Nancy Creek Watershed Improvement Plan - DRAFT

SPRING 2016

Prepared for the City of Brookhaven, Georgia

Brookhaven
GEORGIA

TABLE OF CONTENTS

List of Tables....4
List of Figures....5
Acknowledgements....7
Executive Summary....8
Chapter 1: Background....12
1.1. Objectives....12
1.2. Watershed Description....12
1.2.1. Subwatersheds....13
1.3. Land Use....17
1.4. Water Quality Concerns....19
1.4.1. State 303(d) List of Impaired Waters....19
1.4.2. Total Maximum Daily Loads....20
1.4.3. Other Watershed Concerns....20
1.4.4. Murphey Candler Lake....23
1.5. Regulatory Framework....24
1.5.1. Municipal Separate Storm Sewer System (MS4) Permit....24
1.5.2. Metropolitan North Georgia Water Planning District (MNGWPD)....24
1.5.3. DeKalb County Watershed Protection Plan....25
1.5.4. Georgia Rules for Dam Safety....25
1.6. Watershed Improvement Plan Development Process....26
1.7. Watershed Improvement Plan Overview....26
Chapter 2: Watershed Investigation and Analysis....27
2.1. Assessment of Available Water Quality Data....27
2.2. Watershed Modeling of Baseline Conditions....31
2.2.1 Model Inputs....33
2.2.2. Model Calibration and Results....33
2.3. Stream Walk Methodology and Results....36
2.3.1. Stream Walk Methodology....36
2.3.2. Results....38
2.4. Murphey Candler Lake Sampling....40
2.4.1. Murphey Candler Lake Water Chemistry Sampling Results....40
2.4.2. Murphey Candler Lake Water and Sediment Depth Measurements....42

2.4.3. Murphey Candler Lake Shoreline Conditions 44
2.4.4. Overall Lake Health for Murphey Candler Lake 47
2.5. Limited Upland Conditions Assessment 48
2.6. Summary of Findings 50
Chapter 3. Watershed Improvement Projects and Programs 51
3.1. Watershed Improvement Goals 51
3.2 Process to Identify Projects 52
3.3. Recommended Watershed Improvement Projects 53
3.3.1. Stream Enhancement Projects 53
3.3.2. BMP and BMP Retrofit Projects 56
3.3.3. Murphey Candler Lake Recommended Projects 61
3.4. Future Conditions Model Results 66
3.4.1. Future Conditions Model Results 66
3.5. Impervious Retrofit Assessment Areas 67
3.6 Existing Watershed Programs and Recommendations 71
3.6.1. Enforcement of Existing Ordinances 71
3.6.2. Public Education and Outreach and Public Involvement 72
3.6.3. Infrastructure Inventory and Condition Assessment 73
3.6.4. Inspection of Stormwater Management Facilities 73
3.6.5. City Maintenance Activities 74
3.6.6. Regional Watershed Coordination 74
3.6.7. Implementation Tracking 74
Chapter 4: Implementation Plan 75
4.1. Implementation Costs 75
4.1.2. Recommended Project Cost Estimation Methodology and Assumptions 75
4.1.2. Planning Level Costs for the Recommended Projects 77
4.1.3. Recommended Retrofit Assessment Cost Estimation Methodology and Assumptions 78
4.2. Grant Funding and Financing 79
4.2.1. Grant Funding 79
4.2.2. Funding and Financing Options 81
4.3. Project Ranking Methodology 83
4.4 Initial Project Ranking 84
4.5. Implementation Plan 87

4.6. Short-Term Work Plan 89
4.7. Measuring Progress Toward Goals 90
Definitions 91
References 93
Appendix A: Murphey Candler State of the Lake Report 2015 .....
Appendix B: Project Sheets .....
Appendix C: Subwatershed Summaries .....
Appendix D: Standard Operating Procedures .....

LIST OF TABLES

Table 1-1. Drainage Areas within the Study Area Subwatersheds 13
Table 2-1. Summary of DeKalb County Long-Term Water Quality Monitoring Results in the Study Area 29
Table 2-2. WTM Baseline Conditions Model Inputs 33
Table 2-3. Reference Pollutant Loading Rates for TN, TP, and TSS 34
Table 2-4. Total Annual Loads within the Nancy Creek Watershed 36
Table 2-5. Habitat Assessment Condition Categories 38
Table 2-6. Murphey Candler Lake Water Chemistry Sample Results 40
Table 2-7. Shoreline Rating Component Scores 44
Table 2-8. Shoreline Condition Scores and Ranking by Reach 45
Table 3-1. Recommended Stream Enhancement Projects 54
Table 3-2 Example BMP and BMP Retrofit Projects 56
Table 3-3. Recommended BMP and BMP Retrofit Projects 58
Table 3-4 Example BMP and BMP Retrofit Projects 61
Table 3-5. Recommended BMP and BMP Retrofit Projects 61
Table 3-6. Future Conditions Model Pollutant Removal Reductions by Subwatershed 66
Table 3-7. Recommended Impervious Area Retrofit Assessments 68
Table 4-1. Unit Costs for Capital Construction of New and Retrofit BMPs by Land Use and Soil Type 76
Table 4-2. Unit Costs for Capital Construction of Stream-Related Projects 76
Table 4-3. Basis for Planning Level Operation and Maintenance Costs by Project Type 77

Table 4-4. Summary of Total Fixed Cost by Project Type 78

Table 4-5. Summary of Impervious Area Retrofit Assessment Costs by Subwatershed 79

Table 4-6. Grant Funding Sources and Potential Project Eligibility 80

Table 4-7. May 2016 GEFA Loan Program Interest Rates 82

Table 4-8. Ranking Criteria for Watershed Improvement Projects 83

Table 4-9. Initial Project Ranking Based on Ranking Criteria 85

Table 4-10. Implementation Plan 88

Table 4-11. Example Short-term Work Plan 89

LIST OF FIGURES

Figure ES-1: Nancy Creek Watershed and Study Area 9

Figure ES-2: Recommended Projects and Studies 11

Figure 1-1. Nancy Creek Watershed 14

Figure 1-2. Study Area 15

Figure 1-3. Study Area Subwatersheds 16

Figure 1-5. Distribution of Land Use for the Study Area 17

Figure 1-4. Land Use for the Study Area 18

Figure 1-6. Study Area Land Use and Impervious Area by Subwatershed 19

Figure 1-7. Study Area Land Use and Impervious Area by Subwatershed within Brookhaven 19

Figure 1-8. Streams Classified as Impaired by State 21

Figure 1-9. Drainage Complaints Received by the City of Brookhaven (2014 to June 2015) 22

Figure 1-10. Murphey Candler Lake Historical Timeline 23

Figure 1-11. Cross Sectional Rendering of the Lowering of the Water Level at Murphey Candler Lake 23

Figure 1-12. Watershed Improvement Plan Development Timeline 26

Figure 2-1. DeKalb County Long-Term Water Quality Monitoring Stations in the Study Area 28

Figure 2-2. Nancy Creek at Chamblee Dunwoody Road Fecal Coliform Bacteria Data (Station A) 30

Figure 2-3. Nancy Creek at Chamblee Dunwoody Fecal Coliform Bacteria (Station B) 30

Figure 2-4. Bubbling Creek at Harts Mill Road Fecal Coliform Bacteria (Station I) 31

Figure 2-5. Modeled Subwatershed Areas ... 32

Figure 2-6 through 2-10. Existing Conditions Watershed Model Results for TN, TP, TSS, Fecal Coliform, and Runoff Volume ... 34

Figure 2-11. Habitat Assessment Streams ... 37

Figure 2-13. Example of a Healthy Stream with Bedrock and Protected Stream Buffer ... 38

Figure 2-14. Example of a Stream with a Compromised Stream Buffer ... 38

Figure 2-15. Example of a Stream Buffer Overrun with Invasive Species ... 38

Figure 2-12. Stream Habitat Assessment Results ... 39

Figure 2-16. Water Chemistry Sampling and Lake Depth Locations in Murphey Candler Lake ... 41

Figure 2-17. Lake and Sediment Depth Results for Murphey Candler Lake ... 43

Figure 2-18. Typical Shoreline Zones ... 44

Figure 2-19. Lake Shoreline Ratings around Murphey Candler Lake ... 46

Figure 2-20. Four Level Trophic Scale and Murphey Candler Lake Score ... 47

Figure 2-22. Example of a Functional and Well-Maintained Stormwater Management Structure ... 48

Figure 2-23. Example of a Non-Functional Stormwater Management Structure Needing Maintenance ... 48

Figure 2-21. Known Stormwater Management Structures ... 49

Figure 3-1. Comparison of a Vegetated Riparian Buffer (left) and an Impacted Riparian Buffer (right) ... 52

Figure 3-2. Example of a Stream Restoration Project with Floodplain Reconnection ... 53

Figure 3-3. Example of a Buffer Restoration Project ... 53

Figure 3-4. Recommended Stream Enhancement Projects ... 55

Figure 3-5. Recommended BMP and BMP Retrofit Projects ... 60

Figure 3-6. Recommended Murphey Candler Lake Projects ... 64

Figure 3-7. Example Murphey Candler Lake Shoreline Restoration Renderings of “the Beach” ... 65

Figure 3-8. Example Murphey Candler Lake Shoreline Restoration Renderings of “the Pavillion” ... 65

Figure 3-9. Future Conditions Model Pollutant Removal Reductions by Project Type ... 66

Figure 3-10. Recommended Impervious Retrofit Study Areas ... 70

Figure 3-11. Stormwater Drainage Issue Contributing TSS to the Study Area ... 73

Figure 4-1. Total Fixed Cost by Project Type ... 78

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Horsley Witten Group

EXECUTIVE SUMMARY

Nancy Creek is a perennial stream that originates near the DeKalb County Scott Candler Water Treatment Plant and flows southwest through six jurisdictions to its confluence with Peachtree Creek and then the Chattahoochee River in Atlanta. This Watershed Improvement Plan (Plan) focuses on the upper Nancy Creek watershed which is delineated from the downstream boundary of Brookhaven where Nancy Creek exits the City, as shown in Figure ES-1. The Study Area is approximately 19.3 square miles (12,300 acres) and includes drainage from Dunwoody, Doraville, Chamblee, and Brookhaven with a small area draining into the watershed from Sandy Springs. Nancy Creek and Bubbling Creek, a tributary to Nancy Creek, are considered "impaired" by the State of Georgia. Nancy Creek does not meet state standards for fecal coliform bacteria and fish biota (habitat and total suspended solids concerns) and Bubbling Creek does not meet state standards for fecal coliform bacteria.

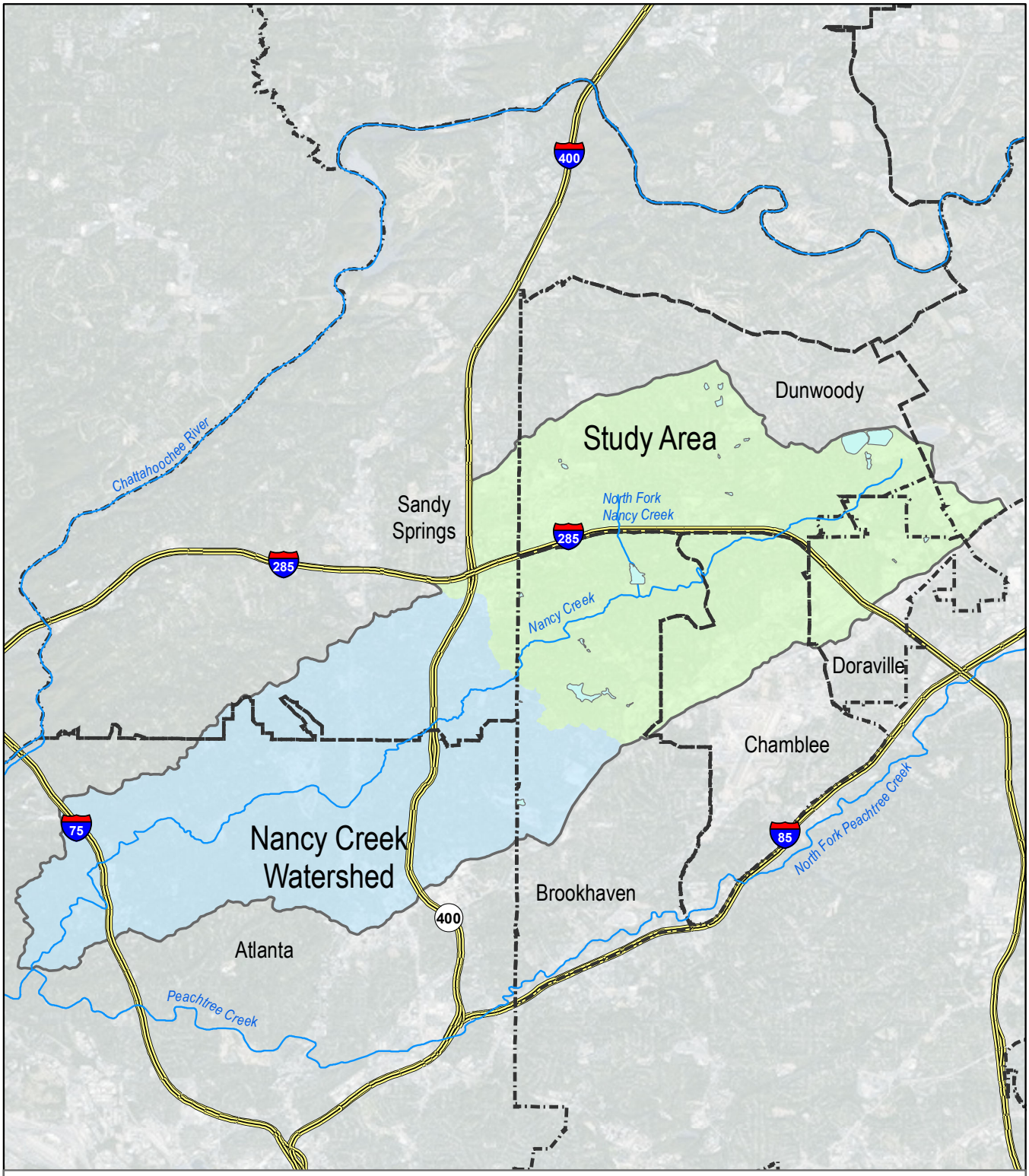
City leaders commissioned this Plan to evaluate watershed conditions in Nancy Creek on a regional scale with a special focus on evaluating the health of Murphey Candler Lake, as it is the focal point of the City-owned Murphey Candler Park. Based on the regional evaluation, the City wanted a prioritized list of projects within the city limits that when implemented would improve watershed conditions. Another important driver for this Plan was increasing Brookhaven's eligibility for grant funds; therefore, the Plan is consistent with the US Environmental Protection Agency's "Nine Elements of Watershed Planning" guidance. The City also wanted to leverage this Plan to stay compliant with the Metropolitan North Georgia Water Planning District (MNGWPD) 2009 Watershed Management Plan requirements. Finally, the City leaders wanted to ensure that the Plan reflected the community; therefore stakeholder and community input played an important role throughout the development process.

The recommendations in this Plan are designed to meet a set of four goals, established by a group of stakeholders and City staff. These goals include to:

1. meet state water quality standards;
2. restore stream buffers to prevent the loss of soil/ stream buffer;
3. improve streams to "sub-optimal" habitat condition or better; and
4. support projects that promote wildlife diversity and aesthetics.

The dominant land use in the Nancy Creek Study Area is medium density residential (40 percent) but the sum of multi-family, commercial, and roadway adds up to be nearly equal to the residential area (37 percent). The overall impervious cover across the Study Area is 39 percent due to the presence of these higher intensity land uses. This level of impervious area is well above the generally accepted threshold of when water quality starts to decline. Based on the in-stream habitat assessments, the overall stream habitat conditions are considered "marginal" within the Brookhaven portion of the Study Area. The watershed is mostly developed, and most of this development occurred prior to more recent stormwater requirements. Based on the results of the field assessments of known stormwater facilities, few would meet current standards and many showed evidence of not being properly maintained. Analysis of the water quality data and results from the stream habitat assessments confirm that water quality is impacted in the Nancy Creek Study Area.

A watershed model of the Study Area divides the 19.3 square miles into eight different subwatersheds, shown in Figure ES-2. The subwatershed boundaries are influenced by the existing DeKalb County Watershed Management Department water quality sampling stations and the location of major tributaries that flow into Nancy Creek. Brookhaven has a significant land presence in five of the subwatersheds including: North Fork Nancy Creek (NC4), Bubbling Creek (NC5), Perimeter Creek (NC6), Nancy Creek Mainstem (NC7), and Silver Creek (NC8). The baseline conditions model indicates that the pollutant loads in the Study Area are higher than those typically found in suburban watersheds throughout the Southeast.



Study Area
Nancy Creek Watershed
Waterbodies
Major Streams
Cities
Expressways

N

0 0.5 1 2 3 4 Miles

Nancy Creek Watershed Improvement Plan

Figure ES-1: Nancy Creek Watershed and Study Area

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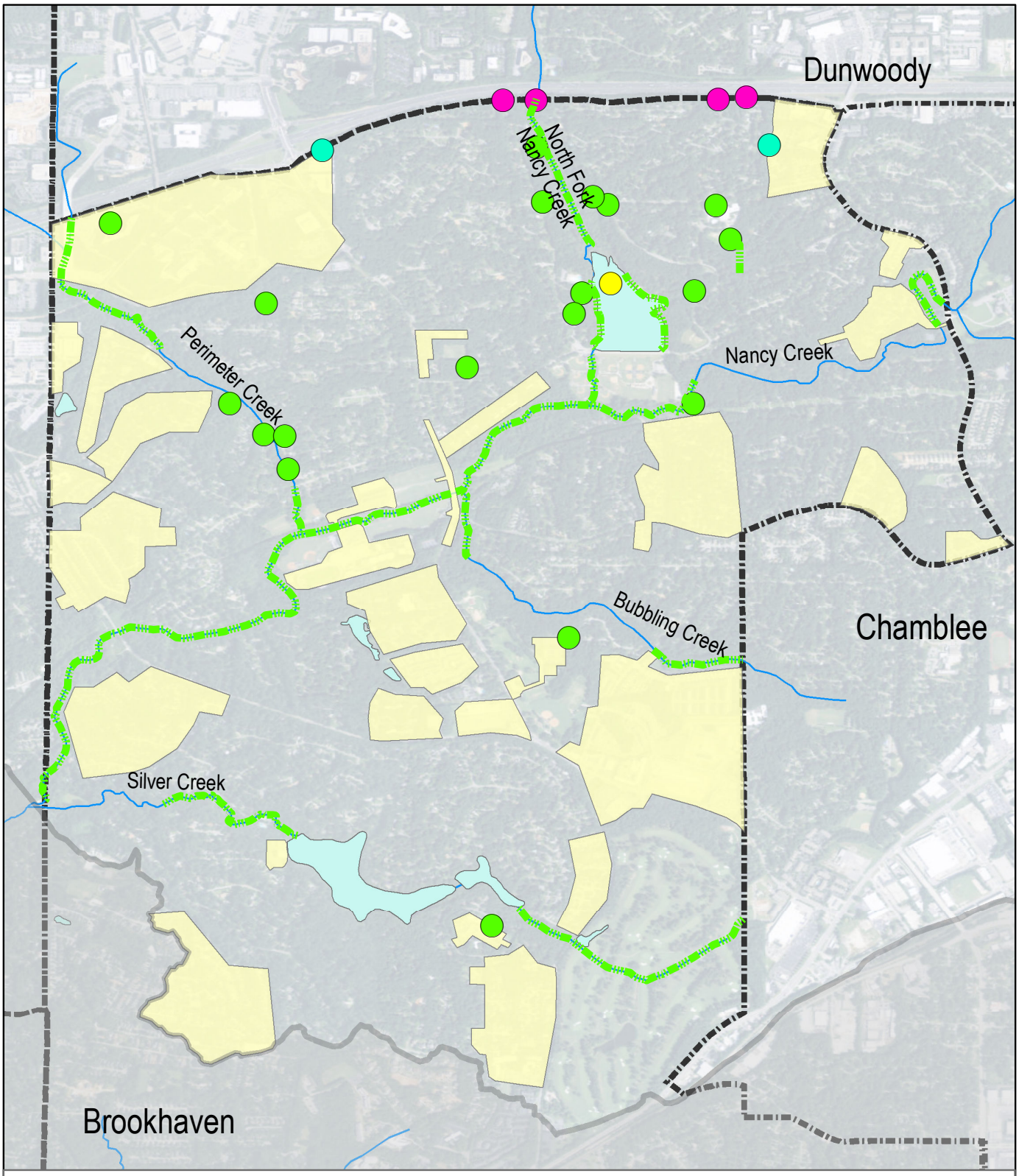
The Plan outlines a combination 43 projects, 28 assessments, and seven programs that if implemented should over time achieve the four stated Plan goals. A total of 43 watershed improvement projects are initially recommended and include: new best management practices (BMPs), retrofit BMPs, stream restoration and/or stabilization, stream buffer restoration, shoreline restoration, and sediment removal. In addition to the projects, 28 future retrofit assessment areas are recommended for areas with high impervious cover percentages. The Plan also recommends continued implementation of five existing programs, some with minor enhancements, and two newly recommended programs. The recommended projects and studies are shown geographically in Figure ES-2.

Watershed improvements in a suburban area are generally expensive due to land constraints and the sheer complexity of construction in places where existing utilities are presents, roads and other uses bisect projects, and existing drainage patters are well established. The estimated cost to plan, design, permit, and construct the recommended proposed projects identified in this Plan is initially estimated in the range of $19.4 million. An additional $330,000 in retrofit assessments is also recommended and is expected to double the implementation cost. Grants, funding sources, and financing options are outlined to assist with implementation. Even with outside funding sources, implementation of this Plan requires a significant long-term investment for the City of Brookhaven.

The Plan includes a 5-year short-term work plan that identifies interim activities for the highest rated projects along with a summation of the anticipated costs for each of the first five years. The recommendations and timeframe presented in this Plan may be revised based on budget constraints, regulatory requirements, and dynamic conditions in the Study Area. Annual reviews of water quality data and conditions in the watershed are recommended as well as a more holistic update every ten years to document and account for the likely changes.

The Plan reflects the input from City leaders, City staff, a group of stakeholders that met six times throughout the project, and input from attendees at four different public meetings. The recommendations are consistent with existing City Plans and the project ranking scheme gives preference to projects that are located on City-owned land and/or have a high degree of consistency with other planned City projects. The implementation of this Plan will meet the four stated goals and is consistent with the City's initial intentions.



Recommended Stream Projects
BMP Retrofit
New BMP
Trash Rack
Sediment Removal
Retrofit Assessments
Waterbody
Streams
Study Area
Cities

N

0 0.1 0.2 0.4 0.6 0.8 Miles

Nancy Creek Watershed Improvement Plan

Figure ES-2: Recommended Watershed Projects and Studies

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CHAPTER 1: BACKGROUND

This Chapter presents background information as a foundation for the technical information presented in subsequent Chapters of the Nancy Creek Watershed Improvement Plan (Plan). Contents include plan objectives, known watershed concerns, and a summary of relevant regulations. This section also includes an overview of the Plan development process including actions to engage the public throughout the Plan development and an outline of the contents of the Chapters that comprise this Plan.

1.1. OBJECTIVES

The overall objective of the Plan is to examine the watershed health on a regional scale and identify projects to improve watershed conditions within the City of Brookhaven limits. The City hopes that the Plan will foster dialogue and regional cooperation that will result in improved water quality and habitat conditions throughout the Nancy Creek watershed. Regional cooperation may yield benefits such as eligibility for regional grant funding, coordination on development activities within the Study Area, and consistent application of watershed policies.

In addition to identifying actions to improve overall watershed health, the Plan includes a focused assessment of Murphey Candler Lake, which is the focal point of Murphey Candler Park, a regional park known for the wide variety of recreational opportunities. Sediment accumulation in Murphey Candler Lake is a concern to park stakeholders, who support dredging and implementation of other projects to protect and improve water quality in the Lake.

The City values stakeholder and community input. The type of recommended projects and the project evaluation methodology reflect this stakeholder and public input. City leaders appointed 12 stakeholders to provide input on the Plan's recommendations during six stakeholder meetings. Stakeholder input is augmented by input from the four public meetings. The selection of the Plan's four long-term goals is one of many important contributions provided by the stakeholders group. These goals are to:

1. meet state water quality standards
2. restore stream buffers to prevent the loss of soil/ stream buffer
3. improve streams to "sub-optimal" habitat condition or better; and
4. support projects that promote wildlife diversity and aesthetics.

Achieving these four goals is a complicated and expensive endeavor. The stakeholders want this Plan to reflect their future vision and accept that the timeline to achieve some of these goals may be longer than anticipated and that some goals may not be fully attainable. Based on the availability of funding, this Plan may take 50 years or more to implement. Implementation may be expedited if outside funding is secured or as the result of upstream improvement projects in neighboring jurisdictions.

1.2. WATERSHED DESCRIPTION

The Nancy Creek Watershed originates near the DeKalb County Scott Candler Water Treatment Plant in the City of Dunwoody. The upstream portion of the watershed includes portions of the cities of Dunwoody, Doraville, Chamblee, and Sandy Springs, as well as Brookhaven. From Brookhaven, Nancy Creek continues to flow southwest through Sandy Springs and Atlanta before it joins Peachtree Creek and then the Chattahoochee River. Water from the Nancy Creek Watershed eventually reaches the Gulf of Mexico. The 12-digit Hydrologic Unit Code (HUC) for Nancy Creek is 031300011203. The HUC code is used by the US Geologic Survey (USGS) and other federal agencies and describes the entire Nancy Creek watershed.

The focus of this Plan is the upper Nancy Creek watershed (Study Area) as bounded by the City of Brookhaven's western border, Figure 1-1. The Study Area encompasses approximately 19.3 square miles (12,300 acres) of land, of which approximately 25 percent (3,023 acres) is within the City of Brookhaven with the remaining 75 percent within one of the adjacent cities.

Figure 1-2 shows the major tributaries and streams within the Study Area. Named tributaries to Nancy Creek within the Study Area include North Fork Nancy Creek, Bubbling Creek, Perimeter Creek, and Silver Creek. A summary of these streams are outlined below:

- **North Fork Nancy Creek** flows south from Dunwoody and is located to the east of the Perimeter Mall area. The dam on North Fork Nancy Creek at West Nancy Creek Drive created Murphey Candler Lake. The Lake is just upstream of the confluence of North Fork Nancy Creek with the Nancy Creek mainstem.
- **Bubbling Creek** originates in Chamblee and flows northwest to the confluence with Nancy Creek.
- **Perimeter Creek** originates in Dunwoody to the west of Perimeter Mall and receives most of the drainage from the Perimeter Mall area. A major tributary of Perimeter Creek flows southeast from Sandy Springs near Northside Hospital and joins Perimeter Creek just inside Brookhaven. Perimeter Creek flows south and west to the confluence with Nancy Creek.
- **Silver Creek** is the name assigned to this unnamed tributary stream for the purposes of this report. This stream includes Silver Lake and Little Silver Lake.

