
Constructed Stormwater Wetlands	Structural
Control Soil Erosion/Stabilize Soil on Construction Sites	All
Debris Removal	Structural
Detention	Structural
Dump Station Promotion	Non-Structural
Educational Signage	Non-Structural
Educational Workshops	Non-Structural
Enforcement for Illegal Dumping	Non-Structural
Football Program Education	Non-Structural
Hydrologic and Hydraulics Study	All
Improve Policy/Ordinance	Non-Structural
Litter/Trash Containers	Structural
Monitoring	Non-Structural
Pet Waste Disposal Stations	Structural
Promotion of Examined Infrastructure/Enforcement For Illegal Dumping	Non-Structural
Rain Gardens	Homeowner
Rainwater Harvesting	Structural/Homeowner
Riparian Buffer	Structural
Storm Drain Marking	Non-Structural
Stream Bank Stabilization	Structural
Stream Restoration	Structural
Vegetated Filter Strip	Structural
Vegetated Swale	Structural

BIORETENTION

Bioretention is a landscape feature and best management practice that promotes filtration and infiltration. Typically these systems can be implemented into parking lot islands or within small areas of residential or industrial land uses. In a bioretention system, surface runoff is directed into a bowl-shaped depression designed to handle a specific volume of stormwater runoff. Native vegetation is planted in the depression to aid in nutrient treatment. The runoff filters through mulch and specialized media layers for further treatment. The treated runoff continues to flow through a perforated underdrain network and eventually into the storm sewer system. Emergency overflow outlets are installed for larger capacity storm events. Bioretention areas with an internal water storage layer may be employed where needed for additional stormwater treatment.

The City of Auburn accepts an estimated pollutant removal efficiency rates of 80% for total suspended solids, 60% and 50% for total phosphorus and total nitrogen. Bioretention is also shown to have moderate reductions in metals, reductions in pathogens and temperature reductions.

BRIDGES/ACCESS POINTS

Bridges and access points to Parkerson Mill Creek allow individuals to safely access the creek and to learn about its ecosystem services. These BMPs provide educational opportunities and encourage interest in Parkerson Mill Creek. Bridges and access points will benefit construction of other BMPs and allow for additional inspection of currently inaccessible areas.

CONSTRUCTED STORMWATER WETLAND

Constructed Stormwater Wetlands (CSW) are systems designed to mimic the function of natural wetland systems. CSW's are excellent at mitigating for the impacts of urbanization and increased volumes and rates of runoff. The City of Auburn recognizes pollutant removal efficiencies of 80% for TSS, 40% for TP, 30% for TN, 50% for metals and 70% for pathogens, making it one of the most efficient pollutant removal BMPs. CSW's not only store stormwater, but the combination of microtopography and native emergent and herbaceous vegetation allows for complex microbial processes to treat pollutants. These BMPs have also been shown to stabilize flow in adjacent streams and reduce peak runoff rates. Various designs for CSW exist but the use of the traditional shallow wetland and pocket wetland should be promoted in the Parkerson Mill Creek Watershed to optimize the treatment of pathogens. These systems can often be land intense, but are worth the land sacrifice for their pollutant removal capability.

CONTROL SOIL EROSION/STABILIZE SOIL ON CONSTRUCTION SITES

Soil erosion control is the process of stabilizing soils in order to prevent or reduce erosion due to stormwater runoff. Common source areas within the Parkerson Mill Creek Watershed include constructions sites and streambanks eroding due to lack of vegetation. Soils can be stabilized using a variety of methods and reference to the Alabama Erosion and Sediment Control Manual should be made when designing, implementing, or maintaining these practices.

DEBRIS REMOVAL

Debris removal in Parkerson Mill Creek involves planned removal of debris at the Lem Morrison Bridge crossing and other crossings where flow problems are created by blockages of debris, log jams, sediment islands, or other obstruction within Parkerson Mill Creek. Woody debris can provide bank protection and habitat; however if flow problems are compounded, removal is required and should be performed in an environmentally friendly manner. Stakeholders are encouraged to monitor for areas needing debris removal.

DETENTION

Detention, primarily in the form of detention ponds are to be designed to meet or exceed the City of Auburn's water quality volume and allow for infiltration and evaporation. These systems are only to be used where other BMPs are not feasible. Wet detention or wet ponds are constructed basins designed to contain a permanent pool of water in order to detain and settle stormwater runoff. These systems can be designed as wet or dry detention, however wet detention has shown to have higher nutrient removal capabilities if planted with native, emergent, wetland vegetation. Wet detention should be used where feasible. A sediment forebay is required to allow for sediment settling and reduced clogging and system maintenance. Detention ponds are designed for larger commercial or industrial areas and can be land-intensive. Areas should be designed considering functions, aesthetics, safety, and maintenance.

DUMP STATION PROMOTION

Stakeholders recognize that RV owners may be one source of illegal dumping into Parkerson Mill Creek. The promotion of dump stations through educational signage and publications is one BMP to be implemented to promote the reduction of pathogens in Parkerson Mill Creek.

EDUCATIONAL SIGNAGE

In addition to signage along Parkerson Mill Creek and at specific BMPs educational signage throughout the watershed, such as stream crossing signage will be used to increase awareness and stewardship of the Parkerson Mill Creek Watershed.

EDUCATIONAL WORKSHOPS

Parkerson Mill Creek partners will provide educational workshops to teach stakeholders and visitors about the watershed. Educational workshops will focus on the design, construction, and maintenance of implemented BMPs, as well as general watershed monitoring, education, and stewardship.

FOOTBALL PROGRAM EDUCATION

Stakeholders recognize the negative effects and potential uncontrolled sources of bacteria that may enter Parkerson Mill Creek due to the population increase associated with Auburn University Football. An educational program and publications will be used and distributed to the Auburn University Football community promoting proper disposal of all waste materials and additional information about Parkerson Mill Creek on the campus of Auburn University.

HYDROLOGIC AND HYDRAULICS STUDY

A comprehensive study of the hydrology of the Parkerson Mill Creek system would aid in the understanding of the precipitation, infiltration, runoff, flowrates, storage, and water use within the watershed. A hydraulic study would yield information about the velocity, flow depth, erosion, and infrastructure that affects the morphology of Parkerson Mill Creek. This information would provide insight as to the sources and causes of problems on

Parkerson Mill Creek and would help to identify prioritized areas for best management practices.

IMPROVED POLICY/ORDINANCE

In order to protect key local natural resources land development needs to be directed in a manner that clarifies why protection is important and how natural resources can be protected under the law. Local policy and ordinances can be more protective than state or federal law and can better reflect the priorities of the local community.

LITTER/TRASH CONTAINERS

Stakeholders are aware of the large quantity of litter entering Parkerson Mill Creek. One of the primary ways litter and trash are entering Parkerson Mill Creek is through stormwater runoff transportation of ignorantly disposed litter. Litter and trash containers are to be implemented to encourage individuals to dispose of their waste properly and reduce the amounts of litter and trash in Parkerson Mill Creek.

MONITORING

A long-term BMP to be implemented in the Parkerson Mill Creek Watershed is monitoring. Continued monitoring efforts of assessed bacteriological, water chemistry, sediment and biological indicators will be preformed. Monitoring of implemented BMPs as well as other additional activities within the watershed is to be considered and promoted.

PET WASTE DISPOSAL STATIONS

Pet waste can be one source of pathogens. Pet waste disposal stations are to be implemented in strategic locations throughout the watershed to promote proper disposal of pet waste.

PROMOTION OF EXAMINED INFRASTRUCTURE/ENFORCEMENT FOR ILLEGAL DUMPING

Illicit Discharge Detection and Elimination requires the prevention, detection, and removal of all physical connects or cross connections to the stormwater drainage network that convey materials other than stormwater. The City of Auburn and Auburn University have existing programs for detection and elimination of illicit discharge. In addition to encouragement of these programs, volunteer groups doing work on Parkerson Mill Creek will be encouraged to detect illicit discharges. Measures need to be implemented to detect, correct, and enforce against illegal dumping of materials in streets, stormdrains, and streams. Spill prevention, containment, cleanup, and disposal methods of spilled materials to prevent and reduce instances of creek contamination need to be considered and implemented throughout the watershed. Dye testing may be considered by Auburn University and the City of Auburn to identify illicit connections.

RAIN GARDENS

A rain garden is a constructed and vegetated depressional area used in residential landscapes to improve water quality, primarily through infiltration. Rain gardens are designed to intercept runoff from small-scale impervious surfaces. In addition to infiltration some nutrient removal can occur in these systems. Plant choices should focus on native vegetation. A guide and useful tool for rain gardens is *Alabama Smart Yards.*

Alabama Smart Yards, a publication by the Alabama Cooperative Extension System, provides more information on the design and installation of rain gardens and can be found at http://www.aces.edu/pubs/docs/A/ANR-1359/ANR-1359.pdf.

RAINWATER HARVESTING

Rainwater harvesting is a BMP that promotes the conservation of rainwater. Rainwater harvesting has many applications throughout the landscape. These applications include rain barrels for residential and institutional land uses and the use of large-scale cisterns in commercial and industrial areas. Rainwater harvesting when applied to lawns, gardens, and vegetated landscapes can reduce the amount of fertilizer application necessary, thus reducing the potential of nutrients entering into Parkerson Mill Creek.

RIPARIAN BUFFERS

Riparian buffers or streamside ecosystems located adjacent to the stream channel can enhance water quality thought the control of NPS pollution and protection of the stream system. These buffers physically protect and separate the stream from future disturbance. Pollutant removal of these systems is dependent on loading rates, stream size/capacity, vegetation, and size of the buffer. The City of Auburn Buffer Ordinance should be used when establishing riparian buffers within the Parkerson Mill Creek Watershed. Additionally, on agricultural lands landowners can be eligible for USDA programs that aid to pay for this practice.

STORM DRAIN MARKING

Storm drain marking is one non-structural BMP that will aid in the marking storm sewer network. Additionally with implementation of storm drain markers the Parkerson Mill Creek community will be educated about storm sewers draining to the creek and the lack of water treatment within this network.

STREAM BANK STABILIZATION

Streambank stabilization measures are designed to stabilize and protect streambanks. Understanding the cause of erosion is crucial to the proper application of a streambank stabilization technique. Techniques work by either reducing the force of impact to the streambank or increasing the resistance to bank erosion. Bioengineering or biotechnical techniques that use integrated plants and inert structural materials are to be used in the stabilization of Parkerson Mill Creek instead of engineered structures, such as rip rap, gabions, and deflectors, whenever possible. This is to increase habitat and aesthetics.

STREAM RESTORATION

Stream restoration techniques to be used on Parkerson Mill Creek are in-stream structures for habitat enhancement, grade control, or erosion prevention. These structures require professional engineering design, trained installation, and proper maintenance.

VEGETATED FILTER STRIPS

Filter strips are a BMP designed to treat sheet flow from adjacent impervious surfaces. Filter strips, are typically a vegetated strip of grass or other permanent vegetation. Filter strips slow the velocity of stormwater runoff, filter sediment and other pollutants, provide for some infiltration, and can prevent wind erosion. The City of Auburn recognizes estimated pollutant removal efficiencies of 50% for TSS, 20% for nutrients (TN and TP), and 40% for Metals. These systems are commonly paired with other BMPs to optimize pollutant removal.

VEGETATED SWALES

Swales are open channel management practices designed to treat, convey, and attenuate stormwater runoff. As stormwater runoff moves through these systems it is first filtered by native vegetation or native grasses and then though the subsoil mixture. These systems are an alternative to a conventional drainage ditch and can be implemented in a variety of locations to treat transportation or residential runoff. Swales are typically designed with more gentle side and longitudinal slopes and have design velocities that allow for stormwater treatment of smaller storm events. The type and coverage in the swale system will affect pollutant treatment. For a grassed swale system the City of Auburn has estimated pollutant removal efficiencies of 80% for Total Suspended Solids (TSS), 50% for Total Nitrogen and Total Phosphorus and 40% for Metals.

BMPs INCLUDED IN STEPL MODELING

The Spreadsheet Tool for Estimating Pollutant Load or STEPL model was used to determine quantities of pollutants within the Parkerson Mill Creek Watershed. The STEPL model uses simple algorithms to calculate nutrient and sediment loads from various land uses within the watershed and provides load reductions based on the implementation of various best management practices (STEPL, 2010). The STEPL model doesn't address the loading or reduction of pathogens however it may be used to assess the reductions of other pollutants. The STEPL model was used to determine the total nitrogen, phosphorus, biogeochemical oxygen demand (BOD), and sediment loads in the Parkerson Mill Creek Watershed. Their amounts, based off of current land use are shown in Table 31.

