Two Mile Branch Watershed Management Plan

City of Valdosta, Georgia

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1.0 Introduction

Two Mile Branch, part of the Suwannee River Basin, is located in the 12-digit hydrologic unit code (HUC) 031102030404. It is a headwater stream of Sugar Creek, which flows into the Withlacoochee River. The Two Mile Branch watershed, approximately 2.6 square miles in size, is completely within the City of Valdosta in Lowndes County, Georgia. Lowndes County is located in south central Georgia near the Florida border. Part of the county is within the Tifton Upland ecoregion characterized as having rolling, hilly topography, while another portion is within the relatively flat Okefenokee Plains ecoregion. Within the watershed, the main stem of Two Mile Branch flows from east to west and contains one dam that forms the Joree Millpond (See Figure 1).

The purpose of this study is to characterize the Two Mile Branch watershed, create an inventory of pollution sources, and develop a management plan to address water quality issues. This study focuses specifically on fecal coliform sources as Two Mile Branch has been placed on the Georgia 303(d) impaired stream list for not supporting its designated use of fishing as a result of past violations of Georgia water quality standards for fecal coliform. The study also focuses on sediment and floatable debris sources within the watershed as these have been identified as potential problems.

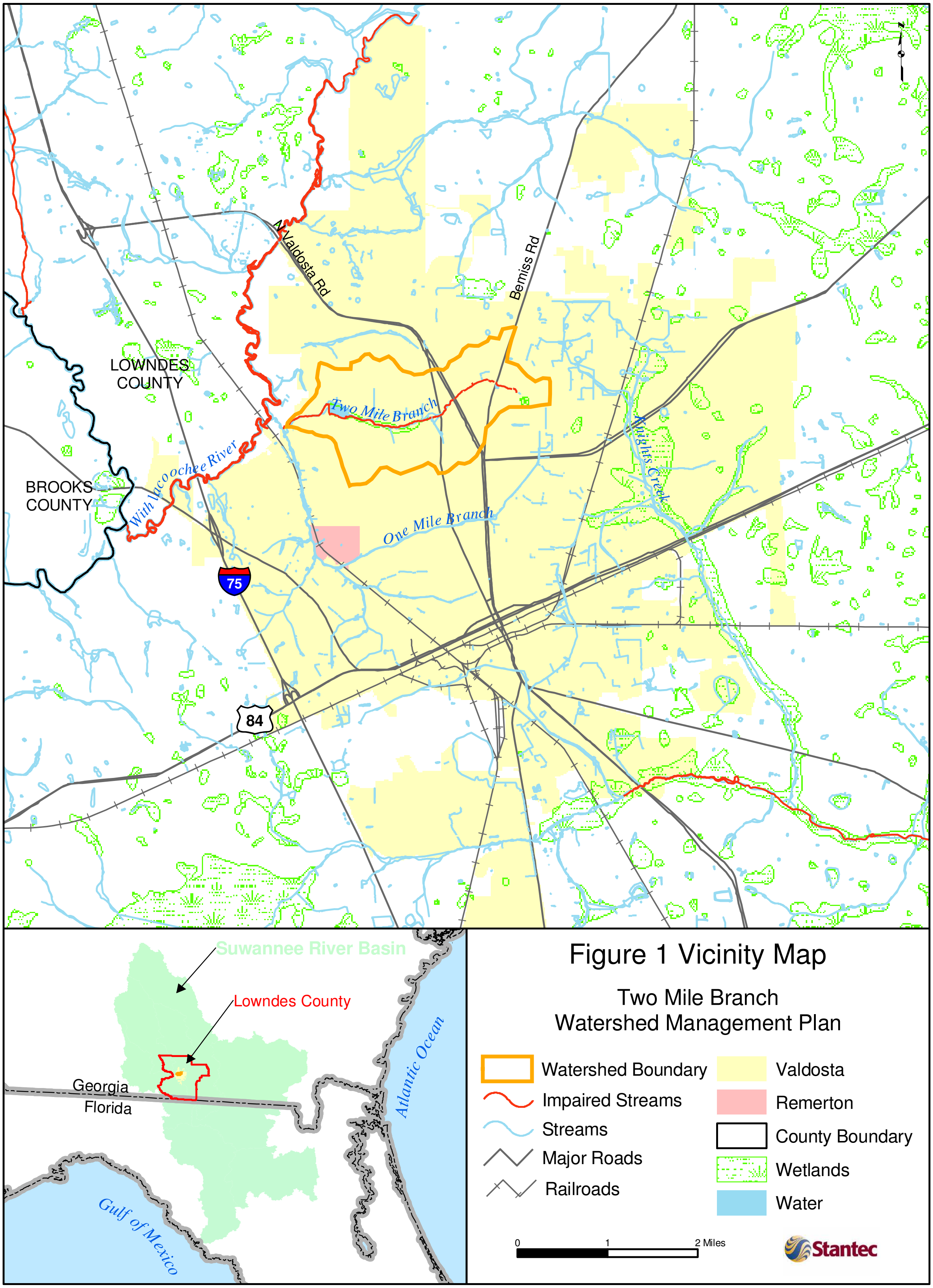
Steps were taken to improve water quality in the watershed after it was listed on the Georgia 303(d) impaired waters list but it appears little has been done to formally document these activities or to monitor their effectiveness. While this current study did not include monitoring, a plan is proposed for future efforts. This is an urban watershed with a high percentage of impervious surfaces therefore water quality most likely continues to be an issue in spite of these efforts. To improve water quality, a number of management activities are proposed. Where possible, load reductions and costs associated with each of these activities have been estimated as well as a schedule of implementation. Funding sources have been identified to help with plan implementation.

2.0 Watershed Characterization

Many other studies have focused on Two Mile Branch and its watershed as well as larger areas that include it. These studies have been reviewed and summarized in this section as they provide useful background information and data that were used in the creation of this management plan. Ordinances and other regulations were obtained and summarized as these tools give the City the legal ability to manage and protect water quality. The material is presented by topic rather than chronological order. Many of these studies overlap in time although they do not appear to build on each other.

2.1 Total Maximum Daily Load (TMDL)

As mentioned, Two Mile Branch has a water use classification of fishing and is “not supporting” that use according to the Georgia 303(d) list. The designated impairment results from violations of the Georgia water quality standard for fecal coliform. A number of Total Maximum Daily Loads (TMDLs) and TMDL Implementation Plans have been written to address this contamination as summarized in this section.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2.1.1 Fecal Coliform TMDL

The U.S. Environmental Protection Agency (USEPA) approved a fecal coliform total maximum daily load (TMDL) for the Two Mile Branch watershed in February of 1998 (USEPA 1998). The TMDL process establishes the allowable loadings of fecal coliform for the stream and its tributaries based on the relationship between fecal coliform sources and instream water quality conditions. According to the TMDL, Two Mile Branch appeared on the 1996 303(d) list as impaired for fecal coliform because greater than 20% of the samples collected and analyzed had a fecal coliform concentration greater than 400 cfu/100ml. Georgia water quality standards state that a 30 day geometric mean cannot exceed 200 mpn/100ml from May through October and 1,000 mpn/100ml from November to April. Note that cfu (coliform unit) and mpn (most probable number) are equivalents.

The U.S. EPA BASINS system and the Nonpoint Source Model (NPSM) were developed for the watershed to define the relationship between the sources and the impacts on Two Mile Branch. The model incorporates data on land use, soils, rainfall, rate of accumulation of fecal coliform, and the maximum storage of fecal coliform in the watershed. The TMDL takes into account individual wasteload allocations from point sources and load allocations for nonpoint sources and natural background levels of fecal coliform. In addition, a margin of safety is incorporated into the TMDL. The target TMDL level for Two Mile Branch is 150 cfu/100ml. The reduction strategy identified to meet the TMDL calls for an 80% reduction in the fecal loading rates from urban pervious and impervious land uses.

The authors of the TMDL caution that no watershed specific or stream specific modeling data were collected for development of this TMDL. For example, land use data was restricted to broad categories such as urban, forest, and agriculture. The authors recommended additional hydrologic and water quality data collection in order to properly assess the condition of the watershed (USEPA 1998).

In 2006, the Georgia Department of Natural Resources Environmental Protection Division (EPD) developed a fecal coliform TMDL for fifteen 303(d) listed stream segments in the Suwannee River basin including Two Mile Branch. The TMDL was approved by the USEPA in February of 2006. Land use data for this TMDL was more reflective of actual conditions in the Two Mile Branch watershed and included more detailed classes such as residential, commercial, urban grass, etc. The first TMDL had assumed over 95% of the watershed was developed and that 50% of the developed acres were impervious. The new TMDL stated that a little over 73% of the watershed was developed, the majority being residential and a small percentage commercial, resulting in a much lower percentage of impervious surfaces in the watershed. The stormwater system, considered a wasteload, is allotted the majority of the total maximum daily load. The margin of safety is set at 10% of the TMDL and the remainder is applied to nonpoint sources and natural background levels.

Predicted loading rates are difficult to compare since the first TMDL looks at a variety of factors that are not included in the later TMDL, such as the concentration of fecal coliform in groundwater outflow. Regardless of prediction methods or rates, both TMDLs call for similar reductions in fecal loads with an 80% reduction required in the 1998 version and a 76% reduction in the 2006 TMDL.

2.1.2 TMDL Implementation Plan

For most TMDLs developed and approved in Georgia, implementation plans are created that attempt to reduce loads to the levels specified in the TMDL. While the Two Mile Branch TMDL has a reduction target, it provided very little detail on the source of contamination. The TMDL Implementation Plan, created in 2001 (SGRDC 2001), attributed the impairment to nonpoint sources of fecal coliform, including urban runoff, leaking septic tanks, and broken sewer lines.

The plan included regulatory and voluntary actions that could be carried out in the watershed to improve the water quality conditions and decrease fecal coliform loads. An implementation schedule and monitoring plan were also part of the document. Existing regulations and management plans included the sanitary code which regulates septic and sewer line installation, a stormwater management plan, erosion control and sedimentation act, and a voluntary tree and landscape ordinance among others. At that time the Part V environmental regulations mandated by the State of Georgia had not been adopted. Part V regulations protect groundwater recharge areas, river corridors, and wetlands, although only wetlands apply in the Two Mile Branch watershed as the other two are not found there. Other actions listed in the plan included the "development of management programs to control runoff including identification and implementation of BMPs", the elimination of illicit discharges, and periodic monitoring. Monitoring in conjunction with the City of Valdosta Watershed Management Plan was carried out at one location in the watershed six times in 2000 (See Section 2.2.1). A funding source was not identified for additional monitoring.

2.1.3 TMDL Implementation Plan Status Report

A status report was published in 2007 by the South Georgia RDC. While the update indicated no monitoring had been conducted, it did list a number of stakeholder group meetings and outreach activities that had occurred since the original implementation plan was created. These included river cleanups, marking storm drains to promote stormwater awareness, education events, newspaper articles, and brochures focusing on stormwater and water quality. Five implementation programs were listed including the Upper Suwannee River Partnership (supported by a Section 106 Grant), the Well and Septic Tank Referencing Online Mapping (WelSTROM) System (supported by a Section 319(h) Grant), the Suwannee River Basin Management Plan, the Timber Harvesting BMP Assurance Exams, and a watershed management plan. This document serves as the watershed management plan for Two Mile Branch. The City of Valdosta administered the development of this plan supported by a Section 319(h) Grant. Since the original implementation plan was completed, the City has become a Phase II stormwater community.

A number of the regulatory actions outlined in the first implementation plan were still in place at the time of the 2007 status report. One change was the adoption in 2004 of the Part V environmental regulations mandated by the State. Also in 2006, the City of Valdosta created a stormwater utility applicable to all who receive stormwater management services with proceeds dedicated to maintaining the service.

2.2 Watershed Studies

2.2.1 Valdosta Watershed Assessment and Protection Plan

In 2002, a watershed assessment was prepared for the City of Valdosta by the University of

Georgia's Watershed Group and Carter & Sloope Inc. The Georgia EPD requires local governments to assess watersheds within their jurisdiction in order to renew, upgrade, or obtain a new NPDES permit for water pollution control plants. The purpose of study was to determine current and future conditions of the watershed and create a management plan that included measures to address nonpoint source pollution. The assessment included water quality modeling, water quality testing, and bioassessments (fish, macroinvertebrates, and stream condition).

The Valdosta watershed assessment included portions of the Withlacoochee (including Two Mile Branch), Little, and Alapaha River watersheds. At least fifteen sites were sampled throughout this area including one location within the Two Mile Branch watershed at the Jerry Jones Drive stream crossing. Just upstream of the site there is a small dam reinforced with Gabion structures and riprap. The sampling team found garbage in the channelized stream and there were signs of channel degradation and erosion. The stream segment was assessed, sampled, and given a classification based on a habitat score, macroinvertebrate score, and a fish score. The reduced quality of the physical habitat at Two Mile Branch contributed to the classification of 'slightly impaired' (UGA 2002). Water was tested on site for temperature, pH, turbidity, conductivity, and dissolved oxygen. Water quality samples were also collected to test for a number of parameters including nitrogen, phosphorous, total suspended solids, biological and chemical oxygen demand, and fecal coliform. Fecal coliform levels exceeded the State of Georgia water quality limit only once for the six samples collected at Two Mile Branch. These samples, taken once a month over a period of six months, were of insufficient frequency to determine a geometric mean and thus inadequate to allow for evaluation of compliance with water quality standards. Other parameters tested at that site did not exceed State water quality limits.

A water quality model, Stormwater Management Model (SWMM), was used to simulate runoff and pollutants from the surface through a network of streams based on model inputs including land use, soils, climate data, and water quality data. The model indicated that as undeveloped land is developed, there will be an increase in flow and pollutants. A scenario was run for one parcel demonstrating how a wet pond could minimize the effects of runoff and pollutants associated with small stormwater events.

The above data, along with other field observations, were used to predict the effects of pollutants on water quality in Valdosta. The study identified sedimentation as a major problem in Valdosta, especially around construction sites lacking in erosion and sedimentation controls. Another problem identified was high stormwater flow leading to channel scour and streambank destabilization. The study also pointed out that stormwater flow carries fecal coliform into streams. The assessment acknowledged that the City had taken steps to repair and rehabilitate City sewer lines to reduce fecal coliform. Other suggestions to decrease levels included managing stormwater and proper septic tank maintenance.

Once the assessment was completed, a watershed management plan was created that included four main activities; 1) improvement of oversight and enforcement of stormwater associated with construction sites, 2) repair and/or replacement of sewer lines, 3) implementation of a comprehensive stormwater management plan, and 4) the development of a schedule to implement these activities as well as others such as water quality monitoring. Seasonal monitoring (4 times a year) was recommended at rotating sites throughout the City as well as biological and habitat assessments every two years.

In terms of stormwater management, the plan suggested using zoning and ordinances to limit the percent of impervious surfaces associated with development and restricting new stormwater outfalls unless the water was treated. Other suggestions were designing stormwater management systems so post-development peak discharge rates equal those found pre-development, maximizing groundwater recharge by encouraging infiltration measures, and constructing new stormwater management systems that could remove 80% of post development annual loads of total suspended solids.

2.2.2 Additional Monitoring

The City of Valdosta continued monitoring water quality at Two Mile Branch in 2003 and 2004. They also sampled Two Mile Branch upstream of the crossing at Bemiss Road four times in 2001. Samples were obtained using an automatic sampler that was activated by rainfall. The sampler took samples at intervals during the entire rain event so longer rain events yielded a larger number of samples. Results at Jerry Jones Road indicate high levels of fecal coliform that exceed water quality standards during the November 28, 2003 and January 26, 2004 sampling events. Much lower values were found during the sample events in February and April (Table 1). These samples meet water quality standards which state from November to April, fecal coliform levels are not to exceed a geometric mean of 1,000 per 100ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample. From May to October, fecal coliform levels are not to exceed a geometric mean of 200 per 100 ml. Since most of the samples were taken more than 30 days apart, a geometric mean can only be calculated for the four sample events collected in February of 2004.

Table 1. Fecal Coliform Monitoring Results for Two Mile Branch at Jerry Jones Road

Date	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
11/18/2003	230	-	-	-	-	-	-
11/28/2003	-	1,620	11,800	29,800	-	-	-
1/26/2004	1,160	1,110	3,490	1,205	-	-	-
2/6/2004	10	0	30	335	-	-	-
2/12/2004	70	160	-	-	-	-	-
2/13/2004	20	80	60	250	180	135	110
2/25/2004	320	80	190	-	-	-	-
Feb Geo Mean	*46*	*32*					
4/12/2004	240	85	640	280			

Results indicate extremely high levels of fecal coliform at the Bemiss Road sample site (Table 2). The geometric mean is well above the water quality standard described above. At this point, Two Mile Branch does not appear to be a perennial stream and therefore has no groundwater flow. Most flow in this portion of the channel would be associated with storm events. These results are further discussed in Section 3.3.

Table 2. Fecal Coliform Monitoring Results for Two Mile Branch at Bemiss Road

Date	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
3/4/2001	13,800	40,800	65,800	11,800	14,200	22,600	-
3/15/2001	6,200	20,700	6,400	9,600	-	-	-
3/20/2001	2,300	2,200	2,100	1,850	2,900	3,800	-
3/29/2001	2,100	200	1,600	-	-	-	-
Geo Mean	*4,509*	*4,391*	*6,133*				

2.2.3 Suwannee River Basin Management Plan

The Suwannee River Basin Management Plan was completed in 2002 with an update scheduled for 2007. The update will not occur since the State of Georgia is currently preparing a statewide water management plan. The 2002 plan, which covered the entire Suwannee Basin within Georgia, focused on water quantity and water quality conditions and issues. Water quality assessments conducted for the plan showed that fecal coliform was the third most commonly listed causes of failure to support designated uses. It was noted that nonpoint sources are likely potential sources of fecal coliform since point sources have been better managed throughout the basin (EPD 2002).