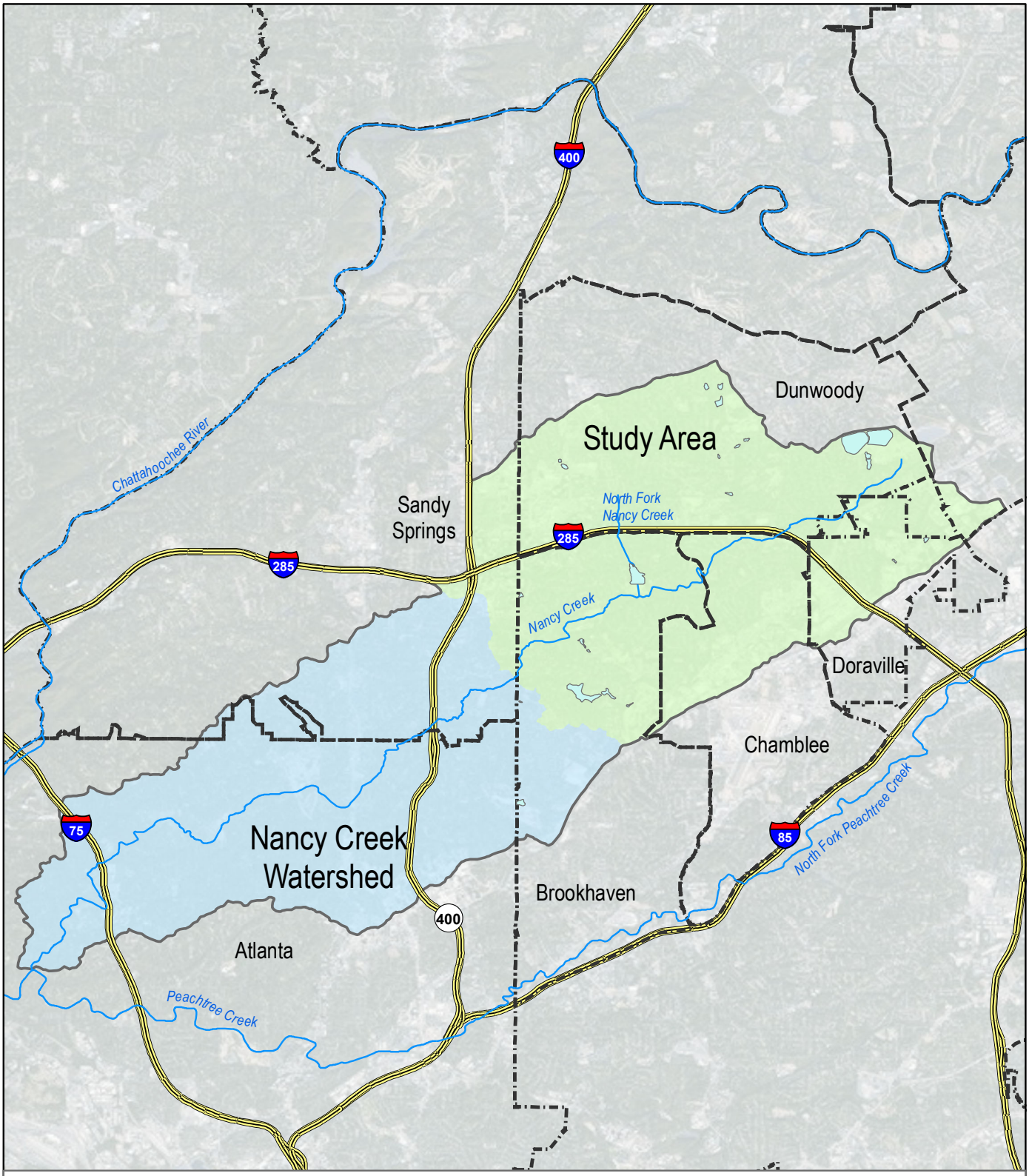
1.2.1. SUBWATERSHEDS

The Study Area is subdivided into 8 different subwatershed areas to analyze water quality. Figure 1-3 shows these subwatershed areas and Table 1-1 shows the area by subwatershed both within and outside of the City. Most of the subwatersheds cross jurisdictional boundaries.

The subwatershed delineations align with the three existing DeKalb County water quality sampling locations in order to correlate model results with historical water quality data. Additional delineations are based on logical termination points where major streams flow into Nancy Creek. The water quality modeling analysis (Chapter 2) uses these subwatershed delineations.

Table 1-1. Drainage Areas within the Study Area Subwatersheds

Subwatershed	Drainage Area (acres)			Drainage Area (percent)	
	Within Brookhaven	Outside of Brookhaven	Total	Within Brookhaven	Outside of Brookhaven
NC-1	0	2,940	2,940	0	100 %
NC-2	0	1,990	1,990	0	100 %
NC-3	3	1,110	1,113	0.2 %	99.8 %
NC-4	470	1,070	1,540	30.5 %	69.5 %
NC-5	280	560	840	33.4 %	66.6 %
NC-6	440	1,360	1,800	24.4 %	75.6 %
NC-7	890	10	900	98.8 %	1.2 %
NC-8	940	280	1,220	76.9 %	23.1 %
Total	3,023	9,320	12,343	24.5%	75.5%



Study Area
Nancy Creek Watershed
Waterbodies
Major Streams
Cities
Expressways

N

0 0.5 1 2 3 4 Miles

Nancy Creek Watershed Improvement Plan

Figure 1-1: Nancy Creek Watershed and Study Area

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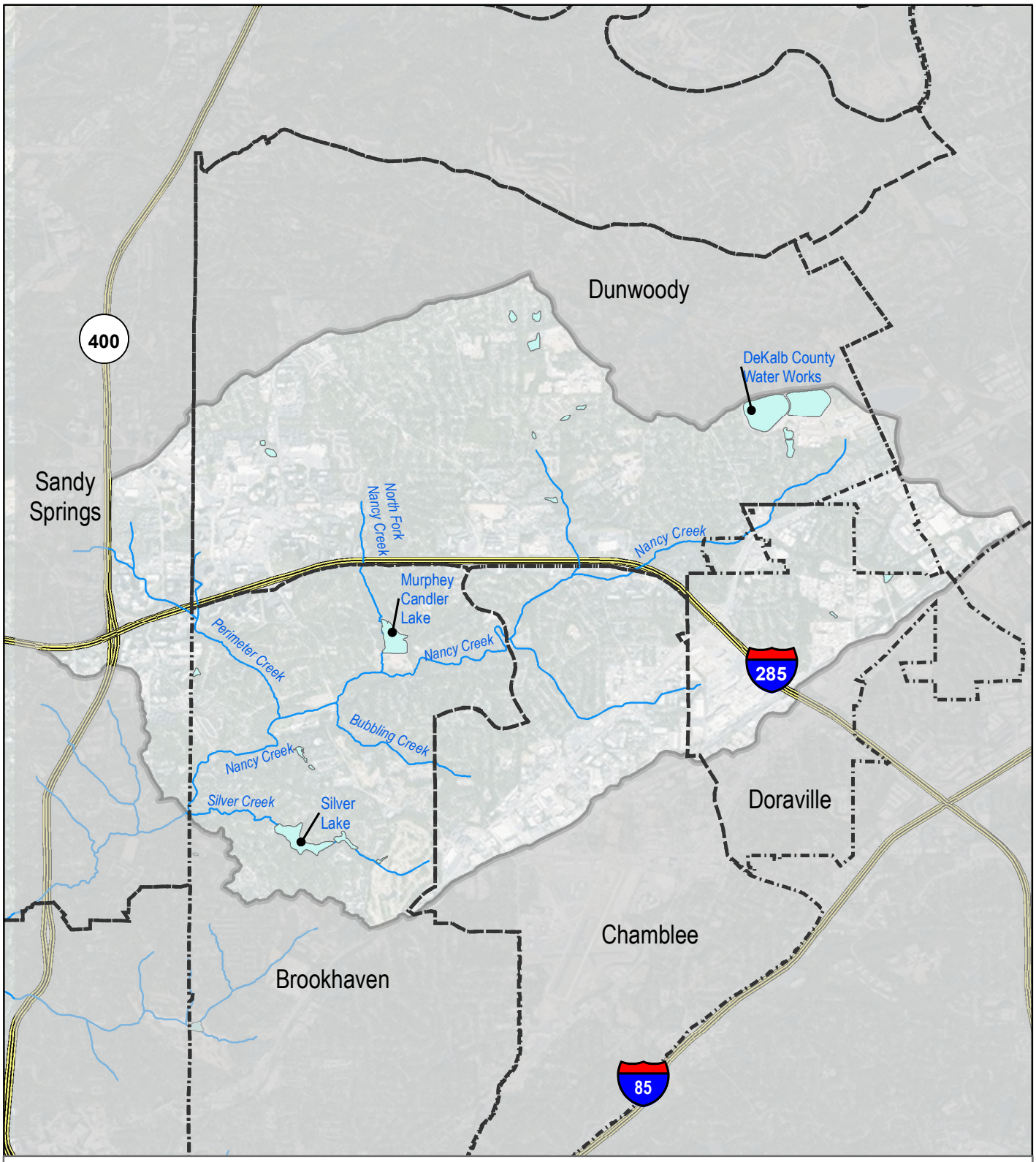

Nancy Creek Watershed Improvement Plan

Figure 1-2: Study Area

Waterbodies
Streams
Study Area
Cities
Expressways

N

0 0.275 0.55 1.1 1.65 2.2 Miles

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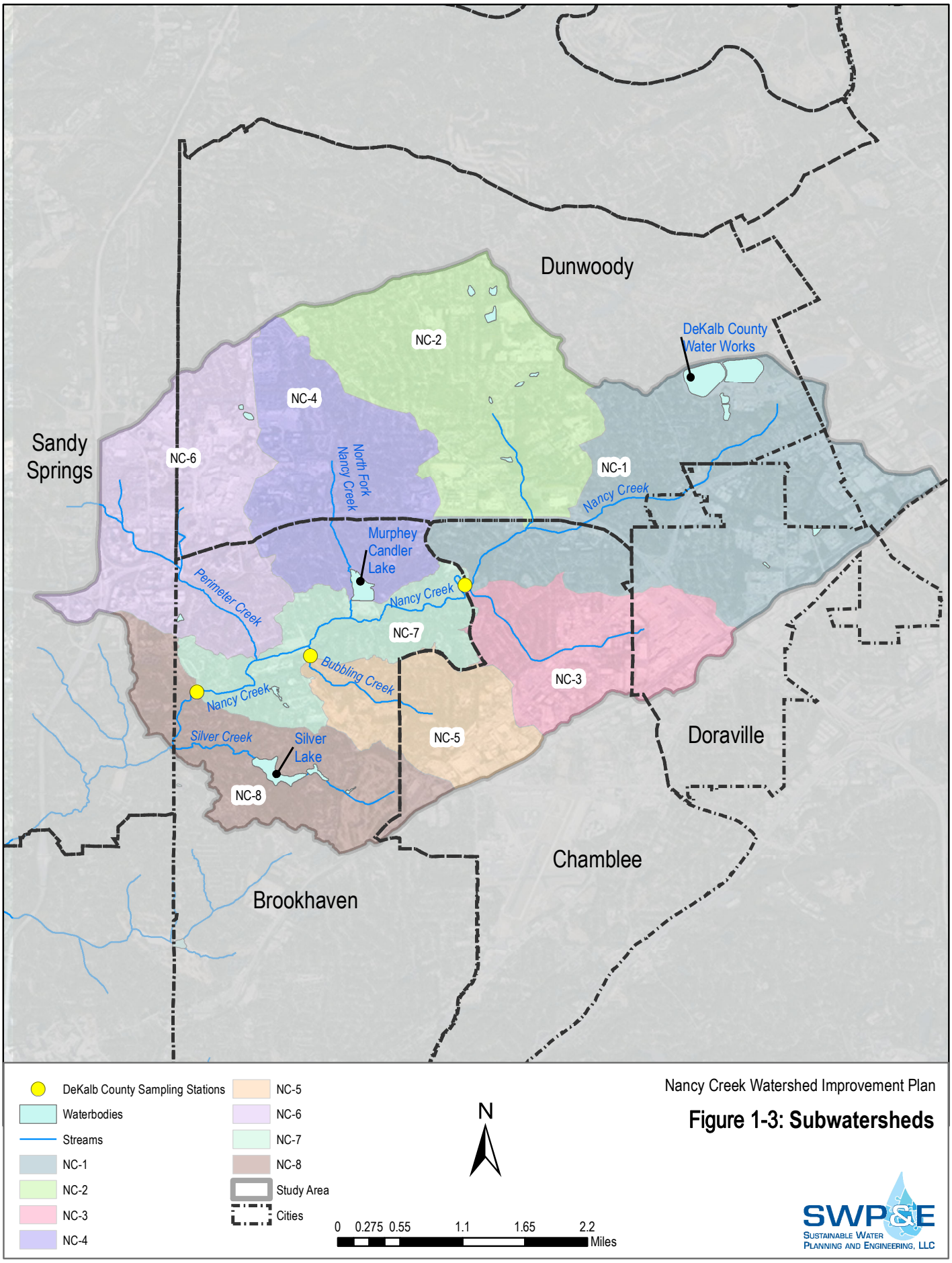


Nancy Creek Watershed Improvement Plan

Figure 1-3: Subwatersheds

1.3. LAND USE

Land use influences water quality. The cumulative amount of impervious cover is a strong indicator of watershed health. Impervious areas include surfaces that do not allow rainfall to infiltrate, such as rooftops, driveways, and parking lots. Rainfall runs off of these surfaces at much higher levels than off of pervious surfaces (i.e., grass, forest), resulting in a range of negative impacts to streams, lakes and rivers, including increased flooding and pollution delivery, and decreased low stream flows. Several studies evaluating the effects of urbanization on stream ecosystems indicate that water quality and habitat conditions decline when impervious area is greater than 10 percent of the watershed, and severe degradation is expected when impervious cover exceeds 25 percent of a watershed[iii].

Figure 1-4 shows land use and/or zoning data compiled from each jurisdiction in the Study Area. The Study Area is dominated by medium density residential land use (41%), followed by multi-family (14%), and commercial (13%); as shown in Figure 1-5. Roadways comprise 10% of the overall land use and I-285 divides the Study Area.

Figure 1-5. Distribution of Land Use for the Study Area

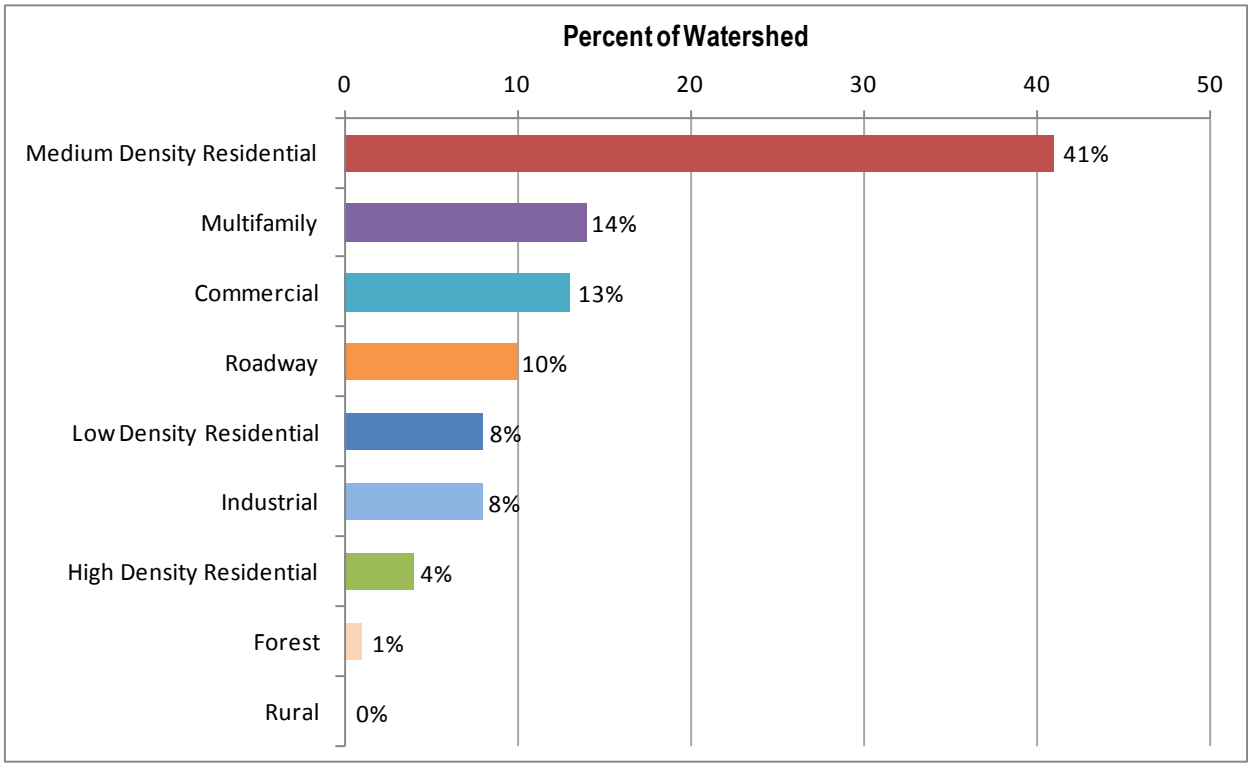
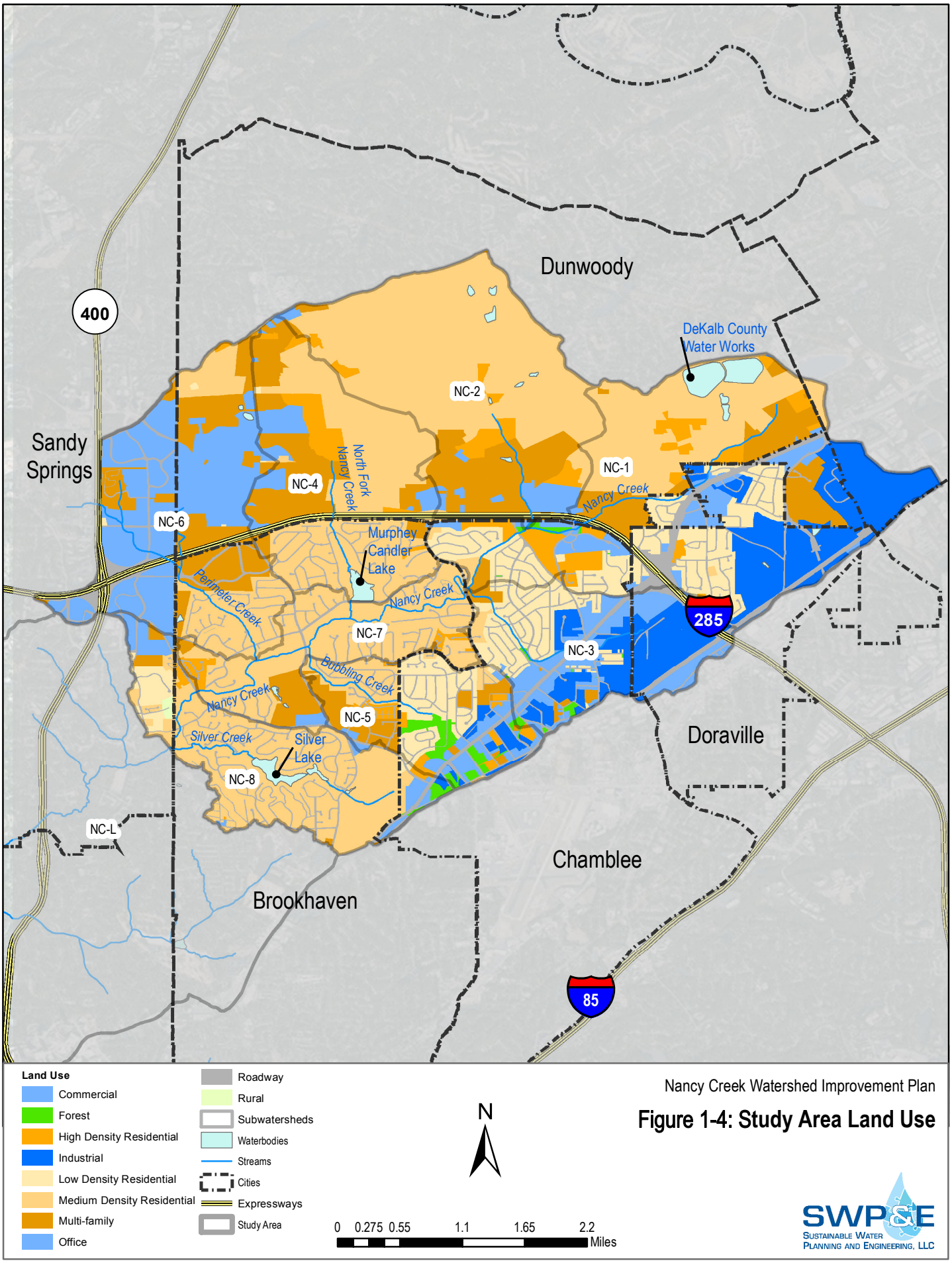


Figure 1-6 presents land use by subwatershed for the Study Area and Figure 1-7 shows land use only within the Brookhaven portion of the Study Area. These figures also present the overall impervious cover for each subwatershed. The impervious cover within all of the subwatersheds exceeds the 25 percent threshold; therefore implying that water quality is considered impacted. The overall impervious cover for the Study Area is 39 percent. A comparison of land use in Figures 1-6 and 1-7 shows that Brookhaven has a higher percentage of medium density residential land use compared to the entire Study Area and generally has a lower impervious area by percentage than the Study Area as a whole.



Nancy Creek Watershed Improvement Plan

Figure 1-4: Study Area Land Use

Figure 1-6. Study Area Land Use and Impervious Area by Subwatershed

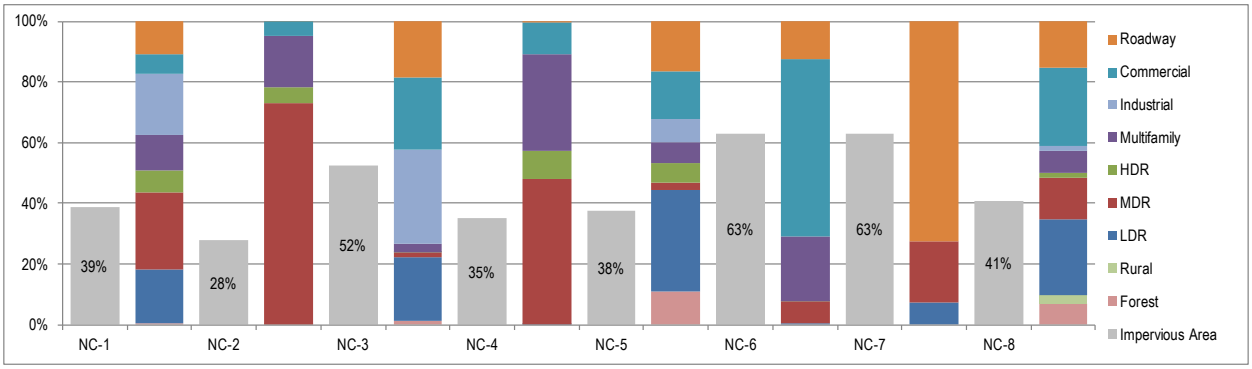
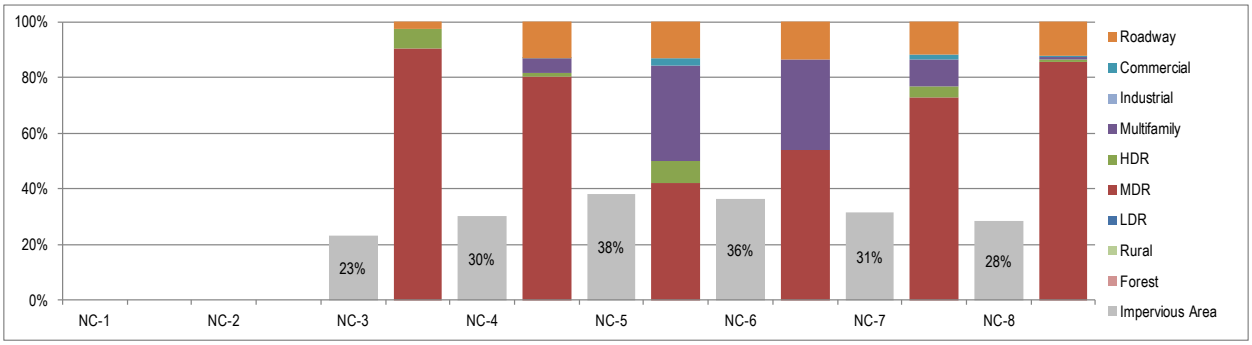


Figure 1-7. Study Area Land Use and Impervious Area by Subwatershed within Brookhaven



1.4. WATER QUALITY CONCERNS

The City commissioned this Plan, in part, to better understand and to address several existing water quality concerns in Nancy Creek and Murphey Candler Lake. One important driver of these concerns is the fact that Nancy Creek and Bubbling Creek are classified as "impaired" by the State of Georgia. In addition, the community has identified Murphey Candler Lake as a key focal point of the City's Murphey Candler Park and is concerned about its overall health. This section provides an overview of these concerns as a basis for the analysis presented in the next two Chapters of this report.

1.4.1. STATE 303(D) LIST OF IMPAIRED WATERS

The state sets water quality standards for streams and for lakes with surface area greater than 1,000 acres. Two streams in the Study Area, Nancy Creek and Bubbling Creek, were sampled by Georgia EPD and the DeKalb County Watershed Management Department. These streams did not meet state water quality standards and therefore; are classified as "impaired" and identified on the state's 303(d) list.

Nancy Creek exceeds the standards for fecal coliform bacteria and for fish biota. Bubbling Creek exceeds the fecal coliform bacteria standard. Fish biota impairment is often correlated to sedimentation that results from too much impervious cover and the consequent loss of fish habitat. Sources of sedimentation include instream bank erosion, runoff from areas with insufficient stormwater controls, and runoff from active construction sites. Fecal coliform bacteria are found in the large intestines of all warm blooded animals, and typical sources include sanitary sewer overflows, pet waste, and wildlife waste.

It is important to note that Nancy Creek and Bubbling Creek were the only two streams in the Study Area that were monitored by the state. Other streams in the watershed have not been sampled by the state to determine if they are meeting state standards, and therefore have not been classified. Consequently, given that the land uses are similar in the other parts of the watershed it is logical to assume that these tributaries would be similarly impaired. The lakes in Brookhaven are all much smaller than 1,000 acres, thus there are no specific numerical state water quality standards.