Table 31. STEPL Nitrogen, Phosphorus, BOD, and Sediment Loads for Parkerson Mill Creek

Nitrogen	Phosphorus	BOD	Sediment
51,082 lb/yr	10,753 lb/yr	177,915 lb/yr	1748 t/yr

Using the Urban LID Tool within the STEPL model several BMPs can be implemented in a variety of land uses. For the Parkerson Mill Creek Watershed the following BMPs were used (Low Impact Development Classification):

- Bioretention
- Rain Gardens
- Detention/Constructed Stormwater Wetlands
- Water Harvesting
- Streambank stabilization/restoration
- Filter Strips
- Swales

For this plan it was proposed that 10% of each land use category be used for the application of BMPs, for a total of 282 acres. Table 32 illustrates the acreage of specific Best Management Practice within each land use category.

Table 32. BMPs included in STEPL Modeling

Land Use	**BMP**	**Acreage**
Commercial		
	Bioretention	24
	Detention	12
	Water Harvesting	2
	Swale	10
Industrial		
	Bioretention	10
	Detention	18
Institutional		
	Bioretention	18
	Rain Garden	8
	Water Harvesting	2
Transportation		
	Filter Strips	8
	Swale	20
Multi-Residential		
	Rain Garden	11
	Water Harvesting	1
	Swale	14
	Filter Strips	2
Single Residential		
	Rain Garden	40
	Water Harvesting	5
	Swale	18
	Filter Strips	22
Urban Cultivated		
	Rain Garden	8
Vacant		
	Swale	4
	Bioretention	6
	Detention	4
Open Space		
	Swale	3
	Bioretention	8
	Detention	4
Total Acreage in BMPs		**282**

Using these BMPs there is a reduction of 3969 lb/yr (7.8%) in nitrogen, 852 lb/yr (7.9%) in phosphorus, 2900 lb/yr in BOD (1.6%), and 381 t/yr (22%) in sediment, according to the model. Figure 66 illustrates the nitrogen, phosphorus, and BOD load reductions.

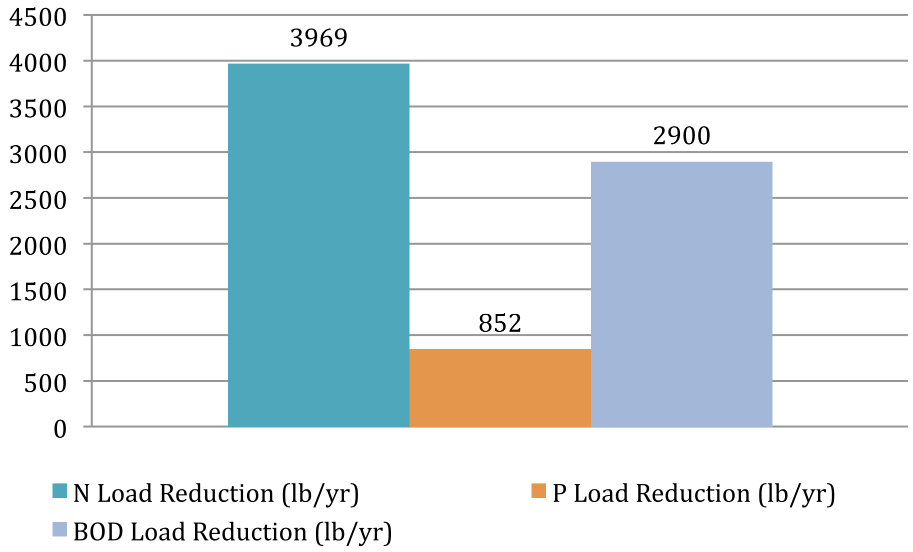


Figure 66. Estimated Load Reductions (lb/yr) for Nitrogen, Phosphorus and BOD

Additional output from the STEPL model can be found in Appendix C.

IMPLEMENTATION

ACTION PLAN

In order to improve the water quality of the Parkerson Mill Creek Watershed action must be taken. Developing an action plan is the primary focus of the Parkerson Mill Creek Watershed Management Plan Committees. This process has been and will continue to be an iterative and comprehensive process. The action plan is designed for a two–year time frame, acknowledging that the action plan will then need to be revised to reflect the current conditions of the watershed. The strategies and tasks recommended in the action plan are not mandatory but will aid the City of Auburn, Auburn University, and Lee County in fulfilling their NPDES Phase II Stormwater permit requirements. The plan includes where feasible: the target, strategy, cost, funding, estimated reduction, level of effort and recommended location.

Table 33. Parkerson Mill Creek Watershed Management Plan Action Plan

Target	Strategy	Cost	Funding	Estimated Reduction	Level of Effort	Recommended Areas & Locations
Pathogens	Illicit Discharge Detection/Examined Infrastructure	Staff Time			City of Auburn and Auburn University	Entire Watershed
	Dump Station	Unknown			Auburn University	Auburn University Campus
	Bioretention	\$7.10/ft^3 per volume	319 Program	Some	Local Government, Private Landowners, City of Auburn, Auburn University	Commercial, Industrial, Institutional, Residential
	Pet Waste Disposal Stations	\$355/per station			City of Auburn and Auburn University	Along Greenway
	Detention/ Constructed Stormwater Wetland	\$3.75/ft^{3}per volume	319 Program	PRE - 70%	Local Government, Private Landowners, City of Auburn, Auburn University	Commercial, Industrial, Open Space
	Storm Drain Marking	\$2,000			City of Auburn and Auburn University	Auburn University, City of Auburn
Erosion and Sedimentation	Stream Bank Stabilization				Local Government, Private Landowners, City of Auburn, Auburn University	Throughout Watershed
	Bioretention	\$7.10/ft^3 per volume	319 Program	PRE- 80%	Local Government, Private Landowners, City of Auburn, Auburn University	Commercial, Industrial, Institutional, Residential
	Detention/Constructed Stormwater Wetland	\$3.75/ft^{3}per volume	319 Program	PRE- 80%	Local Government, City of Auburn, Auburn University	Commercial, Industrial, Open Space
	Vegetated Swale	\$2.25/ft^{3}per volume	319 Program	PRE- 80%	Local Government, Private Landowners, City of Auburn, Auburn University	Transportation Corridors, Residential, Open Space
	Vegetated Filter Strip	\$1.25 linear foot	319 Program	PRE - 50%	Local Government, Private Landowners, City of Auburn, Auburn University	Transportation Corridors, Residential
	Debris Removal	\$10,000-\$50,000			Local Government, City of Auburn, Auburn University	At Creek Crossings
	Stream Restoration				Local Government, Private Landowners, City of Auburn, Auburn University	Throughout Watershed
	Control Soil Erosion				Local Government, City of Auburn, Auburn University	Construction sites and locations within the watershed
	Riparian Buffer		319 Program		Local Government, Private Landowners, City of Auburn, Auburn University	Along Parkerson Mill Creek and its tributaries
	Rain Gardens	\$2.35/ft^{3}per volume	319 Program		Local Government, Private Landowners, City of Auburn	Residential, Institutional

Target	Strategy	Cost	Funding	Estimated Reduction	Level of Effort	Recommended Areas & Locations
Nutrients	Vegetated Swale	\$2.25/ft^{3}per volume	319 Program	PRE - 50%TP/50%TN	Local Government, Private Landowners, City of Auburn, Auburn University	Transportation Corridors, Residential, Open Space
	Bioretention	\$7.10/ft^3 per volume	319 Program	PRE - 60%TP/50%TN	Local Government, Private Landowners, City of Auburn, Auburn University	Commercial, Industrial, Institutional, Residential
	Vegetated Filter Strip	\$1.25 linear foot	319 Program	PRE - 20%TP/20%TN	Local Government, Private Landowners, City of Auburn, Auburn University	Transportation Corridors, Residential
	Water Harvesting (no transport)	\$2.25/gal per volume	319 Program	1.5mg N/L	Private Landowners, City of Auburn, Auburn University	Commercial, Institutional, Residential
	Rain Gardens	\$2.35/ft^{3}per volume	319 Program		Local Government, Private Landowners, City of Auburn, Auburn University	Residential, Institutional
	Rainwater Harvesting	\$2.25/gal per volume	319 Program	1.5mg N/L	Private Landowners, City of Auburn, Auburn University	Commercial, Institutional, Residential
	Riparian Buffer		319 Program		Local Government, Private Landowners, City of Auburn, Auburn University	Along Parkerson Mill Creek and its tributaries
	Detention/Constructed Stormwater Wetland	\$3.75/ft^{3}per volume	319 Program	PRE - 40%TP/30%TN		Commercial, Industrial, Open Space
Education and Stewardship	Enforcement for Illegal Dumping	Enforcement			Local Government, Private Landowners, City of Auburn, Auburn University	Entire Watershed
	Improve Policy/Ordinance	\$2000 + Staff Time			Local Government, Private Landowners, City of Auburn, Auburn University	City of Auburn and Auburn University
	Football Program Education	\$5000 + Staff Time			Local Government, Private Landowners, City of Auburn, Auburn University	Auburn University Campus
	Dump Station Promotion	\$2,500				Auburn University Campus
	Football Program Education	\$2,500				Auburn University Campus
	Bridges/Access Points	Unknown			City of Auburn and Auburn University	Auburn University Campus, City of Auburn
	Educational Signage	\$7,500	319 Program		City of Auburn and Auburn University	Entire Watershed, specifically crossings, and high foot traffic areas
	Litter/Trash Containers	\$300/unit			Local Government, Private Landowners, City of Auburn, Auburn University	Auburn University Campus, City of Auburn
	Educational Workshops	\$1000/ workshop	319 Program		Local Government, City of Auburn, Auburn University	Auburn University Campus, City of Auburn
Monitoring	Monitoring	\$3000 + volunteers	319 Program		City of Auburn and Auburn University	Entire Watershed
	Hydrologic and Hydraulics Study	\$8,000 + volunteers	319 Program		City of Auburn and Auburn University	Entire Watershed

RETROFITS

In areas where possible stormwater best management practice retrofits or simply retrofits should be considered. A retrofit is a practice that is implemented in to a previously developed or built out landscape. Potential areas for retrofits include parking lot islands, recreational park open space, and other small open spaces in commercial, industrial, and institutional land uses. Due to the current land use in the watershed being primarily developed and trends suggesting increased development, retrofits are a great option to treat existing impervious areas.

PUBLIC INVOLVEMENT

The Committees for the Parkerson Mill Creek Watershed Plan recognize the importance of public involvement in development of the plan, its acceptance and long-term sustainability. Throughout this process stakeholders were encouraged to participate and continue to foster stewardship and the proper management of Parkerson Mill Creek.

The Education and Outreach committee will continue to increase local commitment and sustainability. Efforts will continue to increase awareness and knowledge of the watershed among the various communities and entities as part of the public participation process. The Education and Outreach Committee has the goal of creating awareness of watershed issues and water quality that will promote positive action to protect and enhance the Parkerson Mill Creek Watershed. The objectives of continued communication are to:

- Increase participation and activities that result in protection and restoration of Parkerson Mill Creek and its watershed
- Increase the general publics awareness and knowledge of Parkerson Mill Creek
- Promote and educate the general public of the connectedness of Parkerson Mill Creek and its communities
- Reduce pollution by providing knowledge to key stakeholder groups.

Target audiences within in the watershed include:

- Households
- Auburn University
- Agricultural Community
- Local Government
- Development Community
- Businesses
- Educators/Local School Systems
- Partner Organizations

The Parkerson Mill Creek Watershed Management Plan Committees plan to use the resources of stakeholder groups to communicate with each of these communities and groups of individuals.

CHAPTER 6: ASSESSMENT AND SUSTAINABILITY OF THE PARKERSON MILL CREEK WATERSHED PLAN

ASSESSMENT

QUALITATIVE

The Parkerson Mill Creek Watershed will be assessed visually, primarily through the form of watershed walks preformed by stakeholders semiannually. Both the City of Auburn and Auburn University have committed to pursue illicit discharge detection on Parkerson Mill Creek as part of their compliance with Phase II Stormwater Regulations. Student groups, such as IMPACT and Engineers Without Borders have volunteered to visually inspect Parkerson Mill Creek as they perform their prior commitments on Parkerson Mill Creek.

QUANTITATIVE

Parkerson Mill Creek will be assessed quantitatively through continued monitoring, BMP effectiveness and milestone achievement. These efforts will be evaluations of success ultimately determining success based on the achievement of the state Water Quality Standards and the Fish and Wildlife Use classification. Quantitative assessments will be driven by the monitoring efforts outlined below.