Discussion of water quality results, problems, strategies and solutions were divided by subbasin or 8-digit hydrologic unit codes (HUCs). Within the Withlacoochee River subbasin (HUC 03110203), where Two Mile Branch is located, six stream segments (this number has since increased to 15 stream segments) were not fully supporting due to elevated fecal coliform levels. Possible sources were listed as a "combination of urban runoff, septic systems, sanitary sewer overflows, rural nonpoint sources and/or animal wastes" (EPD 2002). Other problems within the subbasin included low dissolved oxygen, erosion and sedimentation, drought conditions, and widespread flooding. One of EPD's priorities for the basin was to address problems associated with metals, fecal coliform, or areas with fish consumption restrictions as a result of air deposition, urban runoff, or other nonpoint sources. According to the plan, the State was to encourage best management practices (BMPs) and begin implementing approved TMDLs for 303(d) listed streams. The Georgia EPD believed permitting and enforcement at the State level would not be effective for controlling the numerous small, diffuse nonpoint pollutant sources found throughout any given watershed. Therefore, EPD proposed a cooperative effort between "state and federal agencies, individual landowners, agricultural and forestry interests, local county and municipal governments, and Regional Development Centers" to put into place regulatory and voluntary land management practices (EPD 2002).

Specific suggestions included developing a watershed plan (as part of an NPDES permit renewal) and engaging in local comprehensive planning, both of which have been completed for the City of Valdosta. The following list appears in the Suwannee River Basin Management Plan as a list of activities for urban nonpoint source runoff control:

- Implement local nonpoint source (NPS) management programs, streambank and stream restoration activities, and community Adopt-A-Stream programs.
- Develop and disseminate local watershed planning and management procedures.

- Implement state and local Erosion and Sedimentation Control Programs.
- Prepare and disseminate technical information on best management practices and nonpoint source monitoring and assessment.
- Implement NPS education programs for grades K through 12 through Project WET (Water Education for Teachers).
- Implement the Georgia Adopt-A-Stream Program, as described below in Section 7.3.6.
- Identify and evaluate resources to support urban watershed planning and management. (EPD 2002)

The City of Valdosta already implements some of these activities, while others are incorporated into this management plan.

2.3 City and County Rules and Ordinances

2.3.1 Comprehensive Plan

The Greater Lowndes 2030 Comprehensive Plan was completed in 2006 and serves as a planning guide for growth and development in Lowndes County as well as the Cities of Valdosta, Hahira, Lake Park, Dasher, and Remerton. The plan identified issues and opportunities and concludes with a community agenda that serves as the implementation tool for the county and different cities. Within the agenda there is a short term work plan that will be updated every five years.

One of the issues raised in the land use portion of the community assessment was the large amount of land dedicated to parking, which leads to stormwater runoff challenges. Opportunities for improvement include shared parking and the use of pervious pavement. Under the environmental portion of the plan, the assessment showed that Valdosta had adopted the Part V environmental ordinances mandated by the State as well as floodplain regulations, tree preservation and replanting ordinances. While the City uses stormwater best management practices for all new development, a comprehensive natural resources inventory has not yet been conducted, making it difficult to steer development away from environmentally sensitive areas. Opportunities include the creation of the natural resource inventory as well as the adoption of a green space conservation program.

Other natural resource opportunities include education, enforcement of current policies and ordinances, establishment of a riparian buffer ordinance and impervious surface limits, and enforcement of erosion and sedimentation controls. The plan notes that the Water Resource Protection District Ordinance (WRPDO) should be expanded to include maintaining, protecting, and restoring wetlands. Regulations would ensure that wetlands and adjacent buffers could be conserved as open space.

The Comprehensive Plan also includes a future development map depicting the county broken into character areas or development categories. Each character area allows for a variety of development types. For example the 'Institutional Activity Center' character area has four permitted zonings including residential professional, office institutional, office professional, and neighborhood commercial. The character areas found in the Two Mile Branch watershed include Park/Recreation/Conservation Area, Transitional Neighborhood, Established Residential Area, Neighborhood Activity Center, Community Activity Center, and Institutional Activity Center.

2.3.2 Master Stormwater Management Plan

The Master Stormwater Management Plan, written in 1996, was based on existing conditions in the City (RSH 1996). A hydrologic model was developed based on soil, land use, and flow data collected throughout the City. The model was then run using a 25-year/24-hour rain event with a rainfall volume of 7.5 inches to determine water surface elevations throughout the watershed. The model used (SWMM) is capable of incorporating nonpoint source pollutant discharges and how they are transported through the watershed although that function was not utilized in the master planning effort. At the time, water quality was not as much of a priority as managing water quantity. In addition to modeling, a field investigation was conducted throughout the watershed to determine any deficiencies in the stormwater system. In the Two Mile Branch watershed a number of problems were highlighted including flooding downstream of road crossings (N. Ashley Street, N. Oak Street, and Jerry Jones Road), flooding on the stream reach between Seymour Street and University Drive, sediment accumulation in Joree Millpond, and severe erosion downstream of Jerry Jones Road. Finally, the plan labeled the headwater region of Two Mile Branch as a retention pond and considered the slow draw down rate to be a problem. It is important to note this headwater region is a natural spring-fed headwater wetland and should not be altered or enlarged (See Figure 2).

Figure 2. Headwater Wetland of Two Mile Branch

Based on the model analysis, field review, and input from landowners, recommendations were made that included enlarging culverts and dredging channels to facilitate efficient removal of surface water from the City during rain events. Some on-line retention facilities were recommended in order to prevent downstream flooding. There were nine specific recommendations for the Two Mile Branch watershed. The first four are culvert replacements and downstream excavation for N. Ashley Street, N. Patterson Street, N. Oak Street, and Berkley Drive. The remaining five are the enlargement of the headwater swamp, which was misidentified as a retention pond, installation of retention ponds upstream of N. Ashley Street, and upstream of N. Oak Street, excavation of the main channel between Seymour Street and University Drive, and erosion control downstream of the culvert on Jerry Jones Road.

The City has implemented some of these recommendations including the installation of new box culverts at N. Oak Street and Berkley Drive. The area downstream of the culvert on Jerry Jones Road has been hardened and a number of baffles have been installed, to reduce the velocity of stormwater leaving the box culvert. The City plans to construct new box culverts at N. Patterson Street and N. Ashley Street before the end of 2008 (Valdosta 2007a).

This stormwater plan focused mainly on water quantity, but in the past ten years, new laws have been passed that require management of water quality as well as quantity. With that in mind, the suggested projects that have not been implemented should be reviewed and adjusted to incorporate methods to improve water quality, while managing water quantity. In addition, the headwater region should not be altered or disturbed and the stream channels should not be dredged. Dredging stream channels is a short term solution that ultimately leads to an unstable channel and increased erosion. The City has indicated there are no plans to carry out either these activities (Valdosta 2007a).

2.3.3 Stormwater Ordinance

The City of Valdosta stormwater ordinance established “minimum requirements and procedures to control the adverse effects of increased post-development stormwater runoff and nonpoint source pollution associated with new development and redevelopment” (Valdosta 2006a). The ordinance sets minimum post-development stormwater management standards and requires the maintenance of the pre-development hydrologic response based on the 25-year storm event after development has occurred. While the City encourages non-structural stormwater management, it also establishes design criteria for structural controls. Finally, the ordinance defines responsibility for long-term maintenance and the procedures required for stormwater management plans.

Detention is required when post-development flows associated with a 25-year storm exceed pre-development flow and cause “adverse impacts” to streams or increase the depth of flooding. For properties where runoff will flow directly into a stream before exiting the property, 24-hour detention of the 1-year storm is required, but detention of the 2-year through 25-year storm is not required (as long as it does not adversely impact the area downstream of the property). Detention facilities for residential subdivisions can be located at an off-site detention facility or on one parcel within the subdivision owned by the property owner’s association. In terms of water quality, the ordinance places a cap on the quantity of total suspended solids load that can leave a newly developed or redeveloped site per year.

2.3.4 Stormwater Utility

An ordinance was adopted by the City of Valdosta that allows for a fee (stormwater utility) to be collected from those properties receiving benefits from the stormwater management services, systems, and facilities provided by the City. All fees collected go into the stormwater utility fund, which is used to maintain those services in order to meet the existing and future stormwater needs of the City (Valdosta 2006b).

Instead of assigning the same flat fee to every residential parcel, the City opted to create tiers to be more fair and equitable. All single family homes pay a fixed rate per month based on the amount of impervious area, which includes hard surfaces such as rooftops, driveways, detached garages, etc.

Table 3. Single Family Stormwater Fees

Single Family	Monthly Rate
1,849 sq. ft or less	$1.25
1,850 – 6,099 sq. ft	$2.50
6,100 sq. ft or more	$4.25

For multifamily units, each apartment, townhouse, or condominium is charged a monthly residential rate, based on two categories:

Table 4. Multi Family Stormwater Fees

Multi Family	Monthly Rate
4 or less dwelling units / building and mobile homes	$1.25 per dwelling unit
5 or more dwelling units / building	$1.00 per dwelling unit

Commercial rates are based on the number of Single Family Units (SFUs) calculated by dividing the customer's total impervious area by 3,704 sq. ft. This value represents one SFU and has been statistically determined to represent the average impervious area for all residential customers in the City. The monthly rate is then the number of SFUs multiplied by the Monthly Rate, which is the base rate for one SFU ($2.50).

In addition, the City produced a manual containing seven options that non-residential landowners can implement in order to reduce the stormwater fee, up to 60%. One option is an integrated non-structural BMP program that involves education, paved area sweeping, landscaping, storm drain stenciling, and a number of other activities. Other options include stormwater quality control structures, stormwater volume control, and zero discharge credit. The stormwater quality control option requires a specific phosphorous and bacteria percent removal rate. Detailed descriptions of each option can be found in the Stormwater Utility Policies and Procedures Manual (Valdosta 2006c).

2.3.5 City of Valdosta Water Resource Protection Districts Ordinance

The Georgia EPD established the Part V environmental criteria to be used in comprehensive planning throughout Georgia (Chapter 39-3-16). In order to address these Part V environmental criteria, the City of Valdosta established an ordinance to protect groundwater recharge areas, river corridor and wetlands. Recharge areas and the pollution susceptibility have been identified by the Georgia Department of Natural Resources. The protected river corridor applies to perennial streams that have an average annual flow of at least 400-cubic feet per second. There are no recharge areas or protected river corridors in the Two Mile Branch watershed. Wetlands as mapped on the U.S. Fish and Wildlife Service National Wetlands Inventory (NWI) Map are depicted on the Water

Resources Protection Districts Ordinance (WRPDO) Overlay Map. In the Two Mile Branch watershed these protected areas are found along Two Mile Branch and in its headwaters (See Figure 1). If a proposed development is located within fifty feet of the mapped wetland area, the City will not issue a local permit until the developer has worked with the U.S. Army Corps of Engineers to determine the extent of jurisdictional wetlands and obtain a Section 404 permit.

2.3.6 Additional Ordinances

The City of Valdosta is in the process of creating Land Development Regulations (LDR) that combine the existing land use and development ordinances of the City while updating the regulations to promote innovative land use control measures. The LDR will include a number of ordinances that help protect environmentally sensitive areas in Valdosta. These are summarized below (Valdosta 2006d).

The Soil Erosion and Sedimentation Control Ordinance requires all land disturbing activities to be managed in order to prevent sediment from leaving the site and contaminating receiving waters. This is achieved by minimizing cut-fill, conforming to natural topography when possible, maintaining vegetation, and stabilizing soil. The City requires education and training for those who design, review, permit, construct, monitor or inspect land disturbing activities. A land disturbing activity is in violation of this ordinance if runoff from the site increases the turbidity in receiving waters by 25 nephelometric turbidity units (NTU).

The City of Valdosta adopted a Flood Damage Prevention Ordinance based on a model recommended by the Georgia Floodplain Management Office for communities participating in the National Flood Insurance Program (NFIP). The ordinance complies with FEMA's floodplain management regulations as described in 44 Code of Federal Regulations (CFR), Section 60.3. Although its main purpose focuses on public health and safety and minimizing public and private losses from flooding, there are some water quality benefits. Among other provisions, the ordinance is designed to “control filling, grading, dredging, and other development which may increase flood damage or erosion and control the alteration of natural floodplains, stream channels, and natural protective barriers, which are involved in the accommodation of floodwaters” (Valdosta Code §50-33). These provisions help protect surface waters by minimizing impacts to floodplains. Floodplains are not only important for flood storage, but also have terrestrial and aquatic habitat functions and help improve water quality by reducing nutrient input into streams. Special flood hazard areas are found along most of the streams in the City, including Two Mile Branch.

The zoning ordinance encourages the most appropriate use of land throughout the City as identified in the comprehensive plan. Zoning districts in the City include residential, commercial, manufacturing, and environmental resource zones. There are also planned districts that allow for more flexible site planning and encourage natural resource conservation. Almost 42% of the Two Mile Branch watershed is zoned as R-15, single family residential on lots that are at least 15,000 square feet in size, and other residential zones make up an additional 20% of the watershed (See Figure 3). Commercial zones make up approximately 10% of the watershed with the majority of that zoned as highway commercial (C-H). A mix of office, educational and institutional zones make up another 10% of the watershed area. Planned use zones, which encourage natural resource conservation, account for less than 2.5% of the watershed and land zoned as environmental resource (E-R) accounts for less than 2% of the watershed. Only half of the area labeled as environmental resource is open space, the other half is a City auditorium and parking lot.

The subdivision ordinance tasks the subdivider with providing adequate stormwater drainage for the site. The ordinance mandates piping of all stormwater unless calculations show the pipe will exceed 42 inches, and then an open ditch can be used. Pavement of some ditches may be required according to this ordinance.

In the utilities chapter, Section 98-184 states that connection to public sewer is required. This applies to all properties within the City limits that are located on a street or right-of-way where there is a public sanitary sewer provided the public sewer is within 200 feet of the property lines. This section stipulates that the property owner must install suitable toilet facilities and connect them to the public sewer at his expense within 90 days of official notice to do so (Valdosta 2006d).

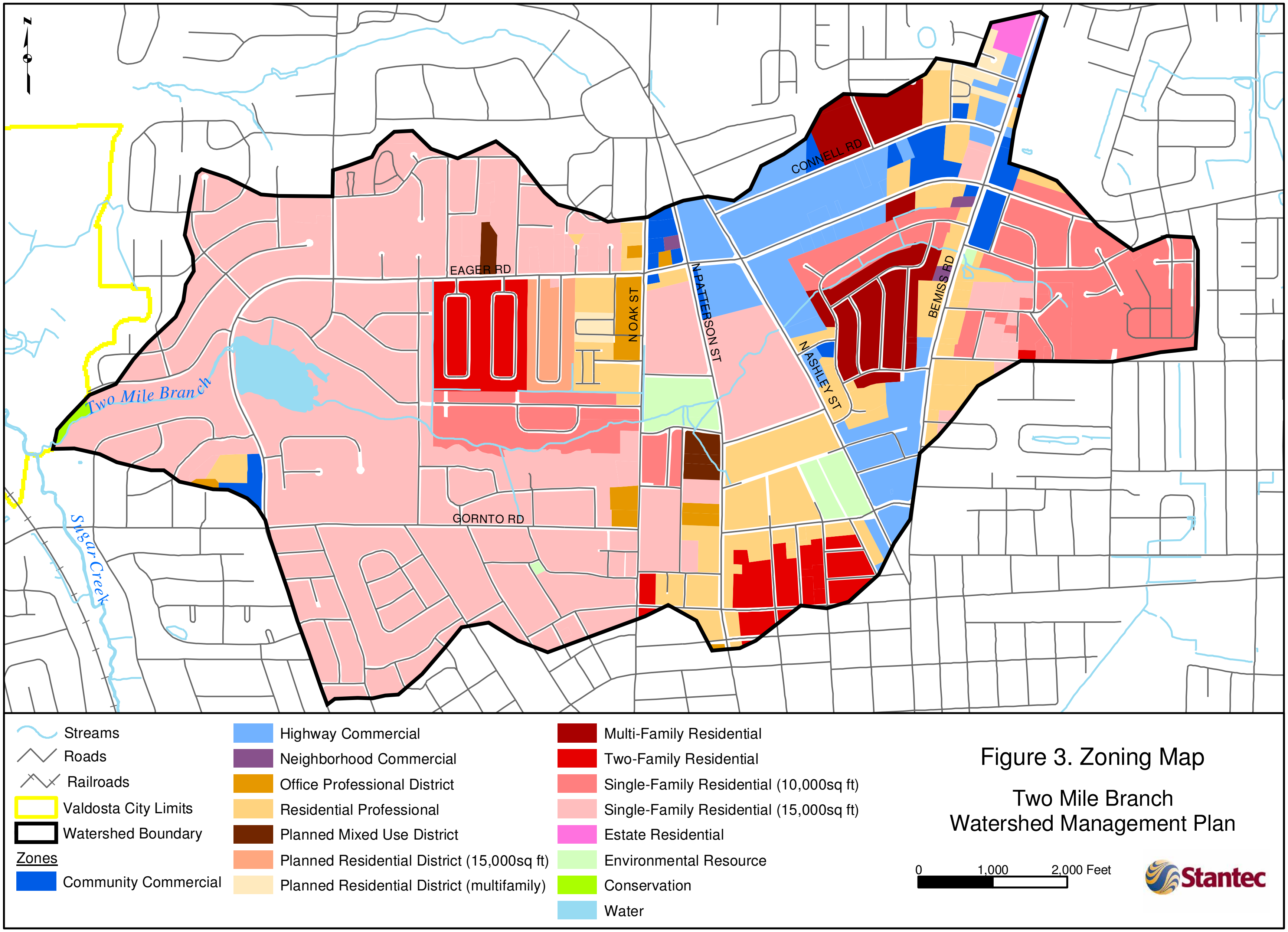


Figure 3. Zoning Map

Two Mile Branch
Watershed Management Plan

2.4 Geospatial Data Analysis

In order to get a better understanding of the watershed and to begin evaluating potential pollutant sources, a variety of geospatial data was obtained and analyzed. Topography and stormwater data including outfalls, pipes, ditches, and inlets were used to delineate the watershed boundary. Other data layers were used to determine land use, soil type, and extent of impervious cover within the watershed. This information will be useful in determining pollutant sources as well as management options throughout the watershed. Buffer width was determined using aerial imagery. The data was provided by VALOR (VAldosta-LOwndes-Regional GIS).

2.4.1 Current and Future Land Use

Land use was calculated using the Valdosta Current Land Use map, the National Wetlands Inventory (NWI) map, and the hydrology map for the Withlacoochee River basin (See Figure 4). The hydrology map was verified using 2006 aerial photography. Field verification of all of the wetlands that appear on the NWI map was beyond the scope of this assessment. It is possible that the NWI overestimates the actual quantity of wetlands along Two Mile Branch although it may underestimate the headwater wetland area (based on a field visit to the area). Most of the mapped wetland areas are undeveloped.