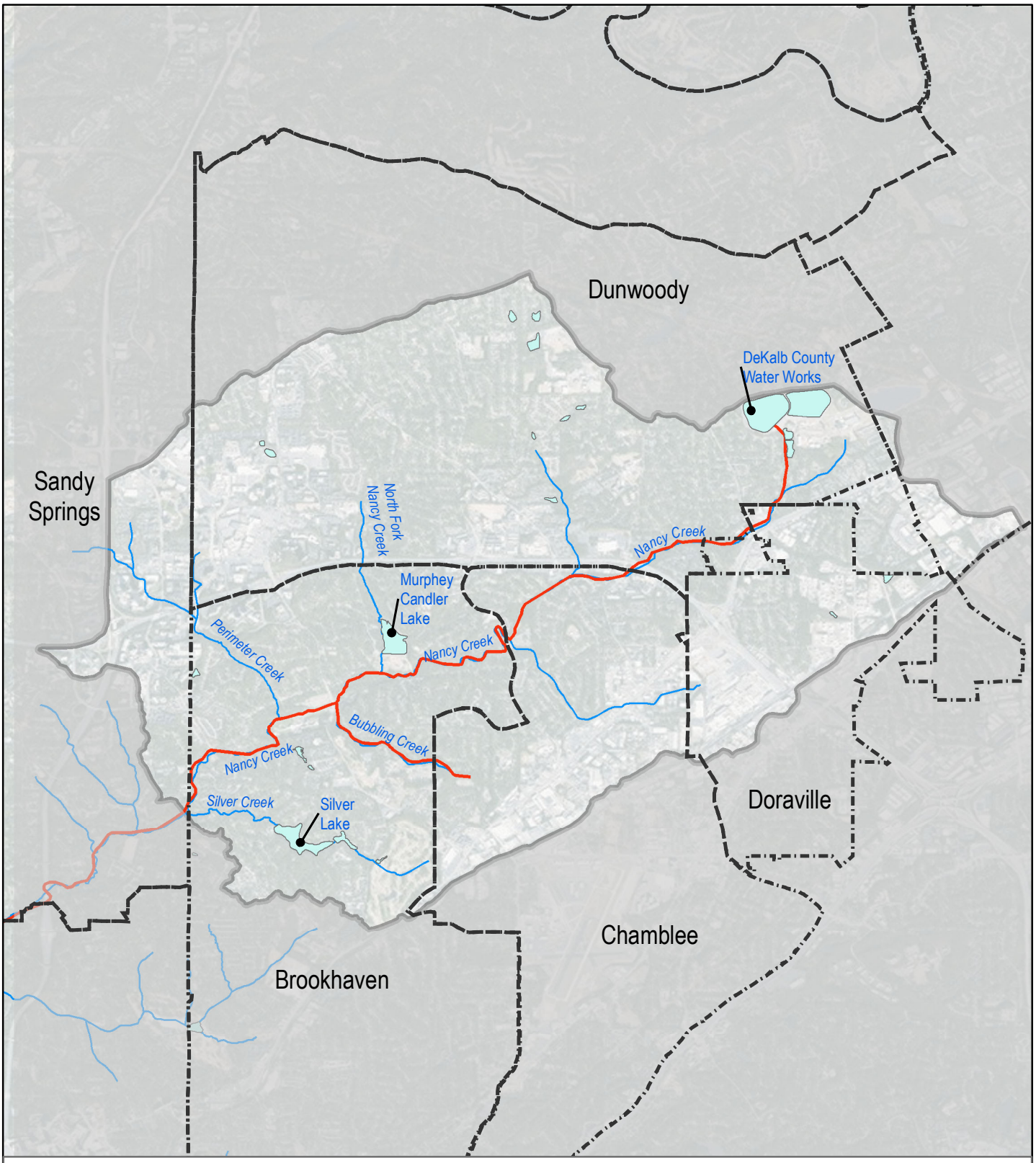
1.4.2. TOTAL MAXIMUM DAILY LOADS

The federal Clean Water Act requires further study and investigation for streams that do not meet state standards. The results of the investigation are known as a Total Maximum Daily Load (TMDL). The TMDL outlines likely sources of pollution as well as the reductions that are needed from current loads in order to meet state standards. To meet state standards, Bubbling Creek requires a 93% reduction in fecal coliform and Nancy Creek requires an 84% reduction in fecal coliform according to the TMDL Implementation Plan[iii]. The TMDL for fish biota indicates that a 35.45% reduction in sediment load is needed in Nancy Creek to meet water quality standards[iv].

1.4.3. OTHER WATERSHED CONCERNS

There are three ongoing watershed concerns that are not reflected in the previous sections. These concerns include:

- **Trash and debris.** Trash including plastic bottles, cans, and other floatables, is a concern; especially within Murphey Candler Lake. Trash from I-285 flows down North Fork Nancy Creek and into Murphey Candler Lake. The trash accumulates in the Lake's upper coves and trash that is washed into the Lake is blown by the wind into the eastern cove. Volunteer groups periodically remove trash via a canoe; however these efforts are not consistent or sustainable.
- **Streambank erosion.** The loss of private property is a concern in portions of the Study Area. Erosion results in the loss of private property and then the eroded sediments are deposited downstream, negatively impacting stream habitat.
- **Stormwater and drainage concerns.** A list of drainage concerns is shown in Figure 1-9 that reflects calls to the City through July 2015. The complaints are grouped into three categories: erosion, infrastructure, and maintenance. The most common concern in the Study Area is infrastructure followed by maintenance.



Nancy Creek Watershed Improvement Plan

Figure 1-8: Impaired Streams on the 303(d) List

Impaired Streams
Waterbodies
Streams
Cities
Study Area

N

0 0.275 0.55 1.1 1.65 2.2 Miles

SWPE
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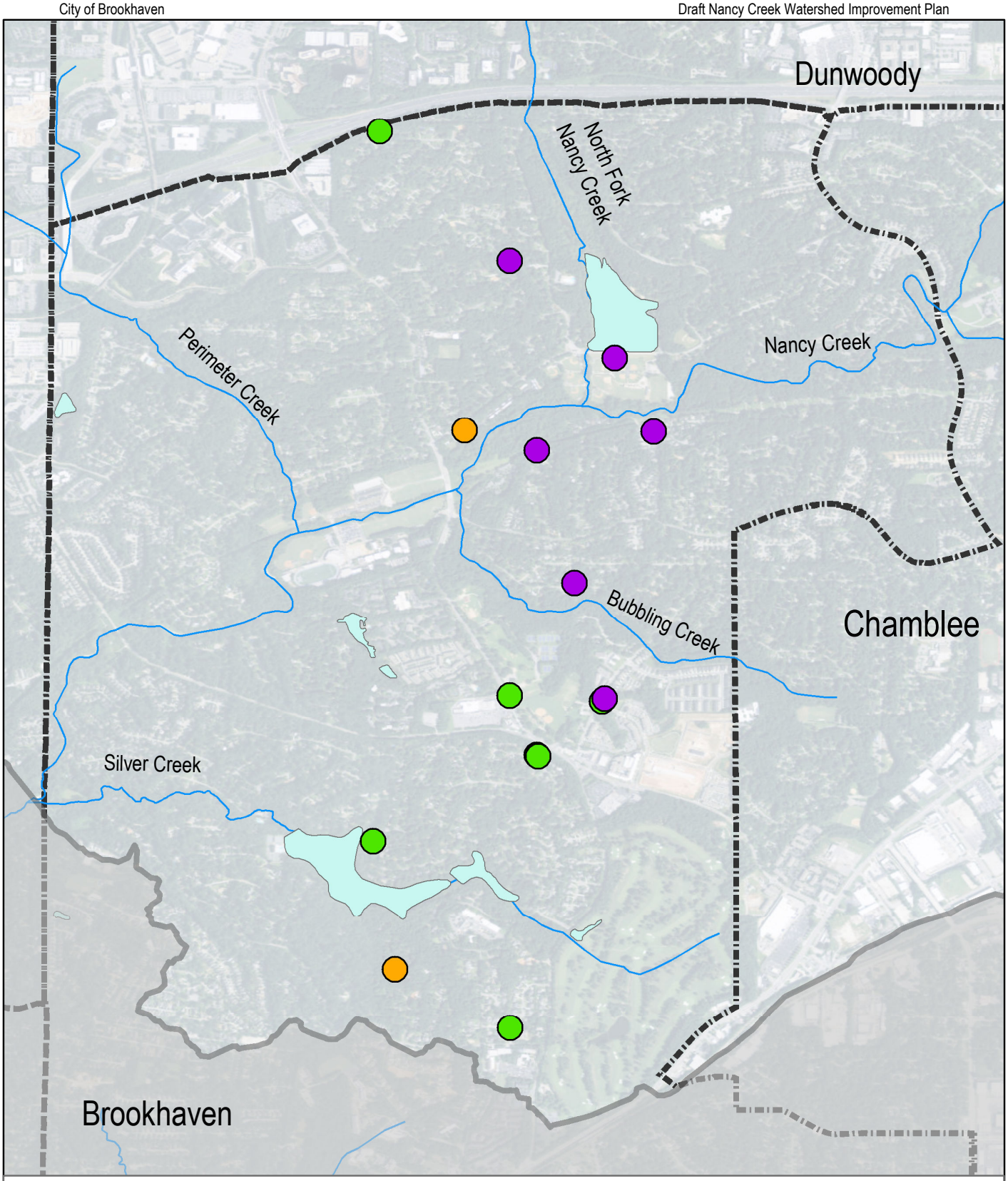


Erosion Concern
Infrastructure Concern
Maintenance Concern
Waterbody
Streams
Cities
Study Area

N

0 0.1 0.2 0.4 0.6 0.8 Miles

Nancy Creek Watershed Improvement Plan

Figure 1-9: Customer Call by Category of Concern

SWP&E
Sustainable Water Planning and Engineering, LLC

1.4.4. MURPHEY CANDLER LAKE

Murphey Candler Lake sits in the 135-acre Murphey Candler Park and is given special attention within this Plan because it is owned and operated by the City of Brookhaven. This section provides an overview of the Lake, its history, and the known concerns. Chapter 2 presents the field data collected as part of this Plan to better characterize lake health.

Murphey Candler Lake was constructed in 1953 where two rivers (North Fork Nancy Creek and an unnamed stream) previously flowed together. Although the dam was constructed in 1953, the oldest known historical record for the dam is from a U.S. Army Corps of Engineers inspection in 1978. The inspection was performed following the passage of the 1978 Georgia Rules for Dam Safety. The Georgia Rules for Dam Safety outline minimum requirements to protect downstream areas from flooding and loss of life. A breach of Murphey Candler Dam could potentially result in the loss of life, so the dam is classified as a "Category I Dam" and regulated by the state accordingly.

Periodically, the state revises the minimum rules based on changes in best practices and availability of better information. A revision to the Georgia Rules for Dam Safety in 1985 resulted in modifications to the Murphey Candler spillway in 2002. At that same time, records indicate that 57,000 cubic yards of sediment were dredged from the bottom of the Lake as a supplemental project. The spillway changes included lowering the Lake level 1.5 feet from 885.5 feet mean sea level (ft msl) to 884 ft msl. The lowering of the water level effectively reduced the size and depth of the Lake and also exposed shoreline that was previously under water. A simplified historical timeline is shown in Figure 1-10. Figure 1-11 presents a graphical rendering of the impact that lowering the Lake has on the size and depth of the Lake.

Figure 1-10. Murphey Candler Lake Historical Timeline

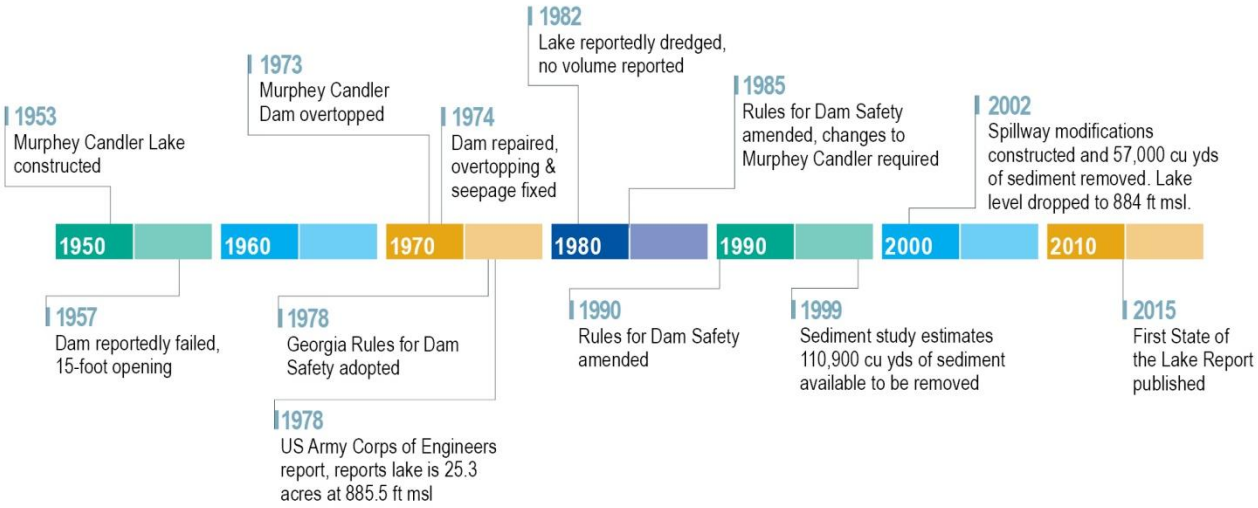
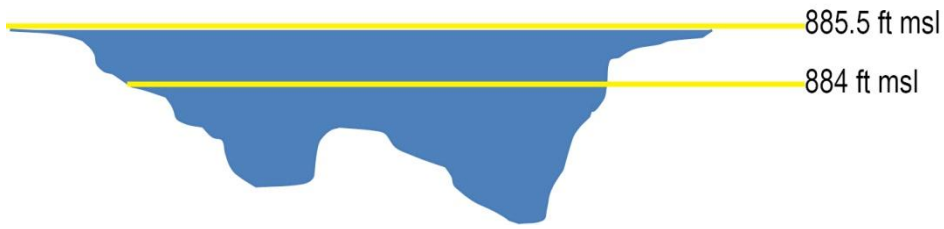


Figure 1-11. Cross Sectional Rendering of the Lowering of the Water Level at Murphey Candler Lake



1.5. REGULATORY FRAMEWORK

Several existing regulations are relevant to this Plan, including the Municipal Separate Storm Sewer System (MS4) Phase II permit, the Metropolitan North Georgia Water Planning District requirements, the DeKalb County Watershed Protection Plan and Consent Order program, and the Georgia Rules for Dam Safety. The Plan is consistent with these regulations, summarized below.

1.5.1. MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) PERMIT

In 1990, the U.S. Environmental Protection Agency (EPA) required operators of MS4 systems serving populations of 100,000 or greater (referred to as Phase I) to implement stormwater programs as authorized under the Clean Water Act. In 1999, the Phase II rules required all MS4's located in "urbanized areas" as defined by the Bureau of Census, to implement stormwater programs. The City of Brookhaven is classified as a Phase II MS4 community and must follow the regulations outlined by the Georgia Environmental Protection Division (EPD) and EPA.

Brookhaven implements a stormwater management plan that includes the required six minimum control measures, to comply with the MS4 permit. The City of Brookhaven's MS4 program and the planned six minimum measures are summarized below.

1. Public Education and Outreach: Distribute pamphlets and develop a stormwater website.
2. Public Involvement and Participation: Implement a storm drain marker program and streamside clean-up program.
3. Illicit Discharge Detection and Elimination (IDDE): Review legal authority, update the outfall map and inventory, implement an IDDE plan including outfall inspections, implement IDDE education/ training program, implement a complaint response program.
4. Construction Site Stormwater Runoff Control: Review legal authority, maintain site plan review procedures and checklists, maintain an inspection program, maintain enforcement procedures for non-compliance, implement a complaint response program, maintain a list of certified employees.
5. Post-Construction Stormwater Management: Review and update legal authority, develop an inventory of stormwater features, inspect public and private stormwater structures, develop and implement a stormwater structure maintenance program, develop an inventory of green infrastructure/ low impact development structures.
6. Pollution Prevention/ Good Housekeeping: Update the MS4 control structure inventory, MS4 inspections, maintenance program, street cleaning, employee training, proper disposal of waste and debris collected through maintenance, assess opportunities to upgrade existing flood management structures, inspect municipal facilities.

An Enforcement Response Plan and Impaired Waters Plan accompany the six minimum control measures to protect and restore water quality. The City submits an annual report that outlines actions taken to comply. Georgia EPD reviews these plans closely.

1.5.2. METROPOLITAN NORTH GEORGIA WATER PLANNING DISTRICT (MNGWPD)

The MNGWPD was created by the Georgia General Assembly in 2001 to create regional water plans to protect shared water resources and facilitate continued economic growth. The MNGWPD created a Watershed Management Plan in 2003 that was updated in 2009 that includes a number of stormwater-related actions for local governments in the metro region. The City of Brookhaven is part of the Metro Water District. Compliance with these requirements is tied to compliance with the City's MS4 permit and compliance is periodically audited by the state. The 2009 Watershed Management Plan is currently being updated; however the requirements are expected to be similar to the existing requirements. A summary of the anticipated action items to be included in the 2016 update to the Watershed Management Plan are summarized below.

- **Adoption and implementation of model ordinances (or equivalent)** – There are several model ordinances that were developed as part of the 2003 Watershed Management Plan. The adoption and implementation of these model ordinances will remain a requirement. These include: post-development stormwater management, floodplain

management and flood damage prevention, stream buffer protection, illicit discharge and illegal connection, and litter control. The City has adopted ordinances to meet this requirement.

- **On-going stormwater system management** – The 2003 and 2009 Plans required specific stormwater infrastructure maintenance activities that complemented asset management practices and MS4 permit requirements. The District's 2016 Watershed Management Plan will continue to encourage local governments to better manage their assets throughout the life cycle.
- **Monitoring** – The 2003 and 2009 Plans required long-term ambient trend monitoring and macroinvertebrate bioassessment monitoring. The requirements for the 2016 Plan are in progress. Currently, DeKalb County Watershed Department performs long-term trend monitoring and biological assessments on a number of stations throughout the county, including several in Brookhaven. No additional sampling is anticipated.
- **Watershed improvement planning** – The specific requirements for the watershed improvement planning and project implementation are in progress but the goal is to encourage communities to undertake efforts such as this Plan and then implement recommended projects over time.
- **Coordination with intergovernmental agencies** – The goal of this requirement is to facilitate a minimum of one conversation annually between stormwater managers, water/wastewater managers, environmental health professionals who oversee septic systems, and community development managers who approve land development projects. The goal of the coordination is to improve the effectiveness and outcome of related programs.
- **Promoting a green infrastructure approach** – Green infrastructure refers to stormwater controls that infiltrate water versus the traditional grey infrastructure (i.e., pipes, detention ponds) which capture, store, and release stormwater. Green infrastructure has a number of ancillary benefits compared to traditional grey infrastructure. The goal of this measure is to promote use, where appropriate.

The recommendations included in this Plan are consistent with the 2009 MNGWPD Watershed Management Plan and are expected to support implementation of the requirements in the 2016 update to the MNGWPD Watershed Management Plan.

1.5.3. DEKALB COUNTY WATERSHED PROTECTION PLAN

DeKalb County developed a Watershed Protection Plan in 2008 to comply with NPDES permit requirements to operate the County's wastewater system that also serves city residents. The Watershed Protection Plan requirement is unique to Georgia. The goal of the Watershed Protection Plan is to ensure that water quality does not decline as a result of sewer service or sewer expansions that often facilitate denser development patterns. As part of the Watershed Protection Plan, last revised in July 2010, DeKalb County performs routine water quality sampling of Nancy Creek and Bubbling Creek.

1.5.4. GEORGIA RULES FOR DAM SAFETY

The Georgia Safe Dams Act of 1978 was passed after the failure of the Kelley Barnes Lake in Stephens County as the dam breach resulted in the loss of 39 lives and millions of dollars in property damage. The Act resulted in the creation of the Rules for Dam Safety that govern the minimum criteria that larger dams in Georgia must meet in order to protect downstream loss of life and property. The state regulates dams above the stated threshold, or dams 25 feet or greater in height or that impound 100 acre-feet or more of water. The Safe Dams Act groups dams into two categories; Category I dams are those in which improper operations or a dam failure could result in the loss of life and Category II dams are those that meet the size threshold but would not result in loss of life if they failed. Murphey Candler Lake is a Category I dam. The regulations outline provisions for design, operations, inspections, and maintenance.

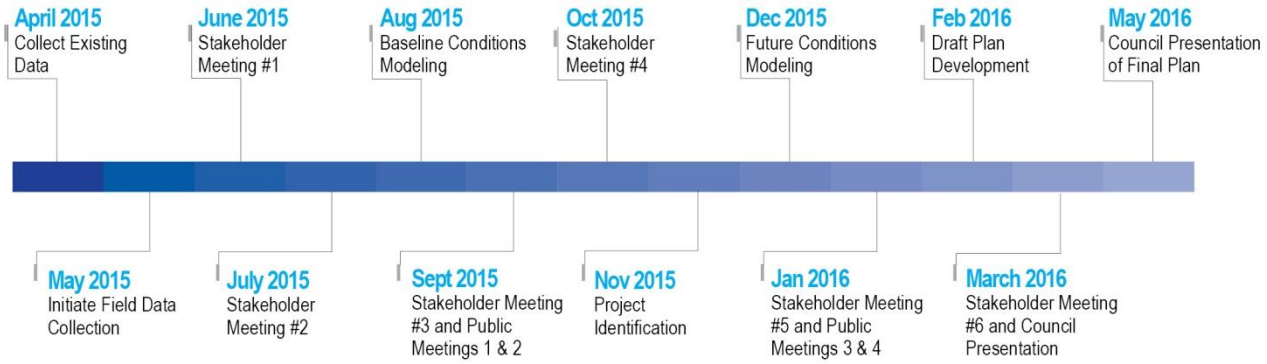
The original 1978 Act was amended in 1985 and 1990. The 1985 amendment changed the spillway size criteria and shifted the responsibility of the safe dam program from the Georgia Soil and Water Conservation Commission (GSWCC) to the Georgia EPD. The 1990 amendment added criteria that require local governments to provide information on proposed developments below dams, as these developments may result in a Category II dam being re-categorized as a Category I dam. The 1985 Safe

Dam Act changes resulted in the 2002 modifications to the Murphey Candler Lake spillway that effectively lowered the Lake level 1.5 feet, as previously described.

1.6. WATERSHED IMPROVEMENT PLAN DEVELOPMENT PROCESS

This Plan was developed over a one-year period through a transparent process with ample opportunities for input provided along the way so that the identified projects reflect Brookhaven's goals. Figure 1-12 shows the timeline and opportunities for input from staff, a committee of key stakeholders identified by the City, and the public.

Figure 1-12. Watershed Improvement Plan Development Timeline



1.7. WATERSHED IMPROVEMENT PLAN OVERVIEW

The primary responsibility for Plan implementation will reside with the Public Works Department. Funding for projects will need to be allocated by City Council, and projects will involve coordination with the City Manager, Parks & Recreation Department, and Community Development Department. The majority of the funding for the Plan's projects and programs will come from the City's stormwater utility fee with other sources such as the City's General Funds, grants, and loans providing supplemental funds based on the project and funding availability.

The Plan is organized in the following Sections:

Chapter 1: Background – Provides an overview of the Plan's objectives and presents background information on Nancy Creek, the Study Area, and existing conditions relevant to the Plan and its recommendations.

Chapter 2: Watershed Investigation and Analysis – Describes the data collection, results, and analysis performed for this Plan.

Chapter 3: Watershed Improvement Projects and Programs – Outlines the recommended projects, evaluations, and programs that are intended to meet the Plan's goals. Includes a summary of how the projects were selected and evaluated.

Chapter 4: **Watershed Improvement Plan** – Presents information to support project implementation including planning level costs, possible funding sources, and prioritization criteria. A short-term work plan presents a list of projects in a suggested implementation order spanning the first 5 years.

Appendices: Additional details and background information are outlined in the Appendices.

CHAPTER 2: WATERSHED INVESTIGATION AND ANALYSIS

This Chapter presents an overview of the existing conditions within the Study Area. The existing conditions assessment is based on available water quality sampling data, as well as data collected throughout the development of the Plan. This section provides an overview of available water quality data, habitat conditions as determined during stream walks, assessments of potential pollutant sources, and new water quality sampling data. This section also includes the baseline water quality modeling results that assigns a relative contribution of different pollutant sources within the Study Area.

2.1. ASSESSMENT OF AVAILABLE WATER QUALITY DATA

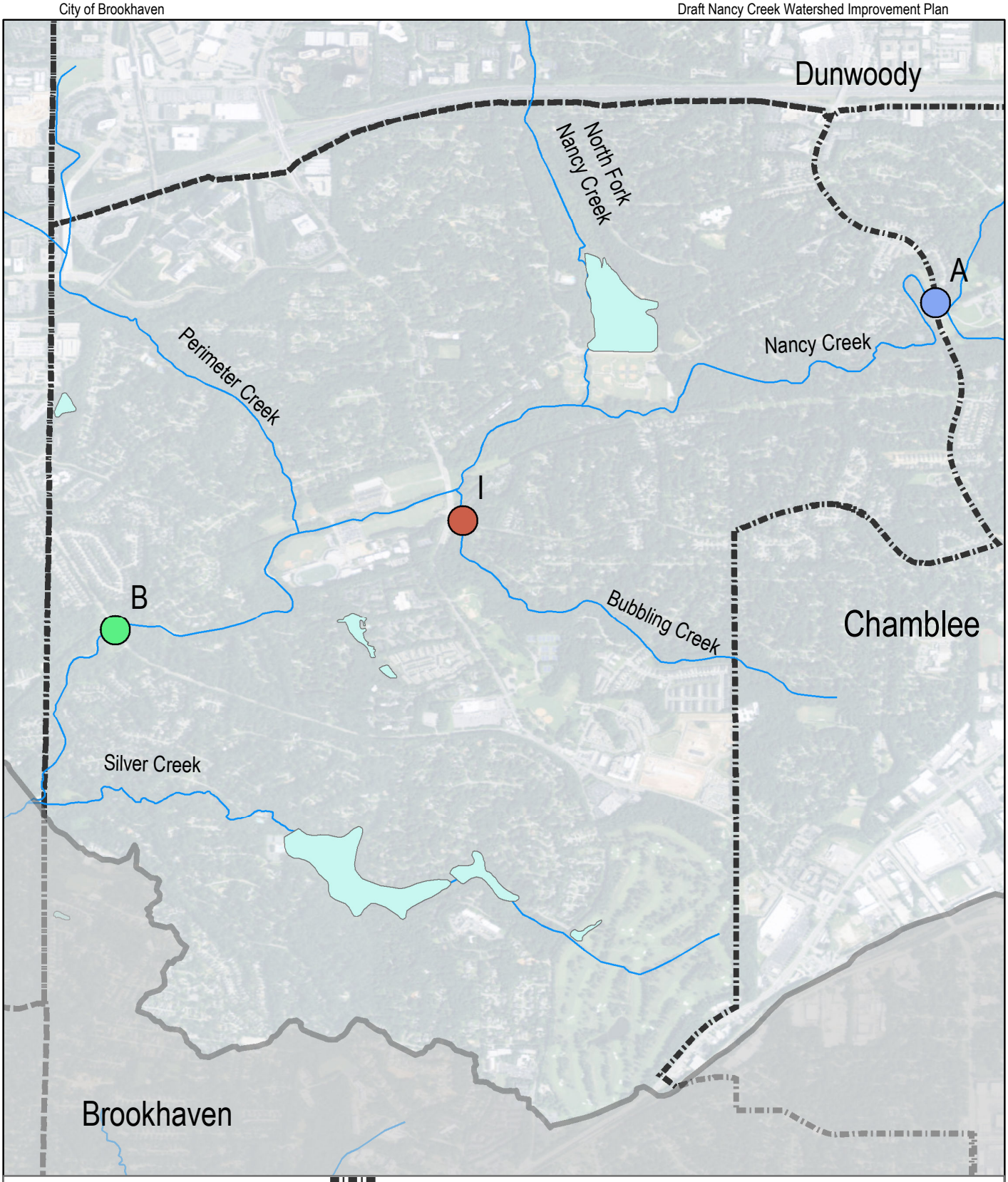
The DeKalb County Watershed Management Department collects water quality samples for major streams throughout the county, as part of their Watershed Protection Plan. There are three sites that fall within the Study Area: Nancy Creek at Chamblee Dunwoody Road (A), Nancy Creek at Johnson Ferry Road (B), and Bubbling Creek at Harts Mill Road (I). These locations are shown in Figure 2-1.