STEPL MODEL

The Spreadsheet Tool for Estimating Pollutant Load or STEPL model was used to determine quantities of pollutants within the Parkerson Mill Creek Watershed. Load reductions based on the implementation of various best management practices were estimated using the STEPL model. The STEPL model doesn’t address the loading or reduction of pathogens within the watershed, but may be used to assess the reductions of other pollutants the watershed. For this plan’s purpose the STEPL model was used in determining the loads for nitrogen, phosphorus, BOD, and sediment for current land use. The STEPL model may be used to assess the effectiveness of BMPs implemented within the watershed.

SUSTAINABILITY

COMMITTEES

The Parkerson Mill Creek Watershed Technical and Education and Outreach Committees will be responsible for determining if assessments are preformed in a timely manner and evaluation criteria are being met. The Technical Committee is responsible for investigations of BMP effectiveness. Agencies responsible for implementing watershed activities will tract BMP implementation, and provide reports to the Parkerson Mill Creek Watershed Management Plan Technical Committee during and post completion of the activity. The Technical Committee will combine these reviews with assessments of pathogens based on E. Coli monitoring in an annual report. Copies of these reports will be submitted to ADEM. The Technical Committee Annual Reports will be compared to past reviews to determine if progress is being made toward the attainment of the water quality standards. The Education and Outreach Committee will be responsible for the coordination and promotion of educational workshops held regarding the Parkerson Mill Creek Watershed.

MONITORING

Water quality and bacteriological monitoring will continue to be preformed by the Alabama Department of Environmental Management. Additional monitoring will be preformed by the City of Auburn and Auburn University. Monitoring will ultimately determine the long-term success of the project.

ADEM conducts intensive monitoring studies on a five–year rotational river basin assessment. Side-by-side monitoring, including the City of Auburn and Auburn University will be encouraged for this monitoring schedule. 319 reports will be available to stakeholders communicating the results of this monitoring effort. Additionally, beginning in November 2010 and continuing during the plan implementation phase the Engineers Without Boarders student club will monitor sites on Auburn University’s campus through Alabama Water Watch. This data will be made available through the AWW website and watershed meetings. Other AWW groups will continue to be encouraged to monitor sites on Parkerson Mill Creek.

All monitoring will consider historical monitoring locations, focusing on areas in Reach 1 and 2, in the headwaters.

Upon implementation of BMPs targeted monitoring may also be included. The effectiveness of each BMP will be considered based on targeted monitoring, as well as overall watershed reductions. Post BMP installation an intensive E. coli monitoring study will be completed in both wet and dry weather events, between April and December of the year following installation and three years post installation.

PLAN REVISION

Any watershed stakeholder may request a management plan review. A review is to be voted on at a watershed stakeholder meeting, including at least one member of the Technical Committee and must pass by a majority.

The Parkerson Mill Creek Watershed Management Plan will be updated and revised on an as needed basis, with exception of a revision to be performed post implementation. Stakeholders will be advised of any Parkerson Mill Creek Watershed Management Plan revision. The plan revision is the responsibility of the Technical Committee. Any communication with stakeholders, including communication of a plan revision is the responsibility of the Education and Outreach Committee.

CHAPTER 7: ADDITIONS, AMENDMENTS, AND UPDATES TO THE PARKERSON MILL CREEK WATERSHED MANAGEMENT PLAN

January 2011

Following the submission of the Parkerson Mill Creek Watershed Management in December of 2010, the Parkerson Mill Creek stakeholder committees (Technical and Education and Outreach Committees) decided to pursue prioritization of the strategies set forth in the Action Plan.

The committees initially decided to investigate practices that would target nonpoint pollution sources, keeping the primary goals of the watershed management plan, but prioritizing targets of pathogens, erosion and sedimentation, and education and stewardship. It was determined that the STEPL modeling for the Parkerson Mill Creek Watershed Management Plan set forth too many ambitious goals for the immediate future and should be revisited.

Long-term solutions, in the form of properly installed and functioning stormwater best management practices and increased watershed awareness and education of stakeholders are to be implemented. These solutions and efforts collectively make up the Parkerson Mill Creek Watershed Enhancement Project. The objectives of this project are to (1) improve water quality in the Parkerson Mill Creek Watershed by implementing, demonstrating, and evaluating effectiveness of best management practices that address nonpoint source pollution in critical areas and throughout the watershed and (2) reducing the impacts of nonpoint source pollution on water quality through increased awareness, education, and outreach to the watershed stakeholders; by continuing water quality and bacteriological monitoring, implementing education and outreach activities and promoting proper planning and non-structural best management practices.

The STEPL model was run to determine the pollutant load reductions for an estimated reduction in total Nitrogen and total Phosphorus of 4% and a reduction in sediment of 7%. Pathogen estimated pollutant load reduction is based off of pollutant load reductions for proposed practices, namely constructed stormwater wetlands established by the City of Auburn Stormwater Design Manual. It is know that pathogens are also closely associated with sediment; therefore, we expect the reduction in pathogen loading to be greater than the projected 1%.

REFERENCES

Alabama Maps. University of Alabama Department of Geography. November 29 2010. University of Alabama. June 2010. <http://alabamamaps.ua.edu/index.html>

Alabama Natural Heritage Program. 2010. *Alabama Inventory List: the Rare, Threatened, and endangered Plants and Animals of Alabama.* Privately printed by the Alabama Natural Heritage Program. 1090 S. Donahue Drive Auburn University 36849.

Alabama Water Watch. 2006. *Alabama Water Watch Bacteriological Monitoring Handbook*. Auburn University, Auburn Alabama.

Alabama Water Watch. 2006. *Alabama Water Watch Water Chemistry Handbook*. Auburn University, Auburn Alabama.

Armon R. and Y. Knott. Distribution comparison between coliphages and phages of anaerobic bacteria (Bacteroides fragilis) in water sources and their reliability as fecal pollution indicators in drinking water. Water Sci. Technol. 31, 215, 1995.

CH2MHILL, East Alabama Regional Planning and Development Commission, Environmental Insight, Inc. Tallapoosa River Basin Management Plan. Montgomery: AL, 2004. 51-56

City of Auburn GIS. Auburn, Alabama, 2010.

City of Auburn Parks and Recreation. City of Auburn. November 2010. <http://www.auburnalabama.org/parks/Default.aspx?PageID=628>

Constanza, Robert. 2008. Ecosystem Services: Multiple Classification Systems are Needed Biological Conservation. 141: 350-352.

Costanza, Robert, dArge, Ralph, et al., 1997. The value of the world's ecosystem services and natural capital. Nature 387 (6630), 253–260.

Dowdle, Deedie. *"Auburn University posts record enrollment, highest freshman ACT scores."* Wire Eagle. September 16 2010.

Dunn, Matt. Email correspondence. 11/15/2010.

Envirofacts. December 1 2010. United States Environmental Protection Agency. July 2010. <http://www.epa.gov/enviro/>

Hakel, S., Lee County Public Health Department, 2010. Personal Communication on December 6, 2010. Septic Tank data accessed through Alabama Department of Public Health Onsite Sewer Information Database.

Impaired Waters and Total Maximum Daily Loads. November 16 2010. United States Environmental Protection Agency. July 2010. <http://water.epa.gov/lawsregs/lawsguidance/CWA/tmdl/index.cfm>

Jennings, G., W. Hunt, D. Clinton, and J. Calabria. *Parkerson Mill Creek Restoration Feasibility Study.*2003.

McIndoe, James. Alabama Department of Environmental Management Water Division – Water Quality Program Administration Code. 1991. Chapter 335-6-10 Water Quality Criteria. 335-6-10-.09.

Menu of BMPs. January 9 2008. United States Environmental Protection Agency. March 2010. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/>

Piedmont. November 15 2010. United States Geological Survey Land Cover Trends Project. December 2010. < http://landcovertrends.usgs.gov/east/eco45Report.html>

Smith, J.E., Jr., and J.M. Perdek. 2003. Assessment and management of watershed microbial contaminants. Crit. Rev. Environ. Sci. Technol. 33:1–27.

Soil Survey Staff, Natural Resource Conservation Service, United States Department of Agriculture. WebSoil Survey. < http://websoilsurey.nrcs.usda.gov/> May 15 2010.

Southeastern Plains. March 8 2010. United States Geological Survey Land Cover Trends Project. December 2010. <http://landcovertrends.usgs.gov/east/eco65Report.html#1>

STEPL – Spreadsheet Tool for Estimating Pollutant Load. January 9 2008. United States Environmental Protection Agency. March 2010. <http://it.tetratech-ffx.com/stepl/>

United States Census Bureau. Interim Projections of Total Population for the United States and States: April 1, 200 to July 1, 2030. 2005.

United States Census Bureau, 2000. Alabama Census. Retrieved from US Census website on April 1, 2010. <http://www.census.gov/main/www/cen2000.html.>

Tallapoosa. Justin Ellis. May 2010. <http://www.riversofalabama.org/Tallapoosa/TALLAPOOSA.htm>

The Auburn University Digital Library. 2006. Auburn University. February 2010. <http://diglib.auburn.edu>

Water Use, by County, in Alabama, 2005 – Lee County. United States Geological Survey. November 2010. <http://ga2.er.usgs.gov/Alabama/wateruse-county.cfm?code=081>

What is Nonpoint Source Pollution? April 15, 2010. United States Environmental Protection Agency. October 15 2010. < http://water.epa.gov/polwaste/nps/whatis.cfm>

Weather Underground. 2010. Accessed May 2010. <http://wunderground.com>

Wetlands Status and Trends. September 30 2010. United States Fish and Wildlife Service. July 2010.<http://www.fws.gov/wetlands/StatusAndTrends/>

APPENDICES

APPENDIX A – Rare or Endangered Species within Lee County

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
Birds					
Haliaeetus leucocephalus	bald eagle	G4	S3B	BGEPA	SP
Falco sparverius	American kestrel	G5	S3B, S5N		
Scolopax minor	American woodcock	G5	S3B, S5N		
Columbina passerine	common ground-dove	G5	S3		SP
Limnothlypis swainsonii	Swainson's warbler	G4	S3B		
Ammodramus savannarum	Grasshopper sparrow	G5	S3		

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
Mammals					
Bos bison	American bison	G4	SX		
Cervus canadensis	elk	G5	SX		
Canis rufus	Red wolf	G1Q	SX	LE	
Puma concolor	mountain lion	G5	SX	LE	
Spilogale putoris	Eastern spotted skunk	G5	S2S3		
Mustela frenata	long-tailed weasel	G5	S3		SP
Ursus americanus	Black bear	G5	S2		
Tadarida brasiliensis	Brazilian free-tailed bat	G5	S3		
Zapus hudsonius	meadow jumping mouse	G5	S3		SP

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
Reptiles					
Lampropeltis calligaster rhombomaculata	mole kingsnake	G5T5	S3		
Lampropeltis getula getula	Eastern kingsnake	G5T5	S4		
Nerodia taxispilota	Brown water snake	G5	S3		

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
Amphibians					
Desmognathus monticola	seal salamander	G5	S5		SP
Plethodon serratus	Southern redback salamander	G5	S2S3		
Plethodon websteri	Webster's salamander	G3	S3		

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
		Fishes			
Moxostoma lachneri	greater jumprock	G4	S3		
Moxostoma sp cf. poecilurum	Apalachicola redhorse	G3	S2		
Campostoma pauciradii	bluefin stoneroller	G4	S2		
Cyprinella callitaenia	bluestripe shiner	G2G3	S1S2		
Cyprinella gibbsi	Tallapoosa shiner	G4	S3		
Hybopsis lineapunctata	lined chub	G3G4	S3		
Hybopsis winchelli	clear chub	G5	S3		
Luxilus zonistius	bandfin shiner	G4	S3		
Notropis hypsilepis	highscale shiner	G3	S2		
Pteronotropis euryzonus	broadstripe shiner	G3	S2		
Micropterus cataractae	shoal bass	G3	S2		
Etheostoma tallapoosae	Tallapoosa darter	G4	S3		
Perca flavescens	Yellow perch	G5	S3		
Percina palmaris	Bronze darter	G4	S3		
Percina smithvanizi	muscadine darter	G2G3	S2		
Ameiurus brunneus	snail bullhead	G4	S3		
Ameiurus catus	white catfish	G5	S3		
Ameiurus serracanthus	spotted bullhead	G3	S2		