Approximately 54% of the watershed contains residential land use including single and multi-family homes. Commercial land use occupies an additional 14% while roads and right-of-ways make up 13% of the watershed area. Public institutions including schools, South Georgia Medical Center hospital, and Valdosta State University North Campus account for almost 10% of the watershed. The largest tract of unused/undeveloped land in the watershed is a wooded 22-acre area. The remaining undeveloped land borders the wetlands of the watershed. Table 5 contains the complete breakdown of land use in the watershed.

Table 5. Two Mile Branch Watershed Land Use

Land Use	Acres	% of Watershed
Residential	899.45	54%
Commercial	238.39	14%
Roads & right-of-ways	224.93	13%
Public Institution	164.15	10%
Unused, undeveloped	45.47	2.6%
Wetland	36.90	2.2%
Other utility	26.78	1.6%
Parks & recreation	17.20	1.0%
Pond	12.20	0.7%
Office, professional	7.95	0.5%
Agriculture	2.92	0.2%

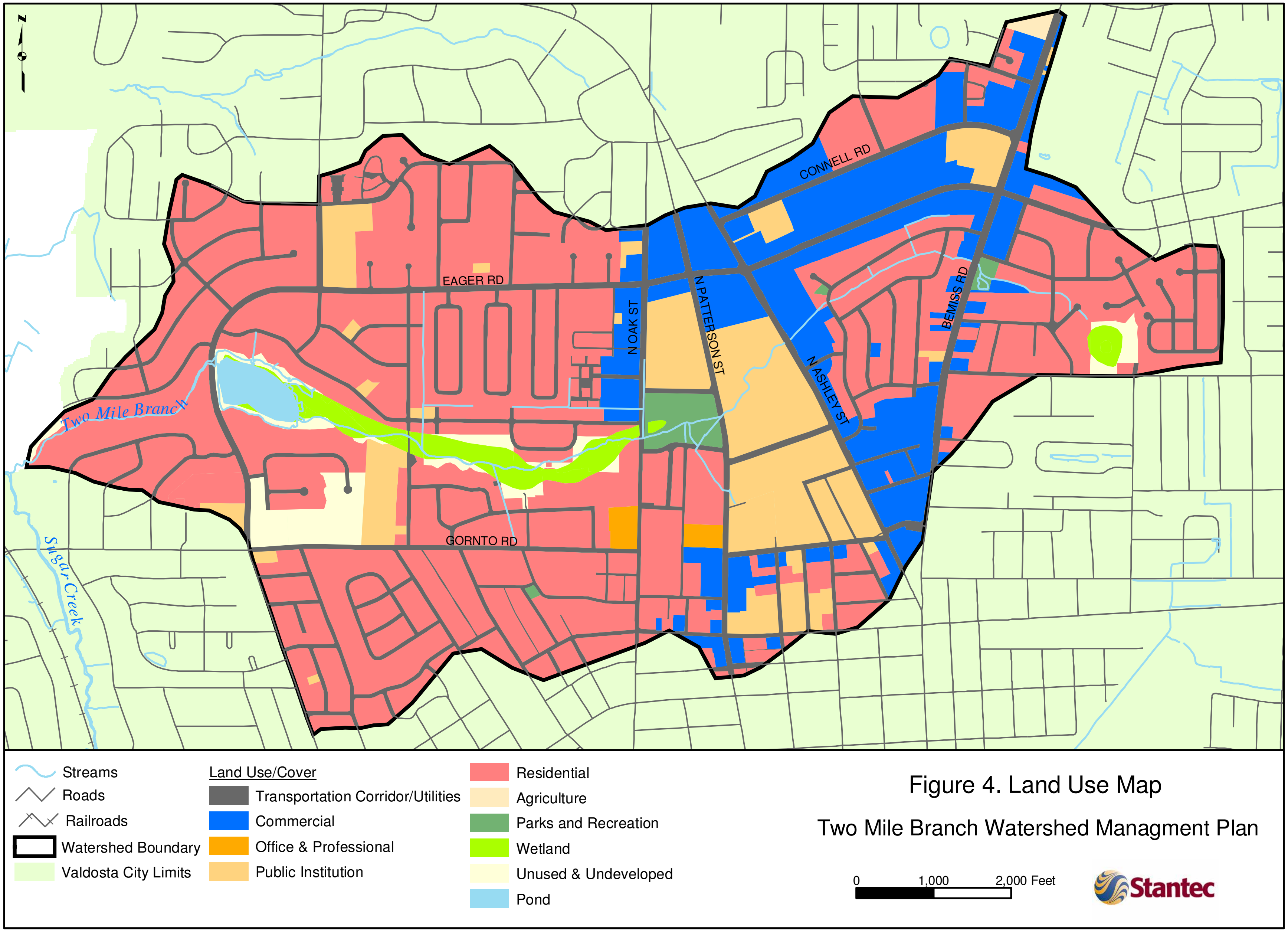


Figure 4. Land Use Map

Two Mile Branch Watershed Managment Plan

The character areas depicted on the Future Development Map along with the current zoning are used by the City of Valdosta Planning and Zoning Division to determine which development or redevelopment plans should be approved. While most of the Two Mile Branch watershed is already developed, there are a number of changes in land use that are expected to occur as described below and depicted in Figure 5 (Valdosta 2007b).

The small agriculture area on Bemiss Road will most likely be developed for commercial or mixed use purposes. Also along Bemiss Road, some existing residential pockets could be redeveloped for commercial purposes. Over time, multi-family residential units may replace existing single-family homes along Pineview Road. Redevelopment of the area in the northeast corner of the N. Ashley Street and Connell Road intersection as well as the northeast corner of the N. Ashley Street and Woodrow Wilson Drive/Bemiss Road is expected. A large condominium complex is in the planning stages on the southwest corner of Roosevelt Drive and N. Patterson Street. This will replace one single-family home and utilize vacant land. Additional buildings are planned on the Valdosta State University campus and a parking garage will replace a building on the hospital campus. Transportation improvements include the extension of Woodrow Wilson Drive to Gornto Road and the possible widening of portions of Eager/Jerry Jones Road. These improvements may create pressure for commercial growth. The City is working to protect the Jerry Jones Residential Corridor for as long as possible; however in character areas that allow for commercial zoning, there will likely be a transition from residential to commercial in the next decade.

Most of these plans will lead to an increase in impervious surfaces in the watershed and therefore an increase in runoff. However, the City stormwater ordinance mandates stormwater control on new development and redevelopment projects. These controls will help mitigate the negative effects of the increase in imperviousness. Some of the commercial redevelopment may not result in an increase of imperviousness; however stormwater control will still be required, which could potentially lead to a decrease in runoff from current conditions.

The City hopes to purchase the wooded 22-acre undeveloped tract for use as a public park and the start of a greenway that would follow Two Mile Branch to McKey Park on N. Oak Street. Since the greenway would follow Two Mile Branch, the City would have to obtain an easement on the privately owned parcel just downstream of N. Oak Street. Development on this lot is likely limited to a single family dwelling due to the 100-yr floodplain and wetlands on site.

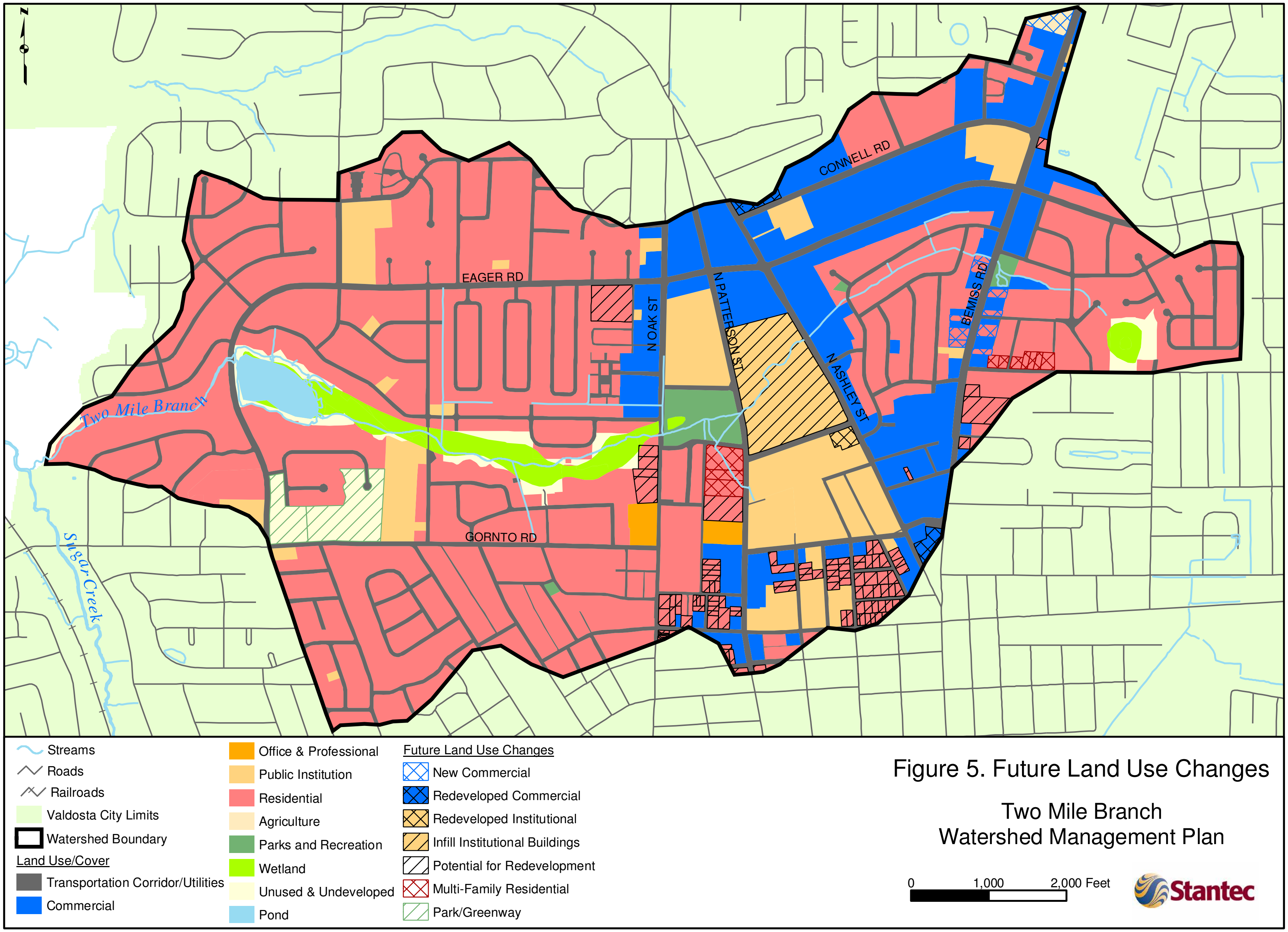


Figure 5. Future Land Use Changes

Two Mile Branch
Watershed Management Plan

2.4.2 Imperviousness

Imperviousness of the watershed was calculated using data provided by VALOR including the buildings layer, non-residential imperviousness layer, and the Lowndes County roads layer, which were all clipped to the watershed boundary. The buildings layer included the footprint of houses and businesses throughout the watershed, although the information was incomplete and somewhat outdated. In order to improve this layer, parcel data and 2006 aerial imagery were reviewed to determine where additional buildings were located in the watershed. Approximate footprints were then added to the buildings layer. The non-residential impervious layer, created in June 2006, included parking lots and driveways for all non-residential areas in the watershed. It also included some buildings. This layer and the building layer were combined in order to eliminate any areas of overlap. The road layer, which is a line file, was buffered to create an average road width of 30 feet throughout the watershed to take into account the varying road widths actually found there. The layer was then added to the previous two for a total of 455 acres (27%) of impervious surface in the watershed (See Figure 6). This is an underestimate as it does not take into account the driveways found on the majority of the residential lots or the sidewalks found in some areas. In addition, as parcels with single-family homes are replaced with larger buildings and parking lots, it is likely that the amount of impervious surface will increase.

2.4.3 Soils

Almost 79% of the soils in the watershed are part of the Tifton-Urban land complex according to the Natural Resource Conservation Service (NRCS) Lowndes County Soil Survey (See Figure 7). These soils may have been altered for development. Tifton soils are well drained; however permeability is only moderate, meaning water movement through the soil can be slow. This has implications for management in that soils may need to be replaced for stormwater BMPs to function correctly.

Approximately 9.5% of the soils in the watershed are hydric. Hydric soils, those soils that are wet near the surface at times, are used as indicators of the presence of wetlands. These soils are mainly found along the riparian corridor of Two Mile Branch and one of its tributaries to the southeast of Joree Millpond. Some of these hydric soil areas are mapped as wetlands, while other areas have been developed, resulting in a loss of wetland functions. Only certain types of stormwater BMPs can be installed in areas with hydric soils.

2.4.4 Buffers

The main stem of Two Mile Branch is approximately 2.85 miles long (15,000 linear feet), excluding the Joree Millpond, which is approximately 1,300 feet long. The majority of the channel from the confluence with Sugar Creek upstream to N. Oak Street has a wooded buffer. On the section of stream from N. Oak Street to N. Ashley Street there is a moderate buffer with less vegetation near the banks. From N. Ashley Street upstream to the headwaters (a little less than 30% of channel length), the channel has a sparse buffer with scattered trees (See Figure 8).