DeKalb County provided data from 2003 through June 2015 that reflected between 138 and 147 sampling events, depending on the station. This sampling is performed on a routine schedule and is not tied to weather conditions (wet versus dry weather samples). Data could not be statistically correlated to weather conditions, but the median of the data can be considered “normal” for that station.

The parameters monitored at these three stations include:

- pH
- Dissolved Oxygen (DO)
- Temperature
- Conductivity
- Turbidity
- 5-day Biological Oxygen Demand (BOD5)
- Total Kjeldahl Nitrogen (NTKN)
- Ammonia (NH3)
- Nitrite-Nitrate (NO2NO3)
- Total Phosphorus
- Fecal Coliform Bacteria
- E-coli
- Solid Total Suspended Solids
- Total Cadmium
- Total Copper
- Total Lead
- Total Zinc
- Hardness
- Alkalinity

Table 2-1 outlines parameters of interest to this Plan and summarizes the median, maximum, and minimum results for each for the three sample stations.



DeKalb Sampling Stations
- A. Nancy Creek at Chamblee Dunwoody Rd
- B. Nancy Creek at Johnson Ferry Rd
- I. Bubbling Creek at Harts Mill Rd
- Waterbody
- Streams
- Cities
- Study Area

N

0 0.1 0.2 0.4 0.6 0.8 Miles

Nancy Creek Watershed Improvement Plan

Figure 2-1: DeKalb County Watershed Management Sampling Stations

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Table 2-1. Summary of DeKalb County Long-Term Water Quality Monitoring Results in the Study Area

Parameter	State Standard	Statistic Shown	A. Nancy Creek at Chamblee Dunwoody Road	B. Nancy Creek at Johnson Ferry Road	I. Bubbling Creek at Harts Mill Road
pH (standard units)	6 < pH < 8.5	Median Maximum Minimum	7.3 9.4 5.2	7.3 9.1 6	7.3 8.5 5.9
DO (Dissolved Oxygen) (mg/L)	>5	Median Maximum Minimum	8.3 15.1 4.4	7.7 13.4 3.4	8.1 16.6 2.7
Temperature (Water)(^{0}C)	<32.2^{0}C	Median Maximum Minimum	15.7 25.5 1.5	16.0 26.1 0.7	17.9 22.7 1.2
Conductivity (umho/cm)	None; a typical range is 50 to 500	Median Maximum Minimum	98 181 37	102 229 44	123 190 21
Turbidity (NTU)	None; anything over 50 is considered "high"	Median Maximum Minimum	8 159 2	8.0 182 2	4.0 1,072 1
TSS (Total Suspended Solids) (mg/L)	None; anything over 100 is considered "high"	Median Maximum Minimum	7 28 1	4.0 24 1	4.0 95 1
Fecal Coliform Bacteria, geo. mean (colonies/100mL)	< 200 in summer (May to October) < 1,000 in winter (November to April)	Median Maximum Minimum	1,400 400,000 60	600 190,000 30	480 300,000 20
# Samples			138	139	147

Notes:

1. Data from 2003 to June 2015 was collected by DeKalb County Watershed Management Department.
2. Raw data was edited to remove data outside of the possible range for that parameter.

Fecal coliform bacteria consistently exceeded state standards. Periodically, other sample parameters did not meet state standards or fell outside of the typical range of values for a healthy waterbody. Generally, all of the sampled parameters met state standards whereas fecal coliform generally did not meet state standards. For both Nancy Creek stations, the state standard was met in only 30 percent of the samples and on Bubbling Creek only 40 percent of the samples met state standards.

The fecal coliform data is erratic (shown in Figure 2-2, 2-3, and 2-4) with values of 60,000 colonies/100mL and greater. The values are significantly above both the state summer and winter standards, which are shown in the Figures for comparison. While there are other contributing sources of fecal coliform bacteria, the primary source is likely from episodic sanitary sewer overflows. DeKalb County currently has a consent order agreement with the Georgia EPD and EPA related to sanitary sewer overflows[v]. Implementation of the consent order projects is expected to reduce overall fecal coliform bacteria levels throughout the Study Area.

Figure 2-2. Nancy Creek at Chamblee Dunwoody Road Fecal Coliform Bacteria Data (Station A)

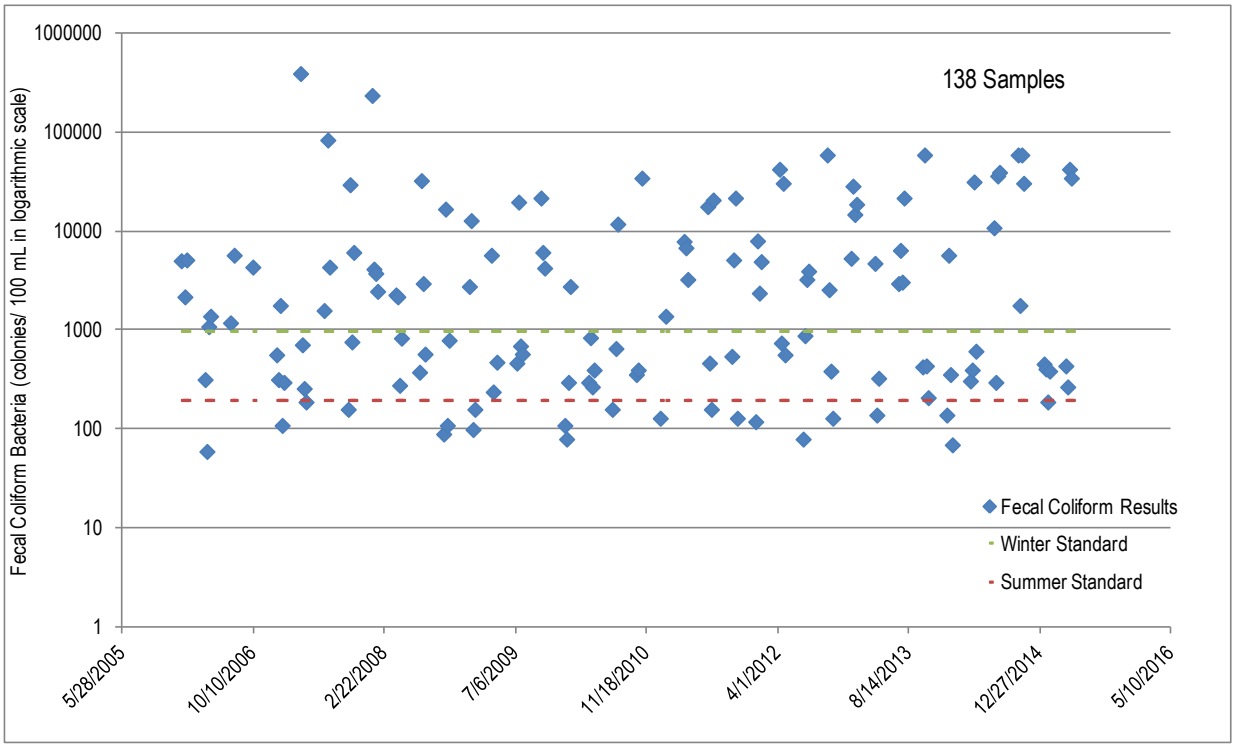


Figure 2-3. Nancy Creek at Chamblee Dunwoody Fecal Coliform Bacteria (Station B)

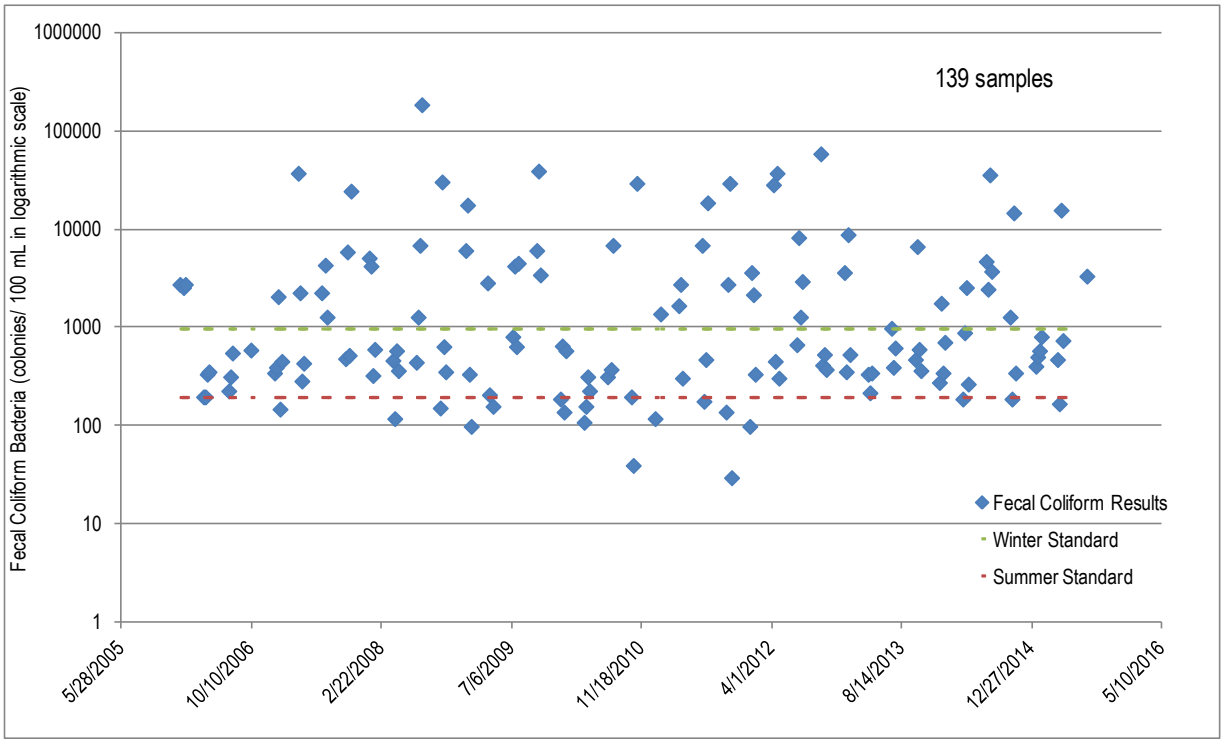
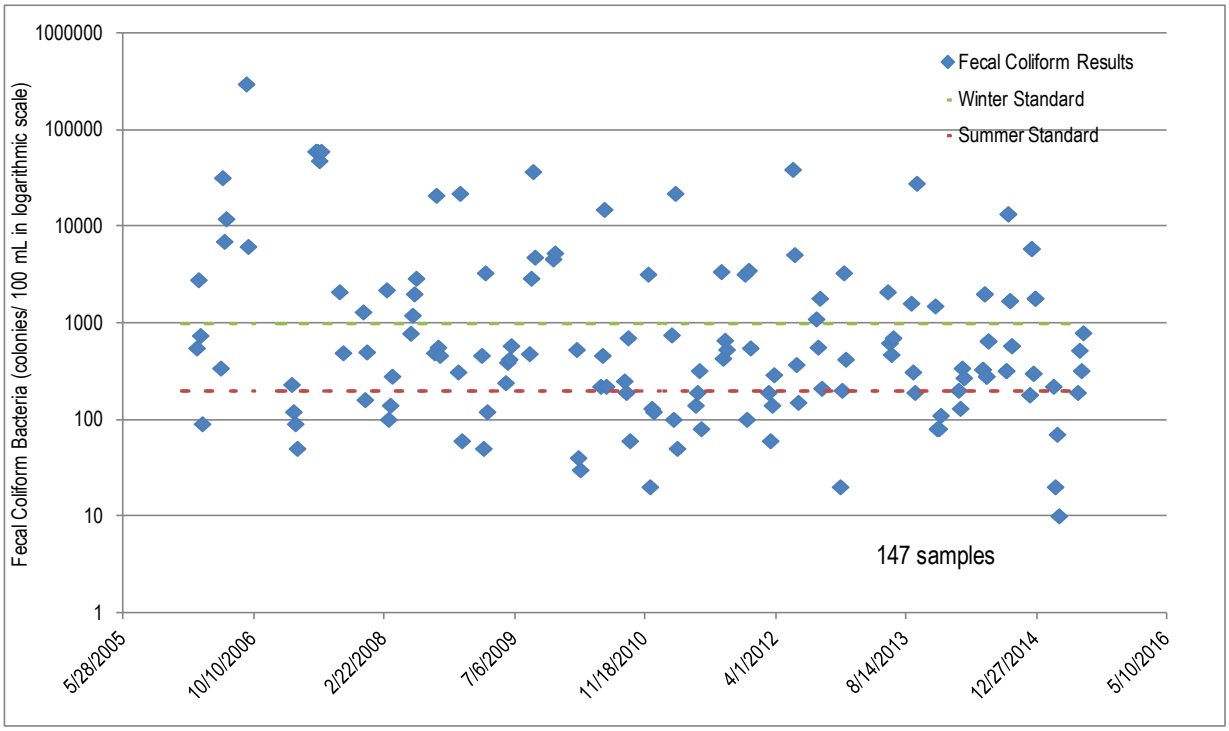


Figure 2-4. Bubbling Creek at Harts Mill Road Fecal Coliform Bacteria (Station I)



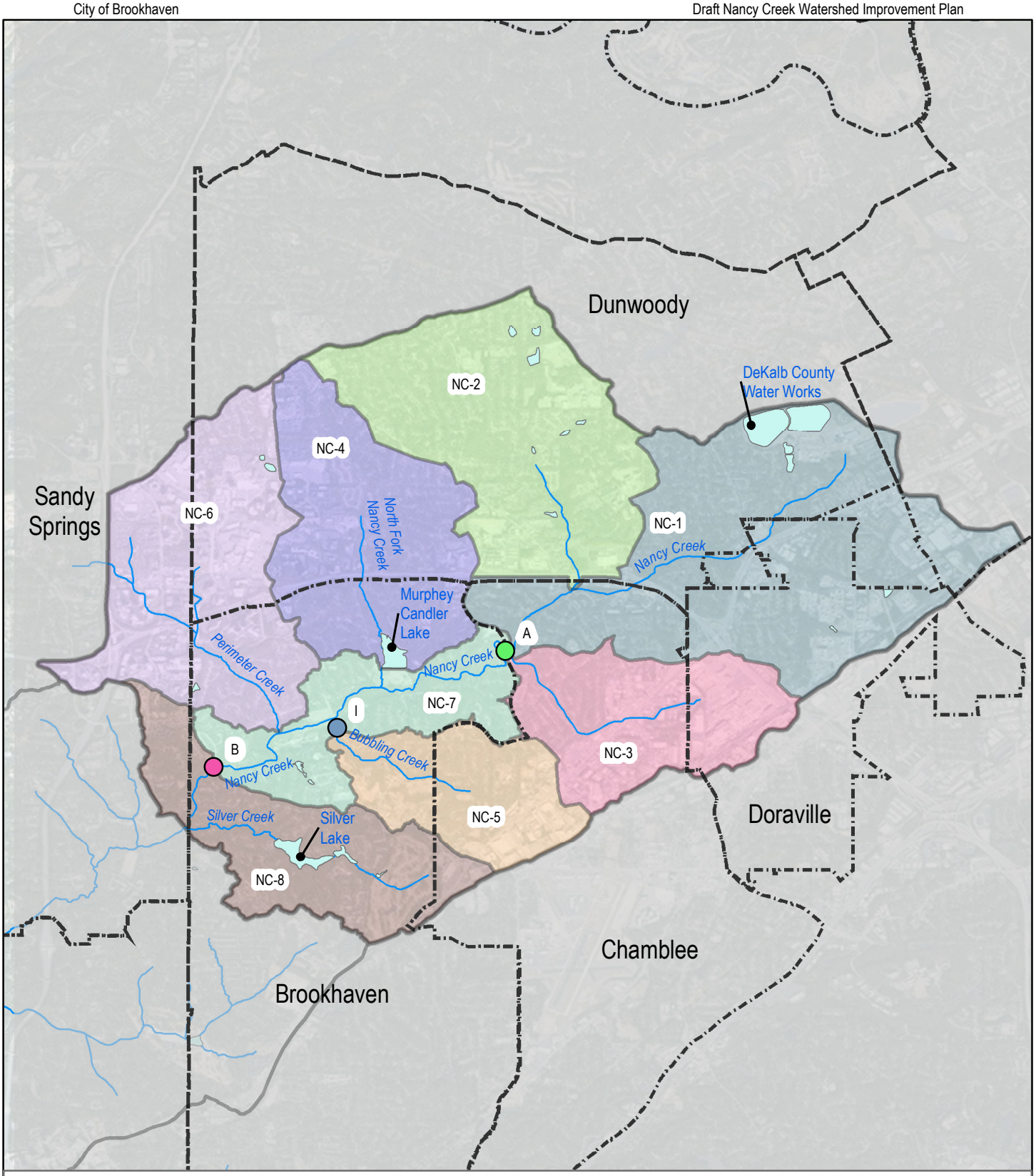
2.2. WATERSHED MODELING OF BASELINE CONDITIONS

The sources and quantities of pollutants within the Study Area are estimated using a spreadsheet-based pollutant loading model called the Watershed Treatment Model (WTM) developed by the Center for Watershed Protection[vi]. The model uses standard pollutant loading coefficients and other typical values to predict average watershed conditions. The watershed model evaluates baseline conditions and forecasts watershed conditions following the implementation of proposed watershed improvements. This section describes the baseline conditions model, including the model inputs, model calibration, and the results. The future conditions model is described in Chapter 3 of this Plan.

The model evaluated two types of pollutant sources: primary sources and secondary sources. Primary sources were determined by land use data and basic watershed information, such as annual rainfall, stream length, and soil types. Secondary sources included a wider range of pollutant loads that cannot be calculated by land use, such as contributions from sanitary sewer overflows (SSOs), illicit connections, and other sources.

The model generates annual pollutant loads for: total nitrogen (lbs/yr), total phosphorus (lbs/yr), total suspended solids (lbs/yr), fecal coliform bacteria (billion/year), and runoff volume (acre-feet/year). The results also show the relative baseline pollutant loads for each subwatershed.

The eight subwatersheds (Figure 1-3) were further subdivided into 14 WTM model areas to evaluate the pollutant loading contributions from within and outside of Brookhaven boundary. The additional subwatersheds were helpful when evaluating the impact that the projects within the City limits would have on the entire watershed as well as provide a better understanding of the overall contribution from the City to existing pollutant loads. Subwatersheds NC-1 and NC-2 do not include any land area within the city limits and therefore WTM model areas for Brookhaven were not needed.



DeKalb County Sampling Stations

- A. Nancy Creek at Chamblee Dunwoody Rd
- B. Nancy Creek at Johnson Ferry Rd
- I. Bubbling Creek at Harts Mill Rd
- Subwatersheds
- Waterbodies
- Streams
- Cities
- Study Area

N

0 0.275 0.55 1.1 1.65 2.2 Miles

Nancy Creek Watershed Improvement Plan

Figure 2-5: Subwatersheds

SWP&E Sustainable Water Planning and Engineering, LLC

2.2.1 MODEL INPUTS

Inputs to the WTM models include GIS data provided by Brookhaven and the surrounding communities as well as information gained from the stream habitat evaluations (described in the next section), and reference values provided by WTM documentation [vi]. Table 2-2 provides a summary of the inputs for the baseline conditions model.

Table 2-2. WTM Baseline Conditions Model Inputs

Inputs	Definition/Methodology	Data Source
Watershed Area	Total area of the watershed or subwatershed	Delineated subwatershed areas from GIS topographic data (LiDAR and available contour data)
Annual Rainfall	Estimated annual precipitation depth	National Oceanic and Atmospheric Administration (NOAA) 30-year historical normal annual precipitation data at the DeKalb Peachtree Airport[vii] (NOAA, 2015)
Stream Length	Total length of streams within the watershed or subwatershed	National Hydrography Dataset (NHD) GIS data
Soils	Hydrologic soil group (HSG) distribution and depths to groundwater	Natural Resources Conservation Service (NRCS) GIS data
Land Use	Low-, medium- and high-density residential, multi-family residential, commercial, industrial, roadway, forest and rural land use areas (in acres)	Assumed from zoning data or land use, where available, and verified using aerial photography
Sanitary Sewer Overflows (SSOs)	Based on miles of sanitary sewer (model assumes 140 overflows per 1,000 miles of pipe per year based on available research)	Extrapolated from Brookhaven GIS data (feet of sewer/acre) and applied to each subwatershed
Nutrient Concentrations in Stream Channels	Nutrient concentration from sediments	Based on reference values for the region as defined in WTM model documentation [vi]
Urban Channel Erosion	Based on an estimate of sediment contribution from streams within the watershed	Used typical value for moderate erosion [vi]. Moderate erosion level chosen based on 2015 stream habitat evaluation

The existing conditions watershed model did not account for benefits from the existing stormwater structures based on the upland assessment, described in Section 2.5. The stormwater management feature assessments showed that most of the stormwater structures were built prior to current stormwater management standards and/or were in need of maintenance.

2.2.2. MODEL CALIBRATION AND RESULTS

Predicted data from the baseline models were compared against historical sampling data to confirm that the model predictions were reasonable. Sampling data was available for three locations within the Study Area, shown in Figure 2-1. The sample data used for calibration was collected between 2003 and 2014 by DeKalb County Watershed Management as part of their Watershed Protection Plan long-term monitoring. The model input variables were adjusted to achieve a reasonable agreement between modeled and observed data.

The annual loading results for total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), fecal coliform, and runoff volumes were normalized by dividing the annual loading output data by the subwatershed area. The normalized subwatershed loads can be compared to each other and also to reference values. Reference values, presented in Table 2-3, are intended to provide context for the watershed model results, which are not tied to specific regulations. Reference value ranges are provided in Table 2-3 for two different types of watersheds, one for a forested watershed and the other for a medium density residential (MDR) watershed. The Study Area is dominated by medium-density residential land use, so the medium-density residential

values are more appropriate for comparison. The forested loading rates are more similar to values anticipated in a minimally impacted watershed.

Table 2-3. Reference Pollutant Loading Rates for TN, TP, and TSS[viii]

Pollutant	Pollutant Loading Rate Ranges	
	Forest (lbs/ac/yr)	MDR (lbs/ac/yr)
Total Nitrogen (TN)	2.4 – 2.7	7.1 – 10.5
Total Phosphorus (TP)	0.1	0.8 - 1.3
Total Suspended Solids (TSS)	20 – 100	240 – 440

Figures 2-6 through 2-10 present the existing conditions model results. The chart labeled "a" shows the total annual loading for that parameter while the chart labeled "b" shows the normalized value (total load divided by the size of the subwatershed). The normalized values can be compared to the reference values and to each other. The charts in Figure 2-6b, 2-7b, and 2-8b include the median reference values derived from the ranges presented in Table 2-3 for comparison purposes.

Figure 2-6 through 2-10. Existing Conditions Watershed Model Results for TN, TP, TSS, Fecal Coliform, and Runoff Volume

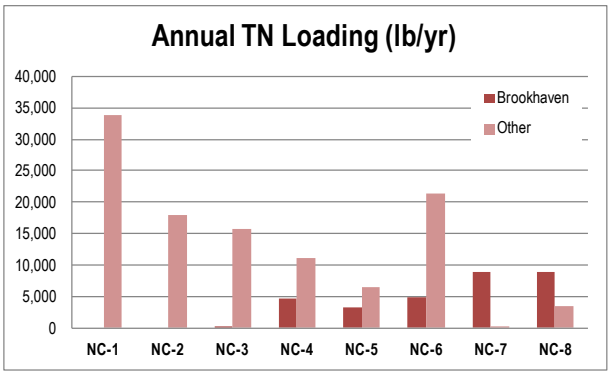


Figure 2-6a. Annual TN Loading (lbs/yr)

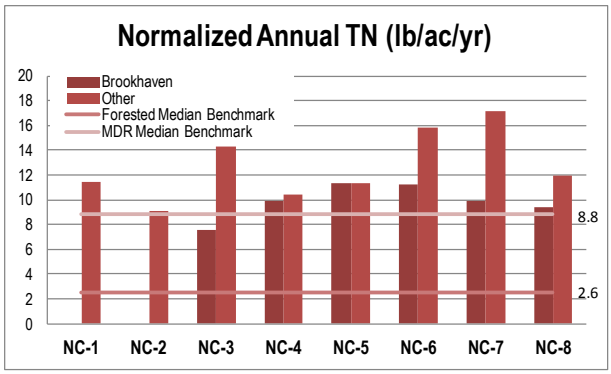


Figure 2-6b. Normalized Annual TN (lbs/ac/yr)

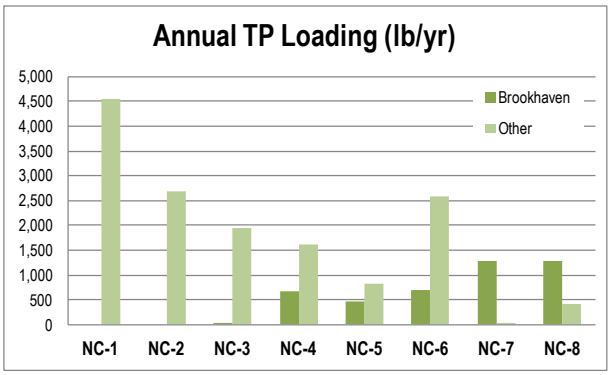


Figure 2-7a. Annual TP Loading (lbs/yr)

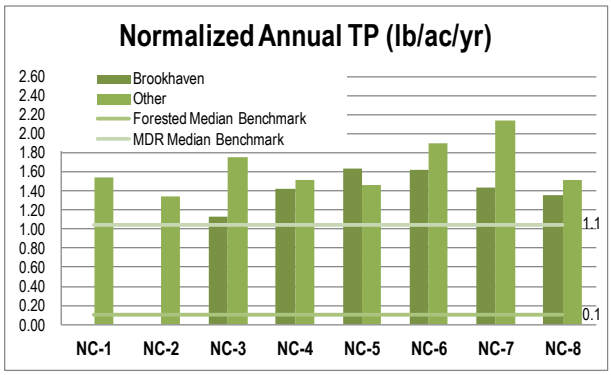


Figure 2-7b. Normalized Annual TP (lbs/ac/yr)

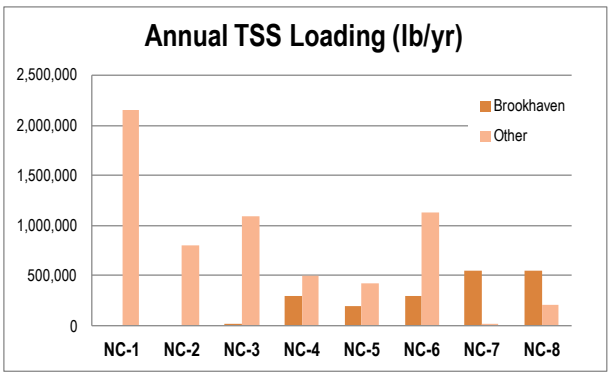


Figure 2-8a. Annual TSS Loading (lbs/yr)