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
		Clams and Mussels			
Elliptio fumata	gulf slabshell	G4	S3		PS
Elliptoideus sloatianus	purple bankclimber	G2	S1	LT	SP
Hamiota altilis	finelined pocketbook	G2	S2	LT	SP
Hamiota subangulata	shinyrayed pocketbook	G2	S1	LE	SP
Lampsilis floridensis	Florida sandshell	G3G4	S2		PS
Pleurobema decisum	Southern clubshell	G2	S2	LE	SP
Pleurobema perovatum	ovate clubshell	G1	S1	LE	SP
Pleurobema pyriforme	oval pigtoe	G1	S1	LE	SP
Quadrula infucata	sculptured pigtoe	G3	S1		
Strophitus connasaugaensis	Alabama creekmussel	G3	S3		PS
Toxolasma corvunculus	Southern purple lilliput	G1	S1		PS
Toxolasma parvum	lilliput	G5	S3		PS
Toxolasma paulus	iridescent lilliput	G4G5Q	S2		PS
Uniomerus columbensis	Apalachicola pondhorn	G3	S2		PS
Villosa villosa	downy rainbow	G3	S1		PS

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
	Crayfish and Shrimp				
Cambarus bartonii	Appalachian brook crayfish	G5	S2		
Cambarus halli	slackwater crayfish	G3G4	S3		
Cambarus howardii	Chattahoochee crayfish	G3	S2		
Procambarus paeninsulanaus	peninsula crayfish	G5	S2		

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status
	Plants				
Botrychium jenmanii	Alabama grapefern	G3G4	S1		
Psilotum nudum	whiskfern	G5	S1		
Isoetes virginica	Piedmont quillwort	G3	S2		
Selaginella arenicola spp *riddellii*	Riddell's spike moss	G4T4	S2		
Selaginella rupestris	ledge spike-moss	G5	S2		
Rhynchospora globularis var. saxicola	Stone Mountain beakrush	G3Q	S1		
Panicum lithophilum	Swallen's panic-grass	G2G3Q	S1		
Juncus georgianus	Georgia rush	G4	S1		
Hymenocallis coronaria	shoals spider-lily	G2Q	S2		
Trillium reliquum	relict trillium	G3	S2	LE	
Trillium rugelii	Southern nodding trillium	G3	S2		
Trillium vaseyi	Vasey's trillium	G4	S1		
Croomia pauciflora	croomia	G3	S2		
Liparis loeselii	Loesel's twayblade	G5	S1		
Brickellia cordifolia	Flyr's brickell-bush	G2G3	S2		
Echinacea pallida	pale-purple coneflower	G4	S2		
Helianthus porteri	confederate daisy	G4	S2		
Rudbeckia heliopsis	sun-facing coneflower	G2	S2		
Rhododendron prunifolium	plumleaf azalea	G3	S2S3		
Baptisia megacarpa	Apalachicola wild indigo	G2	S2		
Pycnanthemum curvipes	a mountain mint	G3	S1		
Berberis canadensis	American barberry	G3	SH		
Waldsteinia lobata	Piedmont barren strawberry	G2G3	S1		
Phacelia dubia var georgiana	outcrop small-flower phacelia	G5T3	S2		
Hypericum nudiflorum	pretty St. John's-wort	G5	S2		

Appendix B – Land Use Changes in the Parkerson Mill Creek Watershed from 1997 to 2002

Open Water

Class Name	Percent	Acres
Open Water	19.79%	4.2
Developed, Open Space	27.08%	5.8
Developed, Low Intensity	8.33%	1.8
Developed, Medium Intensity	5.21%	1.1
Developed, High Intensity	4.17%	0.9
Deciduous Forest	4.17%	0.9
Evergreen Forest	1.04%	0.2
Mixed Forest	6.25%	1.3
Shrub/Scrub	8.33%	1.8
Pasture/Hay	8.33%	1.8
Cultivated Crops	5.21%	1.1
Woody Wetlands	1.04%	0.2
Emergent Herbaceous Wetlands	1.04%	0.2

Low Density Residential

Class Name	Percent	Acres
Open Water	0.31%	1.1
Developed, Open Space	21.63%	78.1
Developed, Low Intensity	21.81%	78.7
Developed, Medium Intensity	21.07%	76.1
Developed, High Intensity	11.71%	42.3
Deciduous Forest	4.81%	17.3
Evergreen Forest	3.27%	11.8
Mixed Forest	7.70%	27.8
Shrub/Scrub	3.27%	11.8
Pasture/Hay	1.48%	5.3
Cultivated Crops	1.97%	7.1
Woody Wetlands	0.99%	3.6

High Density Residential

Class Name	Percent	Acres
Open Water	0.19%	0.4
Developed, Open Space	11.28%	26.2
Developed, Low Intensity	21.70%	50.5
Developed, Medium Intensity	32.50%	75.6
Developed, High Intensity	30.59%	71.2
Deciduous Forest	0.57%	1.3
Evergreen Forest	0.10%	0.2
Mixed Forest	0.57%	1.3
Shrub/Scrub	0.96%	2.2
Pasture/Hay	0.57%	1.3
Cultivated Crops	0.86%	2.0
Emergent Herbaceous Wetlands	0.10%	0.2

Commercial/Industrial/Transport

Class Name	Percent	Acres
Open Water	0.44%	1.6
Developed, Open Space	10.23%	36.5
Developed, Low Intensity	21.21%	75.6
Developed, Medium Intensity	35.31%	125.9
Developed, High Intensity	23.02%	82.1
Deciduous Forest	0.69%	2.4
Evergreen Forest	0.94%	3.3
Mixed Forest	0.75%	2.7
Shrub/Scrub	2.50%	8.9
Pasture/Hay	1.37%	4.9
Cultivated Crops	3.43%	12.2
Woody Wetlands	0.12%	0.4

Transitional

Class Name	Percent	Acres
Developed, Open Space	14.00%	1.6
Developed, Low Intensity	4.00%	0.4
Developed, Medium Intensity	16.00%	1.8
Developed, High Intensity	24.00%	2.7
Deciduous Forest	6.00%	0.7
Evergreen Forest	8.00%	0.9
Mixed Forest	10.00%	1.1
Shrub/Scrub	12.00%	1.3
Cultivated Crops	6.00%	0.7

Deciduous Forest

Class Name	Percent	Acres
Open Water	0.63%	7.6
Developed, Open Space	13.51%	162.1
Developed, Low Intensity	7.28%	87.4
Developed, Medium Intensity	6.88%	82.5
Developed, High Intensity	2.34%	28.0
Deciduous Forest	29.82%	357.8
Evergreen Forest	7.34%	88.1
Mixed Forest	8.69%	104.3
Shrub/Scrub	8.99%	107.9
Grassland/Herbaceous	0.13%	1.6
Pasture/Hay	4.10%	49.1
Cultivated Crops	8.60%	103.2
Woody Wetlands	1.54%	18.5
Emergent Herbaceous Wetlands	0.15%	1.8

Evergreen Forest

Class Name	Percent	Acres
Open Water	0.60%	4.4
Developed, Open Space	17.41%	128.5
Developed, Low Intensity	7.29%	53.8
Developed, Medium Intensity	5.84%	43.1
Developed, High Intensity	1.51%	11.1
Deciduous Forest	12.50%	92.3
Evergreen Forest	19.67%	145.2
Mixed Forest	15.87%	117.2
Shrub/Scrub	7.47%	55.2
Grassland/Herbaceous	0.18%	1.3
Pasture/Hay	2.95%	21.8
Cultivated Crops	7.71%	56.9
Woody Wetlands	0.99%	7.3

Row Crops

Class Name	Percent	Acres
Open Water	0.47%	3.3
Developed, Open Space	14.92%	105.6
Developed, Low Intensity	18.10%	128.1
Developed, Medium Intensity	15.43%	109.2
Developed, High Intensity	6.25%	44.3
Deciduous Forest	3.46%	24.5
Evergreen Forest	5.00%	35.4
Mixed Forest	2.39%	16.9
Shrub/Scrub	6.60%	46.7
Grassland/Herbaceous	0.06%	0.4
Pasture/Hay	10.08%	71.4
Cultivated Crops	16.90%	119.6
Woody Wetlands	0.35%	2.4

Mixed Forest

Class Name	Percent	Acres
Open Water	0.72%	11.3
Developed, Open Space	15.87%	250.0
Developed, Low Intensity	7.04%	111.0
Developed, Medium Intensity	5.84%	92.1
Developed, High Intensity	1.44%	22.7
Deciduous Forest	21.58%	340.0
Evergreen Forest	8.19%	129.0
Mixed Forest	16.19%	255.1
Shrub/Scrub	7.89%	124.3
Grassland/Herbaceous	0.11%	1.8
Pasture/Hay	3.83%	60.3
Cultivated Crops	9.01%	141.9
Woody Wetlands	2.24%	35.4
Emergent Herbaceous Wetlands	0.04%	0.7

Urban/Recreation Grasses

Class Name	Percent	Acres
Developed, Open Space	27.86%	62.3
Developed, Low Intensity	24.68%	55.2
Developed, Medium Intensity	22.39%	50.0
Developed, High Intensity	9.85%	22.0
Deciduous Forest	1.89%	4.2
Evergreen Forest	2.09%	4.7
Mixed Forest	3.08%	6.9
Shrub/Scrub	2.29%	5.1
Pasture/Hay	2.59%	5.8
Cultivated Crops	3.28%	7.3

Emergent Herbaceous Wetland

Class Name	Percent	Acres
Developed, Open Space	50.00%	0.7
Cultivated Crops	50.00%	0.7

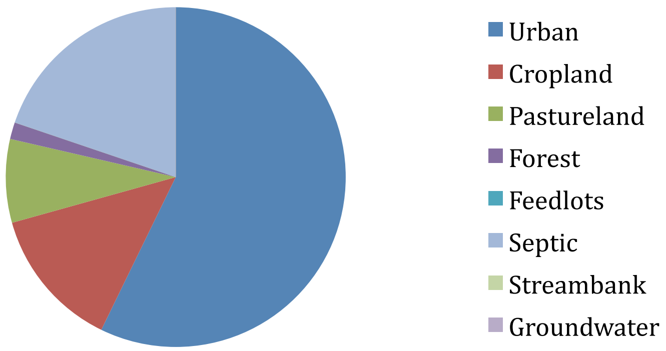
Pasture/Hay

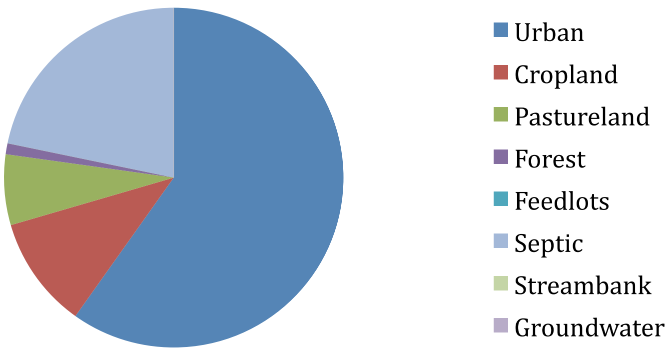
Class Name	Percent	Acres
Open Water	1.00%	10.9
Developed, Open Space	13.37%	145.0
Developed, Low Intensity	9.74%	105.6
Developed, Medium Intensity	6.46%	70.1
Developed, High Intensity	1.62%	17.6
Deciduous Forest	4.35%	47.1
Evergreen Forest	5.19%	56.3
Mixed Forest	4.45%	48.3
Shrub/Scrub	6.75%	73.2
Grassland/Herbaceous	0.02%	0.2
Pasture/Hay	15.91%	172.6
Cultivated Crops	30.70%	332.9
Woody Wetlands	0.39%	4.2
Emergent Herbaceous Wetlands	0.06%	0.7