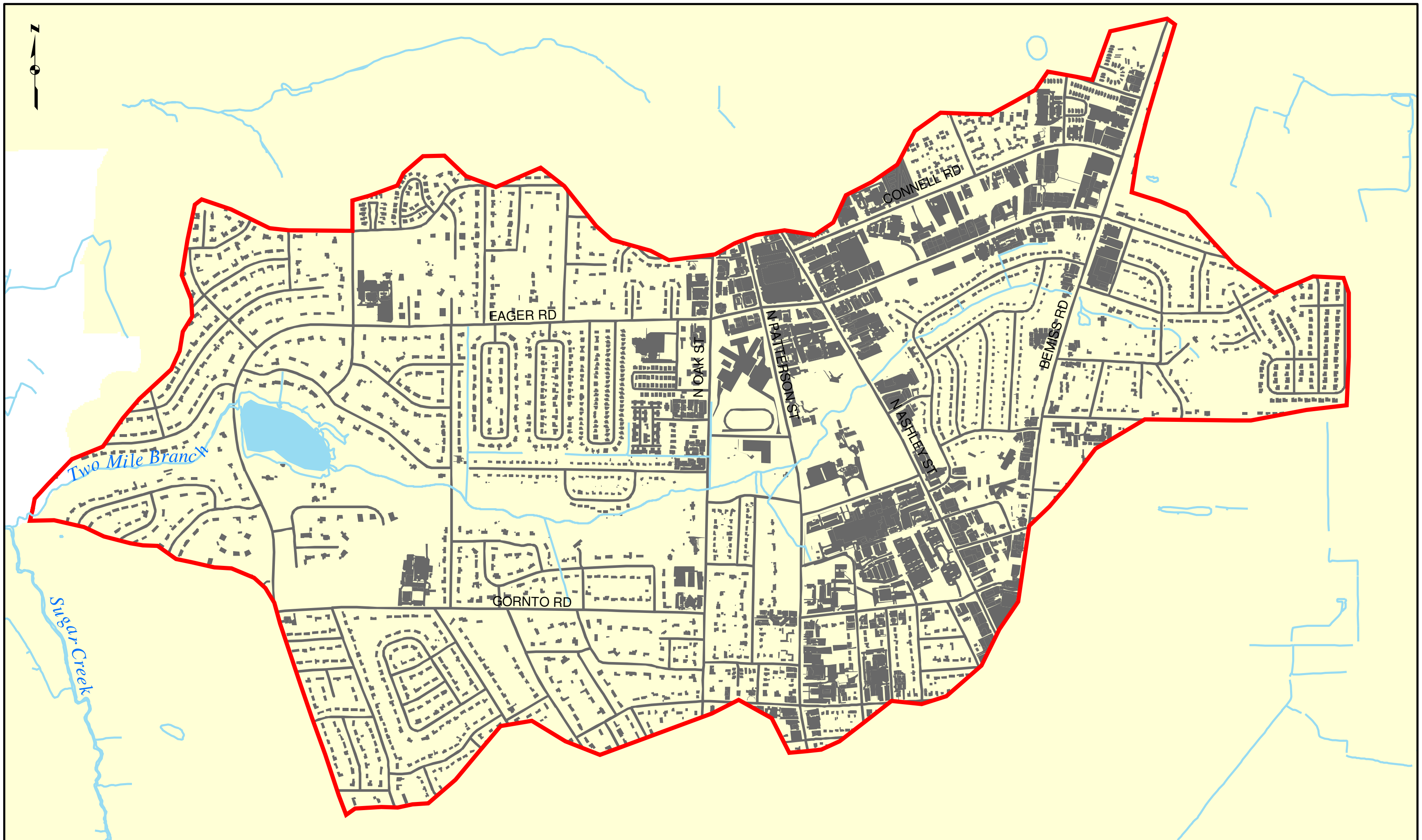


Figure 6. Impervious Surfaces Map

Two Mile Branch Watershed Management Plan

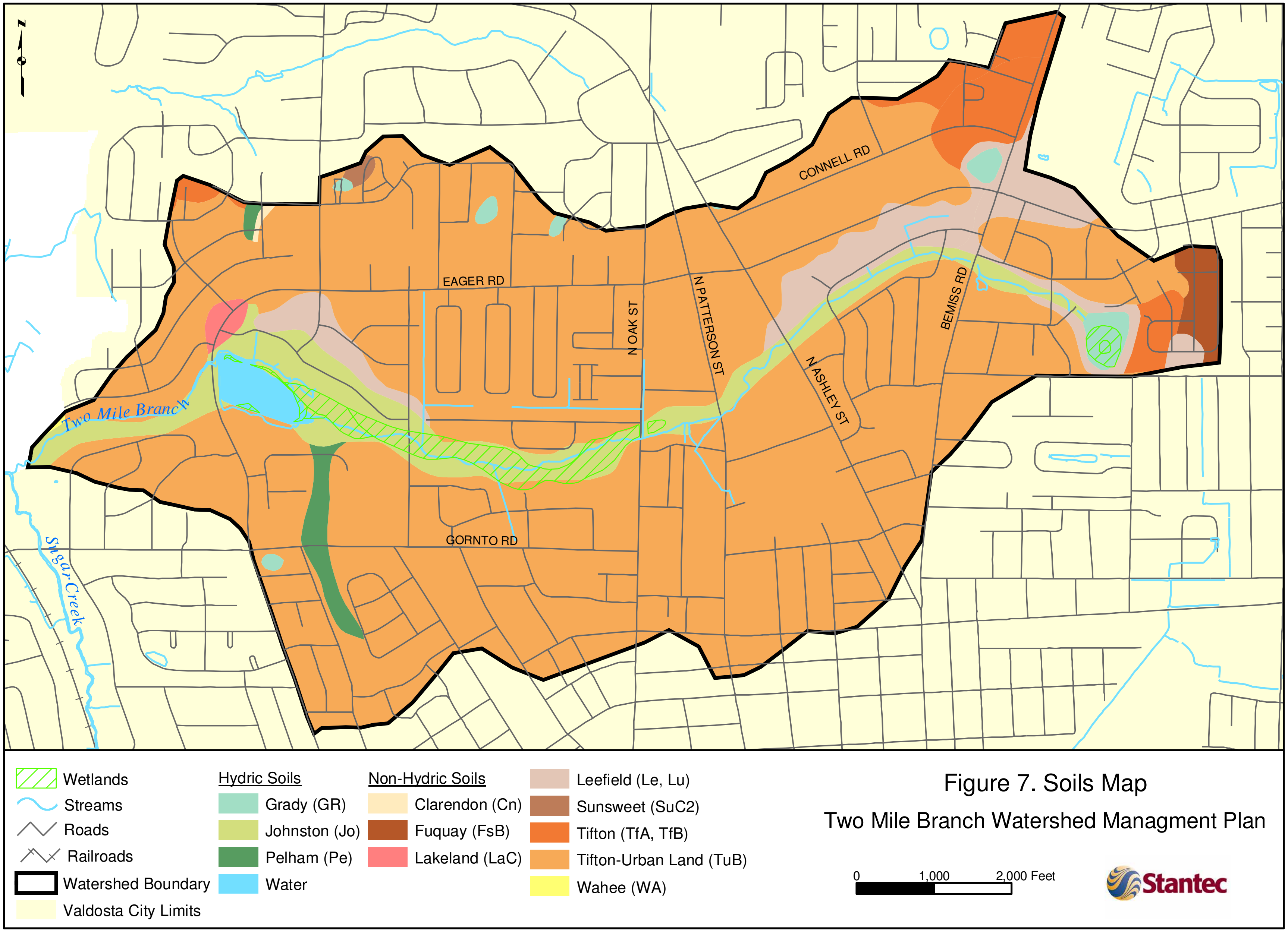


Figure 7. Soils Map

Two Mile Branch Watershed Managment Plan

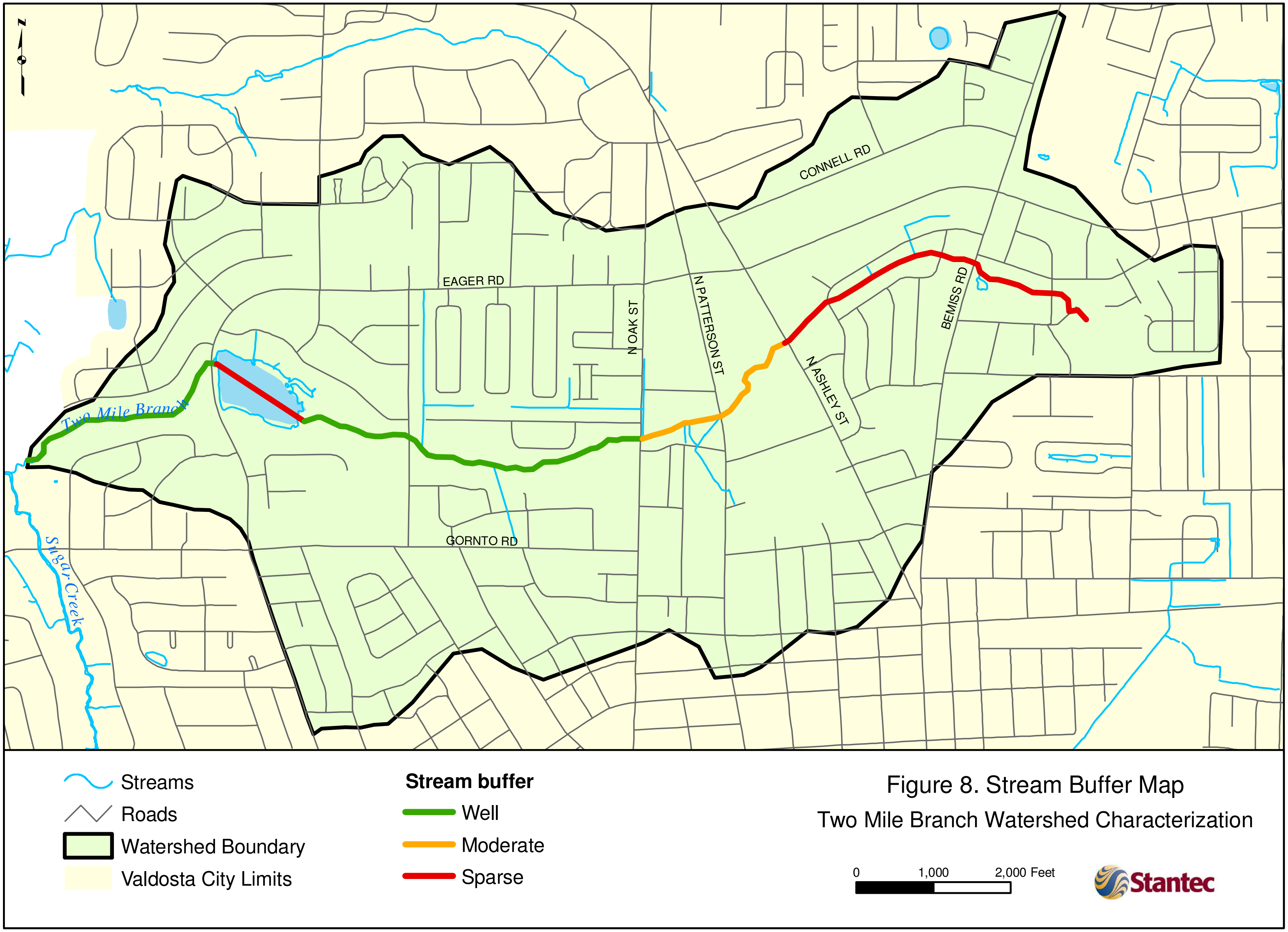


Figure 8. Stream Buffer Map

Two Mile Branch Watershed Characterization

3.0 Inventory of Sources

The inventory of contaminant sources focused on fecal coliform in order to determine the necessary improvements to work toward removing Two Mile Branch from the 303(d) list. Efforts also focused on sediment and floatable debris as requested by the City of Valdosta.

There are several known sources of fecal coliform contamination in surface waters, including leaking sewer lines, stormwater runoff, failing septic systems, and pet and animal waste. Their relative contribution to fecal coliform loading may be dependent on watershed characteristics and their prevalence in the watershed itself. Several studies have shown stormwater runoff and high watershed imperviousness to be the most significant factor contributing to higher fecal coliform contamination. Additionally, these same studies have shown that the dominant source of fecal bacteria in urbanized watersheds is most likely non-human and that surface runoff from residential lawns can be extremely high in fecal coliform counts, demonstrating the possible significance of pet waste as a contributing source to stormwater contamination (Young, 1999). Also, non-human sources have been shown to be significant in non-sewered watersheds, suggesting that though septic systems may contribute to fecal coliform loading, they are not necessarily a dominant source (Kelsey, 2003). The Two Mile Branch watershed was investigated to inventory these sources as well as any illicit discharges.

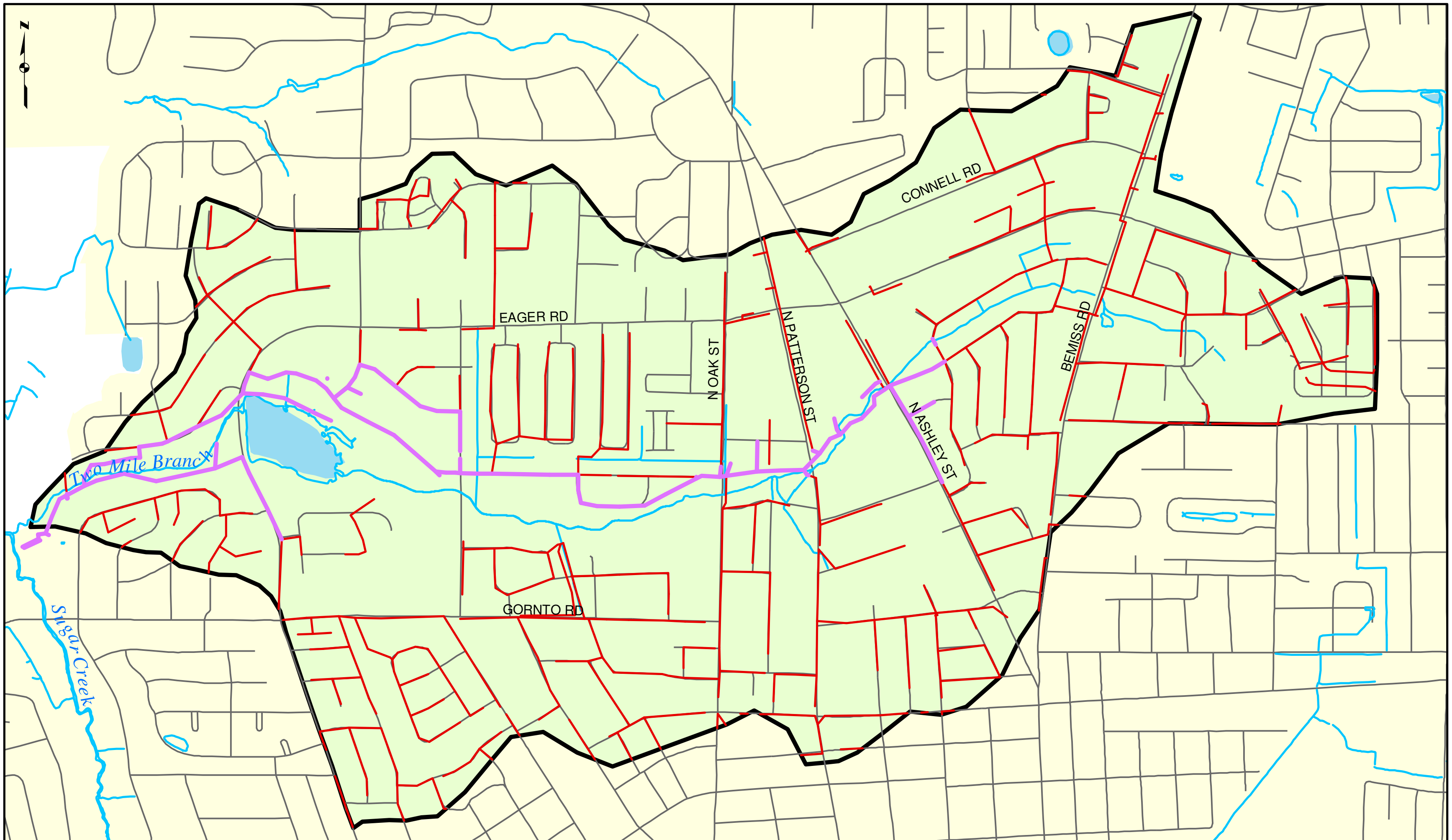
Known sources of sediment and litter include construction sites, areas with bare earth, and areas where flowing water is actively eroding the land. Concurrent with the fecal inventory, potential sediment and litter sources were investigated in the watershed.

3.1 Sewer Collection System

The TMDL documents do not mention the reported sewer leaks between N. Patterson Street and N. Ashley Street that led to the listing of Two Mile Branch as a result of fecal contamination. A written record of the sewer repairs that have occurred in the watershed as a result of the leak is lacking, and is only briefly mentioned in the watershed assessment plan (Section 2.2.1). According to City officials, sewer line improvements were conducted from the confluence of Two Mile Branch and Sugar Creek upstream to Gonwood Circle from 1998 to 1999. Improvements continued upstream to University Drive from 1999 to 2000. These improvements included installing sleeves on some sewer lines and replacing lines where needed. As-built plans and construction plans were used to create a map illustrating the improved and new sewer sections (See Figure 9). These improvements have eliminated a large source of fecal coliform in the watershed.

3.2 Stormwater Sources: Outfall and Illicit Discharge Survey

The City of Valdosta has mapped 69 outfalls in the Two Mile Branch watershed including pipes that end at the stream channel (See Figure 10). It is important to note that during rain events all of these outfalls carry stormwater directly to Two Mile Branch or its tributaries. This stormwater is most likely the main contributing source of fecal coliform in the watershed. As noted previously, studies have shown stormwater runoff and high watershed imperviousness to be the most significant factor contributing to higher fecal coliform contamination.



Streams

Roads

Watershed Boundary

Valdosta City Limits

Existing Sewer Lines

Improved and New Sewer Sections

Figure 9. Sewer Collection System Map

Two Mile Branch Watershed Characterization

0 1,000 2,000 Feet

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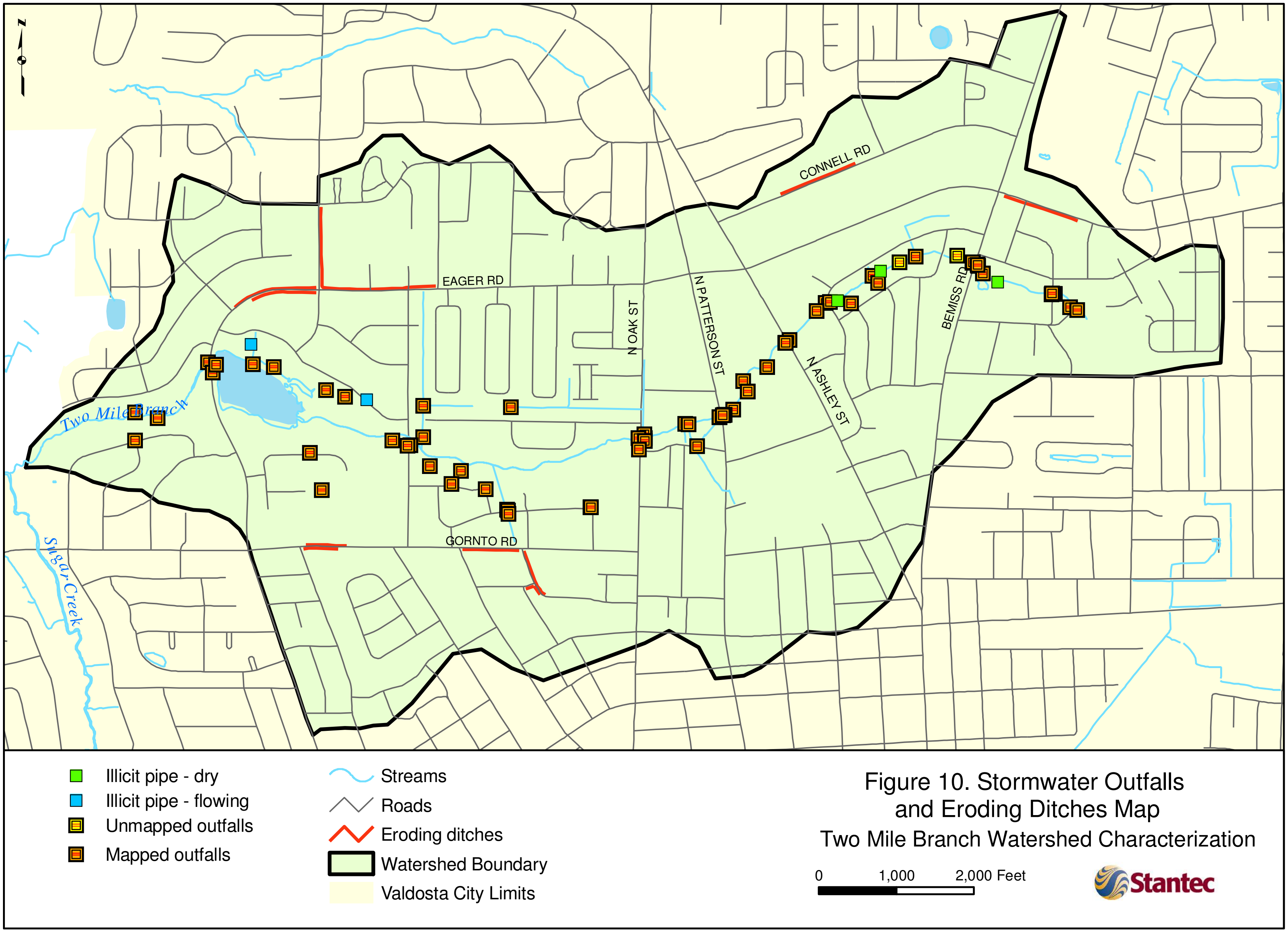


Figure 10. Stormwater Outfalls and Eroding Ditches Map
Two Mile Branch Watershed Characterization

Each of these outfalls was visited during a period of dry weather to check for any illicit discharges. The field investigation also included walking along Two Mile Branch from its headwaters in the Joree Spring neighborhood down to Gonwood Circle to search for additional outfalls.

The field investigation revealed that a ditch has been excavated from the headwater region, across a number of properties and then crosses under Randolph Street and Orland Drive. There was some standing water in the channel although it has no stream features or habitat. It serves primarily as a stormwater channel and draws down the groundwater level in the immediate area. Roadside ditches outfall into the channel at Orlando Drive. Downstream, just before Bemiss Road, the channel enters a small community park. On the south side of the channel a pond receives stormwater from the adjacent neighborhood and then discharges into the stream. This pond most likely also serves to lower the groundwater level in the area. A building next to the pond has two PVC pipes that discharge into the stream. There was no evidence of discharge during the field investigation. A conversation with one of the occupants revealed that the building often has water underneath it. It is likely that the two pipes are part of a tile drain system designed to drain this water. The building sits on an area of Johnston loam soils, which is a poorly drained soil. Roadside ditches discharge into the channel at Bemiss Road. These ditches drain the majority of the properties along Bemiss Road.