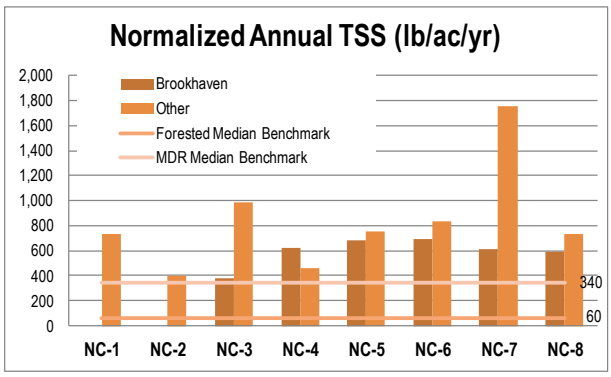


Figure 2-8b. Normalized Annual TSS (lbs/ac/yr)

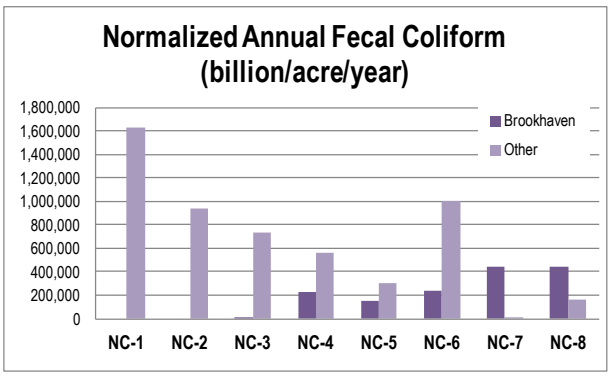


Figure 2-9a. Annual Fecal Coliform Loading (billion colonies/yr)

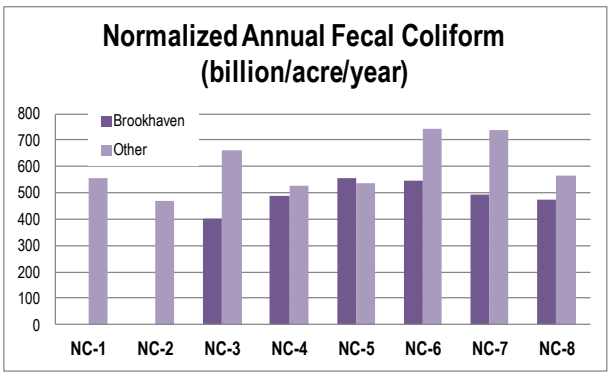


Figure 2-9b. Normalized Annual Fecal Coliform (billion colonies/ac/yr)

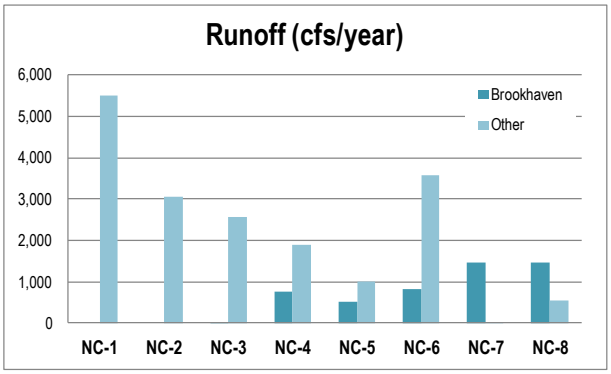


Figure 2-10a. Annual Runoff Volume (cfs/yr)

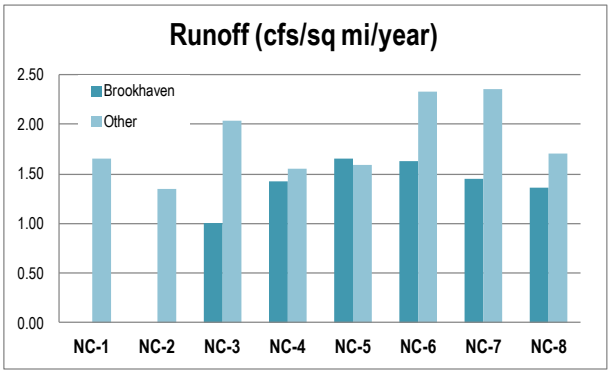


Figure 2-10b. Normalized Runoff Volume (cfs/sq mi/yr)

Table 2-4. Total Annual Loads within the Nancy Creek Watershed

Parameter	Total Loads			Percent Loads	
	Brookhaven	Outside of Brookhaven	Total	Brookhaven	Outside of Brookhaven
TN (lbs/yr)	30,600	110,100	140,700	21.7%	78.3%
TP (lbs/yr)	4,400	14,700	19,100	23.1%	76.9%
TSS (lbs/yr)	1,883,600	6,316,700	8,203,300	23.0%	77.0%
Fecal Coliform (bil. colonies/yr)	1,513,600	5,335,100	6,848,800	22.1%	77.9%
Runoff Volume (cfs/yr)	5,000	18,200	23,300	21.6%	78.4%

Key information derived from the baseline model results include:

1. The modeled pollutant loadings for the subwatersheds in the Study Area exceeded the medium-density residential reference loading rate. This is likely because there are higher intensity land uses (i.e., commercial, industrial, institutional) in addition to medium-density residential land uses.
2. Approximately 25% of the total pollutant load within the Study Area is from within Brookhaven, which correlates to the approximately 25% of the land area in the watershed located within Brookhaven.
3. The relative pollutant load from the areas outside of Brookhaven is slightly higher than those from within Brookhaven which is consistent with the slightly lower impervious cover within Brookhaven.

2.3. STREAM WALK METHODOLOGY AND RESULTS

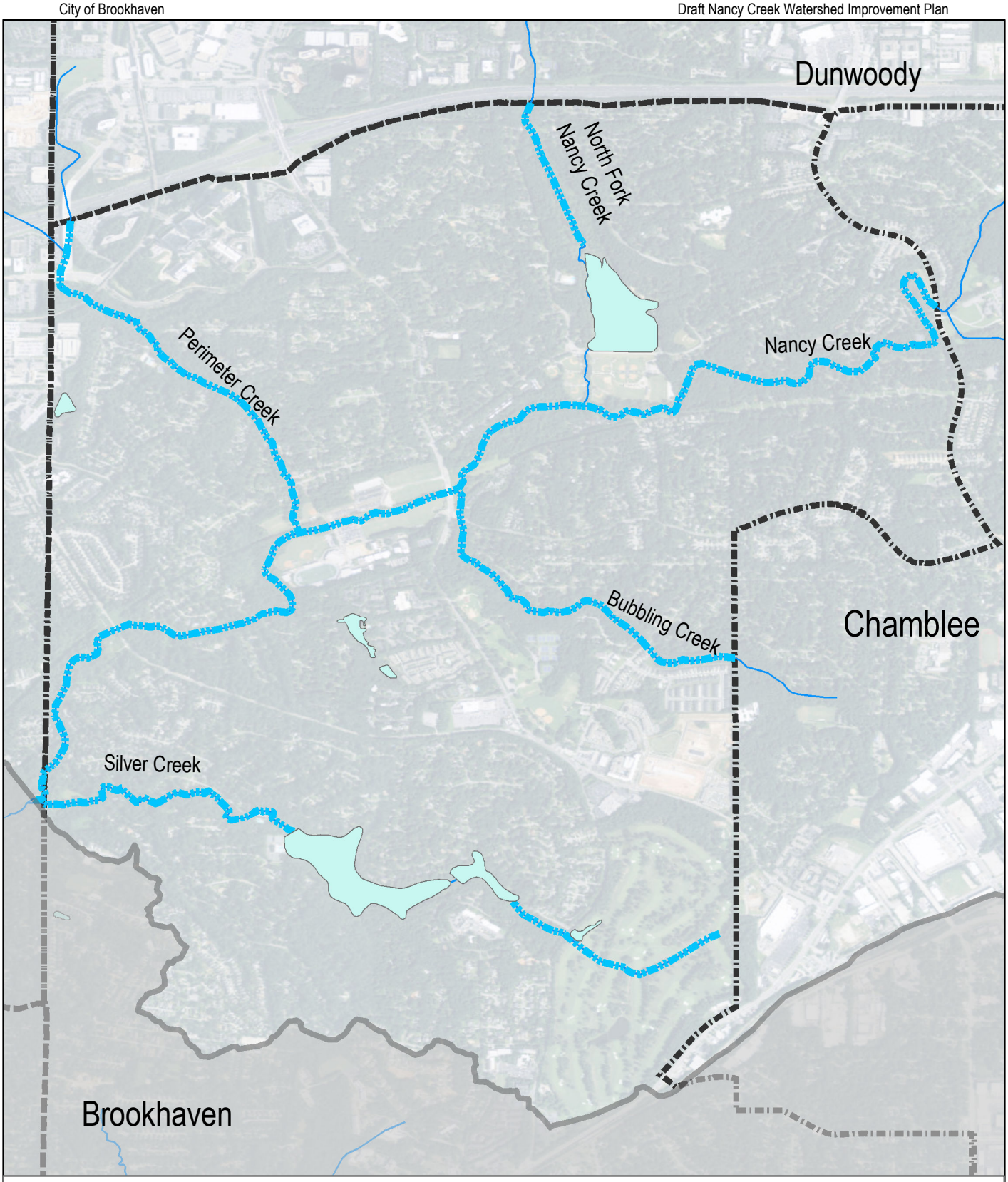
Stream habitat conditions rate the stream health in over eight miles of stream in Brookhaven based on assessments during summer 2015. While water quality samples indicate the health of a stream only for the moment in time when the samples were taken, and only in those locations, the stream habitat conditions reflect a broader range of factors that span a longer period of time and across the entire length of the stream evaluated. Nancy Creek and its major mainstems in Brookhaven with habitat aseessments are shown in Figure 2-11. The habitat assessments are performed at 28 different points, or on average every 1,500 feet of stream.

2.3.1. STREAM WALK METHODOLOGY

The assessments follow the Georgia EPD Standard Operating Procedures (SOP) for Macroinvertebrate Biological Assessment of Wadable Streams in Georgia[ix] for high gradient streams. The evaluation rates 10 different habitat parameters. The habitat parameters include:

- Epifaunal Substrate/ Available Cover
- Embeddedness
- Velocity/ Depth Regime
- Sediment Deposition
- Channel Flow Status
- Channel Alteration
- Frequency of Riffles (or bends)
- Bank Stability (score each bank)
- Vegetative Protection (score each bank)
- Riparian Vegetative Zone Width (score each bank)

Based on the conditions in the stream, each habitat parameter is assigned a score between 0 and 20. Therefore, the range of possible habitat scores is 0 to 200. The state's protocol assigns streams to an overall condition category of Optimal, Sub-optimal, Marginal, and Poor. For this project, the score ranges and categories are slightly modified to (1) eliminate the gaps between categories in the EPD scoring range, and (2) provide more gradation between habitat conditions in the sub-optimal and marginal categories. Table 2-5 shows the comparison between the total habitat scores and the classifications in the State SOP and this Plan.



Nancy Creek Watershed Improvement Plan

Figure 2-11. Habitat Assessment Streams

- Assessed Stream
- Waterbody
- Streams
- Cities
- Study Area

N

0 0.1 0.2 0.4 0.6 0.8 Miles

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Table 2-5. Habitat Assessment Condition Categories

EPD Habitat Score Range	EPD Category	Nancy Creek WIP Category	WIP Category Score Range
166 - 200	Optimal	Optimal	154 - 200
113 – 153	Sub-Optimal	Sub-Optimal Average	136 – 153 111 – 135
60 – 100	Marginal	Marginal Sub-Marginal	86 – 110 61 – 85
0 – 47	Poor	Poor	<60

2.3.2. RESULTS

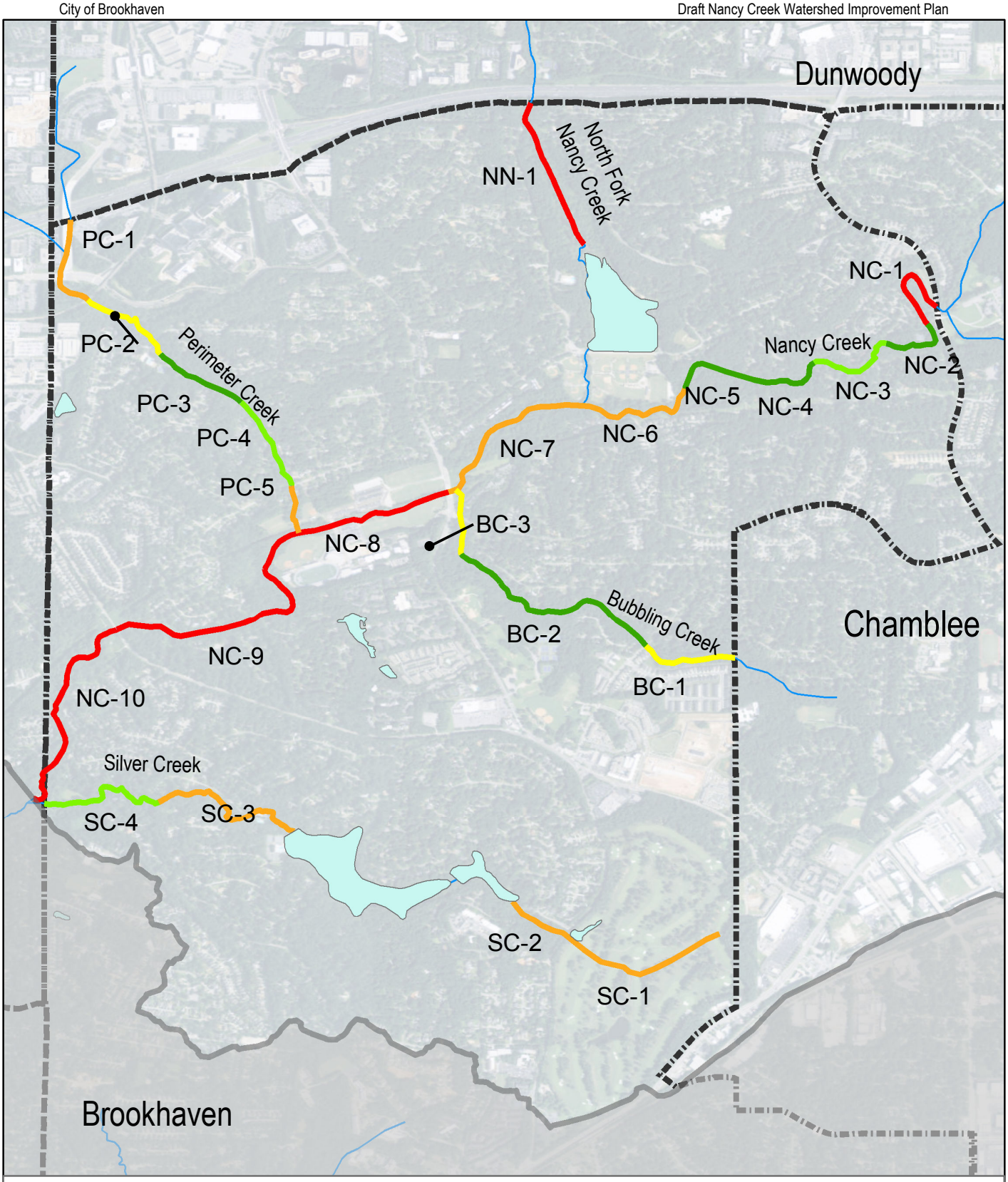
The habitat scores vary widely from 28 (Poor) to 153 (Sub-Optimal) as shown in Figure 2-12. Looking overall in the Brookhaven portion of the Study Area, stream habitat conditions are "marginal" based on a length-weighted score of all 87 out of 200 points.

There are several areas in the watershed where natural bedrock and wide protected stream buffers yield higher ratings using the state's protocols. Sections with natural bedrock include Nancy Creek, Bubbling Creek, and Perimeter Creek as exemplified in Figure 2-13. Similarly, there are areas within the watershed where the private property owners mow inside the protected buffer to the top of the stream bank, as exemplified in Figure 2-14. Fences within the stream buffer are causing damage in several locations (Figure 2-14). Invasive species such as ivy, kudzu, Chinese privet, and bamboo (Figure 2-15) have weakened or killed trees and compromise the integrity of the buffer, and therefore the stream.

Figure 2-13. Example of a Healthy Stream with Bedrock and Protected Stream Buffer

Figure 2-14. Example of a Stream with a Compromised Stream Buffer

Figure 2-15. Example of a Stream Buffer Overrun with Invasive Species



Stream Habitat Classifications
- Poor (1 - 60)
- Sub-Marginal (61 - 85)
- Marginal (86 - 110)
- Average (111 - 135)
- Sub-Optimal (136 - 160)
- **Waterbody**

- **Streams**
- **Cities**
- **Study Area**

N

0 0.1 0.2 0.4 0.6 0.8 Miles

Nancy Creek Watershed Improvement Plan

Figure 2-12: Stream Habitat Assessment Results

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2.4. MURPHEY CANDLER LAKE SAMPLING

Murphey Candler Lake is owned by Brookhaven and serves as an amenity within Murphey Candler Park. There is no known previous water quality or sediment sampling data per conversations with the City, DeKalb County, Murphey Candler Park Conservancy, and active stakeholders. Field activities to characterize the Lake health include water chemistry sampling, measurements of water depth and sediment depth, and shoreline stability ratings. This section describes the overall health evaluation of Murphey Candler Lake. The Lake sampling locations for water chemistry and depth are shown in Figure 2-16.

2.4.1. MURPHEY CANDLER LAKE WATER CHEMISTRY SAMPLING RESULTS

Water chemistry samples were collected during the summer of 2015 at three lake locations and four river locations. The river locations included the three major tributaries flowing into the Lake (North Fork Nancy Creek upstream of the lake, the unnamed tributary that feeds into the northeastern cove of the Lake, and the unnamed tributary that feeds the eastern cove of the Lake), and the outflow (North Fork Nancy Creek downstream of the Lake). Lake sample locations are distributed with one station in the center of the Lake and sample locations on the east and west side of the Lake, near the dam. Both the river and lake water samples were analyzed for fecal coliform bacteria, total phosphorus, and chlorophyll-a. The river sample analysis also included total suspended solids and the lake samples included bed sediment samples for total phosphorus.

In addition to the laboratory results, a field evaluation of transparency was performed at the three lake sampling locations. Transparency is the measure of the clarity of the water and is performed using a Secchi disk, which is a round disk with alternating black and white quadrants. The Secchi disk is lowered until the black and white quadrants are no longer seen, and that depth is recorded as the Secchi disk depth. The higher the Secchi disk depth, the clearer the water.

The results of the water chemistry and field evaluation efforts are presented by station in Table 2-6.

Table 2-6. Murphey Candler Lake Water Chemistry Sample Results

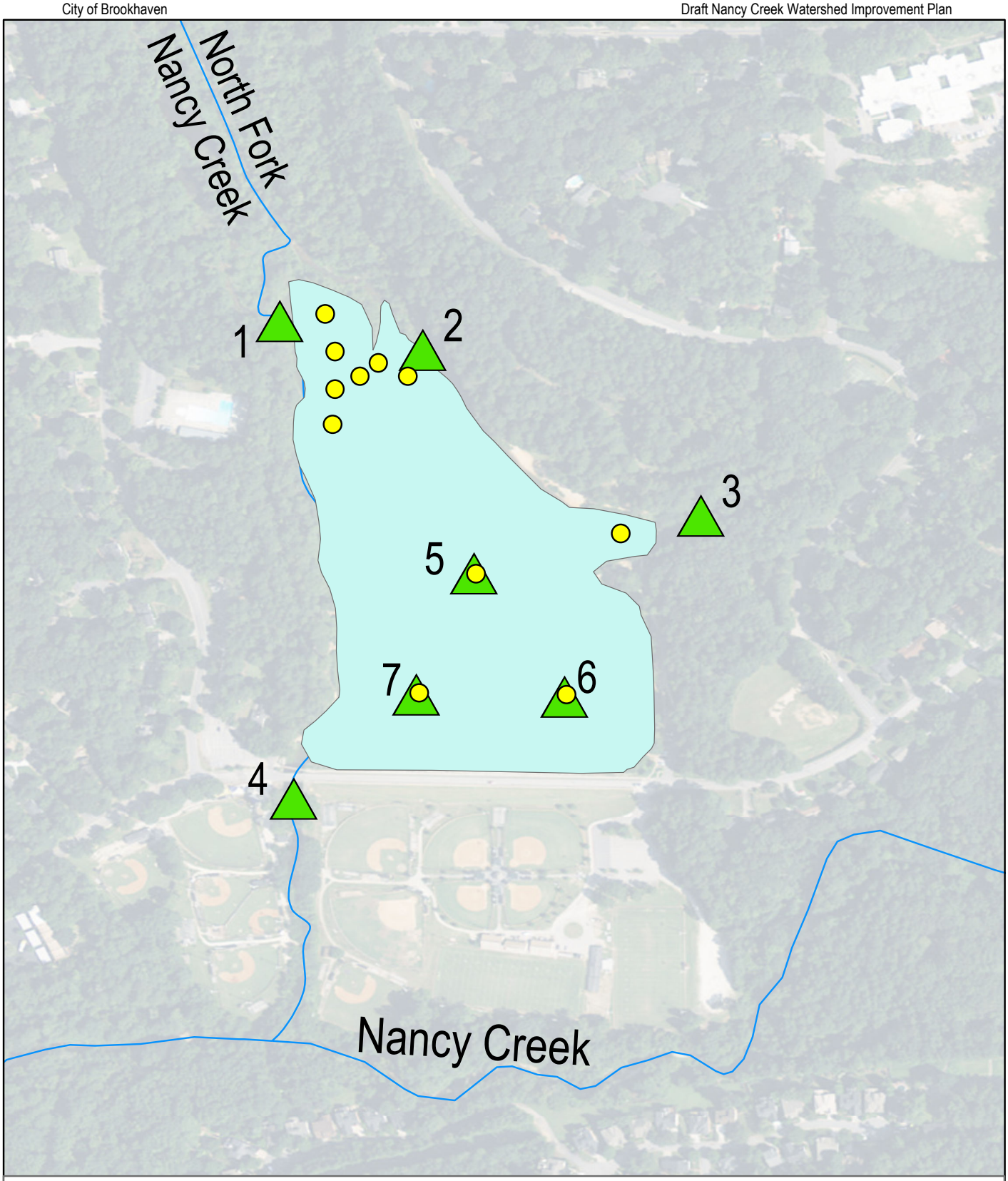
Parameter	Standard/ Guideline	River Samples				Lake Samples		
		1	2	3	4	5	6	7
Fecal Coliform (col/100mL)	Summer std = 200 Winter std = 1,000	1,600	700	90	1,400	6	6	5
Total Phosphorus (ug/mL)	24 [1]	63	137	BRL	73	63	57	64
Chlorophyll-*a* (mg/m^3)	20 [1]	BRL	5.94	BRL	26.2	24.4	49.5	28.9
Secchi Disk Depth (feet)	na					1.75	1.75	2

Notes:

1. Guideline based on trophic status, not a state-based water quality standard

BRL = below reportable limits na = not applicable

Green = meets standard/ guideline; Yellow = 1 to 2 times above the standard/ guideline; Red = >2 times above the standard/ guideline



Lake Sampling Stations
Lake Depth Measurement Stations
Waterbody
Streams
Cities

N

0 0.02 0.04 0.08 0.12 0.16 Miles

Nancy Creek Watershed Improvement Plan

Figure 2-16: Murphey Candler Lake Sampling Stations

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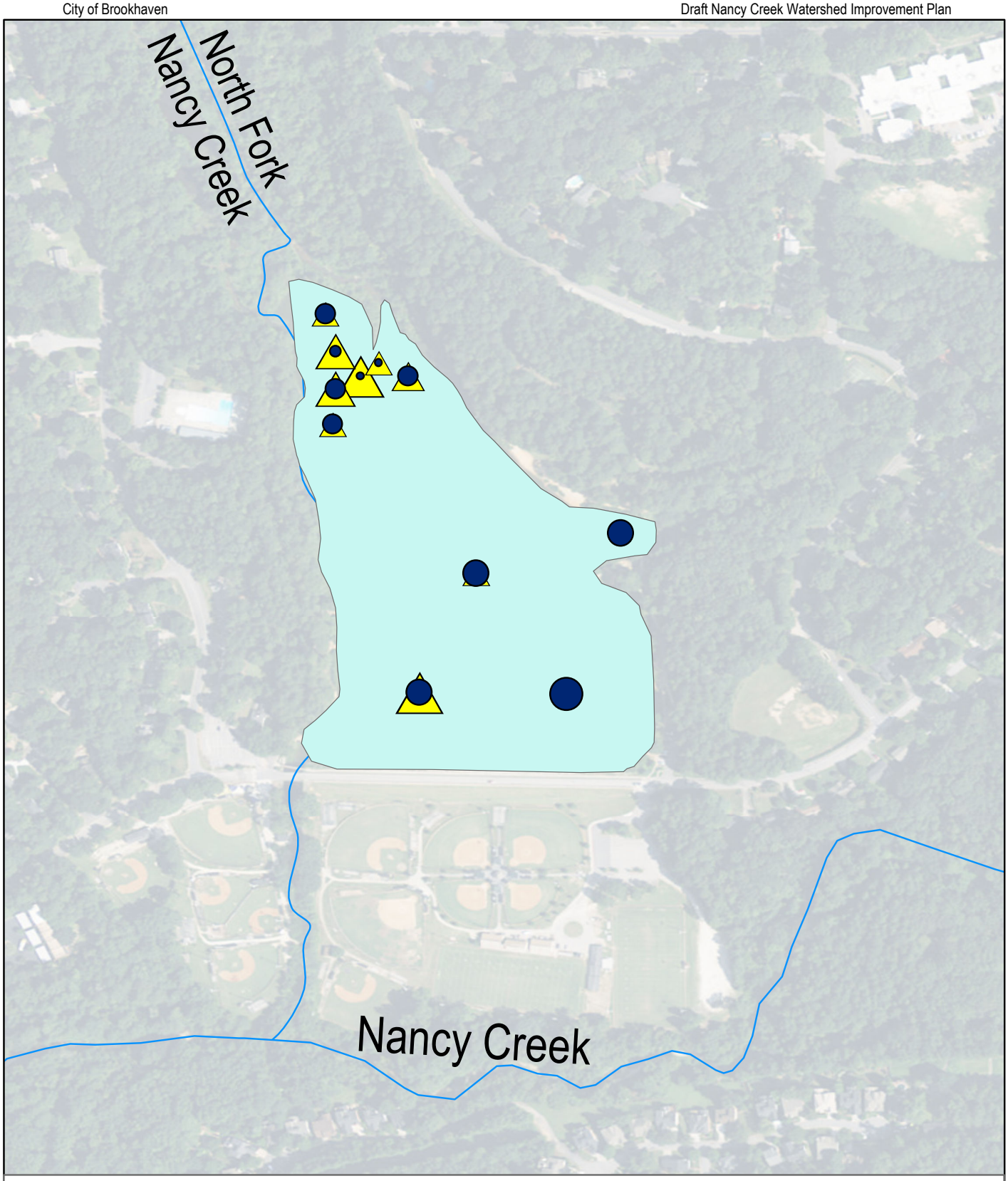
The chemistry results provide the following insights into the health of Murphey Candler Lake:

- Fecal coliform levels in three of the four river samples exceeded state standards. Possible sources include sanitary sewer overflows, wildlife waste, and pet waste. It is advisable to keep pets out of local waterbodies for three days following a rain event to avoid possible illness. People should also avoid water-based activities with the chance of water ingestion for a similar period.
- Chlorophyll-*a* levels in the Lake are high, indicating the presence of algae that creates a cloudy appearance and can impact aquatic health. Chlorophyll-*a* levels also increase with higher levels of phosphorus and nitrogen.
- Total phosphorus levels in the Lake are high. Sources of phosphorus include human and animal wastes, soil erosion, excess fertilizer, and organic matter, such as yard waste and decaying leaves found in stormwater runoff.
- Three sediment samples were collected and analyzed for phosphorus. The results ranged from below reportable limits to 133 mg/kg. These results are not considered "high" based on a literature search. Removal of accumulated sediments is not expected to provide a significant reduction in phosphorus levels.