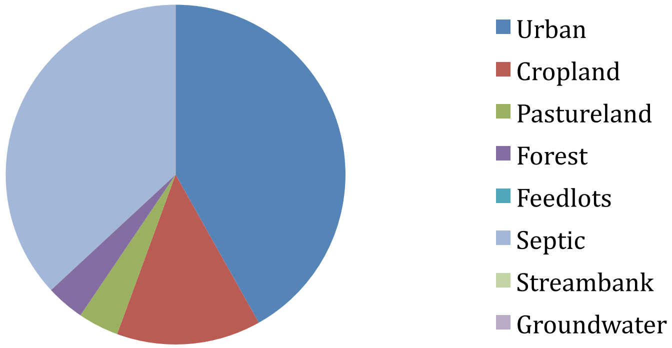
Woody Wetlands

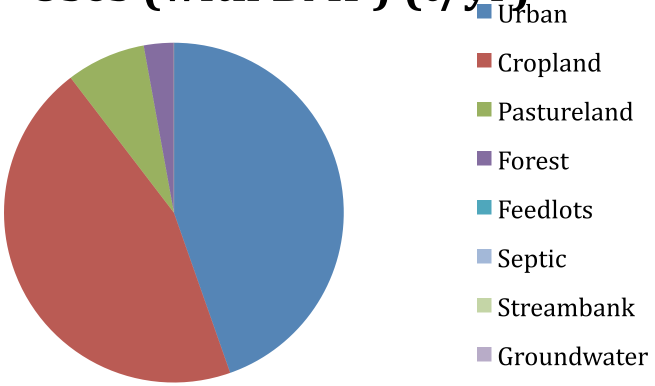
Class Name	Percent	Acres
Developed, Open Space	7.03%	2.9
Developed, Low Intensity	0.54%	0.2
Deciduous Forest	39.46%	16.2
Evergreen Forest	15.14%	6.2
Mixed Forest	16.22%	6.7
Shrub/Scrub	2.70%	1.1
Grassland/Herbaceous	0.54%	0.2
Pasture/Hay	8.11%	3.3
Cultivated Crops	2.16%	0.9
Woody Wetlands	8.11%	3.3

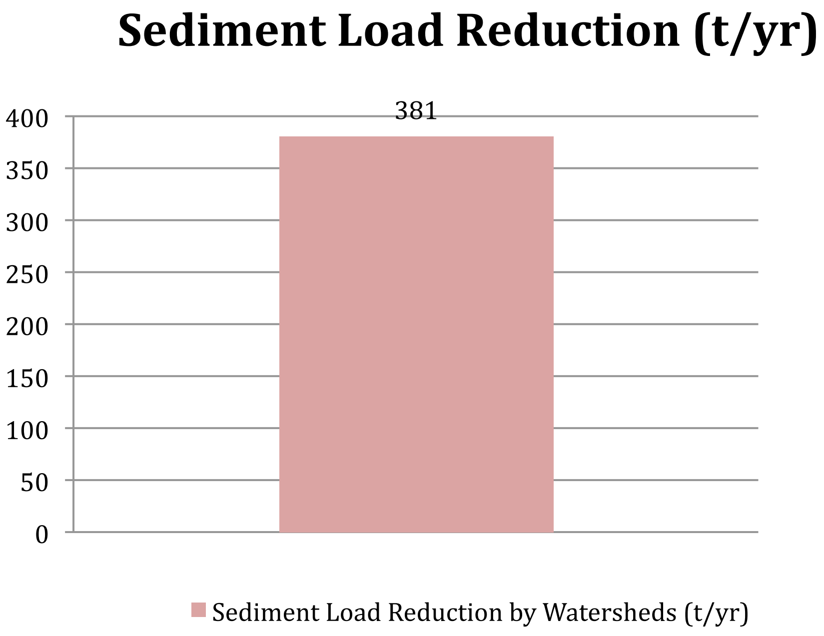
APPENDIX C – Results from STEPL Model

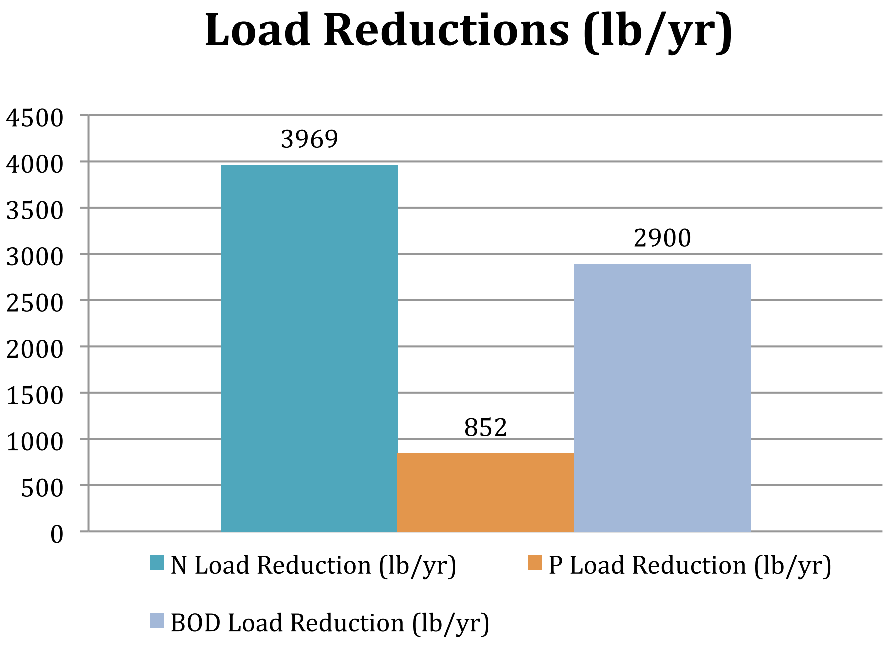

Total N Load by Land Uses (with BMP) (lb/yr)


Total BOD Load by Land Uses (with BMP) (lb/yr)


Total P Load by Land Uses (with BMP) (lb/yr)


Total Sediment Load by Land Uses (with BMP) (t/yr)


Sediment Load Reduction (t/yr)
381
400
350
300
250
200
150
100
50
0
Sediment Load Reduction by Watersheds (t/yr)


Load Reductions (lb/yr)
3969
852
2900
4500
4000
3500
3000
2500
2000
1500
1000
500
0
N Load Reduction (lb/yr)
P Load Reduction (lb/yr)
BOD Load Reduction (lb/yr)

APPENDIX D – City of Auburn Results for ADEM Surface Water Study for TMDL Establishment

E-Coli						
Date	PKML-2	PKML-5	PKML-1	PM3	HC	
4/7/10	727.0	144.0	90.0	108.0		
5/6/10	180.0	180.0	216.0	162.0		
6/8/10	636.0	153.0	108.0	144.0		Geom. Mean Study #1
6/14/10	290.0	350.0	210.0	153.0		
6/21/10	320.0	455.0	131.0	455.0		
6/28/10	91.0	171.0	63.0	144.0		
7/6/10	180.0	135.0	72.0	270.0		
8/3/10	5000.0	2000.0	1182.0	1000.0		
8/5/10	273.0	117.0	45.0	545.0		Geom. Mean Study #2
8/10/10	36.0	380.0	9.0	250.0		
8/23/10	90.0	117.0	45.0	350.0	36.0	
8/25/10	315.0	162.0	1273.0	1182.0	72.0	
8/31/10	182.0	1000.0	300.0	364.0	90.0	
9/14/10	108.0	9.0	9.0	364.0	126.0	
10/5/10	364.0	240.0	9.0	144.0	18.0	

Fecal Coliform					
Date	PKML-2	PKML-5	PKML-1	PM3	HC
4/7/10	1091.0	144.0	117.0	108.0	
5/6/10	260.0	360.0	270.0	260.0	
6/8/10	727.0	189.0	108.0	171.0	
6/14/10	340.0	400.0	300.0	207.0	
6/21/10	380.0	455.0	636.0	818.0	
6/28/10	1273.0	909.0	200.0	189.0	
7/6/10	636.0	320.0	182.0	420.0	
8/3/10	7000.0	10000.0	8000.0	8000.0	
8/5/10	1182.0	919.0	430.0	545.0	
8/10/10	63.0	530.0	9.0	400.0	
8/23/10	108.0	171.0	72.0	590.0	45.0
8/25/10	636.0	432.0	1273.0	7000.0	90.0
8/31/10	900.0	3000.0	300.0	545.0	189.0
9/14/10	200.0	27.0	9.0	636.0	290.0
10/5/10	455.0	240.0	45.0	350.0	63.0

% E-Coli Composition

Date	PKML-2	PKML-5	PKML-1	PM3	HC
4/7/10	66.6%	100.0%	76.9%	100.0%	
5/6/10	69.2%	50.0%	80.0%	62.3%	
6/8/10	87.5%	81.0%	100.0%	84.2%	
6/14/10	85.3%	87.5%	70.0%	73.9%	
6/21/10	84.2%	100.0%	20.6%	55.6%	
6/28/10	7.1%	18.8%	31.5%	76.2%	
7/6/10	28.3%	42.2%	39.6%	64.3%	
8/3/10	71.4%	20.0%	14.8%	12.5%	
8/5/10	23.1%	12.7%	10.5%	100.0%	
8/10/10	57.1%	71.7%	100.0%	62.5%	
8/23/10	83.3%	68.4%	62.5%	59.3%	80.0%
8/25/10	49.5%	37.5%	100.0%	16.9%	80.0%
8/31/10	20.2%	33.3%	100.0%	66.8%	47.6%
9/14/10	54.0%	33.3%	100.0%	57.2%	43.4%
10/5/10	80.0%	100.0%	20.0%	41.1%	28.6%

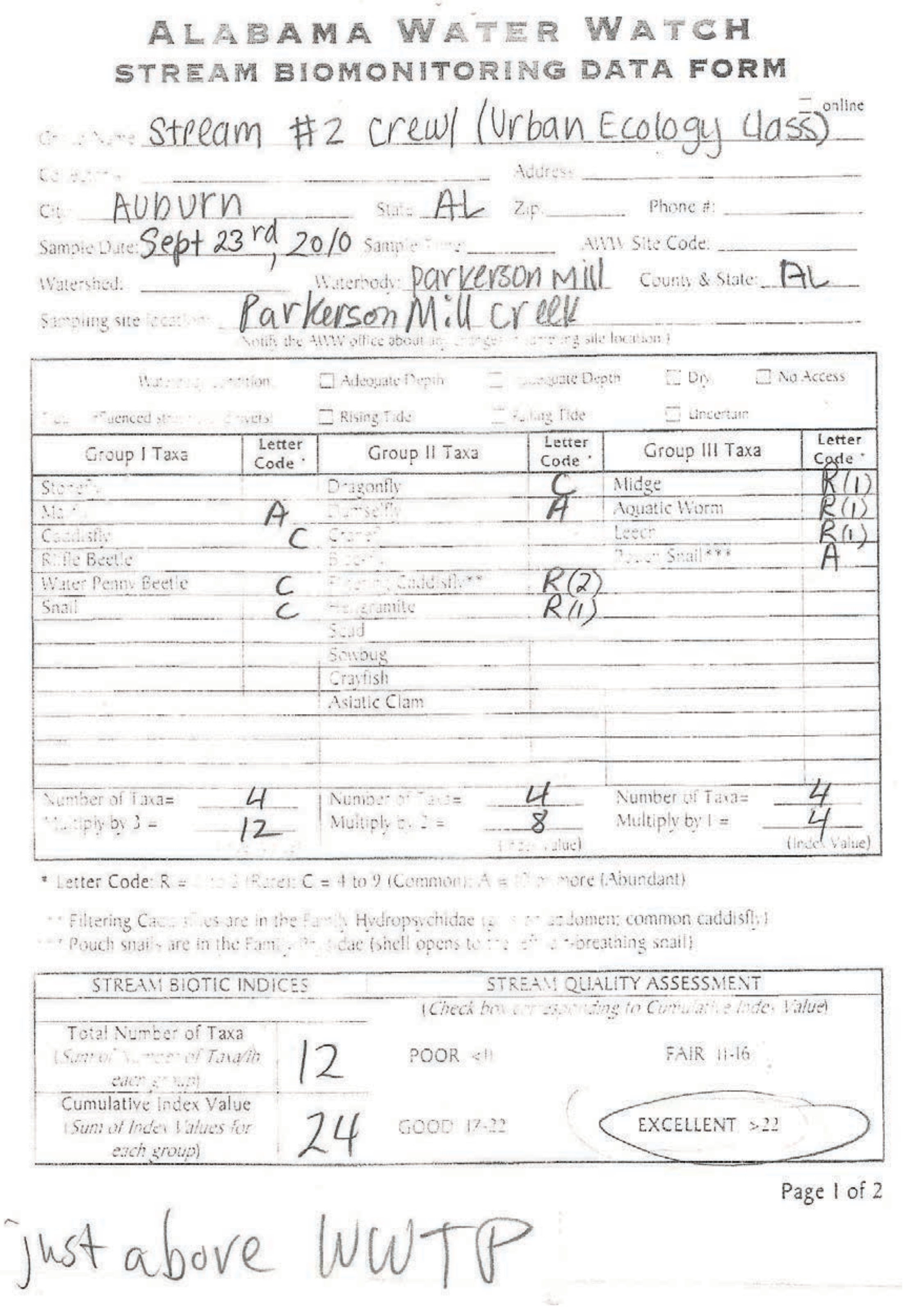
Geometric Mean Study #1

	PKML-2	PKML-5	PKML-1	PM3
6/8/10	636	153	108	144
6/14/10	290	350	210	153
6/21/10	320	455	131	455
6/28/10	91	171	63	144
7/6/10	180	135	72	270
Geom. Mean	**249.50**	**223.88**	**106.15**	**208.05**
State WQ Criteria	126	126	126	126

Geometric Mean Study #2 (City)

	PKML-2	PKML-5	PKML-1	PM3
8/5/10	273	117	45	545
8/10/10	36	380	9	250
8/23/10	90	117	45	350
8/25/10	315	162	1273	1182
8/31/10	182	1000	300	364
Geom. Mean	**138.36**	**242.74**	**93.01**	**459.65**
State WQ Criteria	126	126	126	126

APPENDIX E – Urban Ecology Class Benthic Macroinvertebrate Monitoring Form



ALABAMA WATER WATCH
STREAM BIOMONITORING DATA FORM

☐ online

Group Name: Stream #2 crew/ (Urban Ecology Class)
Contact: ______ Address: ______
City: Auburn State: AL Zip: ______ Phone #: ______
Sample Date: Sept 23rd, 2010 Sample Time: ______ AWW Site Code: ______
Watershed: ______ Waterbody: parkerson Mill County & State: AL
Sampling site location: Parkerson Mill creek
(Notify the AWW office about any changes in sampling site location.)