Downstream of Bemiss Road the channel is paved for a small portion and there is an unmapped outfall on the northern streambank. This outfall carries stormwater from a few commercial parking lots. There was more trash in the stream from this point on, and the stream becomes more incised and very unstable in this area. Downstream of Seymour Street the stream has cut down to the clay soil layer resulting in approximately six feet of incision. The amount of trash was also greater here than the upstream portion. Two outfalls in this area, both on the northern streambank, carry stormwater from the commercial areas on Connell Road and Northside Drive. One of these outfalls, an 18” reinforced concrete pipe, has not been mapped. Further downstream, a small one-inch PVC pipe is located on the northern bank. The pipe did not have discharge and it was unclear where it originated. By now the channel is considered an intermittent or perennial stream. Three more outfalls carry stormwater into the stream before University Drive. A corrugated plastic pipe that appears to serve as an underdrain from a house was found just before University Drive. Roadside ditches discharge into the stream here as well. Downstream of University Drive, the streambanks consist of retaining walls, one of which is falling in towards the stream. Downstream of this point, the channel is surrounded by woods. A brief investigation revealed a likely wetland area on the north side of the channel although it could be cut off from the stream.

Roadside ditches discharge stormwater into the stream at N. Ashley Street. On the northern side of the stream there is a large amount of organic debris piled up in the floodplain. Seven outfalls drain stormwater from the surrounding Valdosta State University parcels. All were dry although three of them had failing headwalls. The stream then crosses under N. Patterson Street, where there are roadside ditch stormwater outfalls, and then flows into McKey Park. Two channels discharge into the stream from the south. The first channel originates near the hospital although it is fed by a large network of pipes and stormwater inlets that extend throughout the southeastern portion of the watershed. This channel has groundwater flow although previous studies have indicated it is not a jurisdictional stream. The second channel is a short grass-lined ditch, fed by a number of stormwater inlets, which appears to remain dry except during storm events.

Roadside ditches discharge into the stream at N. Oak Street and Berkley Drive. Between these two streets the channel is well buffered. Spot checks along the channel revealed the stream was incised, there were large trees toppled into the stream, and many exposed roots. Privet, an invasive plant species, was found throughout the floodplain in sections. Two outfalls that discharge into the stream from the south side were dry. The stream channel borders the properties to the south, while to the north there is a large floodplain between the stream and the houses on Canna Drive. Stormwater from three large neighborhoods travels behind the houses on the north side of Canna Drive before discharging into Two Mile Branch just upstream of Berkley Drive.

On Millpond Road there are two outfalls that discharge into a wetland adjacent to Two Mile Branch. One of these outfalls had a small amount of flow that was traced back to a pipe coming from a single-family home. Further down Millpond Road there is one pipe outfall and one open channel that carry stormwater from the northwest portion of the watershed. The open channel had one illicit discharge from a small PVC pipe on a single-family residential lot. Both illicit discharges were most likely from tile drains. The soils in this area north of the stream and pond are Johnston loam, a hydric soil that is very poorly drained. It is likely that many of the houses in this area have drainage issues due to the high water table. The remaining outfalls downstream of Berkley Drive were dry. Appendix A contains a complete list of the unmapped outfalls and pipes that were found in the watershed.

3.3 Septic Systems

Septic systems are domestic wastewater treatment systems commonly used when sewer lines are not available. Each septic system has an underground tank where sludge and solids sink to the bottom and liquid waste flows out into a drainfield, which is a network of shallow pipes spread over a large area. A properly functioning system allows liquid waste to be gradually released into the drainfield where it can be absorbed by plants or percolate through the subsoil where it is purified, recycled through natural biochemical reactions, and released harmlessly into the groundwater (DCA 2007). Many factors such as improper installation or inadequate maintenance can cause septic system failure, which may lead to significant environmental problems. Septic systems that are installed in unsuitable soils may malfunction by leaking raw, untreated sewage to the soil surface or a nearby stream, or by contaminating the groundwater. Poorly drained soils, including hydric soils, are considered unsuitable for septic systems.

Failing septic systems are a potential source of fecal coliform in the watershed as identified in the TMDL. It is difficult to determine how many failing septic systems may exist in the watershed as there is no map of septic systems. While the sewer collection map depicts sewer lines found in the watershed, it does not show connections to individual houses and it is possible that all lines are not mapped. Due to these limitations, utility billing records were searched in order to determine if buildings in the watershed were connected to the public sewer system. It was assumed that if not connected to the public sewer system it must have a septic system. Records had to be searched individually, therefore only a subset of the 2,500 plus parcels in the watershed was examined. The subset was selected based on existing sewer line mapping, recently annexed areas (as the county does not have a public sewer system), soils, and field reconnaissance.

Soils are rated for septic system suitability by NRCS and all of the soils within the watershed are limited in terms of suitability. However, these ratings are based on large areas and a soil investigation of an individual site may reveal an area suitable for a septic system. Utility bills for those parcels located in areas with poorly drained or very poorly drained soils (See Figure 7) were reviewed. Efforts were then focused on parcels in two developed areas that were annexed by the City within the past few years. These areas do not have sewer lines according to current sewer collection system map. In addition, manholes were not found during field reconnaissance and a few homeowners confirmed these two neighborhoods had septic systems. Additional parcels surrounding these areas were selected as well as a few large parcels found in the watershed. The records search of the 335 parcels indicated that approximately 76 parcels have septic systems (See Figure 11).

There is very little data on septic system failure rates. While the Lowndes County Health Department currently tracks permits for new septic systems and septic repairs, mapping of the data only began in 2003. According to this data, there were nine permits issued within the watershed since 2003. Upon further investigation it was discovered that four of the permit locations are incorrectly mapped and are not located within the watershed. A field visit to a fifth permit site revealed an abandoned house. The remaining four permits are located in an area that was recently annexed by the City. A data search for permits from 2000-2003 was also conducted on select parcels resulting in one additional permit. All five permits were for repairs to existing septic systems (See Figure 11).

The most obvious septic system failures are easy to spot. For example, a homeowner can check for pooling water or muddy soil around the septic system or notice if the toilet or sink backs up after flushing or doing laundry. Another sign is strips of bright green grass over the drainfield. Septic systems also fail when partially treated wastewater comes into contact with groundwater. This type of failure is not easy to detect, but it can result in the pollution of wells, nearby streams, or other bodies of water. Septic systems designed in soils with a shallow depth to seasonal high water table can contaminate the groundwater that then contaminates nearby wells, ditches, and streams. While the parcels with repair permits likely had obvious signs of failure, it is difficult to determine how many systems are failing that do not have obvious failure signs. Water quality sampling can help identify areas with potentially leaking septic systems.

In the Two Mile Branch watershed, water quality testing results from samples collected at Bemiss Road indicated high levels of fecal coliform during rain events (Section 2.2.2). The contributing watershed for this collection location is less than 160 acres in size. However, much of the area drains into stormwater inlets that outfall downstream of the sample location. In addition, a large portion of this subwatershed drains to a detention pond location upstream of the headwater swamp. By eliminating these areas, the actual area that drains to the sample location is less than 35 acres. The cluster of parcels with septic systems located just upstream from Bemiss Road and downstream of the headwater swamp (See Figure 11) are likely to be significant contributors to the high fecal coliform counts recorded at Bemiss Road. Soil survey information for this area indicates a high seasonal water table, which means the drainfields may be inundated at times and therefore would leak sewage. Finally, a feasibility study conducted by the City of Valdosta, pointed out that part of the area was low and wet and needs sewer lines (Valdosta 2003). As part of that same feasibility study, the County Health Department determined this to be an area of moderate concern. This study identified nineteen houses with septic systems in the headwaters. Another factor that could be contributing to the high fecal levels is stormwater runoff.

3.4 Wildlife and Domestic Pets

Despite the TMDL assessments and implementation plans, no information on the numbers or density of domestic animals is available for the watershed. Pet waste is often overlooked as a source of both nutrient and bacteria/parasite contamination in stormwater. However, feces from dogs and cats have as much as 2.5 times the amount of nitrogen, the same amount of phosphate, and half as much potash as cattle manure (University of Wisconsin – Extension Office, 1993). It is also a significant source of diseases and parasites, such as Giardia lamblia, Cryptosporidium, Salmonella, and E. coli. A bacterial source tracking study in Seattle, WA reported that approximately 20% of bacteria isolates were matched with dogs (EPA, 1993). The impact of pet waste on stormwater contamination is a factor of both the number of pets in a watershed, and the efficacy of pet owners in disposing of the waste.

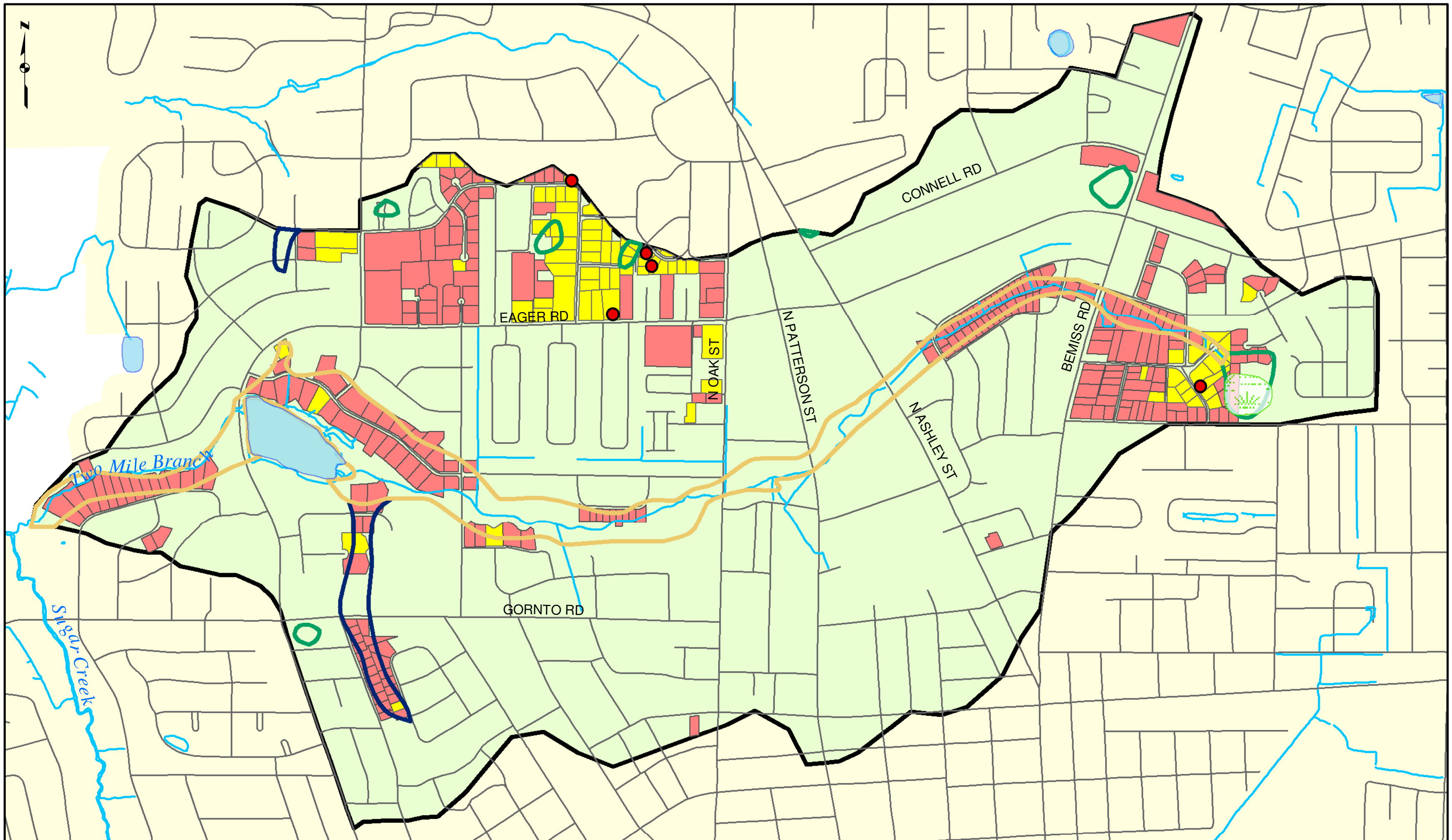
In an effort to quantify the density of domestic animals in the watershed, the number of household pets was calculated based on market research statistics from the American Veterinary Medical Association (AVMA, 2007). This includes national statistics on the percent of households owning various types of pets, as well as the average number of pets per each household. National statistics showed that 36.1% of households owned dogs, 31.6% owned cats, and 4.6% owned birds. Additionally, the average number of pets owned per household is 1.6 dogs, 2.1 cats, and 2.1 birds. Given the 2,460 residential parcels currently present in the subject area, it was calculated that roughly 1,420 dogs, 1,630 cats, and 240 birds are domestically owned within the Two Mile Branch watershed. Since the majority of birds are kept indoors, they are not a likely source of fecal coliform. Dogs produce an average of 0.75 pounds each per day. This would amount to 200 tons of dog waste per year. Cats in the watershed would produce less waste. Studies show that over half of the cats in the United States remain indoors. Outdoors cats usually attempt to bury waste making it less susceptible to runoff. However, cats are not always able to bury waste and therefore it can be carried by stormwater to streams.

No current data exists on the pet waste habits of the residents of the Two Mile Branch watershed. However, an extensive citizen survey, which included data on pet waste removal, was conducted in 2005 by the North Carolina Department of Environment and Natural Resources. The results of the survey showed that 47% of urban pet walkers, 49% of suburban pet walkers, and 59% of rural pet walkers 'rarely' or 'never picked up pet waste. Those reporting to 'always' or 'often' pick up pet waste were 35% of urban, 34% of suburban, and 27% of rural pet walkers (Bartlett, 2006).

An additional source of fecal coliform in the watershed is from wildlife. The TMDL (EPD 2006) states there are 21 deer per square mile in the Lowndes County. This would equate to approximately 55 deer in the 2.6 square mile watershed. This contribution is minor compared to the number of domestic animals within the watershed. Canada geese and other waterfowl will also contribute fecal coliform to the watershed once construction on the Joree Millpond is complete. A management recommendation for reducing the number of Canada geese is found in Section 4.1.3.

3.5 Sediment and Floatable Debris

While performing the field portion of the fecal coliform source inventory, attention was paid to any potential sediment or floatable debris source. Overall the upland areas of the watershed appeared clean with minimal trash or debris and very little sediment. At the time there was one small construction site containing two single family homes and one major construction site, a hospital expansion, in the watershed. Sediment fences were in place at the main site as well as covers on all existing stormwater inlets. In general the site looked well managed although some fences appeared to be in need of repair. In addition, outside of the main construction area, a trench had recently been excavated to bury cable. The excavated soil had been piled on existing pavement alongside the trench. There were no erosion control measures in place around this pile area and it was evident that some of the soil had runoff. Finally, accumulated soil was found in the retention pond downhill of the site. In order to minimize issues such as these, the City should revisit sites where construction will occur for extended periods of time. Preparations were underway for what appeared to be a second major construction site near the hospital.



Lake/Pond
Swamp/Marsh
Roads
Streams
Watershed Boundary
Valdosta City Limits

Hydric Soils
Grady (GR)
Johnston (Jo)
Pelham (Pe)

Surveyed Parcels
Surveyed area
Septic parcels
Septic repairs

Figure 11. Septic Survey Map
Two Mile Branch Watershed Characterization

0 1,000 2,000 Feet

Stantec

Another sediment source found in portions of the watershed was eroding ditches (See Figure 12). Some ditches had steep, vertical banks and it was evident that sediment was carried downstream during storm events. It also appeared some of the ditches were sprayed in order to kill vegetation or they were mowed. Vegetation helps stabilize ditches and should not be removed. Those ditches that appeared to be in the worst shape were identified and recorded (See Figure 10).

With regard to instream sediment and erosion problems, the main stem of Two Mile Branch was incised and actively eroding along the majority of its length. In the portion upstream of N. Ashley Street, the channel was eroded down to the hardpan and a new channel had begun to form within it (See Figure 13). From N. Ashley Street downstream, the streambanks were steep and eroding (See Figure 14). Given these observations of geomorphic conditions in Two Mile Branch, the channel itself is likely to be the single largest source of sediment transported downstream to Joree Millpond and will continue to be so into the future without active measures to stabilize the stream and implement additional stormwater control.

Figure 12. Eroding roadside ditch

Figure 13. Two Mile Branch upstream of N. Ashley Street

Figure 14. Two Mile Branch downstream of N. Ashley Street

4.0 Identification and Targeting of Management Opportunities

Stormwater is most likely the largest source of fecal coliform in the watershed therefore management measures should focus on this issue. Leaking septic systems appear to be a major source of fecal coliform in the headwaters of the watershed as evidenced by the high levels found at Bemiss Road just downstream of an area where the houses have septic systems. Illicit discharges do not appear to be a major source of fecal contamination. Although two flowing discharges were found as well as a few dry PVC pipes, it is likely all of them drain groundwater that may collect around buildings as they were all found in areas of poorly drained soils. Although pet waste is a likely source, it is difficult to quantify how much it impacts the watershed compared to the other sources. A number of structural and non-structural best management practices (BMPs) will help address these sources. Recommendations for specific BMPs are detailed in the following sections.

4.1 Structural BMPs

Exposure to sunlight is one of the most important factors causing bacteria die-off. Die-off means the bacteria has disappeared from the water column and settled on the bottom sediments. However, the bacteria can survive and re-suspension of sediments means the bacteria can reenter the water column (Schueler and Holland 2000). Structural BMPs that allow for exposure to sunlight and removal of accumulated sediment are ideal for treating fecal coliform. These include wet detention ponds and stormwater wetlands, both constructed with forebays to allow for sediment removal. Another way to remove bacteria from stormwater is by filtering and straining water through the soil profile similar to how a septic drainfield works. Structural BMPs that work in this way include bioretention cells and water quality swales.

A detailed field investigation was conducted to search for opportunities to retrofit these types of structural BMPs as well as improve some existing water features in the watershed. The result is a list of 29 proposed projects (See Table 6 and Figure 15). The different BMP types are described in the following sections along with their estimated costs, pollutant load reductions, and feasibility.