2.4.2. MURPHEY CANDLER LAKE WATER AND SEDIMENT DEPTH MEASUREMENTS

Figure 2-17 shows the Lake water depth and sediment depth measurement results. To measure the water depth, a fiberglass rod was extended into the lake until there was resistance, indicating the top of the lake bed. The water depth ranges from 0.75 feet on the peninsula at the northern end of the lake to depths of 6 to 9 feet in the lower half of the lake nearer to the spillway. No measured water depths were found in the historical records; however, there was a Georgia EPD Final Subsequent Inspection Report dated October 10, 2002 that noted that the lake level was about 6 to 8 feet deep at the dam following the completion of the spillway modifications. The 2002 estimates are consistent with the measured depths.

The sediment depths were measured at the same 11 locations as water depths by pushing the probe past the lake bed until the sediment was too consolidated to extend the probe further. The sediment depths ranged from 0.25 feet to 5 feet with a mean value of 2 feet. The sediment depths were generally greatest at the northern end of the Lake. The location closest to the spillway was an outlier with a sediment depth of 5 feet and it is assumed that a pocket of softer sediment was hit as the surrounding areas did not have this level of accumulation. The only previous record of sediment depth was in a 1999 benthic sediment survey that study. This study estimated 110,000 cubic yards of sediment in the lake and using similar techniques found a range of sediment thickness from 2.5 feet to 5.5 feet[x]. Overall, the sediment thickness is less than it was in 1999 which is likely a result of the 2002 dredging and removal of an estimated 57,000 cubic yards of sediment.



Water Depth (feet)
- 0.75 - 1.00
- 1.01 - 2.00
- 2.01 - 4.50
- 4.51 - 7.00
- 7.01 - 9.00

Sediment Depth (feet)
- 0.25 - 0.50
- 0.51 - 1.50
- 1.51 - 2.00
- 2.01 - 3.50
- 3.51 - 5.00

Waterbody
Streams
Cities

N

0 0.02 0.04 0.08 0.12 0.16 Miles

Nancy Creek Watershed Improvement Plan

Figure 2-17: Murphey Candler Lake Water Depth and Sediment Depth Sampling Results

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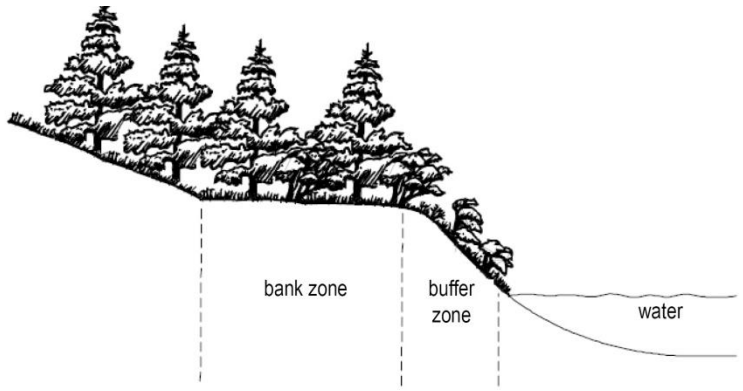
2.4.3. MURPHEY CANDLER LAKE SHORELINE CONDITIONS

The shoreline stability was rated on a scale from 7 (poor) to 25 (stable) by evaluating conditions in both the bank zone and the shore zone. The bank zone is the area just above the current waterline up to the bank. The shore zone is the upland area. The bank and shore zones are demonstrated in Figure 2-18. The shoreline was divided into ten reaches based on observed changes in stability conditions. The overall stability for each reach is the sum of the scores for slope, vegetative cover, and erosion potential for the bank and shore plus a score for the buffer width. This methodology was adapted based on a literature search of similar projects[xi], shown in Table 2-7 and summarized below. High scores indicate instability and lower scores indicate stable banks.

Table 2-7. Shoreline Rating Component Scores

Bank Zone Stability		Buffer Zone Stability	
Cover	Points	Cover	Points
Native Vegetation	1	Native Vegetation	1
Rip-Rap/ Retaining Wall	2	Invasive Vegetation	2
Weedy/ Invasive Vegetation	3	Turf Grass	3
Turf Grass	4	Bare Soil	4
Bare Soil	5	Impervious Area	5
Soil Erodibility	Points	Soil Erodibility	Points
No signs of Erosion	1	No signs of Erosion	1
Some Erosion	2	Some Erosion	2
Highly Erosive	3	Highly Erosive	3
Slope	Points	Slope	Points
>10: 1 (Gentle)	1	>10: 1 (Gentle)	1
5:1 to 10:1 (Moderate)	2	5:1 to 10:1 (Moderate)	2
Vertical to 4:1 (Steep)	3	Vertical to 4:1 (Steep)	3
Buffer Width	Points		
<25 feet	1		
25 feet – 50 feet	2		
>50 feet	3		

Figure 2-18. Typical Shoreline Zones



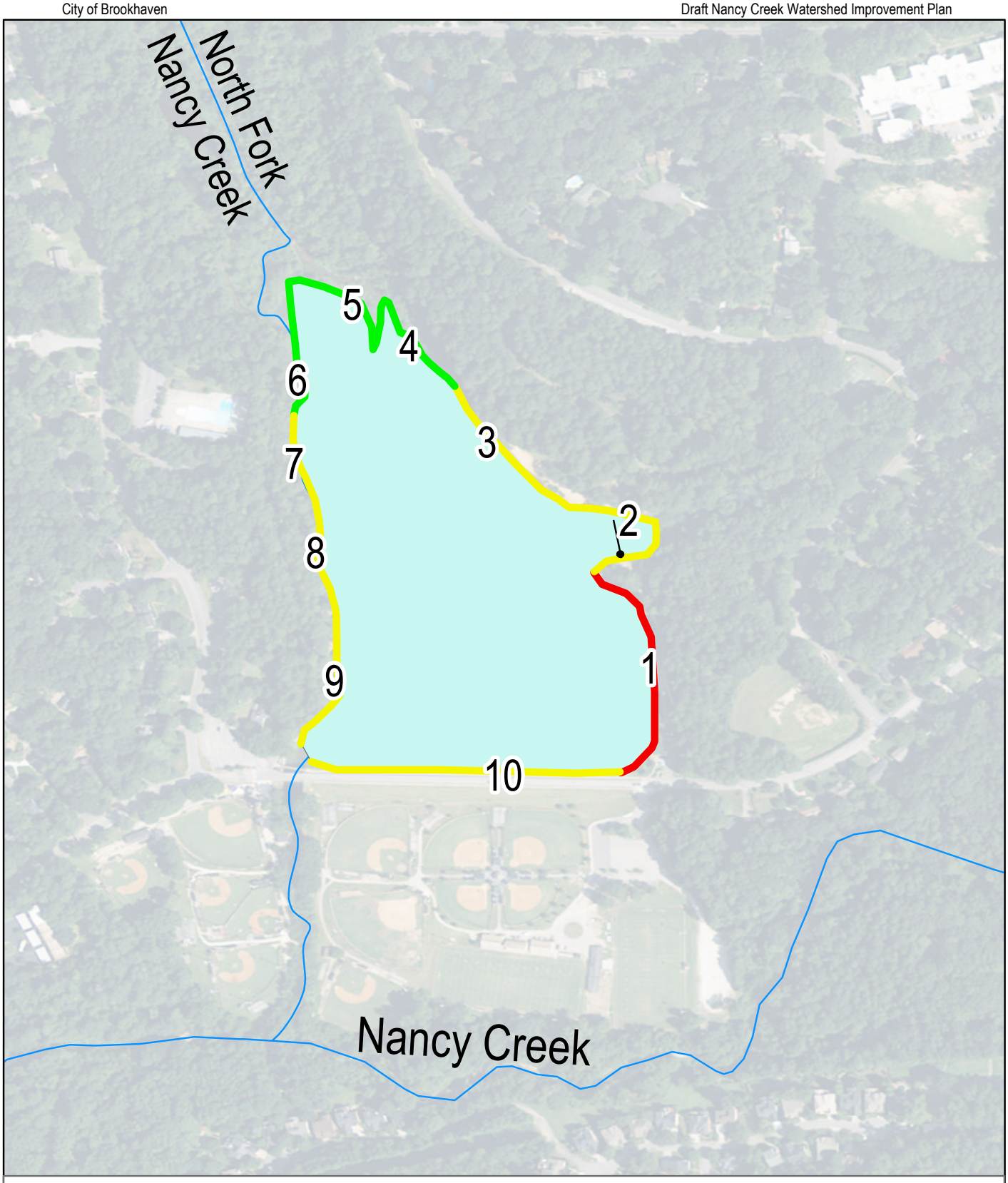
The number of points assigned to each reach for cover and soil erodibility were determined based on a visual examination of the bank and shoreline areas. The points were assigned based on the most dominant category from Table 2-7. Steep slopes are more prone to erosion and can impact vegetation growth. The slope of the shoreline was estimated by placing a fiberglass rod at the water's edge. An electronic measuring device was used to determine the length of the shore zone and the height was determined from measurements on the fiberglass rod. The slope can be presented as a ratio of Horizontal Distance: Vertical Distance. Both numbers are divided by the vertical distance to get the X:1 ratio needed to determine the number of points to assign using Table 2-7. The buffer width was measured using a tape to determine the number of points to award each reach. The buffer ended when the undisturbed vegetation was disrupted. For Murphey Candler Lake, the buffer typically ended at the trail.

The points allocated to each category above were totaled for each reach and the reach was rated as stable, threatened, or poor. The results are shown in Table 2-8 and Figure 2-19. One section of shoreline rated as poor due to significant exposed soil and steep slopes. There were also three reaches at the northern end of the lake that rated as stable with sufficient vegetation. The overall rating for the shoreline is considered "threatened".

Table 2-8. Shoreline Condition Scores and Ranking by Reach

Reach ID	Reach Length (feet)	Total Score	Ranking
1	687	10	Poor
2	557	13	Threatened
3	347	17	Threatened
4	307	21	Stable
5	615	21	Stable
6	289	18	Stable
7	264	14	Threatened
8	283	15	Threatened
9	502	13	Threatened
10	797	12	Threatened
TOTAL	4648	154	Length-weighted average = 14.7 (Threatened)

Poor = total score of 7 – 11
Threatened = total score of 12 – 17
Stable = total score of 18 - 25



Shoreline Condition
- Poor
- Threatened
- Stable
- Waterbody
- Streams
- Cities

N

0 0.02 0.04 0.08 0.12 0.16 Miles

Nancy Creek Watershed Improvement Plan

Figure 2.19: Murphey Candler Lake Shoreline Condition

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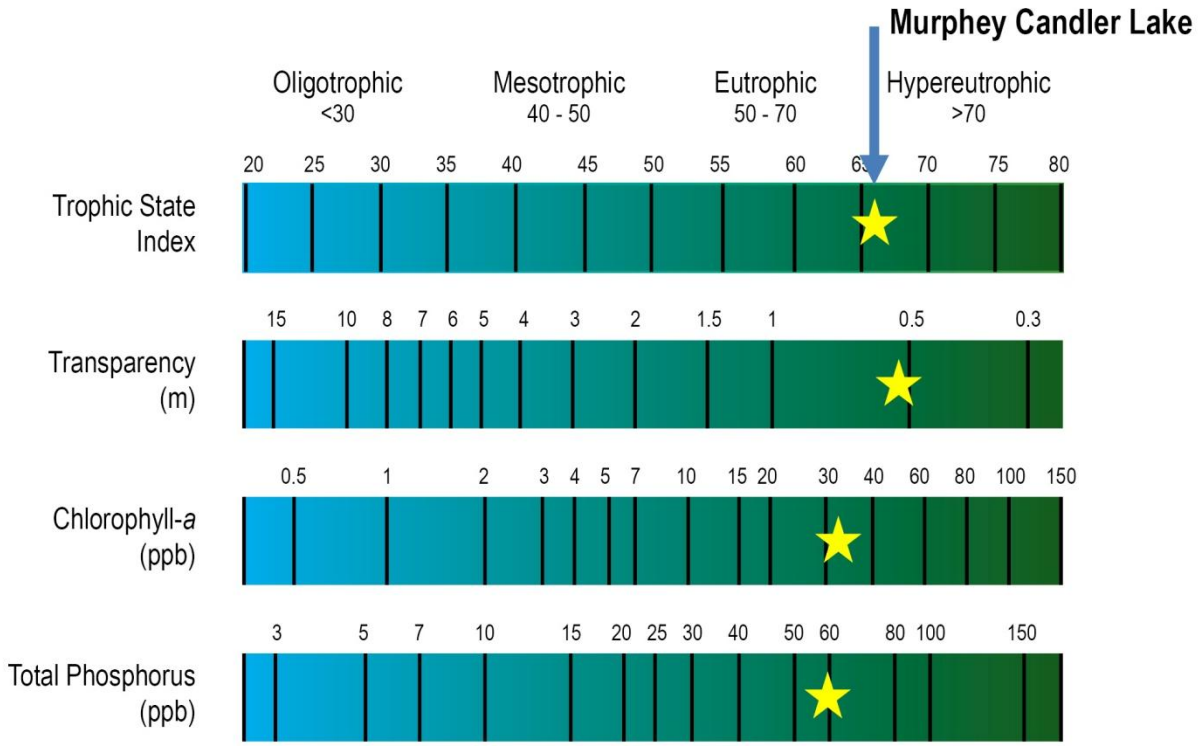
2.4.4. OVERALL LAKE HEALTH FOR MURPHEY CANDLER LAKE

The biological well-being of a lake is commonly measured using the four-level trophic state scale[xii] developed by Carlson in 1977. The trophic state level reflects the rate of algae growth in the lake and is determined by summing the points assigned to transparency, chlorophyll-*a,* and total phosphorus measurements. Figure 2-20 presents the scale and the ranking for Murphey Candler Lake based on sampling performed during summer 2015.

Oligotrophic lakes are typically clear, have a healthy aquatic community, and favored by swimmers. Eutrophic lakes are typically considered "murky" due to a high presence of algae and have lower levels of dissolved oxygen which can impact fish and other aquatic species. If too much algae accumulates (higher end of the eutrophic range and hypereutrophic) the algae can reduce the dissolved oxygen levels that fish need to survive. Hypereutrophic lakes are characterized by large algae blooms or algae mats.

Figure 2-20. Four Level Trophic Scale and Murphey Candler Lake Score



The trophic state for Murphey Candler Lake is "eutrophic" based on the high levels of chlorophyll-*a* and phosphorus and relatively low transparency, as shown in Figure 2-20. While algae may not be visible throughout Murphey Candler Lake, the average transparency is less than 2 feet (0.5 meters). This cloudiness is typical in lakes with high chlorophyll-*a* values indicating small floating algae.

A eutrophic classification is not uncommon for a suburban watershed lake that is 60+ years old. Conditions will decline without actions to limit nutrient input and recycling that contribute to algae growth and decay. Implementing actions to reduce sediment and nutrient loads to Murphey Candler Lake could help the Lake achieve mesotrophic status overtime.

Additional information on Murphey Candler Lake is presented in the State of the Lake Report that is located in Appendix A.

2.5. LIMITED UPLAND CONDITIONS ASSESSMENT

Limited investigations were performed of upland areas in order to confirm existing land uses and review existing management practices. Two types of limited upland conditions assessments were performed; a limited windshield survey and assessments of a sample of the known stormwater management structures.

The windshield survey focused on confirming land use information and management practices. Land uses were consistent with the GIS data provided by each community. Several active construction sites were identified upstream of Brookhaven in the watershed but all appeared to be following best appropriate management practices for sediment and erosion control.

The upland assessment also included a visual inspection of over half of the 108 known stormwater management structures in the Brookhaven portion of the Study Area. The structures were located using the City's GIS pond inventory and priority was given to inspecting ponds in the subwatersheds with the highest pollutant loading based on the watershed model. The inspections were consistent with the City's protocols, which follow the checklist in the Georgia Stormwater Management Manual (Appendix E)[xiii]. Retrofit opportunities were noted where applicable.

There are a total of 108 known stormwater management structures in the Brookhaven portion of the Study Area based on the City's GIS. Approximately 3,025 acres drains to these 108 facilities. Of the 108 stormwater management structures, 62 ponds (60 percent) were evaluated as part of this Plan, Figure 2-21. Only 4 of the evaluated stormwater management structures were functioning in a beneficial manner and/or did not require some kind of maintenance, as the example in Figure 2-22. Most of the structures inspected were on private property. Often private property land owners are not aware that they are responsible for maintenance and/or do not know how to properly maintain these structures. Figure 2-23 shows a private pond in need of maintenance.

As part of the City's new MS4 permit, stormwater management features are required to be inspected every 5 years and deficiency letters are required to be mailed to the owners informing them that maintenance is required. Some of the non-functional stormwater management structures were classified as such because they were designed prior to modern day stormwater requirements and although they were maintained, they were not providing real benefits to the watershed.

Figure 2-22. Example of a Functional and Well-Maintained Stormwater Management Structure

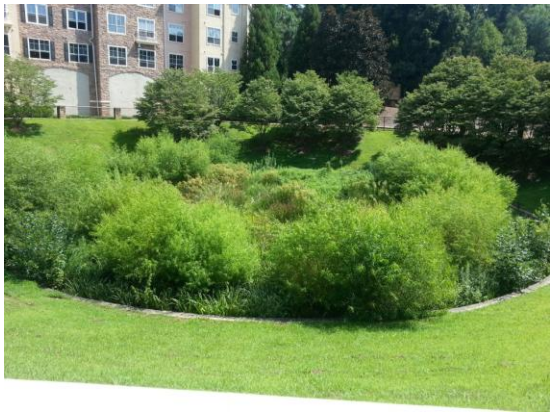


Figure 2-23. Example of a Non-Functional Stormwater Management Structure Needing Maintenance

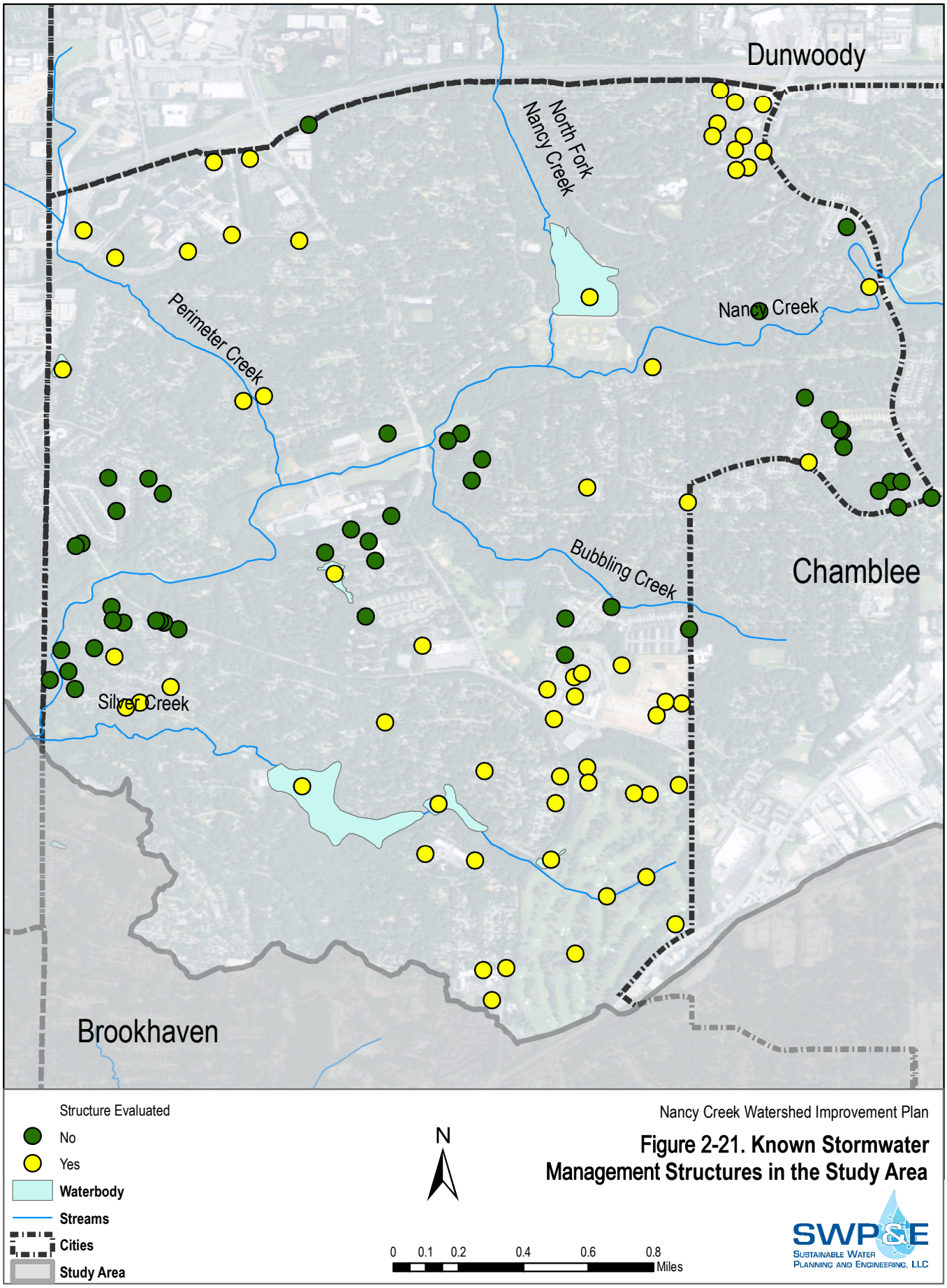


Figure 2-21. Known Stormwater Management Structures in the Study Area

2.6. SUMMARY OF FINDINGS

- There are known fecal coliform bacteria challenges on Nancy Creek and Bubbling Creek. The exceedances appear to be connected to the aging sanitary sewer system but pet wastes and urban wildlife are other possible sources.
- Murphey Candler Lake is considered "eutrophic" due to relatively high concentrations of chlorophyll-*a*. Streambank erosion from upgradient streams and sedimentation in the Lake is one source of nutrients that can result in these higher concentrations. Shoreline stability is considered threatened. There is interest in restoring the shoreline which was reportedly left exposed after the Lake was dredged and the spillway modified, lowering the water level in 2002.
- The overall impervious area in the Study Area is 38 percent. Studies show that watersheds with impervious area greater than 25 percent have degraded habitat conditions. The overall stream habitat condition in the City limits rates "marginal", consistent with the relatively high percentage of impervious area. Additional stormwater controls will be needed to improve the watershed conditions.
- There are only 108 stormwater management features within the Brookhaven portion of the watershed draining an area of approximately 3,025 acres. Since most of these features are intended to serve drainage areas less than 1 acre, much of land area is uncontrolled. In a developed watershed, like Nancy Creek, there are relatively few opportunities for larger stormwater management features which means that a larger number of smaller features will be needed.
- The baseline conditions watershed model shows that the pollutant loading is generally higher than that of a typical medium-density residential "reference" watershed. This is likely because there are more intense land uses (commercial, industrial, and roadway) and few stormwater management features in the Study Area.

CHAPTER 3. WATERSHED IMPROVEMENT PROJECTS AND PROGRAMS

This Chapter identifies the projects, additional studies, programs, and policies that are needed to meet the Plan's goals for the Study Area. The methodology for selecting projects that contribute toward the Plan's goals is presented followed by a list of recommended projects by project type. This chapter also reviews the model used to evaluate the benefits from the recommended projects and additional assessments recommended to further progress toward the Plan goals. Finally, this section recommends enhancements to the City's existing programs and policies.

The projects recommended in this Chapter will be placed into a recommended implementation order with planning level implementation costs in Chapter 4. Individual project sheets with pictures and location maps are presented in Appendix B and Appendix C summarizes the conditions in each subwatershed and lists the projects and studies recommended within that subwatershed.

3.1. WATERSHED IMPROVEMENT GOALS

This section explains the method for measuring and quantifying the extent to which each recommended project supports the four Plan goals.

Goal #1: Meet state water quality standards

Meeting state water quality standards is an important goal for this Plan and currently streams exceed the state regulations for fecal coliform bacteria and fish biota. The review of historical sampling data (Chapter 2.1) shows extremely high levels of fecal coliform bacteria (greater than 60 times the winter standard). Fecal coliform bacteria levels that high are more commonly associated with sanitary sewer issues versus domestic or wildlife animal contributions. The DeKalb County Watershed Management Department is currently under a consent order with EPD and EPA to address sanitary sewer overflows. Based on the ongoing efforts by the DeKalb County Watershed Management Department to address fecal coliform bacteria contributions from the sanitary sewer system; this Plan focuses on the fish biota water quality concerns (TSS levels). If fecal coliform levels remain high after sanitary sewer upgrades are completed, additional investigations of other sources and subsequent projects may be needed to meet state fecal coliform bacteria standards.

The state's biota TMDL for the Nancy Creek watershed notes that a 35 percent reduction in TSS is needed to meet state's biota standards (Chapter 1.4.2). Projects that reduce the TSS load and contribute toward the 35 percent reduction support this goal. The future conditions watershed model (described in Chapter 3.4) assesses whether the recommended projects are sufficient to meet the Plan goal or whether additional reductions are needed. The future conditions watershed model also quantifies the relative TSS reduction anticipated from each recommended project.

In addition to the state's numeric water quality standards, the Georgia Water Use Classifications and Water Quality Standards Rules include subjective requirements. One of these requirements states that water should be free from "floating debris" to the extent that the debris would "interfere with legitimate water uses"[xiv]. The accumulation of trash and floating debris in Murphey Candler Lake is viewed as a violation of this standard, even though the impairment is not on the state's impaired waters list. Therefore, projects that reduce the level of floating debris support this goal.

Goal #2: Restore stream buffers to prevent the loss of soil/ stream buffer

In parts of the Nancy Creek watershed, the natural riparian buffer is limited to turfgrass or invasive species that do not stabilize the stream banks as much as an undisturbed vegetated buffer. Figure 3-1 illustrates the difference between two sites within the Study Area: a forested riparian buffer and an impacted riparian buffer. Projects to protect, enhance, or restore the stream buffer prevent this erosion and sedimentation. The Plan recommends stream improvement projects for each reach of stream with erosion and/or stream buffer issues based on the 2015 habitat assessments to meet this goal. In addition to supporting this ogal, stream restoration projects also reduce TSS loads contributed from bank erosion (goal #1).

Figure 3-1. Comparison of a Vegetated Riparian Buffer (left) and an Impacted Riparian Buffer (right)

Goal #3: Improve streams to "sub-optimal" habitat condition or better

Improving stream habitat conditions to the Sub-Optimal level is an ambitious goal for a suburban stream. Based on the stream assessments, only 22.7 percent of the assessed stream miles are classified as "sub-optimal". Habitat assessment scores range from 28 out of 200 or "poor" to 153 out of 200 or "sub-optimal" using the Georgia protocols. To meet this goal, stream improvements are needed in approximately 6.25 miles of stream. Additional stormwater management controls in upland areas are also needed to achieve this goal and protect the long-term integrity of any stream restoration projects. The WTM model estimates the quantity of upland controls that are needed in Chapter 3.4. All stream improvement projects contribute toward meeting this goal.