Waterbody condition: ☐ Adequate Depth ☐ Inadequate Depth ☐ Dry ☐ No Access
Tidally influenced streams (rivers): ☐ Rising Tide ☐ Falling Tide ☐ Uncertain

Group I Taxa	Letter Code *	Group II Taxa	Letter Code *	Group III Taxa	Letter Code *
Stonefly		Dragonfly	C	Midge	R(1)
Mayfly	A	Damselfly	A	Aquatic Worm	R(1)
Caddisfly	C	Crane fly		Leech	R(1)
Riffle Beetle		Beetle larva		Pouch Snail***	A
Water Penny Beetle	C	Filtering Caddisfly**	R(2)		
Snail	C	Hellgrammite	R(1)		
		Scud			
		Sowbug			
		Crayfish			
		Asiatic Clam			
Number of Taxa=	4	Number of Taxa=	4	Number of Taxa=	4
Multiply by 3 =	12	Multiply by 2 =	8	Multiply by 1 =	4
(Index Value)		(Index Value)		(Index Value)	

* Letter Code: R = 1 to 3 (Rare); C = 4 to 9 (Common); A = 10 or more (Abundant)

** Filtering Caddisflies are in the Family Hydropsychidae (gills on abdomen; common caddisfly)
*** Pouch snails are in the Family Physidae (shell opens to the left; air-breathing snail)

STREAM BIOTIC INDICES		STREAM QUALITY ASSESSMENT (Check box corresponding to Cumulative Index Value)	
Total Number of Taxa (Sum of Number of Taxa in each group)	12	POOR <11	FAIR 11-16
Cumulative Index Value (Sum of Index Values for each group)	24	GOOD 17-22	[✓ EXCELLENT >22]

Page 1 of 2

just above WWTP

APPENDIX F – ADEM Field Ops Report

Water Quality Assessment
Parkerson Mill Creek
Auburn, Alabama
Lee County

October 1997

Environmental Indicators Section
Field Operations Division
Alabama Department of Environmental Management

Introduction

The city of Auburn in Lee County has an NPDES permit (AL0050237) to discharge treated wastewater to Parkerson Mill Creek downstream of Lee County Road 10. Parkerson Mill Creek is a tributary to Chewacla Creek and located in the Tallapoosa River basin.

At the request of the Municipal Branch of the Water Division of the Alabama Department of Environmental Management (ADEM), staff members of the Environmental Indicators Section of Field Operations Division conducted a study to document the effects of the wastewater discharge on the in-stream macroinvertebrate community of Parkerson Mill Creek. This effort included aquatic macroinvertebrate sampling, habitat assessment, toxicity testing and chemical analyses.

The Aquatic macroinvertebrate sampling and habitat assessments along with the chemical sample collection were conducted on October 15, 1997. The toxicity portion of the study was initiated on November 18, 1997.

Sampling Locations and Methodology

The following sampling locations were chosen for Parkerson Mill Creek (see Figure 1). In addition, an established ecoregional reference stream with similar stream characteristics and habitat types was sampled and compared to Parkerson Mill Creek to further assess the conditions of the stream.

PM-1 (control)	T18N, R25E, Sec 24, NW 1/4 Parkerson Mill Creek approximately 0.3 mile downstream of Lee County Road 10, immediately upstream of the Auburn Southside WWTP effluent mixing zone.
PM-1a	T18N, R25E, Sec 24, NW 1/4 Parkerson Mill Creek just downstream of the Auburn Southside WWTP effluent mixing zone.
PM-3	T18N, R25E, Sec 24, NW 1/4 Parkerson Mill Creek approximately 0.25 mile downstream of the Auburn Southside WWTP outfall.
HCR-1 (ecoregional reference)	T21S, R10E, Sec 29, SW 1/4 Hurricane Creek just upstream of the bridge on an unnamed gravel road located off Alabama Highway 77.

Macroinvertebrate samples were collected using the intensive Multihabitat Bioassessment method (MB-I) described in the *ADEM Standard Operating Procedures and Quality Control Assurance Manual, Volume 2* (1996). Habitat quality was assessed using the modified Barbour & Stribling (1996) habitat assessment form. All macroinvertebrate assessments were calculated using the Biological Condition Scoring Criteria (BCSC) (EPA 1989). Table 1 provides a simplified interpretation of the biological metrics used to evaluate this stream. Individual station metrics are listed in Figure 3.

In-stream water samples collected for field parameters and chemical analyses were grab collections using the methodology outlined in the *ADEM Standard Operating Procedures and Quality Control Assurance Manual, Volume 1*, (1994).

Samples collected from the WWTP discharge for toxicity testing were 24-hour composite samples taken at the permitted sampling point. The toxicity test was conducted as specified in NPDES permit number AL0050237 and per methodology outlined in *ADEM Standard Operating Procedures and Quality Control Assurance Manual, Volume 4*, (1994).

Sample handling techniques, physical data collection and chain-of-custody procedures utilized during this assessment were as described in the *ADEM Standard Operating Procedures and Quality Control Assurance Manual, Volumes 1*(1994), *2*(1996) & *4*(1994). Chain-of-custody was maintained by locking the samples in a Departmental vehicle when not in sight of a Field Operations Division employee.

Discussion and Results

A. Physical

Parkerson Mill Creek at the studied reaches was estimated to have hardwood canopy of varying amounts partially shading the stream. Parkerson Mill Creek is a rapidly moving non-braided stream comprised mainly of sandy substrate with run depths of approximately 0.5-1.5 feet and pools of 2-2.5 feet. Multiple habitats suitable for colonization by aquatic macroinvertebrates are present at each sampling location. Habitat assessments indicate that all locations have similar habitat quality (Table 2). However, the score for the most downstream station (PM-3) is less similar than those of the two upstream stations. Evaluating the individual assessment parameters indicates that this is largely due to changes in substrate composition between the control (PM-1) and downstream locations as well as changes in stream morphology. The ecoregional reference site HCR-1 was similar to the study stations in stream characteristics and habitat types. The habitat quality (Table 2) of two of the three study locations was within ninety percent of the ecoregional reference station. The station with the lowest habitat assessment was still within seventy-five percent of the ecoregional reference station. EPA suggests sites are considered similar when habitat assessments are at least seventy-five percent comparable.

B. Chemical

The Water Use Classification for Parkerson Mill Creek is Fish & Wildlife, which specifies that the waters be suitable for fishing, propagation of fish, aquatic life, and wildlife, and any other usage except for swimming, and water-contact sports or as a source of water supply for drinking or food processing purposes (*Rules and Regulations: Water Quality Criteria and Use Classifications*, Water Division-Water Quality Program, ADEM, Ch.335-6-10).

The field parameters measured at each station were pH, conductivity, dissolved oxygen, turbidity and water temperature (Figure 2). Results showed little change in the pH, dissolved oxygen, conductivity, or turbidity between stations (Table 3). The lower conductivity below the Auburn Southside WWTP discharge at PM-1a was possibly a recording error. The water temperature at PM-1a was found to exceed the temperature criterion included in the Water Use Classification of Fish &Wildlife. The criterion for water temperature states that the maximum in-stream temperature rise above ambient water temperature due to the addition of artificial heat by a discharger shall not exceed 5° F in streams, lakes, and reservoirs in non-coastal and estuarine areas.

Water samples were also collected for laboratory analyses and results are provided in Table 3. At locations below the effluent discharge, several parameters increased when compared to the control station PM-1. Among those were total dissolved solids (TSS) and chloride. Nutrient levels were also affected by the effluent discharge. Levels of ammonia, phosphate, total Kjeldahl nitrogen and total organic nitrogen (TON) increased at PM-1a. The downstream station (PM-3) had a higher level of nitrate and TON than any of the other studied stations, possibly influenced by the WWTP sludge field that runs adjacent to that segment of the creek. The concentration of zinc at PM-1a (0.072 mg/L) and at PM-3 (0.069 mg/L) were higher than the control station PM-1 (<0.030). The concentration of copper at PM-3 (0.032 mg/l) was higher than either of the other stations (<0.020 mg/L).

The National Criteria for in-stream zinc concentrations as described in *Quality Criteria for Water* (EPA 440/5-86-001, 1986) are calculated values that take into consideration in-stream hardness and are based on the one-hour average concentration and four-day average concentration for acute and chronic limits, respectively. These criteria indicate that the zinc concentration at PM-1a (72 µg/L) was below the acute limit of 79.2 µg/L and equaled the chronic limit of 71.8 µg/L. The zinc concentration at PM-3 (69 µg/L) was below both the acute (80.8 µg/L) and chronic (73.2 µg/L) limits. The National Criteria for in-stream copper concentrations as described in *Quality Criteria for Water* (EPA 440/5-86-001, 1986) indicate that the copper concentration at PM-3 (32 µg/L) exceeded both the acute limit of 11.0 µg/L and the chronic limit of 8.1µg/L.

C. Aquatic Macroinvertebrate Assessment

Aquatic macroinvertebrate data were analyzed according to the Biological Condition Scoring Criteria (BCSC) developed by EPA (Plafkin 1989). The control (PM-1) was considered slightly impaired when compared to the ecoregional reference station HCR-1. PM-1a was evaluated as slightly impaired, in comparison to the control PM-1 and moderately impaired in comparison to the ecoregional reference station HCR-1 (Table 2).

PM-3, the most downstream station, was also evaluated as slightly impaired when compared to the control PM-1 and moderately impaired when compared to the ecoregional reference HCR-1 (Table 2).

D. Bioassay

Short-term chronic toxicity tests conducted on the Auburn Southside WWTP effluent indicated that there was a significant difference to *Ceriodaphnia dubia* and *Pimephales promelas* survival when exposed to a 100% effluent concentration (Appendix A). This effluent concentration is similar to the measured in-stream waste concentration of approximately 100% at the time of aquatic macroinvertebrate and chemical sample collection.

The National Criteria for in-stream chlorine concentrations as described in *Quality Criteria for Water* (EPA 440/5-86-001, 1986) is based on the four-day average concentration for chronic limits. These criteria indicate that the chlorine concentration in the toxicity sample (0.49 mg/l) was above the chronic limit of 11 μg/L (0.011mg/l).

Effluent samples were also collected for laboratory analyses in conjunction with the toxicity test. Results summarized in Table 3 indicated that dissolved and total levels of zinc were detectable in the effluent sample collected on November 18, 1997.

Conclusions

The results of this study indicate the water quality of Parkerson Mill Creek below the Auburn Southside WWTP to be slightly impaired compared to the upstream control station. However, the results also indicate slight impairment of the control station suggesting impact in the upper watershed. Slight degradation to the macroinvertebrate community below the discharge was evidenced by decreased taxa richness and increased pollution tolerance of the community at PM-1a. Although nutrient concentrations increased below the discharge, there was no associated increase in total number of organisms collected (Figure 4). These results are indicative of an invertebrate community negatively impacted by toxic wastes (Welsh 1992). In addition, the results of the short-term chronic toxicity tests indicated a toxic effect present in the effluent. Associated water samples suggest that increased trace metal toxicity and/or chloride may be causing the slight impairment. The data from PM-3, further downstream from the WWTP, suggest that the stream has not recovered from the impacts of the WWTP, however the decrease in habitat may be exacerbating the water quality impacts. The presence of copper at PM-3 suggests an additional source of impact. The adjacent WWTP sludge fields may be causing impairment despite seemingly adequate riparian buffer zones.