Table 6. Proposed Structural BMP Projects and Estimated Cost

No	Location	BMP Type	Estimated Cost
1	Corner of Cowart Avenue & N Patterson Street	stormwater wetland	$21,500
2/3	McKey Park near Roosevelt Drive	stormwater wetland	$90,000
4	VSU North Campus near buildings, Pendleton Drive	bioretention	$12,000
5	VSU North Campus across from hospital	bioretention[1]	$72,000[1]
6	VSU North Campus near parking lot, Pendleton Drive	bioretention	$8,500
7	Corner of Moody Drive & Bemiss Road	bioretention	$22,000
8	Jac's Lanes, Connell Road	bioretention	$11,000
9	Connell Road between SprayGlo & daycare center	stormwater wetland	$19,000
10	Near the corner of Northside Drive & Bemiss Road behind Morningside Baptist Church	bioretention[1]	$87,000[1]

No	Location	BMP Type	Estimated Cost
11	Shopping center on northeast corner of Northside Drive & N Patterson Street	bioretention	$34,500
12	Northeast corner of Habersham Road & Bemiss Road	bioretention	$20,000
13	Taylor-Cowart Park on Bemiss Road	stormwater wetland	$20,000
14	VSU North Campus near baseball stadium	bioretention[1]	$58,000[1]
15	Southeast corner of Berkley Drive & Canna Drive on City owned parcel	stormwater wetland	$74,000
16	East side of N Oak Street, north of Northside Drive	bioretention	$10,000
17	At south end of Windemere Drive	bioretention	$15,000
18	Near southwest corner Gonwood Circle & Canna Drive on City owned parcel	stormwater wetland	$31,500
19	Near back parking lot of Scott Summers Family Dentistry on Slater Street	bioretention	$3,300
20	Northside Baptist Church near covered drive off of Slater Street	bioretention	$7,300
21	On location of existing detention pond at northwest corner Northside Baptist Church off of Slater Street	bioretention	$7,000
22	On location of existing detention pond at northeast corner Northside Baptist Church off of Fleming Street	bioretention	$10,500
23	Wilson Eye Care Center on the corner of W Park Avenue & N Patterson Street	bioretention	$6,500
24	On location of existing detention pond at overflow parking for Northside Baptist Church, east side of Fleming Street	bioretention	$10,000
25	Between McLane Funeral Service & South Georgia Family Medicine on N Patterson Street	bioretention	$46,000
26	Pond located south of Taylor-Cowart Park on Bemiss Road	pond retrofit	N/A
27	St John Catholic Church near Berkley Road entrance	stormwater wetland	$11,000
28	Joree Millpond located east of Jerry Jones Road	littoral shelf	N/A
29	Various roadside ditches	water quality swale or grass channel	$5.50 ft^3 $1.50 ft^2
Total Estimated Cost for Structural BMP Projects			**$490,600[2]**

1: A different BMP type may be more suitable for these projects

2: Total cost does not include projects 26, 28 and 29

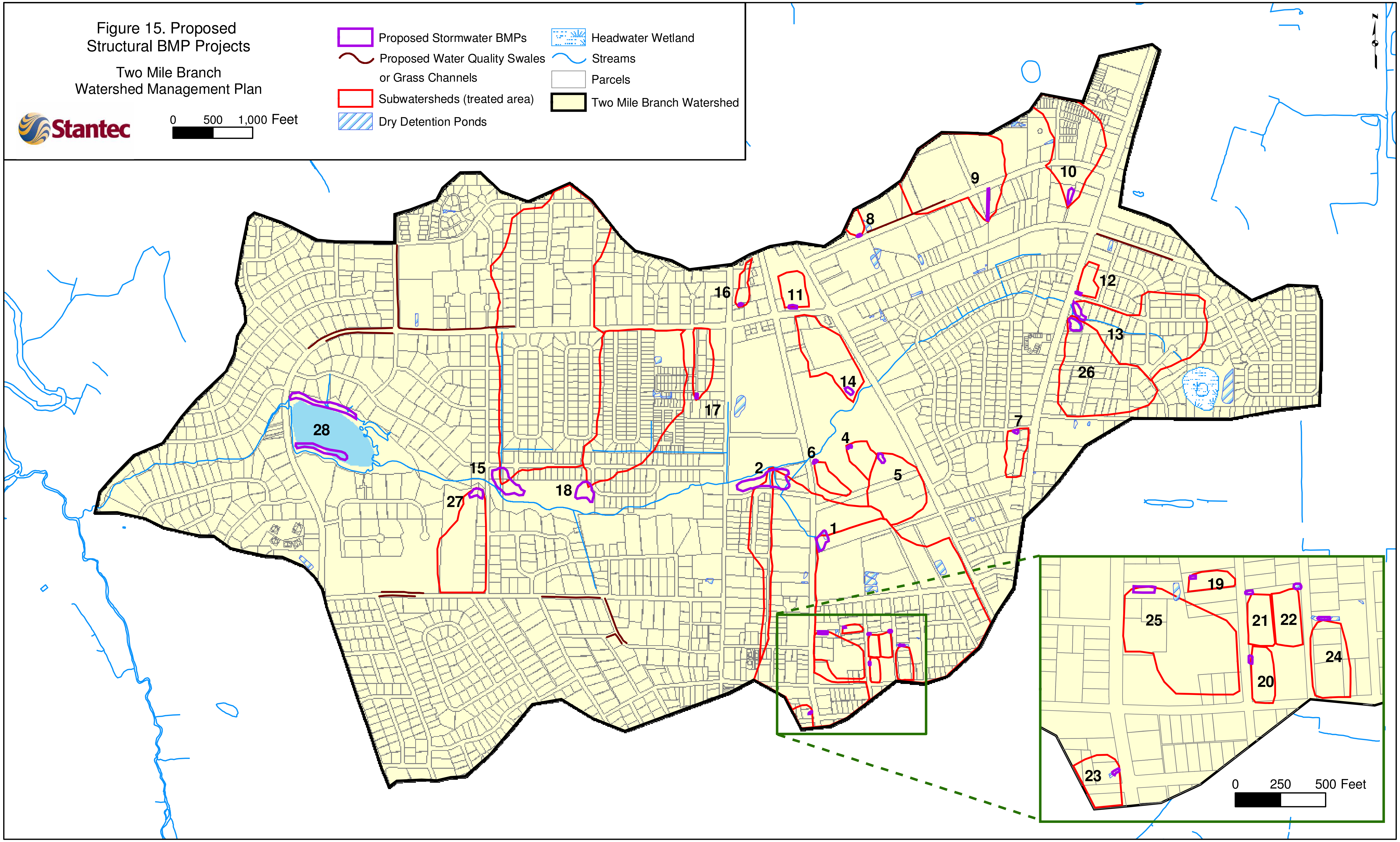


Figure 15. Proposed
Structural BMP Projects
Two Mile Branch
Watershed Management Plan
Stantec
0 500 1,000 Feet
Proposed Stormwater BMPs
Proposed Water Quality Swales
or Grass Channels
Subwatersheds (treated area)
Dry Detention Ponds
Headwater Wetland
Streams
Parcels
Two Mile Branch Watershed
N
1
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4.1.1 Bioretention Cells

Bioretention cells remove pollutants using physical, chemical, and biological processes including absorption, microbial action, plant uptake, sedimentation, and filtration. Bioretention areas differ from detention ponds and stormwater wetlands because they only hold water for short periods of time. They usually drain down within 24 hours after a rain event (Hunt 1999). A typical bioretention area includes a set of underdrains overlain by a specialized sandy fill media that ranges from 2 to 4 feet deep. The underdrain allows treated stormwater to enter the stormdrain system or be discharged into a grass channel. Since water drains down quickly, bioretention areas can be landscaped with typical landscaping plants surrounded by a mulch layer. It is important to spread out the vegetation to allow sufficient sunlight to reach the mulch layer. A layer of mulch covers the surface. Bioretention cells should be located in areas where the water table is at least 2 feet below the surface.

Figure 16. Bioretention cell located in a shopping center

Most of the proposed projects in Two Mile Branch are bioretention cells. These cells are a good fit for small drainage areas (less than 10 acres) with high levels of impervious surfaces as they can be used as a landscape feature for a commercial or institutional property. Bioretention cells are particularly suitable for urban landscapes because they require small areas for implementation and can often be constructed in existing green spaces such as traffic islands.

Projects 4, 5, and 6 VSU Campus

These projects are located on the VSU campus and would treat stormwater from campus buildings, parking lots, and some of the hospital complex. The cells would intercept stormwater before it entered the stormwater system or in the case of number 5, some of the existing pipes would be removed. However, additional development is planned on the campus and it is possible number 5 would interfere with these plans. While 4 and 6 are out of the way of future development, they will likely not be large enough to handle increased runoff from new impervious surfaces. The City should work with VSU to determine how best to incorporate stormwater management into development plans. This would be a good opportunity to install demonstration BMPs.

Project 7 Bemiss Road

This bioretention cell would treat runoff from a number of businesses on Bemiss Road. Currently an abandoned house is located behind the commercial area. The cell would be constructed partially on this parcel and could also treat some runoff from the adjacent nursing home.

Project 8 Jac's Lanes

A small bioretention cell could replace the landscaping in front of Jac's Lanes to treat runoff from the building and parking lot.

Project 10 Morningside Baptist Church

Currently a shallow ditch carries stormwater from Connell Road to Northside Drive behind the Morningside Baptist Church. A bioretention cell or a water quality swale would replace some of the ditch. The drainage area is greater than 10 acres, therefore a detailed engineering analysis of feasibility would be necessary to determine if a bioretention cell would work.

Project 11 Northside Drive Shopping Center

This is a great opportunity to work with the property owner to revitalize this partially vacant shopping center by installing bioretention cells along the edge of the parking lot. Currently, cracked and crumbling asphalt covers the parking area and there is no green space between it and the street. Landscaped bioretention cells would improve curb appeal and treat runoff from the parking lot and building.

Project 12 Habersham Road Business

A small bioretention cell would treat runoff from a parking lot and building across the street from Taylor-Cowart Park.

Project 14 VSU Campus north of Two Mile Branch

There is a large open area on the VSU North Campus, north of Two Mile Branch that is ideal to treat runoff from the adjacent field house and commercial buildings. This drainage area is larger than 10 acres in size and it is possible that a stormwater wetland would be more suitable for this area. Additional study is necessary to determine depth to water table and soil suitability.

Project 16 N Oak Street Office Park

A small wooded parcel receives runoff from a number of buildings and parking lots making it the ideal location for a bioretention cell. Some trees would be lost to make room for the BMP.

Project 17 Windemere Drive

Currently stormwater travels south on Windemere Drive before entering a small culvert into the stormwater collection system at the end of the street. Sediment deposits in this area indicate that stormwater most likely ponds in front of the culvert. Currently the area is used as a parking lot for 6-8 vehicles. These spaces would be lost in order to construct the bioretention cell; however it appears there is ample parking on the other side of the adjacent office building.

Projects 19 Scott Summers Family Dentistry

A small bioretention cell is ample to treat runoff from the parking lot of this dentist office.

Projects 20, 21, 22, 24 Northside Baptist Church

Northside Baptist Church contains multiple buildings and parking lots on both sides of Fleming Street. Some of the newer facilities have detention ponds installed. These detention ponds could be retrofit as bioretention cells to not only detain stormwater, but also improve water quality. In addition, a bioretention cell (#20) could be constructed in front of the covered driveway to treat runoff from this side of the complex.

Project 23 Wilson Eye Care Center

Stormwater crosses a grassy area before entering the stormwater collection system at this medical office. A bioretention cell would treat the parking lot and part of the building runoff.

Project 25 McLane Funeral Service

Runoff from the McLane Funeral Service and the adjacent church flows to a small vacant lot, currently owned by the funeral service, where there is a stormwater inlet. A detention pond next to the lot also discharges here. A bioretention cell would treat stormwater from the funeral service as well as the detention cell which holds runoff from the adjacent church and parking lot.

4.1.2 Stormwater Wetlands

Stormwater wetlands serve many purposes. They improve water quality, improve flood control, enhance wildlife habitat, and provide education and recreation opportunities. Particulates, organic matter, metals, soil-bound phosphorous, and soil-bound pathogens are removed through sedimentation and filtration. Vegetation in the wetland takes up some of the nitrogen and provides a media for microbes to digest nitrate, organics, and pathogens. Finally exposure to sunlight and dryness removes pathogens. Stormwater wetlands are constructed with a number of features including a forebay, shallow water areas, deep pools, occasionally submerged areas, upland areas, and outlets. Stormwater enters the forebay first, which is a 2-3 foot deep pool, where sediment and litter settle out of the water. Forebays are designed with good access so they can be cleaned out when necessary and usually account for 10% of wetland area. Deep pools, about 5-10 percent of a stormwater wetland, provide fish habitat for mosquito eating fish. Shallow water (6-12” deep) makes up a large portion, 40%, of the wetland and is where wetland vegetation grows. Occasionally submerged areas, or shallow land, is only wet during storm events and provides a place for vegetation that likes to be wet only some of the time. This area accounts for 30-40% of the wetland. Finally upland areas can be included in the wetland design to allow for observation points. The diverse vegetation found in a stormwater wetland helps prevent mosquitoes by attracting other insect and bird species. The vegetation also provides aesthetic value for the community (See Figure 17).

Figure 17. Stormwater wetland at an elementary school

Stormwater wetlands work best in areas where water naturally flows and the water table is closer to the surface since wetland vegetation prefers a wet environment. However, a liner can be used to create a stormwater wetland in a drier location as long as there is sufficient runoff. While a stormwater wetland is usually sized to be 2-5% of the area it treats, smaller wetlands can be constructed with some of the flow bypassing the system.

Project 1 South Georgia Medical Center

Currently a small detention pond holds runoff from portions of the hospital buildings and parking lots. Once construction is complete at the hospital, this detention pond could be retrofit as a stormwater wetland and expanded to include the stormwater ditch and the area currently serving as construction storage. This facility would be capable of treating a portion of the runoff that flows through the current ditch. A second stormwater wetland would be necessary downstream as described below.

Project 2/3 McKey Park

A large stormwater wetland that would encompass both of the side channels in McKey Park would treat the remainder of the runoff from the southeast corner of the watershed. A boardwalk through the wetland could be incorporated into the proposed greenway trail and could include educational signs for citizens and local schools. A number of trees would be lost by installing the wetland; however it is likely these trees would topple over in the future as the channel continues to erode and widen in this vicinity. Fast growing species including bald cypress and river birch can be planted in the wetland. Many other trees, shrubs, flowers, and aquatic vegetation are suitable for the stormwater wetland creating a beautiful landscape for the park (See Appendix B).

Project 9 SprayGlo

Currently a ditch carries stormwater from Connell Road between the SprayGlo commercial site and a daycare center. The ditch is deep with steep, eroding banks. The ditch should be stabilized and a stormwater wetland could be constructed as space allows.

Project 13 Taylor-Cowart Park

This park has space to construct a stormwater wetland adjacent to the stream channel. Water would be diverted from the stream channel during rain events for treatment and then flow back into the stream. The cypress trees in the park would not have to be removed since they can survive in wet areas.

Projects 15 and 18 Eager Road Neighborhoods

Two stormwater wetlands can be constructed in the floodplain parcel owned by the City to treat runoff from multiple neighborhoods. Some tree removal would be necessary to allow for construction. The cleared areas around the wetlands could serve as access points to the proposed Two Mile Branch greenway.

Project 27 St John Catholic Church

All of the stormwater from the buildings and parking lots discharges from two pipes into a large wooded area on the northern end of the church property. A small stormwater wetland can be constructed here to treat the runoff although some trees would be lost.

4.1.3 Wet Detention

Wet detention ponds are designed to retain stormwater and treat it. Runoff is held in the pond and treated until it is displaced by runoff from the next rain event. Sedimentation removes particulates, organic matter, and metals. Biological uptake removes dissolved metals and nutrients (EPA 1999). There are two modifications on the standard wet detention pond that improve their pollutant removal effectiveness. The first is the addition of a forebay where heavy particles can settle out of the water. This forebay can be cleaned out periodically to remove excess sediment. The second is a shallow ledge, known as a littoral shelf, constructed along the edge of the permanent pool. Aquatic plants, established on the shelf, trap sediment and slow down flow into the pond. Plants can also take up nutrients. Finally the shelf acts as a safety measure against accidental drowning.

Project 26 Bemiss Road Pond

The pond next to Taylor-Cowart Park currently serves as a wet detention pond although it may not have been designed for that purpose. It receives stormwater from the adjacent neighborhood. The pond could be improved by planting vegetation around the edge to prevent erosion and trap sediment. A forebay could also be added on allowing the City to remove trapped sediment.

Project 28 Joree Millpond

Although Joree Millpond was not designed as a BMP, it does help improve water quality. The millpond essentially acts as a large regional detention pond, holding water and allowing sediment to settle out. Creating a littoral shelf around the north and south edges of the pond will improve these water quality functions. The vegetation planted on the shelf will help prevent erosion along the pond edge and will slow water entering from the outfalls located along the north side. Figure 18 is an example of a detention pond with mentioned retrofits.

Figure 18. Detention pond retrofit with new forebay and vegetated shelf

4.1.4 Dry Water Quality Swales and Grass Channels

Dry water quality swales are open vegetated channels that capture runoff and filter it through a prepared soil layer before discharging through an underdrain. Essentially, they are linear bioretention cells with grass instead of plants and mulch. These swales can be constructed in place of typical stormwater conveyances such as roadside ditches. These swales are not designed to treat watersheds greater than 5 acres.

A less expensive option for improving roadside ditches is to replace them with grass channels. A grass channel is a broad, shallow channel vegetated with grass or with turf reinforcement mats (TRM). The TRM can withstand higher velocities than grass alone, thereby preventing erosion. It is important to note that grass channels provide less water quality benefits than swales.

Project 29 Improving Various Roadside Ditches

There are a number of roadside ditches in the watershed that have steep eroding banks (See Figure 14). This sediment can be carried into streams during rain events. Constructing water quality swales in place of some of these ditches would help treat roadside runoff. However, swales can not be installed in areas with a slope greater than four percent. Another less expensive option to prevent further erosion is to regrade the ditches to create 3:1 or 4:1 side slopes. The regarded channels can be lined with grass if velocities are less than 4 ft/s or with TRM for velocities up to 12 ft/s. More detailed analysis will be required to determine slopes and velocities and the ideal approach to each site identified.