Goal #4: Support projects that promote wildlife diversity and aesthetics

Wildlife diversity and aesthetics are important to the stakeholders. Although this goal is not quantitatively measured as part of this evaluation, the ranking protocols described in Chapter 4 assign value to capture the importance of this goal to the community. Any project that improves a wildlife corridor (i.e., riparian buffer) also supports wildlife diversity. Projects that are visible to the community also enhance aesthetics. Implementing management measures to help address the previous three goals will by default result in overall improvements in habitat for a range of aquatic and terrestrial species, and reduce the invasive plant communities; all of which will help promote a more diverse wildlife community and improve aesthetics.

3.2 PROCESS TO IDENTIFY PROJECTS

The field assessment results, public input, and a review of the City's GIS data and known problem areas serve as a basis for the recommended projects. The originations for the recommended projects include:

- **Streamwalks.** The habitat assessment scores that are below "sub-optimal" trigger a recommendation for a stream improvement project. The nature of the recommendation is tied to the individual scores for buffer width and bank stability as well as other site constraints and conditions.
- **Stormwater Investigations.** Several projects are recommended based on the existing pond conditions and opportunities to improve existing conditions, noted in the existing stormwater facility investigations.
- **Public Input.** The public provided input during the four public meetings and the six stakeholder meetings. Previous drainage complaints were also considered a form of public input.

- **Review of the City's GIS data.** With a limited number of existing stormwater controls, additional projects are recommended upstream of areas with high baseline conditions model pollutant loads. New stormwater controls are recommended in strategic areas based on a review of the City's GIS parcel data and stream habitat results.

3.3. RECOMMENDED WATERSHED IMPROVEMENT PROJECTS

This Plan recommends 43 watershed improvement projects to address the four stated goals. These projects are conceptual in nature and will need to be properly designed and permitted prior to construction. Projects are recommended based on watershed benefits and not limited to City-owned or publicly-owned land. Projects on private property are sometimes complicated by uncooperative land owners. The City may not choose to invest public funds on private property. Complications associated with permitting, hazardous waste discovery, or archaeological site discovery can also affect implementation and are identified during the design phase of a project.

The recommended projects fall into one of three categories; stream enhancement projects, BMP projects, and Murphey Candler Lake projects. The projects are presented by project type within the next three sections of this Chapter. Chapter 4 presents the projects within an ordered implementation plan that outlines the extent to which each project supports meeting the project goals. Appendix B presents individual projects sheets and Appendix C includes a summary of recommended projects by subwatershed.

3.3.1. STREAM ENHANCEMENT PROJECTS

Stream enhancement projects include stream restoration, streambank stabilization, and stream buffer restoration/ enhancement projects. While these projects reflect a different level of intensity, the desired outcome of all stream enhancement projects is a healthy stream habitat. Stream restoration is the most intensive and generally refers to projects that re-establish the connection between the stream channel and the floodplain. Often these projects include grade control and sometimes they include reshaping the stream reach. Streambank stabilization is less intensive and often used where urban constraints limit the ability to reconnect the stream to the floodplain. Streambank stabilization includes stabilizing streambanks with grading, structure reinforcement (armoring or riprap) or bioengineered solutions (e.g., logs, live stakes, rootwads, etc.). Buffer restoration is the least intensive and includes removing invasive species and replanting healthy, native vegetation in the buffer zone. Figure 3-2 shows an example of a stream restoration project, and Figure 3-3 shows an example buffer restoration project. Stream enhancement projects reduce sediment loads to the stream from bank erosion, improve habitat conditions, and improve wildlife diversity and aesthetics.

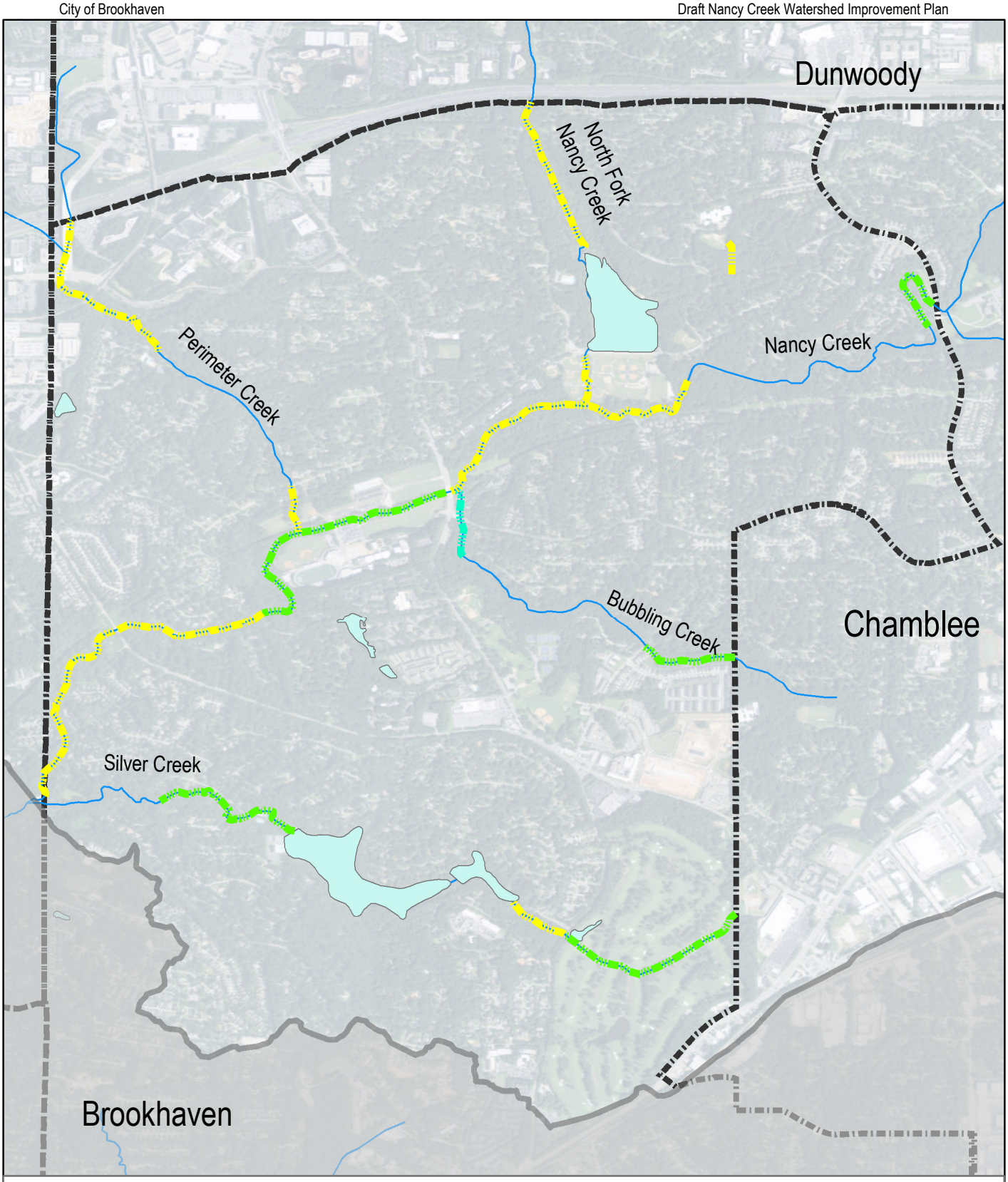
Figure 3-2. Example of a Stream Restoration Project with Floodplain Reconnection

Figure 3-3. Example of a Buffer Restoration Project

Table 3-1 lists the 16 recommended stream enhancement projects. These projects include nine stream restoration projects, two streambank stabilization projects, and five buffer restoration projects. The stream enhancement projects are shown in Figure 3-4.

Table 3-1. Recommended Stream Enhancement Projects

Number	Project Type	Sub-watershed	Description	Goals Supported			
				1	2	3	4
NC4-008	Stream Restoration	North Fork Nancy Creek	Restoration of 390 linear feet of eroding drainage channel at Kittredge Magnet School leading into a tributary to Murphey Candler Lake. Associated with NC4-014.	Y	Y	Y	Y
NC4-010	Stream Restoration	North Fork Nancy Creek	Restore approximately 3,400 linear feet of North Fork Nancy Creek from I-285 to Murphey Candler Lake that is classified as "poor" and "threatened".	Y	Y	Y	Y
NC5-001	Buffer Restoration	Bubbling Creek	Invasive species are threatening stream buffer health and causing downed trees. Remove invasive species and replant to healthy forest density.		Y	Y	Y
NC5-003	Streambank Stabilization	Bubbling Creek	Significant stream erosion in compact suburban area. Stabilize streambanks and enhance floodplain connectivity. Improve transition to Nancy Creek.	Y	Y	Y	Y
NC6-001	Stream Restoration	Perimeter Creek	Restore stream and add grade control structures to mitigate velocity and protect infrastructure adjacent to the stream. Protect wide buffers, where they exist. Partner with MARTA and private property owners.	Y	Y	Y	Y
NC6-002	Streambank Stabilization	Perimeter Creek	Restore and/or maintain stream buffers to protect stream habitat. Some areas will require stabilization, especially near infrastructure.	Y	Y	Y	Y
NC6-009	Stream Restoration	Perimeter Creek	Stabilize and/or restore property along Perimeter Creek just upstream of the confluence with Nancy Creek. Buffer encroachment has resulted in significant bank erosion.	Y	Y	Y	Y
NC7-001	Streambank Stabilization	Nancy Creek Mainstem	Restore the vegetated buffer zone in the D'Youville community to the extent available to protect banks from erosion that is starting to occur.	Y	Y	Y	Y
NC7-002	Stream Restoration	Nancy Creek Mainstem	North Fork Nancy Creek from the spillway to confluence with Nancy Creek. Address erosion with grade control and improve buffer within confines of existing recreation. Integrate planned trail and bridge.	Y	Y	Y	Y
NC7-003	Buffer Restoration	Nancy Creek Mainstem	Support ongoing restoration of the stream buffer along the Marist campus.	Y	Y	Y	Y
NC7-005	Stream Restoration	Nancy Creek Mainstem	Restoration of Nancy Creek from Marist to Johnson Ferry Road.	Y	Y	Y	Y
NC7-006	Stream Restoration	Nancy Creek Mainstem	Restoration of Nancy Creek from the football field in Murphey Candler Park to Ashford Dunwoody Road. Includes stream in Murphey Candler Park along with private property. Coordinate with planned greenway trail.	Y	Y	Y	Y
NC8-001	Buffer Restoration	Silver Creek	Improve vegetated buffer along Silver Creek with golf course appropriate vegetation to help protect against stream bank erosion.	Y	Y	Y	Y
NC8-003	Buffer Restoration	Silver Creek	Restore the stream buffers downstream of Silver Lake Dam to the extent possible and limit future buffer intrusions.	Y	Y	Y	Y
NC8-004	Stream Restoration	Silver Creek	Restore stream and protect utilities upstream of Little Silver Lake. Coordinate with the ongoing Ashford Dunwoody Road corridor study and any recommended projects.	Y	Y	Y	Y
NC8-005	Stream Restoration	Silver Creek	Restore Nancy Creek from Johnson Ferry to the Brookhaven city limits.	Y	Y	Y	Y



Recommended Stream Projects

Stream Improvement Project Type

- Buffer Restoration
- Stream Restoration
- Streambank Stabilization
- **Waterbody**
- **Streams**
- **Cities**
- **Study Area**

N

0 0.1 0.2 0.4 0.6 0.8 Miles

Nancy Creek Watershed Improvement Plan

Figure 3-4: Recommended Stream Enhancement Projects

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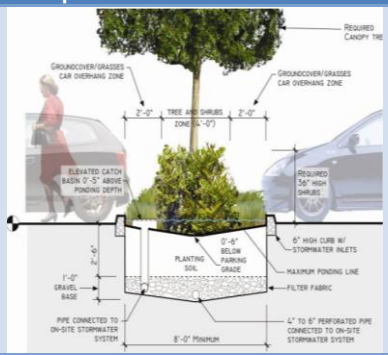
3.3.2. BMP AND BMP RETROFIT PROJECTS

BMPs include a wide variety of stormwater practices that reduce the negative impacts associated with stormwater runoff. BMPs typically improve stormwater quality and attempt to mimic pre-development runoff conditions. BMP retrofit projects involve modifying existing BMPs to maximize the water quality benefits that they provide. The term BMP includes a wide variety of different practices, generally the term BMP in the context of this Plan refers to "green infrastructure" practices, or stormwater features that infiltrate stormwater. BMPs that infiltrate stormwater reduce the volume of stormwater runoff following rain events through infiltration and improve water quality of runoff. Examples of the types of recommended BMPs with descriptions are outlined in Table 3-2.

Table 3-2 Example BMP and BMP Retrofit Projects

BMP Type	Description [xv]	Example
Bioretention Area	Bioretention areas are shallow stormwater basins or landscaped areas that utilize engineered soils and vegetation to capture and treat stormwater runoff. Bioretention areas may be designed with an underdrain that returns runoff to the conveyance system or designed without an underdrain to exfiltrate runoff into the soil.	
Bioswale or Bioslope	Bioslopes are linear, non-structural BMPs with a permeable media that allows stormwater runoff to infiltrate and filter through the practice before exiting through an underdrain. Generally, a pretreatment device, such as filter strip, grass shoulder, or pea gravel diaphragm, is placed upstream of the bioslope to capture sediment and debris.	
Rain Garden	A rain garden is a shallow depression that is planted with deep-rooted native plants and grasses. Rain gardens accept runoff from a downspout, driveway, or other impervious area. The captured rainwater runoff infiltrates through the vegetation and improved soils into the ground, reducing stormwater runoff. Rain gardens are similar to a bioretention area, but typically receive runoff from a smaller area.	
Enhanced Swale	Enhanced swales are vegetated open channels that are designed and constructed to capture and treat stormwater runoff within dry or wet cells formed by check dams or other structures.	

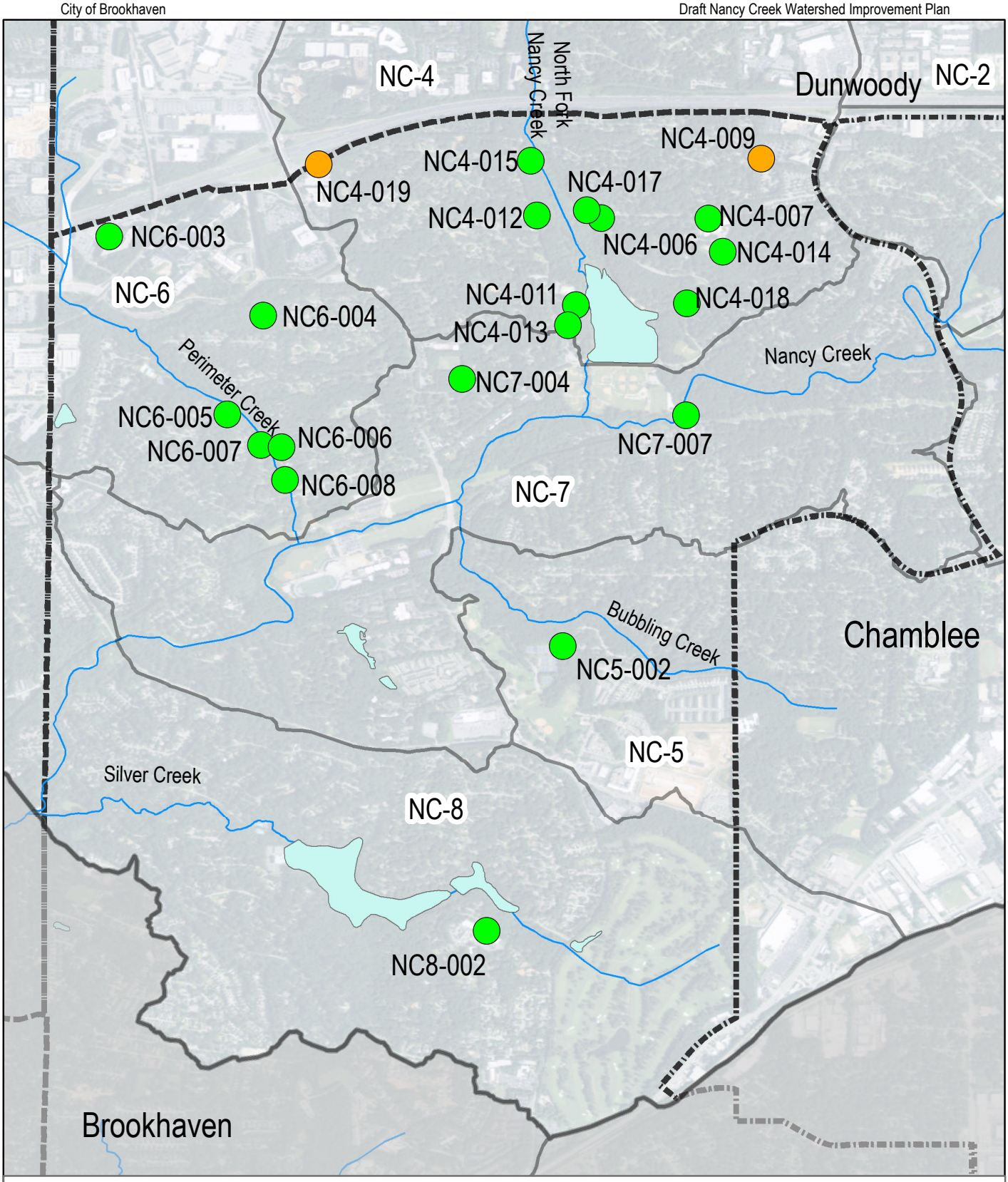
BMP Type	Description [xv]	Example
Street Trees or Stormwater Planters or Tree Boxes	Stormwater planters are similar to bioretention areas in their design purpose to detain, filter, and infiltrate stormwater. In addition, stormwater planters utilize native or non-invasive flowers, shrubs and trees to provide aesthetic qualities to the site. Planters and tree boxes receive stormwater from a variety of sources such as, rooftops, downspouts and runoff from streets.	
Constructed Wetlands or Stormwater Wetlands	Stormwater wetlands are constructed wetland systems used for stormwater management. Stormwater wetlands consist of a combination of shallow marsh areas, open water, and semi-wet areas above the permanent water surface. As stormwater runoff flows through a wetland, it is treated, primarily through gravitational settling and biological uptake.	
Offline Stormwater Pond	A stormwater pond that is constructed adjacent to a river or stream. A control structure diverts a portion of the stormwater to the pond during high flow periods. The pond will have a permanent pool (or micropool) of water. The pond provides water quality treatment through sediment precipitation in the permanent pool. Water will gradually flow back into the waterbody or infiltrate, depending on the design.	
Stormwater Pond Retrofit	Stormwater BMPs in locations where existing stormwater controls are ineffective. Retrofits are convert ineffective stormwater management into functional facilities. Stormwater retrofit BMPs are influenced by the location and existing constraints. Any of the BMPs identified in this table are appropriate for retrofit projects.	

A total of 21 BMP projects are recommended; 19 new BMPs and two BMP retrofit projects. Three of the recommended new BMPs are located on undeveloped property; two of these locations are landlocked parcels with a high percentage of the parcel within the stream buffer and/or a regulated floodplain. The other undeveloped property is likely to develop. The intent is to route existing impervious area to a new BMP as part of development. Simply treating the runoff from new impervious area does not provide the modeled additional watershed benefits. The recommended BMPs are listed in Table 3-3 and shown in Figure 3-5.

Table 3-3. Recommended BMP and BMP Retrofit Projects

Number	Project Type	Subwatershed	Description	Goals Supported			
				1	2	3	4
NC4-006	New BMP	North Fork Nancy Creek	New bioretention area at the bend in East Nancy Creek Drive in Murphey Candler Park. Recommend three-tiered and tie in adjacent catch basin drainage as well as direct road drainage before draining to the stream.	Y	Y		Y
NC4-007	New BMP	North Fork Nancy Creek	New bioretention or enhanced swale area in front of Kittredge Magnet School.	Y	Y	Y	Y
NC4-009	BMP Retrofit	North Fork Nancy Creek	Retrofit an existing office stormwater structure to retain stormwater and provide water quality treatment and address drainage issue in downstream residential area.	Y	Y		Y
NC4-011	New BMP	North Fork Nancy Creek	Provide additional stormwater management with the planned revisions to the parking lot adjacent to Murphey Candler Pool. Options include several bioretention areas, enhanced swales, or street trees.		Y		Y
NC4-012	New BMP	North Fork Nancy Creek	Address existing drainage issues with the planned sidewalk extension. Add bioswales upstream and downstream of the catch basin.		Y		Y
NC4-013	New BMP	North Fork Nancy Creek	Provide additional stormwater management with the planned revisions to the parking area along Candler Lake West. Options include several bioretention areas, enhanced swales, or street trees.		Y		Y
NC4-014	New BMP	North Fork Nancy Creek	Provide stormwater management through underground detention associated with upgrades to the existing recreational field and repair to existing drainage at Kittredge Magnet School. Associated with NC4-008.	Y	Y		Y
NC4-015	New BMP	North Fork Nancy Creek	Create an offline pond area to trap sediment upstream of Murphey Candler Lake, catching drainage from North Fork Nancy Creek. Location to be refined based on planned park survey.	Y	Y		Y
NC4-017	New BMP	North Fork Nancy Creek	Offline pond area to trap sediment upstream of Murphey Candler Lake, catching drainage from unnamed tributary on the NE side of the lake. Location to be refined based on planned park survey.	Y	Y		Y
NC4-018	New BMP	North Fork Nancy Creek	Offline pond area to trap sediment upstream of Murphey Candler Lake, catching drainage from the unnamed tributary draining to the east cove. Location to be refined based on planned park survey.	Y	Y		Y
NC4-019	BMP Retrofit	North Fork Nancy Creek	Retrofit existing detention pond serving commercial building to provide water quality and perform needed maintenance.	Y			
NC5-002	New BMP	Bubbling Creek	Integrate new BMPs with planned improvements at Blackburn Park including field renovations, building improvements, and parking enhancements.	Y	Y	Y	Y
NC6-003	New BMP	Perimeter Creek	Existing large building served by ineffective stormwater management. Opportunities to integrate	Y	Y	Y	Y

Number	Project Type	Subwatershed	Description	Goals Supported			
			bioretention areas to increase stormwater management and reduce velocities in creek.				
NC6-004	New BMP	Perimeter Creek	Large undeveloped parcel likely to develop. Consider partnership opportunity to expand stormwater required for development to reduce stormwater velocity and volume.	Y	Y		Y
NC6-005	New BMP	Perimeter Creek	Landlocked parcel adjacent to Perimeter Creek. Check tax status and consider securing for stormwater control structure. Would need construction and maintenance access agreements.	Y	Y	Y	Y
NC6-006	New BMP	Perimeter Creek	Consider new BMP to replace existing inline structure on private property to HOA owned land.	Y	Y		Y
NC6-007	New BMP	Perimeter Creek	Evaluate relocating existing non-functioning BMP in residential yard to HOA owned property. Design to provide water quality and quantity benefits.	Y	Y		Y
NC6-008	New BMP	Perimeter Creek	Landlocked parcel adjacent to Perimeter Creek. Check tax status and consider securing for stormwater control structure. Would need construction and maintenance access agreements.	Y	Y	Y	Y
NC7-004	New BMP	Nancy Creek Mainstem	Integrate stormwater improvements and recreation field enhancements at Montgomery Elementary School. Underground detention under field an option.	Y	Y	Y	Y
NC7-007	New BMP	Nancy Creek Mainstem	Large BMP that is overgrown and does not appear to be receiving flow. Convert into a constructed wetland to capture stormflows adjacent to Nancy Creek. Intended to function like a constructed wetland.	Y	Y	Y	Y
NC8-002	New BMP	Silver Creek	Opportunities to integrate one or more bioretention facilities at the Our Lady of the Assumption Catholic Church. Can be integrated into science curriculum.	Y	Y		Y



Recommended BMP Projects

- BMP Retrofit
- New BMP
- Subwatersheds
- **Waterbody**
- **Streams**
- **Cities**
- **Study Area**

N

0 0.1 0.2 0.4 0.6 0.8 Miles

Nancy Creek Watershed Improvement Plan

Figure 3-5: Recommended BMP and BMP Retrofit Projects

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3.3.3. MURPHEY CANDLER LAKE RECOMMENDED PROJECTS

While all of the projects upstream of Murphey Candler Lake will improve water quality and habitat conditions within the Lake, there are three types of projects that are focus specifically on the Lake. These projects include installation of trash racks to minimize floatable debris in the Lake, shoreline restoration, and removal of accumulated sediment in the Lake. Table 3-4 presents examples and descriptions of these types of projects.

Table 3-4 Example BMP and BMP Retrofit Projects

BMP Type	Description	Example
Trash Racks	Floating trash racks collect trash and floatables so that they can be removed before flowing downstream. There are many versions of trash racks. The recommended version attaches on the downstream side of a culvert. Trash needs to be removed after major rains and at a minimum monthly.	
Shoreline Restoration	The majority of the Murphey Candler Lake shoreline is classified as “poor” or “threatened”. Shoreline restoration combines native vegetation with improved soils and geotextile fabrics to protect newly planted vegetation. The rendering shows an option for one section of shoreline restoration.	
Sediment Removal or Dredging	Sediment accumulates in lakes and periodically must be removed to maintain lake functionality. Permits are required for almost all dredging activities. Dredging is very expensive. The disposal of sediment can cost as much as the removal. Dredging is considered a maintenance activity, as sediment continues to accumulate and is performed every 30 years, on average.	

Six of the recommended projects are specific to Murphey Candler Lake, as shown in Table 3-5. The projects are also shown in Figure 3-6.

Table 3-5. Recommended BMP and BMP Retrofit Projects

Number	Project Type	Subwatershed	Description	Goals Supported			
				1	2	3	4
NC4-001	Trash Rack	North Fork Nancy Creek	Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.	Y			Y
NC4-002	Trash Rack	North Fork Nancy Creek	Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the	Y			Y

Number	Project Type	Subwatershed	Description	Goals Supported			
			culvert to capture floatables and debris from the catch basins and associated drainage channels.				
NC4-003	Trash Rack	North Fork Nancy Creek	Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.	Y			Y
NC4-004	Trash Rack	North Fork Nancy Creek	Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.	Y			Y
NC4-005	Shoreline Restoration	North Fork Nancy Creek	Restore 3,400 linear feet of shoreline around Murphey Candler Lake (shore classified as “poor” or “threatened”).		Y		Y
NC4-016	Sediment Removal	North Fork Nancy Creek	Maintenance dredging of accumulated sediment in the northern and eastern coves in Murphey Candler Lake.				Y

3.3.3.1. SEDIMENT REMOVAL FOR MURPHEY CANDLER LAKE

The City is concerned with the visible accumulation of sediment in Murphey Candler Lake, which is most pronounced in the northern coves and eastern cove. In part, the City commissioned this Plan to study the sources of sediment, as well as the permitting requirements, and optimal timing for sediment removal. This section provides a summary of the most recent dredging activity and outlines the likely sources of sediment, the frequency of maintenance dredging, and a summary of dredging alternatives.

Sediment accumulation in Murphey Candler Lake appears to be due primarily to stream bank erosion upstream of the Lake. The habitat conditions in North Fork Nancy Creek downstream of I-285 and upstream of Murphey Candler Lake are “poor” with exposed banks greater than 20 feet tall in places and evidence of active erosion. Project NC4-010 recommends restoration of this impacted section. Similarly, project NC4-008 recommends stabilization of an impacted segment of an unnamed tributary upstream of Murphey Candler Lake that is highly eroded. Implementation of these and other upstream projects reduces the rate of accumulation of sediments in Murphey Candler Lake.