TABLE 1
Biometric Interpretation

METRIC	RANGE	INTERPRETATION
Habitat Assessment	170-220 118-169 60-117 0-59	Optimal Sub-optimal Marginal Poor
Total Taxa Richness EPT Taxa Index		Generally Increases with Increasing Water Quality
Biotic Index		Generally Increases with Increasing Water Quality
Community Loss Index		Generally Increases with Decreasing Water Quality
Percent Contribution of Dominant Taxon		Generally Decreases with Decreasing Water Quality
Ratio of EPT and Chironomidae Organism Abundances		Chironomids Increase with Decreasing Water Quality
% Contribution of Functional Feeding Types %Shredders %Scrapers %Predators %Collector Gatherers %Collector Filterers %Macrophyte Piercers %Others		Percentages and Composition should be similar to background station for similar stream sizes and habitat composition

BIOLOGICAL CONDITION SCORING CRITERIA

% Comparison to Reference Score	Biological Condition Category	Attributes
>81%	**Nonimpaired**	Comparable to best situation within ecoregion. Balanced trophic structure Optimum community structure for stream size and habitat
82-52%	**Slightly impaired**	Community structure less than expected Composition lower than expected due to loss of intolerant spp % contribution of tolerant forms increases
52-19%	**Moderately impaired**	Fewer species due to loss of most intolerant forms Reduction in EPT index
<19%	**Severely impaired**	Few species present

Parkerson Mill Creek
Auburn, AL

TABLE 2
Aquatic Macroinvertebrate Data

	PM-1 (Control)	**PM-1a**	**PM-3**	**HCR-1 (Ref.)**
Habitat Assessment	117	126	89	118
Habitat Quality (% comparability to Reference site)	99%	94%	75%	
Habitat Quality (% comparability to Control Site)		93%	76%	
Total Taxa Richness	34	24	28	48
Biotic Index	5.89	7.71	6.11	4.14
EPT/EPT+Chironomid	0.25	0.00	0.02	0.86
Percent Contribution of Dominate Taxa	33	47	78	20
EPT Index	8	2	4	13
Percent Shredders(CPOM)	0.62	0.42	0.86	0.12
Community Loss Index Compared to Control		0.70	0.46	
Community Loss Index Compared to Reference	0.94	1.58	1.25	
Biological Condition (Category) Compared to Control		**Slightly Impaired**	**Slightly Impaired**	
Biological Condition(Category) Compared to Reference	**Slightly Impaired**	**Moderately Impaired**	**Moderately Impaired**	

TABLE 3
Chemical Analyses & Field Parameters

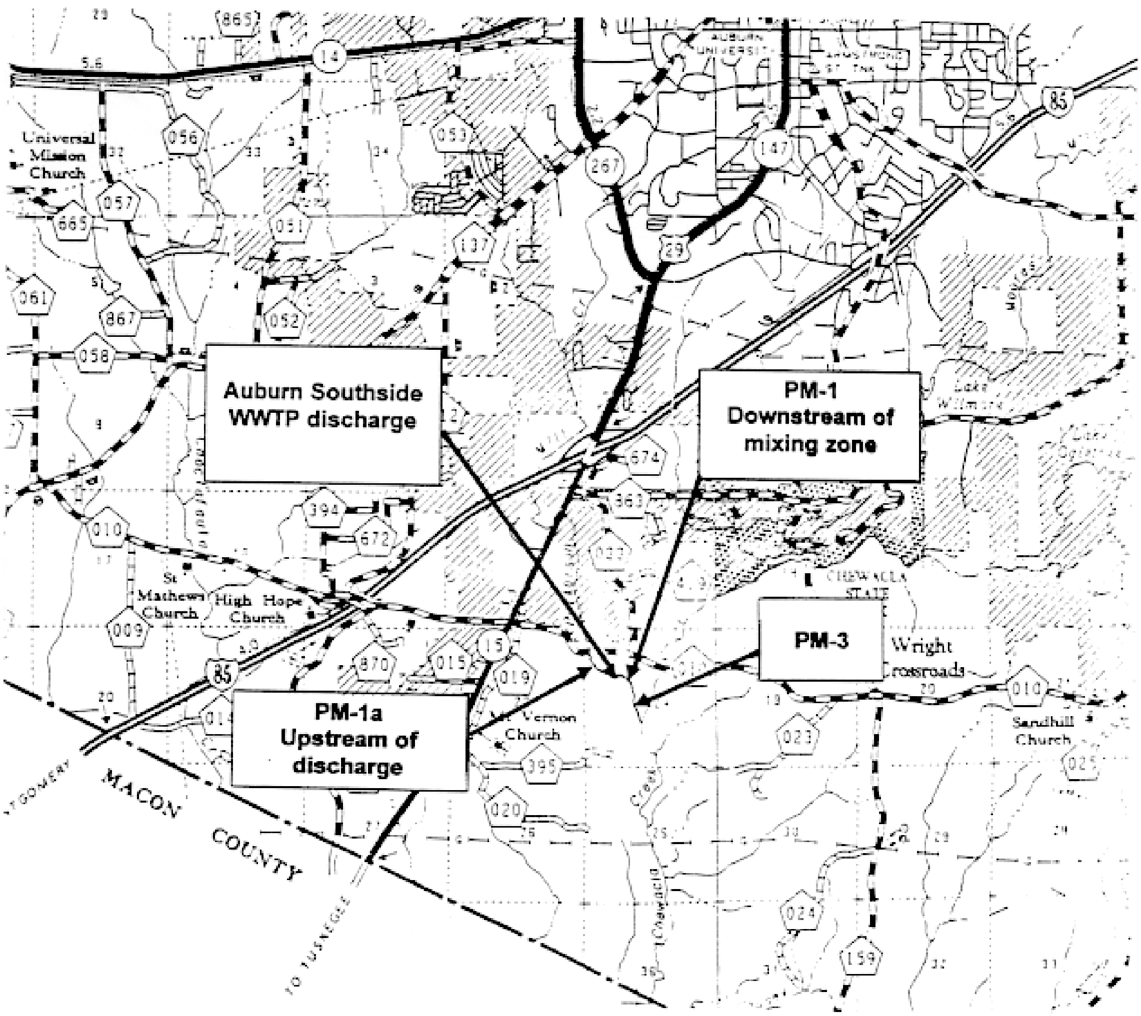
Parameter	**PM-1**	**PM-STP**	**PM-STP[1]**	**PM-1a**	**PM-3**	**HCR-1**
Date Collected	10/15/97	10/15/97	11/18/97	10/15/97	10/15/97	10/17/97
Organics (ug/L)						
Diazinon	<0.01	<0.01	<0.01	<0.01	<0.01	-
Ethion	<0.01	<0.01	<0.01	<0.01	<0.01	-
Malathion	<0.03	<0.03	<0.03	<0.03	<0.03	-
Methyl Parathion	<0.012	<0.012	<0.012	<0.012	<0.012	-
Paration	<0.015	<0.015	<0.015	<0.015	<0.015	-
Phosdrin	<0.05	<0.05	<0.05	<0.05	<0.05	-
Miscellaneous Inorganics (mg/l)						
Total Alkalinity	61.0	58.0	64	56.0	54.0	9.0
Hardness	63.2	62.9	80	63.1	64.6	4.9
BOD	0.7	0.4	6.0	0.6	1.3	0.5
Hexavalent Chromium	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Dissolved Solids	85	234	-	218	203	49
Total Suspended Solids	<1.0	1	1	2	<1.0	<1.0
Chloride	10.5	42.2	-	39.7	37.4	3.8
Nutrients (mg/L)						
Ammonia	<0.3	0.69	<0.3	0.47	0.15	<0.3
Nitrate	0.32	4.17	-	4.16	4.57	0.01
Phosphate	0.071	1.21	-	1.10	1.06	0.05
Total Kjeldahl Nitrogen	<0.15	0.79	-	0.74	0.65	<0.15
Total Organic Nitrogen	<0.2	0.10	-	0.27	0.50	<0.2
Trace Metals (mg/L)						
Arsenic	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	-
Cadmium	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	-
Calcium	13.2	17.5	-	17.2	17.5	-
Chromium	<0.015	<0.015	<0.015	<0.015	<0.015	-
Copper	<0.020	<0.020	<0.020	<0.020	0.032	-
Lead	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	-
Magnesium	7.349	4.657	-	4.903	5.067	-
Mercury	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Nickel	<0.009	<0.009	<0.009	<0.009	<0.009	-
Silver	<0.015	<0.015	<0.015	<0.015	<0.015	-
Zinc	<0.030	0.080	0.74	0.072	0.069	-
Fecal Coliform (colonies/100mL)						
Fecal Coliform Bacteria	Est.18	<1	-	Est. 1	Est.57	-
Field Parameters						
Flow (cfs)	0	6.4	-	6.4	5.1	5.1
pH (standard units)	8.3	6.6	7.3	7.1	7.3	7.6
Conductivity(umhos/cm)	162	381	342	172[2]	355	54
Dissolved Oxygen(mg/L)	9.9	7.0	-	8.1	7.8	5.5
Turbidity (NTU)	2.6	2.0	-	4.3	1.7	9.4
Water Temperature (C)	18	24	-	24	19	22

[1] This sample is a composite sample taken during the toxicity test.

[2] Possible recording error.