4.1.5 Load Reductions

Load reductions that will be achieved by implementing the proposed projects are difficult to quantify as there has been little research on the effectiveness of stormwater BMPs for treating fecal coliform. The Georgia Stormwater Management Manual reports that detention ponds and stormwater wetlands remove 70% of fecal coliform and 80% of total suspended solids. For bioretention cells and water quality swales, the manual reports 80% total suspended solids removal, but has no information on fecal coliform removal.

A study on a bioretention cell in an urban setting in North Carolina showed fecal coliform load reductions between 71 and 90% (Hunt & Lord 2006, Hunt et al 2007). Another study in Charlotte, North Carolina on a stormwater wetland showed a reduction of 70% in fecal coliform loads (Hathaway 2007). Table 7 includes removal efficiencies for fecal coliform and suspended solids as well as nitrogen and phosphorous. Data was compiled from the Georgia Stormwater Management Manual, the Maryland Department of Natural Resources, and the North Carolina Department of Natural Resources in addition to the papers cited above.

Table 7. Stormwater BMP Removal Efficiencies

BMP Type	Fecal Coliform	Total Suspended Solids	Nitrogen	Phosphorous
Bioretention	71-90%	80-85%	35-40%	45-60%
Stormwater Wetland	70%	80%	30-40%	35-50%
Wet Pond	70%	80%	25-30%	40-50%
Water Quality Swale	NA	80%	50%	50%
Grass Channel	NA	NA	20%	20%

The BMP removal efficiencies in Table 7 were used to calculate how much fecal coliform each BMP would remove from the watershed in the following manner. The 2006 TMDL stated a current load of 3.23E+11 counts per 30 days. Assuming an even distribution of load throughout the watershed, this number along with the area treated by each watershed can be used to calculate how much fecal coliform would pass through each BMP. A removal efficiency of 70% was used for the stormwater wetland projects and a 75% removal rate was used for the bioretention cells (See Table 8). If all of the stormwater BMP projects are constructed, approximately 25% of the watershed will be treated. This will result in a 17.5% reduction of fecal coliform in the watershed. While this does not achieve the 76% reduction called for in the TMDL, it is a significant reduction. A further reduction of 12% will be achieved by connecting septic systems to the sewer system as described in Section 4.2.6. The remaining 46.5% reduction has likely been achieved by the leaking sewer line repairs. However, these numbers are based on literature and limited monitoring data. Additional monitoring of fecal coliform levels as projects are implemented will help determine the actual reductions and allow for an adaptive management strategy. Further reductions can be achieved by implementing additional non-structural programs as described in Section 4.2.

Table 8. Stormwater BMP Removal Efficiencies

BMP Project ID	Acres treated by BMP	% of total watershed area	Fecal (cfu) passing through BMP	Amount of fecal (cfu) remoed s a result of BMP treatment
15	95.47	5.70%	1.84E+10	1.29E+10
1	83.61	4.99%	1.61E+10	1.13E+10
2	60.34	3.60%	1.16E+10	8.14E+09
18	40.34	2.41%	7.77E+09	5.44E+09
13	25.23	1.51%	4.86E+09	3.40E+09
9	24.67	1.47%	4.75E+09	3.33E+09
10	16.07	0.96%	3.10E+09	2.32E+09
27	14.30	0.85%	2.76E+09	1.93E+09
5	11.18	0.67%	2.16E+09	1.62E+09
14	10.43	0.62%	2.01E+09	1.51E+09
25	6.24	0.37%	1.20E+09	9.03E+08
17	4.24	0.25%	8.17E+08	6.13E+08
7	3.20	0.19%	6.17E+08	4.63E+08
11	3.15	0.19%	6.08E+08	4.56E+08
4	2.56	0.15%	4.93E+08	3.70E+08
6	2.21	0.13%	4.25E+08	3.19E+08
12	1.90	0.11%	3.66E+08	2.74E+08
24	1.87	0.11%	3.61E+08	2.70E+08
16	1.48	0.09%	2.85E+08	2.14E+08
23	1.28	0.08%	2.46E+08	1.85E+08
8	1.18	0.07%	2.28E+08	1.71E+08
22	1.02	0.06%	1.97E+08	1.48E+08
21	0.87	0.05%	1.67E+08	1.26E+08
20	0.85	0.05%	1.64E+08	1.23E+08
19	0.52	0.03%	1.01E+08	7.58E+07
BMP total	**414.19**	**24.71%**	**7.98E+10**	**5.66E+10**

4.1.6 Cost

Construction cost for most of the BMPs was calculated based on current research (Table 4). These costs do not include design fees or the cost associated with acquiring land and easements. Bioretention cells are estimated to cost $10 per square foot; stormwater wetlands cost $8 per cubic yard for construction and an additional $0.30 per square foot for vegetation. Grass channels can be constructed for $3-4 a linear foot if grass is used and $7-9 a linear foot if TRM is used. Water quality swales cost approximately $7-8 per square foot. Constructing a wet detention pond would be somewhat less than a stormwater wetland. A cost was not estimated for the millpond project since construction is already underway and grading a shelf should not result in a significant cost increase. A cost was not estimated for the other pond retrofit project since it is unknown how much expansion would be necessary to treat stormwater without further study.

4.1.7 Recommended Priorities and Schedule

For each project, the contributing catchment (watershed) was delineated. Within each catchment the land use and percentage of impervious surface was determined. Based on this information, a rough estimate of BMP size needed to treat the contributing catchment was calculated. In order to prioritize the projects, points were given to each one based on public or private ownership, cost per acre treated, and clearing needs (Table 8 and 9). Projects located on sites where multiple landowners have a stake can be costly and time consuming to negotiate. Projects on public land are often easier to implement as agreements can be made to use the site whereas land acquisition is necessary on private land. Sites where the vegetative cover is wooded require greater effort for clearing and grubbing than sites with few or no trees. In addition there may be pubic opposition to a project if mature trees will be removed. Sites covered in asphalt or concrete will require more effort to prepare the site for a stormwater BMP. Finally, cost is taken into consideration. Stormwater BMPs that treat more acreage for less money are given a higher priority than those that have high costs.

Table 9. Feasibility Factors and Cost

Factors / Score	Land Ownership	Site Cover	Cost/acre treated
1	Private with more than 1 landowner	Wooded or concrete	High (<$11,000)
2	Private or university owned	Mixed	Medium (<$6,000)
3	Public	Grassed (few or no trees)	Low (<$3,000)

In order to implement these projects the City will need to take the following steps. For projects that are located on private land the City will have to purchase land or obtain easements and for those on public land, the City will have to work with the department who manages the property. While this process is occurring, funding options can be pursued. A number of funding sources are listed in Section 5.0. Funding and land approval can be the most time-consuming part of the process especially if the City attempts to obtain grant funding. Once funding and land approval have been obtained, an engineering feasibility assessment followed by design can occur. This process can take approximately 1-3 months for each BMP. Construction is the last step and should require less than a month or two to construct any of the proposed projects.

Table 10. Stormwater BMP Project Rankings

No	Project	Land Ownership	Site Cover	Cost/ac treated	Total
13	Taylor-Cowart Park on Bemiss Road	3	2	3	8
2/3	McKey Park near Roosevelt Drive	3	2	3	8
1	South Georgia Medical Center, N Patterson Street	3	2	3	8
24	Northside Baptist Church, east side of Fleming Street	2	3	2	7
23	Wilson Eye Care Center, N Patterson Street	2	3	2	7
18	City owned parcel corner Gonwood Circle & Canna Drive	3	1	3	7
15	City owned parcel corner of Berkley Drive & Canna Drive	3	1	3	7
14	VSU North Campus near baseball stadium	2	3	2	7
9	Connell Road between SprayGlo & daycare center	1	3	3	7
17	At south end of Windemere Drive	2	1	3	6
27	St John Catholic Church near Berkley Road entrance	2	1	3	6
22	On location of existing detention pond at northeast corner Northside Baptist Church off of Fleming St	2	3	1	6
21	On location of existing detention pond at northwest corner Northside Baptist Church off of Slater Street	2	3	1	6
20	Northside Baptist Church near covered drive off of Slater Street	2	3	1	6
19	Near back parking lot of Scott Summers Family Dentistry on Slater Street	2	3	1	6
10	Near the corner of Northside Drive & Bemiss Road behind Morningside Baptist Church	1	3	2	6
8	Jac's Lanes, Connell Road	2	3	1	6
7	Corner of Moody Drive & Bemiss Road	2	3	1	6
6	VSU North Campus near parking lot, Pendleton Drive	2	2	2	6
4	VSU North Campus near buildings, Pendleton Drive	2	2	2	6
25	Between McLane Funeral Service & South Georgia Family Medicine on N Patterson Street	2	2	1	5
12	Northeast corner of Habersham Road & Bemiss Road	2	2	1	5
5	VSU North Campus across from hospital	2	2	1	5
11	Shopping center on northeast corner of Northside Drive & N Patterson Street	2	1	1	4
16	East side of N Oak Street, north of Northside Drive	2	1	1	4

4.2 Non-Structural Management Recommendations

There are a number of non-structural management recommendations that can be implemented in the Two Mile Branch watershed. Each recommendation is described below along with the associated costs and load reductions where applicable.

4.2.1 Pet Waste Management Programs

Pet waste is a potentially significant source of bacteria, pathogens, and nutrients to surface waters via stormwater runoff. One method for reducing the contribution of pet waste to stormwater contamination is the implementation of pet waste management programs. These programs generally include pet waste collection stations and educational campaigns.

Pet waste collection stations are comprised of an educational message, instructions for proper use, plastic bags for collecting waste, and a garbage can for disposal (See Figure 19). It is recommended that these stations be located where pet owners need them most, including parks and rest areas. The stations can be built by local organizations, allowing them to be specifically designed to fit budgetary constraints. The NC DOT implemented such a program by installing stations at rest areas along major highways in North Carolina. A survey conducted on the success of the stations showed that that approximately 70% of the people used the pet waste bags provided (Holman, 2007a). It should be noted that an increase in fecal coliform levels occurred after a station was installed near an urban stream in Charlotte, NC. Investigation showed that the station only provided bags and did not include a trash receptacle. Pet owners were using the area for their pets, but not disposing of the waste (Holman, 2007b). The recommendations from the study stressed the importance of providing a trash receptacle and placing stations away from water bodies. Additional recommendations resulting from the study showed that the stations worked best with well-identified signs explaining the pickup process, bag usage increased when the trash receptacle was located next to the station, and that educational material at the stations about pet waste issues was needed (Holman, 2007a).

Figure 19. Pet waste station

While studies have demonstrated that pet waste can be a significant pollutant source surveys have shown that citizens do not believe that it is an important water pollution problem (WDOE, 2007). Additionally, some studies reported that as little as 27% of the pet-owning population picks up after their pets (Bartlett, 2006).

Therefore, in addition to the installation of pet waste collection systems, it is recommended that educational campaigns be conducted to increase the public's awareness of pet waste as a water pollutant source. These campaigns can include easily distributable pamphlets which can be placed in veterinary clinics, animal shelters, and other sites. Such a pamphlet for the City of Valdosta has already been developed by the City and two pet waste receptacles have also been installed in McKey Park. Additional receptacles could be installed in Taylor Park-Cowart Park off of Bemiss Road and Hyta's Park off of Jerry Jones Drive.

4.2.2 Backyard Rain Gardens and Rainwater Harvesting

The structural BMPs listed in the previous section focused on commercial and institutional areas in the watershed along with a few that treated large residential neighborhoods. The BMPs can also be constructed on a small scale to treat runoff from individual houses and driveways. Bioretention cells, or rain gardens as they are often referred to by homeowners, are usually the preferred option for residential treatments (See Figure 20).

A rain garden is a planted depression designed to absorb rainwater runoff from impervious surfaces such as driveways, roofs, sidewalks, and compacted lawns, trapping water before it reaches storm drains and streets. Runoff is decreased in two ways: the trapping of the rainwater increases infiltration to groundwater, and the plantings absorb excess water and transfer it to the atmosphere via transpiration. Rain gardens also have the added benefit of providing habitat beneficial to wildlife. When properly landscaped, standing water is only present in the garden for a day or two as it slowly filters into the ground, and does not become a breeding ground for mosquitoes.

Figure 20. Backyard rain garden

Public awareness and interest in rain gardens can be increased through the establishment of rain garden programs that encourage homeowners to construct rain gardens on their own. These programs are often organized by cooperative extension offices that partner with environmental advocacy groups and conservation districts to provide training on rain garden construction. Homeowner participation can be increased with incentives such as cost-share programs. Funding for such a program can be found through grants such as the EPA Section 319(h) Grant. See Appendix C for details on contacts in Georgia and North Carolina who can be useful in establishing a rain garden program.

Rain gardens cannot be located in areas where the water table is within 2 feet of the surface. Homeowners in this situation who want to treat stormwater from their houses could install small stormwater wetlands. This can be as simple as planting wetland vegetation in existing wet areas in their yards.

Another method for reducing stormwater runoff is the use of rain barrels for the collection of rainwater running off of roofs (See Figure 21). This can be a potentially easy and cost-effective method to reduce stormwater runoff in residential areas. Rain barrels are installed below the drain spout of roofs, and should include a connection hose, an overflow spout, and a lid to keep out mosquitoes. Rain barrels could prove popular as alternative water sources for watering landscape plants especially as droughts occur and watering restrictions take effect in the southeast.

Figure 21. Rain barrel

4.2.3 Sediment and Erosion Control Monitoring

Construction practices result in the clearing of land and the disturbance of soil. Stormwater runoff from construction sites can result in soil erosion and sedimentation, increasing sediment loads to streams. Construction best management practices (BMPs) have been developed to mitigate these impacts. However, these BMPs are only successful if properly implemented, monitored, and maintained. While the Two Mile Branch watershed is already heavily developed, re-development is occurring. It is recommended that regular monitoring of sediment and erosion control practices on long-term construction sites take place in order to ensure proper maintenance. Sediment and erosion control measures can lead to significant environmental impacts if not properly maintained.

4.2.4 Connect to Public Sewer System

Effective on August 1, 2006, the City of Valdosta annexed approximately 1,200 property parcels into the City of Valdosta including those homes that have been identified as having septic tanks in the Two Mile Branch watershed. As part of the annexation, the City agreed and legally committed to providing public water and sewer mains and services for all existing homes within the islands and prepared a master plan and priority schedule for providing the service.

During November 2006, the City prepared a loan application and later received and accepted a loan from the Georgia Environmental Facilities Authority (GEFA) in the amount of $24,097,000 for construction of various water and sewer improvements including a budgeted amount of $5,000,000 for providing water and sewer to the annexed islands. Also during 2007, the voters of Valdosta and

Lowndes County passed a referendum for a Special Purpose Local Option Sales Tax (SPLOST), which will provide additional funds for construction of water and sewer facilities including installation of water and sewer within the islands. The City is presently working to have plans prepared for the work. As the mains are constructed for those homes identified as contributing to the problems of fecal coliform in the watershed, the City will work with the owners to encourage and complete connection to public sewer and proper closure of the septic tanks.

4.2.5 Channel Stabilization and Restoration

This watershed planning effort has highlighted the fact that a serious sediment problem exists in Two Mile Branch. This sediment problem is also illuminated by the currently ongoing large-scale excavation project to remove excess sediment from Joree Millpond at the downstream end of the watershed. It should be noted that Stantec's reconnaissance efforts revealed only two sources, a construction site and eroding ditches, where upland sources of sediment may exist as a result of active land disturbance and development in the watershed. Rather, the assessment indicates that the largest source of sediment in Two Mile Branch is likely to be the stream itself, where extensive bank and stream bed erosion are occurring as a result of the geomorphic instability of the stream channel.

It is recommended that the City undertake a detailed geomorphic assessment of Two Mile Branch in the interest of developing a reach-scale plan for stabilization and restoration of the stream. Established patterns of natural channel evolution have shown that when a stream channel or the hydrology of its watershed are significantly altered, such perturbations will result in a period of geomorphic instability, characterized by active channel erosion in high velocity reaches, and excessive sediment depositions in low velocity reaches. Such patterns result from the channel's self-correcting efforts to once again achieve a state of equilibrium between flow and sediment transport. A detailed reach-scale geomorphic assessment will allow for the optimization of management strategies to address individual stream segments. Some segments may exhibit only minor instability and may be headed toward equilibrium on their own and, as such, warrant little or no intervention. Some segments may exhibit moderate instability which can be cost-effectively controlled with spot-wise stabilization though bioengineered techniques such as bank regrading and rootwad installation. Other segments may be severely unstable warranting full channel restoration through natural channel design principles. An initial conservative estimate based on field visits for this implementation plan show that at least 3,000 -5,000 feet (20-30%) of stream need to be stabilized or restored.

4.2.6 Load Reductions

Load reductions associated with implementation of the structural BMPs were calculated in Section 4.1.5. Load reductions associated with the backyard rain garden program would be calculated in the same manner as the bioretention cell projects. For example, each rain garden installed to treat a half acre residential lot could result in a fecal coliform reduction of 7.58E+07 counts/30 days while treatment of an acre residential lot would result in a reduction of 1.48E+08 counts/30 days.

There is very little information available on the amount of fecal coliform a failing septic system contributes to surface waters. The South Carolina Department of Health and Environmental Control (SCDHEC) has written a number of fecal coliform TMDLs for non-supporting surface waters (SCDHEC 2003a and 2003b). The source assessment for the TMDLs included inputs from failing septic tanks. To calculate the input, SDHEC assumed 2.5 persons were served by each septic system and a volume of 70 gallons of wastewater was generated per person per day. The assumed fecal coliform concentration in the wastewater was 10^4 cfu/100ml. For a failing septic system scenario, it was assumed that all of the wastewater reaches the stream.

This calculation was used to estimate a load reduction of 3.78E+10 fecal coliform counts/month that may be achieved by connecting septic systems found in poorly drained soils to the public sewer system (See Table 11). Since it is unknown how many septic systems are failing, the table contains calculations for the reduction achieved from 1, 5, or 19 failing septic systems. Since the City has estimated there are 19 septic systems in the headwater area, the worst case scenario is 19 failing systems. Eliminating 19 failing systems could result in a reduction of approximately 12%. This is likely an overestimate as all of the systems may not be failing and it is unlikely all of the wastewater reaches the stream.