Figure 1

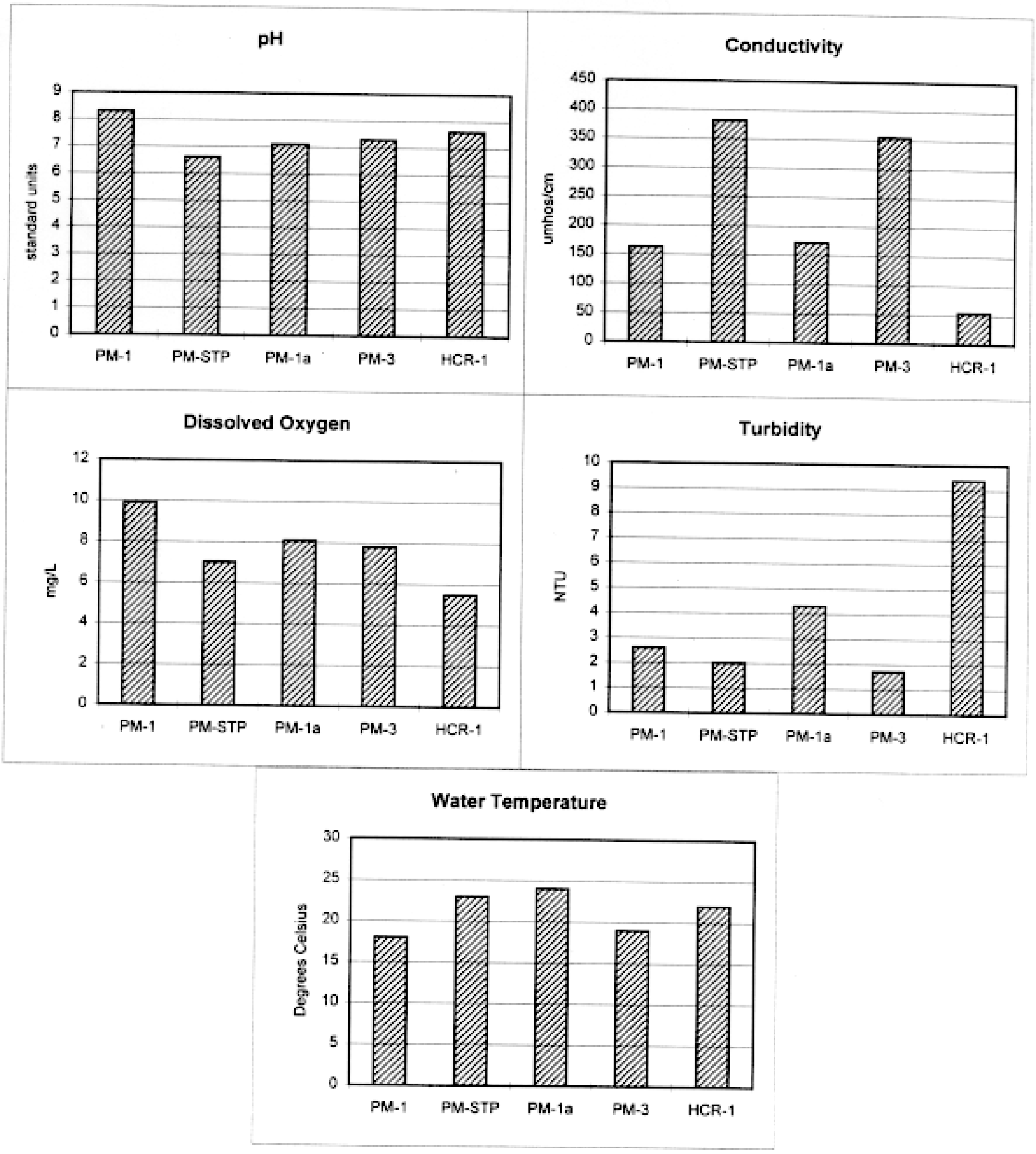
Station Location Map



Scale: 1" = 1 mile ↑N

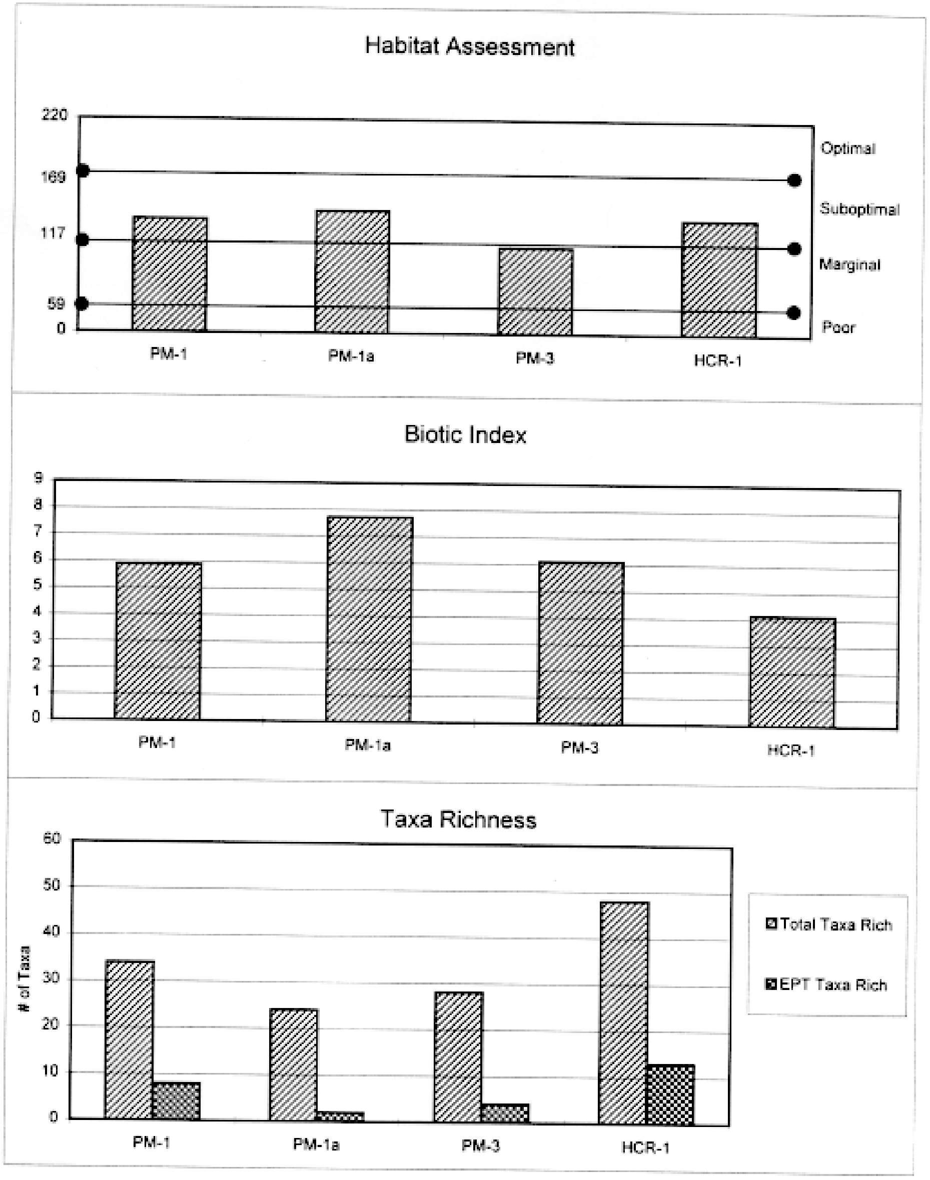
Parkerson Mill Creek
Auburn, AL

Figure 2
Field Parameters



Parkerson Mill Creek
Auburn, AL

Figure 3
Individual Metrics



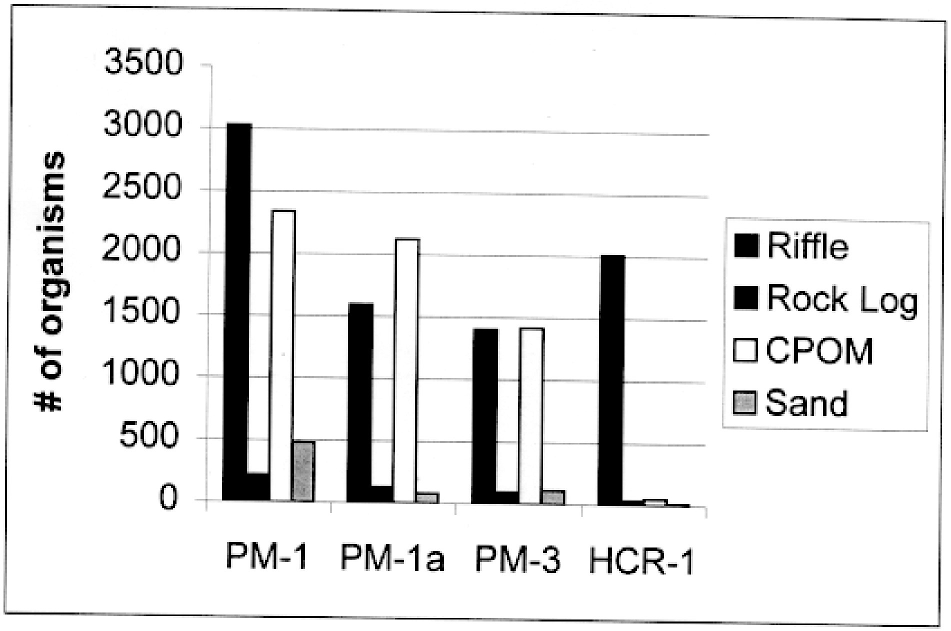
Habitat Assessment

Biotic Index

Taxa Richness

Parkerson Mill Creek
Auburn, AL

Figure 4
Total Number of Organisms



	Stations			
	PM-1	PM-1a	PM-3	HCR-1
Riffle	3030	1596	1404	2010
Rock Log	218	128	95	34
CPOM	2340	2124	1416	50
Sand	481	79	113	11

APPENDIX A

Toxicity Test Report

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
FIELD OPERATIONS DIVISION
ENVIRONMENTAL INDICATORS SECTION
BIOASSAY UNIT

TOXICITY TEST REPORT

1. GENERAL

NPDES PERMIT NO.: 0050237 DSN: 001 COUNTY: Lee

Facility Name: Auburn - Southside WWTP

Receiving Water: Parkerson Mill Creek Design Flow: ---

Test Type: 24-Hour Acute Screening. A chronic screening test was planned, but mortality was observed at 24h.

Test Id. #: 971118-02

Test Organism	Date/Time Started YYMMDD HHMM	Date/Time Ended YYMMDD HHMM	Control Validity (Acceptable/Unacceptable)
Ceriodaphnia dubia	971118 1614	971119 1450	Acceptable
Pimephales promelas	971118 1415	971119 1420	Acceptable

2A. SUMMARY OF RESULTS FOR SCREENING TEST

Test Org.	Effluent Conc.	Test Number (1) Surv	Repro	Grow	(2) Surv	Repro	Grow	(3) Surv	Repro	Grow	(4) Surv	Repro	Grow
C. d.	100%	FAIL	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----	-----
P. p.	100%	FAIL	N/A	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

3. LABORATORY ANALYSES OF UNDILUTED SAMPLES(S)

Sample Id.	pH su	Alkalinity mg/L as CaCO3	Hardness mg/L as CaCO3	Conductivity umhos/cm @ °C	TRC mg/L
971118-02	7.3	64	80	342 at 24.7	0.49

4. SAMPLE COLLECTION:

Were split samples collected?: no

Were samples collected as specified in NPDES Permit (Location and/or Type)? yes

Sample Id.	Sample(s) Collected YYMMDD HHMM to YYMMDD HHMM	Arrival Temp (°C)	Used in Test(s) YYMMDD to YYMMDD
971118-02	971117 1005 to 971118 0950	3	971118 to ---

5.CONTROL/DILUTION WATER

Carboy #	Preperation YYMMDD	Begin Use YYMMDD	Initial Water Chemistries pH (su)	Alkalinity (mg/L)	Hardness (mg/L)	Conductivity @ °C (umhos/cm)
C-4	971117	971118	8.2	69	70	153 at 22.6

PERMITTEE: Auburn - Southside WWTP NPDES #: 0050237 DSN: 001 TEST Id #: 971118-02

6. TOXICITY TEST INFORMATION

Test Organism	Organism Age	Organism Source	Org./Test Vessel	Replicates/Conc.
C.d.	<8h	ADEM In-house cultures	1	10
P.p.	<24h	ADEM In-house cultures	10	4

Test Organism	Temperature Range (°C)	D.O. Range (mg/L)	pH Range (su)	Light Intensity Average (ft-c)
C.d.	24.9 - 25.8	7.6 - 8.7	7.3 - 7.9	65
P.p.	24.5 - 24.9	3.9 - 8.7	7.3 - 7.3	60

7. FEEDING: Fed Daily

Brine Shrimp	Fed 0.15 mL Suspension of Newly Hatched Larvae 2 Times Daily.
YCT	Fed 0.15 mL Suspension Containing 1800 mg/L TSS Daily.
Algae	Fed 0.15 mL Suspension Containing 3.3 x 10^7 Algal Cells/mL Daily.

8. REFERENCE TOXICANT TESTS

TOXICANT - Sodium Chloride (NaCl)

Test Organism	Test Date YYMMDD	Results LC50 (mg/L)	95% Confidence Interval (mg/L)
C.d.	971118	1945.00	1802.59/2098.66
P.p.	971119	7256.43	6995.63/7526.96

9. TEST CONDITION VARIABILITY

A. Deviations From Standard Test Conditions: Light intensity was not recorded on 971118. The P. promelas control organisms were loaded with a pipet that had been used to load another test. These deviations did not adversely affect the test results.

B. Test Solution Manipulations or Test Modifications

☐ Dechlorination
☐ Aeration during the test
☐ Aeration prior to test initiation or sample renewal
☐ Filtration
☐ pH adjustment
☒ NO sample modifications

PERMITTEE: Auburn - Southside WWTP NPDES #: 0050237 DSN: 001 TEST Id #: 971118-02

10A. ACUTE SCREENING TOXICITY TESTS RESULTS:

TEST ORGANISM: ***Ceriodaphnia dubia*** **ACUTE TOXICITY INDICATED? FAIL**

Solution Concentration (%)	% Survival
Control (0%)	100
100	0

STATISTICAL ANALYSES (Using Survival data as proportion surviving that is arc sine transformed):	COMMENTS:
☒ No Statistical Analysis Necessary	Acute mortality might be due to high chlorine concentration in the sample.

TEST ORGANISM: ***Pimephales promelas*** **ACUTE TOXICITY INDICATED? FAIL**

Solution Concentration (%)	% Survival
Control (0%)	100
100	25

STATISTICAL ANALYSES (Using Survival data as proportion surviving that is arc sine transformed):

Shapiro Wilk's Test (Normality)
Test Statistic: 0.899 Critical Value: 0.749 (Parametric)
Normally Distributed ☒ Yes (if test stat is > critical value) GOTO VARIANCE F-TEST
☐ No (if test stat is < critical value) GOTO WILCOXON RANK SUM TEST

F-TEST – could not be run

T-TEST
t Statistic: 5.669 Critical t value: 1.94
Significant Difference ☒ YES (if t stat is > critical t) FAIL
☐ NO (if t stat is < critical t) PASS

WILCOXON RANK SUM TEST or MODIFIED T-TEST
Sample Rank Sum: 10.0 # of reps 4 Critical Rank Sum: 11.0
Significant Difference ☒ YES (if sample rank sum is < critical rank sum) FAIL
☐ NO (if sample rank sum is > critical critical rank sum) PASS

COMMENTS:

Acute mortality might be due to high chlorine concentration in the sample.

Signature: ____________________ Date: __________