Table 11. Estimated Load Reduction for Septic Systems

# failing septic systems	# persons served	septic flow (gal/day)	septic (l/day)	cfu/day	cfu/month	% reduction
1	2.5	175	662.45	6.62E+07	1.99E+09	0.62%
5	12.5	875	3312.24	3.31E+08	9.94E+09	3.08%
19	47.5	3325	12586.49	1.26E+09	3.78E+10	11.69%

Assume 70 gal/day/person and a concentration of 10,000 cfu/100ml in discharge

4.2.7 Cost

The following paragraphs outline costs associated with the non-structural BMP programs. The City should be aware there are additional programmatic costs associated with administering each of these programs.

The pet waste program is a low cost non-structural BMP that the City is already implementing. Receptacles were purchased for approximately $320 a piece. The Valdosta Lowndes County Recreation, Parks and Community Affairs Department empties the receptacles as part of its regular park maintenance. Installing educational signs about water quality and pet waste would be an additional cost but would improve the educational value of the stations.

The costs associated with running the backyard rain garden program are variable. There is the cost associated with the actual construction of the rain garden, approximately $500-1,000 for one that treats a half acre assuming minimal earthwork and no underdrain required. There are additional costs associated with coordinating the program and providing technical assistance for design and layout. These costs can be decreased by using volunteers.

The rain harvesting program is another low cost non-structural BMP. Installation and materials for a 50-gallon rain barrel are approximately $100-300. The City could purchase rain barrels and sell them to homeowners for a reduced cost.

Sediment and erosion control monitoring is part of the construction inspection that City Engineering Department staff regularly conduct. Increasing monitoring efforts would require additional staff time.

In order to implement the measure of connecting septic systems to sewer, the City will work towards installation of sewer mains to all of the recently annexed County islands. In 2007, SPLOST VI was approved with $8 million of the proceeds earmarked for water\sewer line extensions and road paving in these areas. The SPLOST VI cycle begins on January 1, 2008 and ends on December 13, 2013. Additional funds in the form of a loan from GEFA will also be used for this effort. The cost to connect the nineteen houses on septic systems in the headwater region is estimated at $152,802 according to the City's feasibility study (Valdosta 2003). It will cost approximately $17,040 per lot for the houses located near Eager Road and N. Oak Street. The study stated a cost of $1.79 million but this includes lots that are in the adjacent watershed.

A geomorphic study of Two Mile Branch would cost approximately $25,000 to $35,000 to complete. Channel stabilization costs approximately $50-150 a linear foot while restoration costs range between $200 and $400 a linear foot. It is likely at least 3,000 to 5,000 linear feet will need stabilization or restoration to reduce sediment inputs. Sediment load reductions would be calculated as part of the geomorphic study.

4.3 Education and Outreach

Public support is a key element in the implementation process. Education and outreach are essential to successful implementation as such efforts are necessary to ensure local project support and success. The City of Valdosta already publishes a bi-monthly newsletter, City Beat, which is mailed to all customers of the City of Valdosta's Department of Utility Services. At least three articles a year focus on stormwater as required by the City's stormwater NOI. The past five issues have included ten articles about stormwater. This newsletter can be used by the City to promote the non-structural management projects including the pet waste program, backyard raingardens, and water harvesting at no additional cost. The pet waste program on its own is an educational tool as pet owners can begin to make the connection between pet waste and water quality.

The newsletter can also be used to educate the public on the benefits of structural stormwater BMPs including stormwater wetlands and bioretention areas. Public meetings should be held prior to beginning the design process for any structural BMP located on publicly owned land. The public is more likely to accept a project if they understand the benefits and have an opportunity for their concerns to be addressed. Funding for structural BMPs should include funds to pay for the public meeting process. This would include the cost of having a designer present the project and answer questions as well as the cost of having City employees run the meeting. The actual cost will vary and could range from $2,500-5,000 for the process.

Structural BMPs on public land can serve as examples for developers and landowners throughout the City. The public education aspect can be enhanced by installing a sign explaining the purpose of the BMP. Production and installation of a 4x6-foot sign may cost about $3,000. Cost will vary depending on sign design and material used to create it.

Additional public education may be necessary for landowners with septic systems contemplating hooking up to the sewer system when it becomes available. The City cannot require landowners in the recently annexed areas to connect to the sewer system. While voluntary sewer connections should be encouraged, the City should also work with the Lowndes County Health Department to conduct public education about septic systems and maintenance including how the systems may fail in poorly drained soils and contaminate seasonally high water tables.

5.0 Funding Opportunities

The methods available for financing retrofit projects are based upon county and municipal powers for taxing, making special assessments, borrowing, issuing bonds, receiving public and private grants and donations, charging user fees, establishing special funds, and receiving revenue sharing funds (Golgowski and Dowling). The Stormwater Utility in the City of Valdosta currently charges a fee per Single Family Unit (SFU) which is used to maintain its stormwater management services in order to meet the existing and future stormwater needs of the City. If these funds prove insufficient, the following funding opportunities may be available from the Federal and State government. Some of the contacts listed below are from the Watershed Restoration Action Strategy for the Willacoochee River (SGRDC 2004).

- EPA Environmental Education Grants: With annual funding between $2 and $3 million dollars, the Grant Program sponsored by EPA's Environmental Education Division awards grants to help support environmental education projects to enhance public awareness and knowledge of environmental issues. More than 75% of the grants awarded from this program receive less than $15,000 (http://www.epa.gov/enviroed/grants.html).

- EPA Section 319(h) Grants: This program provides Federal funding to State and Tribal governments to fund eligible projects which prevent, control and/or abate nonpoint source pollution. In the State of Georgia, these grants are administered through the Georgia Environmental Protection Division.

- EPA Five Star Restoration Program: The program provides challenge grants and technical support to enable community-based restoration projects. It also aims to provide environmental education and training to students, conservation corps, citizen groups, corporations, landowners, and government agencies through projects that restore wetlands and streams. The average amount awarded is $10,000 per project (http://www.epa.gov/owow/wetlands/restore/5star/). Applications for the 5-Star Restoration Program can be found at: http://www.nfwf.org/programs/5star-rfp.cfm.

- EPA Targeted Watersheds Grant Program: is a competitive grant program that provides funding to community-driven environmental watershed projects and promotes water resource protection and restoration through cooperative conservation. http://www.epa.gov/twg/twg_basic.html

- EPA Continuing Program Grant: is a baseline grant program awarded primarily to States and Tribes. These grants are available under specific statutes (such as Clean Air Act Section 105, Clean Water Act Section 106, Resource Conservation and Recovery Act Section 3011) or under a combination of these programs into a Performance Partnership Grant. The purpose of these grants is to help support ongoing State and Tribal environmental programs, such as air, water, and waste.

- EPA Project Grants: are available to a broader range of recipients for a wide spectrum of Agency priorities such as pollution prevention, watershed planning, environmental justice, and environmental education. These project grants change from year to year and some of them are managed by the U.S. EPA HQ in Washington, DC.

- EPA Water Pollution Control Program: The U.S. EPA provides annual grants to State water pollution control agencies and Indian Tribes to assist them in establishing and maintaining programs to prevent and control water pollution. Water Pollution Control grants are authorized by Section 106 of the Clean Water Act.

- EPA Water Quality Cooperative Agreements Program: The U.S. EPA Region 4 provides funds through a competitive process for Water Quality Agreement Grants that are authorized by Section 104(b)(3) of the Clean Water Act. The funds are available for States, Indian Tribes, interstate agencies, and other public or nonprofit organizations. The grants are used to develop, implement, and demonstrate innovative approaches relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. Awarded grants will have project periods from one to two years.

- EPA Water Quality Management Planning Program: are awarded to States to support unified watershed assessments and watershed restoration priorities. The grants are authorized by Section 604(b) of the Clean Water Act and are generally awarded to State water quality agencies as continuing environmental program agreements. States are obligated to give 40% of the grant money to Regional Public Comprehensive Planning Organizations and Interstate Organizations.

The EPA Catalog of Federal Funding Sources for Watershed Protection, which includes details about the programs listed above, can be found at http://cfpub.epa.gov/fedfund/.

- USACE 206 Aquatic Ecosystem Restoration Program: provides the Army Corps of Engineers the authority to restore degraded aquatic ecosystems. Projects begin after a non-Federal sponsor requires assistance under the program. The Corps provides the first $100,000 of the feasibility study costs, after which the non-Federal sponsor must contribut 50% of the study costs. Furthermore, the sponsor provides 35% of the design and construction cost and 100% of the cost of operation and maintenance.

- Special Purpose Local Option Sales Tax (SPLOST): is a one-cent sales tax which the State of Georgia allows counties to collect to fund specific improvement projects. SPLOST must be approved by voters in a general referendum in which the total amount of revenue has been specified. Lowndes County is currently collecting for its fourth and fifth SPLOST cycle. The SPLOST VI cycle will begin in January 2008 and end in December 2013.

- Clean Water State Revolving Fund Program: Title VI of the Clean Water Act created the Clean Water State Revolving Fund (CWSRF) program. These State-run programs operate much like environmental banks that are funded with State and Federal contributions. The CWSRF provides low interest rates and flexible loan terms for funding wastewater treatment plants, nonpoint source pollution control and estuary protection. The CWSRF assists a variety of borrowers including municipalities, farmers, homeowners, small businesses and nonprofit organizations. Loans are available at a low interest rate for a maximum of twenty (20) years.

- Resource Conservation and Development Program: The Resource Conservation and Development Program (RC&D) encourages and improves the capability of civic leaders in designated RC&D areas to plan and carry out projects for resource conservation and community development. Program objectives focus on "quality of life" improvements achieved through natural resources conservation and community development. Such activities lead to sustainable communities, prudent land use, and the sound management and conservation of natural resources.

6.0 Monitoring and Milestones

The City of Valdosta will also work towards implementing the structural and non-structural BMPs described in Section 4.0 according to the Implementation Schedule (See Table 12). This schedule is dependent on funding, land acquisition, and public support. Table 13 outlines the approximate costs for the entire implementation plan.

The largest data gap is the lack of monitoring data available for the watershed. The following is the minimum number of samples for the assessment of data for 303(d) listing purposes for bacteria. At least 16 grab samples must be collected at Jerry Jones Road (4 samples collected within a 30 day period over 4 calendar quarters to calculate 4 geometric means). The 30 day sampling period should not overlap the months of April/May and October/November due to changes in the instream water quality standards for bacteria. The SGRDC has a contract with the Georgia EPD to conduct the required sampling within the next two years.

If water quality standards are not met after this round of sampling is complete in 2009, the City should conduct sampling each year as projects are implemented. This data will help the City determine which projects are the most beneficial. This information will be useful not only in determining how to proceed or revise the management plan in Two Mile Branch, but also in other watersheds located in the City.

Table 12. Implementation Schedule

Activity	Date									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Structural BMP Implementation										
Project 28 Joree Millpond	■									
Project 1 South Georgia Medical Center	■	■								
Project 2/3 McKey Park	■	■	■	■						
Project 13 Taylor Cowart Park	■	■	■	■	■					
Projects 15 and 18	■	■	■	■	■					
Projects 4-12, 14, 16-27						■	■	■ approximately 5 BMPs every five years	■	■
Non-structural BMP Implementation										
Pet Waste Program	■	■	■	■	■	■ on-going	■	■	■	■
Backyard Rain Garden					■	■	■	■ on-going	■	■
Rainwater Harvesting			■	■	■	■	■ on-going	■	■	■
Sediment and Erosion Control Monitoring	■	■	■	■	■	■ on-going	■	■	■	■
Connect to Public Sewer System	■	■	■	■	■	■				
Channel Stabilization and Restoration		■	■	■	■	■				
Monitoring										
4 geometric means for delisting purposes	■	■								
Additional 4 geometric means			▨	▨	▨	▨ Additional monitoring as necessary until stream is delisted	▨	▨	▨	▨

*Schedule dependent on funding and public support

Table 13. Approximate Costs for Implementation Plan

Activity	Approximate Costs per Unit[1]	Number of Units	Approximate Total Cost
Structural BMP Implementation	$3,300-$90,000	26	$490,600
(excluding projects 26,28 and 29)			
Non-structural BMP Implementation			
Pet Waste Program	$320 per station	10	$3,200
Backyard Rain Garden	$500-$1,000 per rain garden	50	$25,000-$50,000
Rainwater Harvesting	$100-$300 per rain barrel	100	$10,000-$30,000
Sediment and Erosion Control Monitoring	additional staff hours (apprx. 8 hrs/mo) at current programmatic costs (assume $50/hr)	12 days/year	$4,800
Connect to Public Sewer System	$18,000 per lot (some lots are estimated to cost less)	50-75	$900,000-$1,350,000
Detailed Geormorphic Assessment and Stablilization Plan	$25,000-$35,000	1	$25,000-$35,000
Stream restoration	$200-$400 per linear foot	up to 8,200 ft[2]	$940,000-$1,900,000[3]
and channel stabilization	$50-$150 per linear foot	up to 4,500 ft[2]	$316,000-$950,000[3]
Monitoring			
4 geometric means for delisting purposes	$500-$1000	1	$500-$1000
Additional 4 geometric means	$500-$1000	1	$500-$1000
Approximate Total Range			**$2,715,600-$4,815,600**

[1] All costs are approximate and may vary from range given

[2] Restoration and stabilization lengths are crude approximations and would be refined after a detailed geomorphic assessment

[3] Restoration and stabilization efforts would be broken into projects and prioritized based on feasiblity, cost, and benefits

7.0 Conclusions and Next Steps

While Two Mile Branch has been placed on the 303(d) listed for impairment by fecal coliform, initial reconnaissance of the watershed and evaluation of readily available assessment information have shown that some actions were already taken to alleviate pathogen loads within it. Specifically, major sections of the wastewater collection system, which were previously subject to leaks and overflows, have been rehabilitated. Sufficient water quality data to evaluate the benefits of this remedial action are currently unavailable. While the rehabilitation efforts may not have completely alleviated the fecal coliform problem in this watershed, they have most likely resulted in significant reductions in pathogen loads. In order to quantify the benefits of previous rehabilitation and management efforts, high priority has been given to collecting the necessary data to evaluate the current water quality status of Two Mile Brach with regard to fecal coliform levels. Sampling will be conducted in a manner as to allow for calculation of geometric means in order to gauge compliance with water quality standards and proceed with removal of Two Mile Branch from the 303(d) List.

While the sewer line rehabilitation efforts may have made a significant difference in Two Mile Branch, the watershed remains highly urbanized with significant levels of impervious surface within it. Even with the infrastructure improvements, a significant likelihood remains that fecal coliform levels in Two Mile Branch will continue to violate water quality standards as a result of stormwater runoff contributions from the watershed and re-suspension of sediments in stream. The next step will be to implement the structural stormwater BMP retrofits and management measures identified in this plan to reduce those contributions.

Even if the fecal coliform problem were completely alleviated, this characterization effort has highlighted the fact that a serious sediment problem exists in Two Mile Branch. This sediment problem is also illuminated by the currently ongoing large-scale excavation project to remove excess sediment from Joree Millpond at the downstream end of the watershed. The assessment indicates that the largest source of sediment in Two Mile Branch is likely to be the stream itself, where extensive bank and stream bed erosion are occurring as a result of the geomorphic instability of the stream channel. A geomorphic study is necessary to determine what areas should be stabilized or restored.

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Appendix A. Street Addresses of Illicit Pipes in the Two-Mile Branch Watershed

Street Address	Description
2409 Bemiss Rd	Dry
417 University Dr	Dry
2507 University Dr	Dry
804 Millpond Rd	Flowing
909 Millpond Rd	Flowing
2418 Bemiss Rd	Unmapped Outfall*
Between 423 and 425 University Dr	Unmapped Outfall*

*These sites are not necessarily illicit discharges. Present are reinforced concrete pipes, suggesting that they are unmapped outfalls.

Appendix B. Suggested Wetland Vegetation for Stormwater Wetlands

Wetland Zone	Trees	Shrubs	Herbaceous	Sedges/Rushes	Aquatic Herbs
Deep Pool (>2.5' deep)	Bald Cypress	N/A	N/A	N/A	Cow Lily, Water Lily, Water Lotus
Shallow Water (0"-12" deep)	Atlantic White Cedar, Bald Cypress, Black Willow, Overcup Oak, Swamp Tupelo, Water Tupelo	Sea Ox-eye, Swamp Dog-hobble, Swamp Rose	Arrow Arum, Arrowhead, Cardinal Flower, Lizard's Tail, Pickerelweed, Southern Blue Flag	Rice Cutgrass, Rush (juncus), Soft Stem Bulrush	N/A
Shallow Land (0"-12" above water)	Black Willow, Green Ash, Pond Pine, River Birch, Sweetbay, Water Oak, Willow Oak	Buttonbush, Coastal Dog-hobble, Elderberry, Inkberry, Silky Dogwood, Sweet Pepperbush, Ti-ti	False Nettle, Rose Mallow, Smartweed, Touch-me-not	Rush (juncus), Wool Grass	N/A
Non-floodable Land	Cherrybark Oak, Red Maple, Sycamore, Tulip Poplar, Water Oak	Wax Myrtle	Grape Fern, Southern Lady Fern	River Oats, Wire Grass	N/A

Taken from: Hunt, W. 2000. Designing Stormwater Wetlands for Small Watersheds. Urban Waterways. Published by: NCSU Cooperative Extension. AG-588-2.

Appendix C. Backyard Rain Garden Program Contacts

The University of Georgia College of Agricultural & Environmental Sciences Extension Office provides educational programs of statewide significance, ranging from providing farmers with crop information, to its Master Gardeners program in cities. The extension office also administers programs encouraging citizen involvement in the protection of natural resources. The following contact may be reached with regards to a rain garden program:

Mark Risse
Biological and Agricultural Engineering Extension Water Quality Co-Coordinator
706-542-9067
mrisse@engr.uga.edu

The Stormwater Engineering Group of the North Carolina State University Cooperative Extension has already implemented an extensive rain garden program in the State of North Carolina. Contacts in this office can provide valuable information regarding garden location selection strategies, technical training, community involvement, and helpful partnerships. The group also provides inter-state training. The following contact can be reached with regards to these rain garden program topics:

Mitch Woodward
Area Environmental Agent
Wake County Cooperative Extension
919-250-1112