Natural accumulation of sediment is expected in any lake. Routine dredging activities are typically recommended when 25 to 30 percent of the storage capacity is lost to sediment accumulation. The sediment accumulation rate is calculated at 1 acre-ft/ year based on the watershed model. Therefore, Murphey Candler Lake requires maintenance dredging every 30 to 40 years. Murphey Candler Lake was last dredged in 2002; therefore, these calculations suggest that the next dredging of Murphey Candler Lake should be planned between 2030 and 2040. Looking overall at Murphey Candler Lake, the area weighted average sediment accumulation represents approximately 16 percent of the total storage volume in the Lake. The overall accumulation is below the threshold for dredging but would reach the 25 percent threshold will be met in the next 10 years, which is 24 years since the previous dredging.

This dredging frequency is true if the sediment is distributed throughout the entire Lake. Visual evidence and sampling data show that the sediment is accumulating in the upper reaches and eastern cove, and not significantly impacting the storage levels in the remainder of the Lake. Looking at the data collected for the upper and lower portions of the Lake separately provides a different conclusion.

The sediment accumulation is the greatest in the northern portion of the Lake. If the analysis only looks at the upper portions of Murphey Candler Lake, sediment accumulation represents almost half of the total storage volume and therefore dredging is

recommended for the upper portions of the Lake. In the lower portion of the Lake, sediment accumulation is less than 10 percent of the storage volume.

Sediment removal, or dredging, is recommended within the next 10 years for the upper portion and eastern cove of this Lake. Sediment removal, or dredging, does not provide significant watershed-wide benefits but is an important maintenance responsibility for lake owners, which in this case is the City. Dredging requires a significant capital expense and requires years of time to properly plan, permit, contract, and finance. Although dredging is recommended, the timeline in Chapter 4 shows the dredging activities occurring in Years 5 to 10 to allow the City sufficient time to prepare for a successful outcome. If the City can secure the funding and permits earlier than this timeframe, there is justification to expedite this project.

This project will require a number of permits. The specific permits and the intensity of permitting are dependent on the sediment removal methods, proposed equipment, sediment disposal methods, and the quantity of sediment to be removed. Likely permits include a "404 permit" from the US Army Corps of Engineers, the associated Georgia 401 water quality certification, a Georgia stream buffer variance, and a City land disturbance permit. To reduce permitting costs, this Plan recommends removing accumulated sediments only to the original Lake design conditions. The dredging will not restore the pre-2002 water depth but rather remove sediment to the original lake bottom. Based on field depth measurements, historical information, and aerial GIS imagery, approximately 12,000 cubic yards of sediment from the northern coves and the eastern coves are recommended for removal.

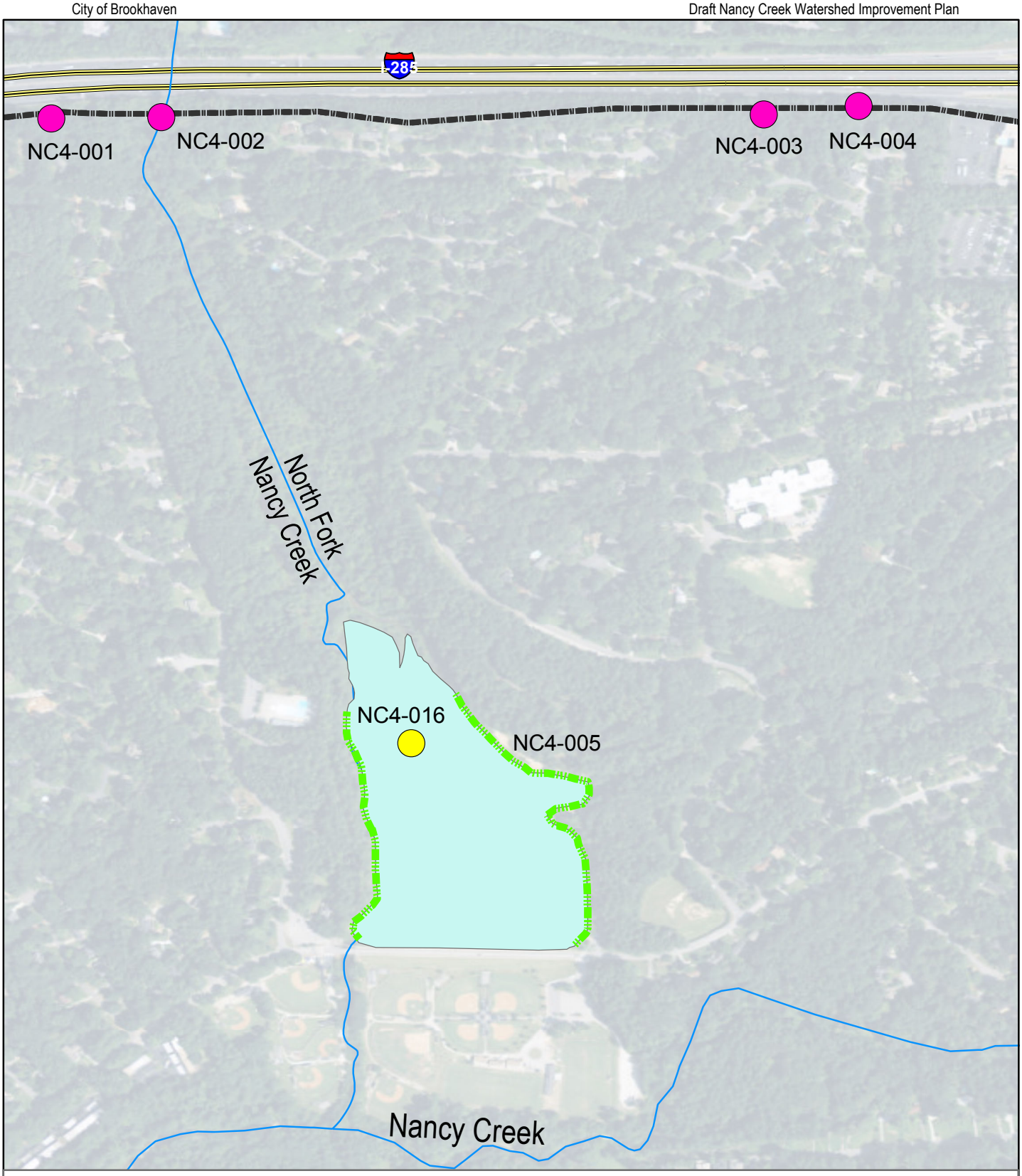
To reduce overall project costs, the removed sediment can be hauled and used in Lynwood Park to improve ball fields, consistent with the Park Specific Master Plan recommendations[xvi]. If needed, removed sediment may also be spread on Field 11 in Murphey Candler Park. The implementation plan in Chapter 4 presents additional information regarding the cost and schedule of this project as well as for the other recommended projects.

3.3.3.2. MURPHEY CANDLER LAKE SHORELINE RESTORATION

Overall, the shoreline conditions around Murphey Candler Lake are considered threatened to poor. As the property owner, the City expresses a strong interest in restoring the shoreline along the Lake. As part of this Plan, artistic renderings were created to show how areas of the shoreline could be stabilized to reduce sedimentation and provide a more aesthetically-pleasing park space. Figures 3-7 and 3-8 show the "before" and "after" artistic renderings for two areas where the Murphey Candler Lake shoreline is currently considered poor. These renderings reflect some conditions that are seen as important to the stakeholders and the City. The design of the shoreline restoration should consider typical design considerations as well as the following:

- **Plants:** Native vegetation is to be used. Attention should be paid to the variable water level which may leave vegetation on the banks periodically inundated when water levels fluctuate naturally. Attention should also be given to the change in sunlight conditions as the plants mature. The landscape contract should include a one-year warranty on new plants.
- **Erosion and Sediment Control:** Geotextile fabrics are critical to stabilizing the banks while the vegetation matures. Geotextile fabric should always be used when slopes are 3:1 or steeper. In most cases, the fabric should biodegrade over time, but should last long enough to keep the slopes stable while the vegetation matures. Landscaping fabric is essentially a weed barrier and is not appropriate. Always follow manufacturer's installation instructions, which typically recommend installing the fabric with overlapping seams. Use coir logs to help stabilize the banks. Coir logs can be planted with plugs of herbaceous vegetation.
- **Hardscaping:** Decorative walls should be made of granite consistent with others in Murphey Candler Park.
- **Soil:** The soil should be specified based on soil tests performed during design. Generally, construction grade dirt without amendments is not suitable for this application.
- **Access:** Access should be provided in limited locations along the shoreline.

Additional information on the care for newly planted buffer areas is located in the SOPs in Appendix D.



Recommended Projects
- Sediment Removal
- Trash Rack
- Shoreline Restoration
- Waterbody
- Streams
- Cities

N

0 0.03 0.06 0.12 0.18 0.24 Miles

Nancy Creek Watershed Improvement Plan

Figure 3-6: Recommended Murphey Candler Lake Projects

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Figure 3-7. Example Murphey Candler Lake Shoreline Restoration Renderings of "the Beach"

Figure 3-8. Example Murphey Candler Lake Shoreline Restoration Renderings of "the Pavillion"

3.4. FUTURE CONDITIONS MODEL RESULTS

The future conditions model builds on the baseline conditions WTM model results, described in Chapter 2, to predict the future conditions once the 43 recommended projects are implemented. The WTM model evaluates the pollutant load reductions (i.e., benefits) from the recommended watershed improvement projects for the whole Study Areas and within each subwatershed. This section presents the pollutant loading reductions for each subwatershed, for the study area, and by project type.

3.4.1. FUTURE CONDITIONS MODEL RESULTS

The recommended projects are grouped based on their projected pollutant removal capabilities into one of four categories; structural BMPs, trash racks, stream restoration, buffer restoration. Information on the data inputs, model assumptions, and model analysis is available in a Technical Memorandum[xvii].

Table 3-6 presents the percent reductions in annual pollutant loads for total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), fecal coliform, and runoff volume by subwatershed. Modeled reductions from the 43 proposed projects are also shown by project type in Figure 3-9.

Table 3-6. Future Conditions Model Pollutant Removal Reductions by Subwatershed

Subwatershed	Pollutant Removal Reduction (%)				
	TN	TP	TSS	Fecal Coliform	Runoff Volume
NC-4: North Fork Nancy Creek	13.9%	15.1%	15.8%	12.2%	7.1%
NC-5: Bubbling Creek	6.2%	6.0%	5.4%	5.2%	5.5%
NC-6: Perimeter Creek	7.8%	8.1%	9.8%	6.7%	6.5%
NC-7: Nancy Creek Mainstem	4.5%	5.2%	7.8%	4.1%	2.5%
NC-8: Silver Creek	1.2%	1.4%	3.7%	0.9%	1.0%
Study Area Total	5.7%	6.2%	7.9%	4.9%	3.7%

Figure 3-9. Future Conditions Model Pollutant Removal Reductions by Project Type

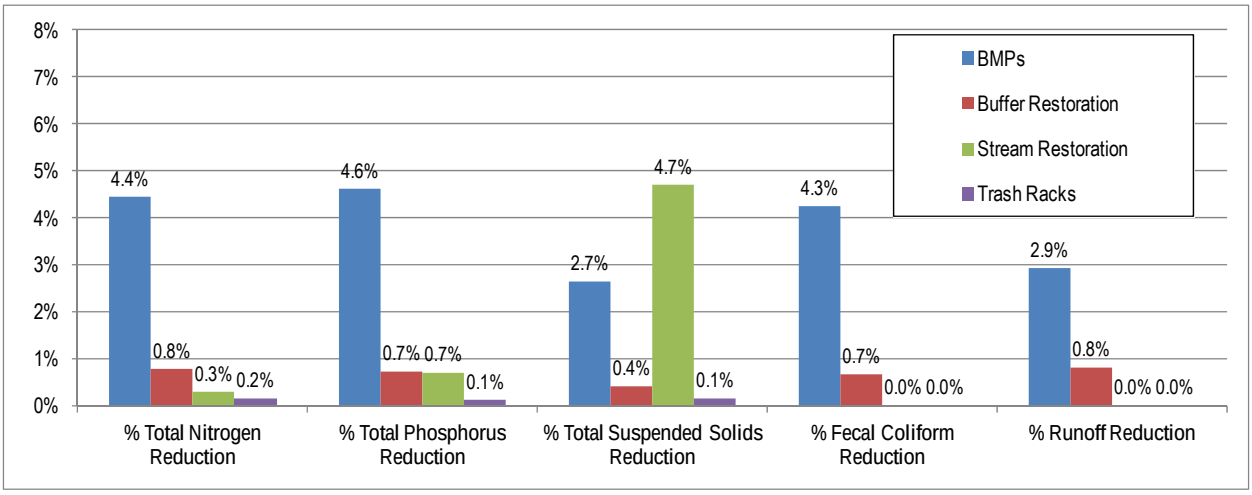


Table 3-6 shows that the 43 recommended projects are expected to reduce TSS loads by almost 8 percent, which is insufficient to meet the targeted 35 percent TSS reduction. Additional projects are needed in order to meet this goal. The recommended process to identify and evaluate additional projects is summarized in the following section.

Figure 3-9 indicates that stream restoration is most effective at reducing TSS loads. The load reductions for the other pollutants, however, are higher for structural BMP projects. Buffer restoration provides smaller pollutant load reductions and trash racks provide only nominal reductions for the modeled parameters. The relative load reductions influence the project ranking as described in Chapter 4.

3.5. IMPERVIOUS RETROFIT ASSESSMENT AREAS

The 43 identified projects are insufficient to meet the targeted TSS reduction of 35 percent but provide an important first step as they exemplify the range of control measures. Implementation of these projects will also demonstrate the value of control measures specific to Brookhaven. One of the challenges in Brookhaven is that there is a high percentage of unmanaged impervious cover that generates a higher volume runoff. There are also a limited number of BMPs that are appropriate within these densely developed areas. BMPs that manage and treat impervious cover reduce the upland sediment loads and reduce runoff flow rates. The result is less streambank erosion; therefore focusing on managing additional impervious area will help Brookhaven achieve progress toward the Plan's TSS goals.

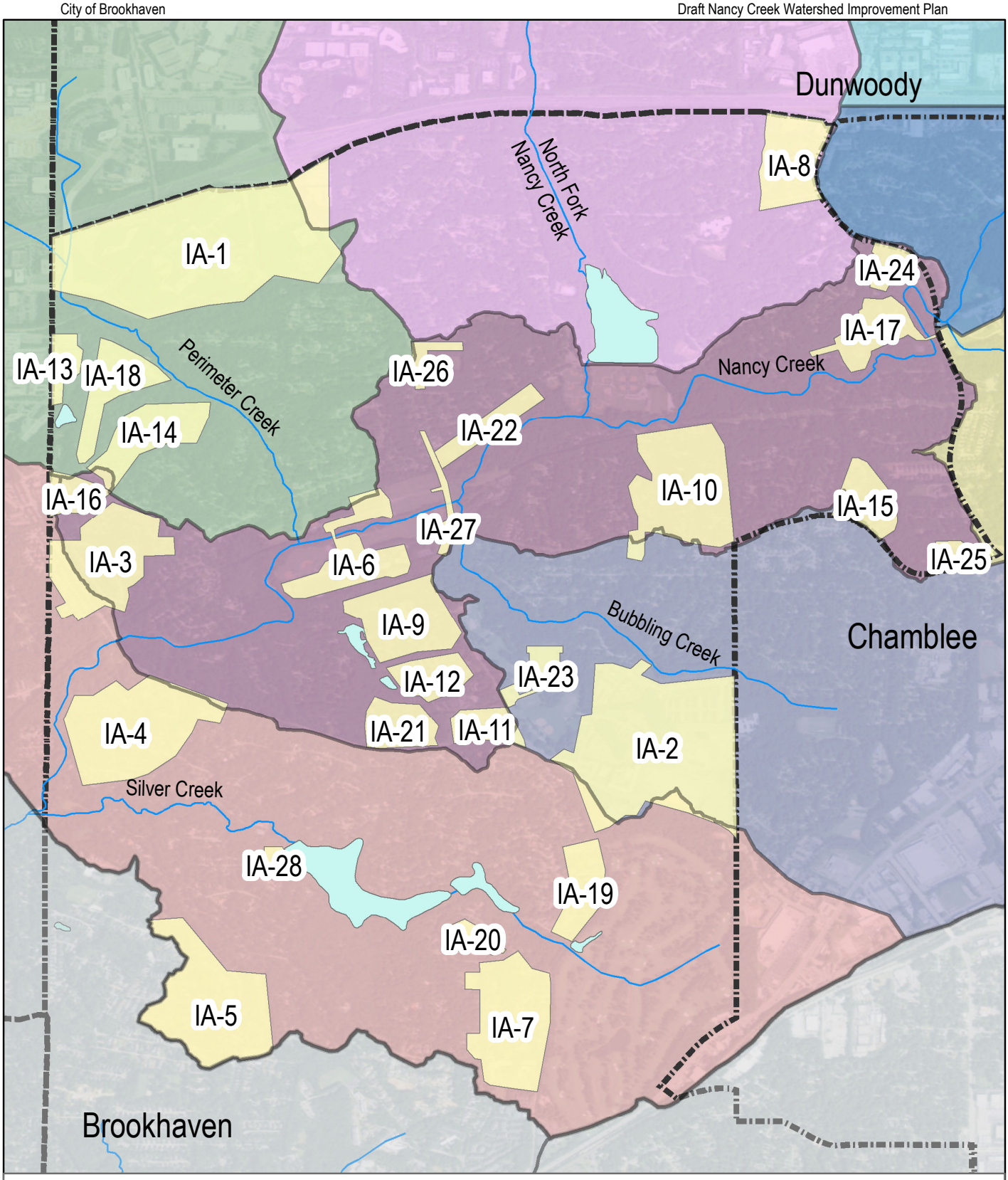
To meet the 35 percent TSS reduction goal, approximately 270 acres of currently unmanaged impervious cover needs to be treated by a new BMP. This acreage is estimated based on the TSS loading rates in the WTM model and a structural BMP TSS removal efficiency of 80 percent, consistent with the Georgia Stormwater Management Manual [xv]. An analysis of impervious cover mapping and aerial photography identified the areas with the most concentrated impervious cover within the Brookhaven portion of the Study Area. A more intense upland inventory assessment to identify stormwater retrofit opportunities is recommended for these concentrated impervious areas. Conceptual designs and further feasibility assessments may be part of these retrofit assessments; which will identify additional solutions for managing impervious area and reduce TSS loads. The solutions within the retrofit assessments will likely be similar to those within this Plan, such as bioretention areas, infiltration trenches and stormwater pond projects.

This Plan recommends 28 discrete retrofit assessment areas that will identify projects in addition to those listed in this Plan for implementation. These retrofit assessment areas are described by subwatershed in Table 3-7 and shown in Figure 3-10. Although described as individual areas in Table 3-7, these areas are grouped for implementation purposes in Chapter 4.

Table 3-7. Recommended Impervious Area Retrofit Assessments

Number	Total Area (acres)	Impervious Area (acres)	% Impervious Area	Unmanaged Impervious Area to Treat (acres)	Description
North Fork Nancy Creek (NC4)					
IA-8	22.8	9.1	39.8%	4.6	Northeast area of subwatershed with concentration of office and commercial land use.
Bubbling Creek (NC5)					
IA-2	98.5	36.9	37.4%	37	Upper reaches of the subwatershed within Brookhaven, south of Bubbling Creek. Includes a small area in NC-8 subwatershed. Second largest recommended retrofit assessment area.
IA-23	6.4	2.5	38.5%	0.1	Middle portion of the subwatershed and includes the commercial area near Blackburn Park. Impervious area to treat is low because of a recommended project in this area. If that project doesn't treat all of the runoff, additional projects would be needed.
Perimeter Creek (NC6)					
IA-1	123.3	50.2	40.8%	43	Largest area recommended for retrofit assessment. Located in the northwest corner of the City, bounded by I-285 and Perimeter Summit Boulevard.
IA-13	6.9	5.1	74.7%	5.2	Study area with the highest impervious area percentage. Located adjacent to Sandy Springs and includes the eastern portion of St. Joseph's Hospital.
IA-14	21.7	4.8	22.3%	4.9	Medium-density residential area located in the western portion of the subwatershed.
IA-18	17.8	4.2	23.5%	4.2	Medium-density residential area located in the western portion of the subwatershed.
Nancy Creek Mainstem (NC7)					
IA-3	39.1	14.5	37.2%	14.5	High density residential area located between S Johnson Ferry Road and Old Johnson Ferry Road.
IA-6	23.3	11.4	49.1%	11.4	Marist campus. Coordinate with ongoing school improvements and engage the active Environmental Sciences curriculum.
IA-9	28.1	7.9	28.0%	7.9	Area includes the Ashford Dunwoody YMCA complex and adjacent properties.
IA-10	47.0	7.8	16.5%	7.5	Residential area located south of Nancy Creek and North of Harts Mill Road.
IA-11	9.7	6.9	71.4%	6.9	Commercial area at the intersection of Ashford Dunwoody Road and Johnson Ferry Road.
IA-12	11.9	6.5	54.8%	6.5	Multi-family complex off Ashford Dunwoody Road south of YMCA and across from Blackburn Park.
IA-15	14.0	4.8	34.4%	4.3	Residential area located north of Harts Mill Road in the eastern portion of the subwatershed.
IA-16	8.2	4.7	56.8%	4.7	Commercial/ medical area off Old Johnson Ferry Road.
IA-17	16.0	4.5	27.9%	4.1	Located in the upper reaches of the watershed in the D'Youville residential community.
IA-21	13.4	2.8	20.9%	2.8	Residential area north of Johnson Ferry Road and west of Ashford Dunwoody Road.
IA-22	10.5	2.5	23.9%	2.5	Strip of impervious area along West Nancy Creek Drive to the east of Ashford Dunwoody Road.

Number	Total Area (acres)	Impervious Area (acres)	% Impervious Area	Unmanaged Impervious Area to Treat (acres)	Description
IA-24	5.0	2.3	45.9%	2.0	Located in the upper reaches of the subwatershed in a residential area off Chamblee Dunwoody Road north of Nancy Creek.
IA-25	5.4	2.1	39.0%	2.0	High density residential area at the intersection of Chamblee Dunwoody and Harts Mill Road.
IA-26	4.2	1.6	38.5%	0.8	Located along Ashford Dunwoody Road near and including Montgomery Elementary School. Integrate with educational opportunities.
IA-27	4.3	1.1	24.9%	1.1	Strip located along Ashford Dunwoody Road south of West Nancy Creek Drive. Coordinate with the ongoing Ashford Dunwoody Road corridor study and any recommended projects.
Silver Creek (NC8)					
IA-4	49.9	13.2	26.4%	13.2	Medium density residential area on both sides of Mill Creek to the south of Nancy Creek.
IA-5	49.9	12.6	25.2%	12.6	High density residential area bounded by Silver Lake Drive and Windsor Parkway and includes Lynwood Park. Coordinate study with planned park improvements.
IA-7	39.4	9.8	25.0%	9.8	Area bounded by Ashford Dunwoody Road and Lanier Drive NE and includes multi-family and institutional land uses.
IA-19	14.6	3.6	24.5%	3.6	Medium density residential area to the west of Ashford Dunwoody Road and north of Silver Creek.
IA-20	5.1	2.8	52.2%	0	Area surrounding the Our Lady the Assumption Catholic Church. Impervious area to treat is zero because of recommended project in this area. If that project doesn't treat all of the runoff, additional projects should be recommended.
IA-28	2.5	0.7	30.3	0.8	Area includes the Brittany Swim and Tennis Club, adjacent to Silver Lake.



Retrofit Assessments
NC-1
NC-2
NC-3
NC-4
NC-5
NC-6
NC-7
NC-8
Waterbody
Streams
Cities
Study Area

N

0 0.1 0.2 0.4 0.6 0.8 Miles

Nancy Creek Watershed Improvement Plan

Figure 3-10: Recommended Impervious Retrofit Assessment Areas

SWP&E
Sustainable Water Planning and Engineering, LLC

3.6 EXISTING WATERSHED PROGRAMS AND RECOMMENDATIONS

A number of ongoing Brookhaven programs and policies benefit the four stated goals of this Plan. These programs are expected to continue into the future and are outlined here as part of a comprehensive watershed program. Two new programs are recommended; regional collaboration and implementation tracking. Implementation enhancements are suggested for three of the existing City programs. Recommended enhancements fall within: enforcement of existing ordinances, public education and involvement, and city maintenance activities. The existing programs, with recommended enhancements, and the recommended new programs are described below.

3.6.1. ENFORCEMENT OF EXISTING ORDINANCES

The City enforces several ordinances that provide protection to the Nancy Creek Watershed. A summary of each of these ordinances is provided below.

- **Erosion and Sedimentation Control (Section 14-27 through 14-38).** Part of the larger Environment Control ordinance, the City requires land disturbance projects that are greater than 1 acre in size to be permitted and implement best practices to prevent the migration of sediment. Maintaining sediment on active land disturbance sites keeps it out of the Nancy Creek watershed.
- **Post-Development Stormwater Management (Section 14-27 through 14-38).** Part of the larger Environmental Control ordinance, the City requires projects that add or modify more than 5,000 square feet of impervious area to mitigate the stormwater quality and quantity impacts. The ordinance was expanded in March 2016 requiring single-family projects that add, modify, or construct more than 3,000 square feet of impervious area to manage the water quality volume. This ordinance, with amendments, follows the standards outlined in the Georgia Stormwater Management Manual. New development and redevelopment projects in the Nancy Creek watershed are required to construct stormwater controls designed to meet water quality standards and prevent future flooding. Property owners are also required to sign a maintenance agreement.
- **Stream Buffers (Section 14-44).** The stream buffer protection ordinance protects the riparian buffer during land disturbance activities. The protections include a 50-foot undisturbed buffer with an additional 25-foot impervious setback from the point of wrested vegetation on both sides of a stream. This buffer requirement aligns with the state 25-foot water quality buffer. Stream buffers play a critical role in the protection of stream health.
- **Tree Protection and Replacement (Section 14-39).** Revised in 2015, the Tree Protection and Replacement ordinance protects the existing tree canopy in Brookhaven and requires recompense for tree removal through onsite planting, offsite planting, or payment into a Tree Recompense Fund. The Tree Recompense Fund can be used to plant trees on public property and/or to promote healthy urban forests on public property. Permits are required for tree removal, providing additional protection to the stream buffer even if land is not disturbed.
- **Floodplain Management (Chapter 14, Article IV).** This ordinance establishes restrictions on land development and construction activities within known floodplain and floodway areas. The ordinance protects public health, safety, and well being but also benefits watershed health by preserving floodplains to mitigate stormwater flows during rain events.

These ordinances are consistent with the MNGWPD requirements and are considered to be protective of watershed health. These ordinances, or their equivalent, are also implemented in the other jurisdictions within the Study Area. Additional ordinances are not recommended at this time. The City should continue to implement these ordinances and ensure that staff and contractors are properly trained.

This Plan recommends one minor enhancement to the application of the Tree Recompense Fund within the Tree Protection and Replacement Ordinance. Currently, the ordinance allows the City Arborist to direct money that is paid into the recompense fund toward the “promotion of a healthy urban forest.” Invasive species were identified throughout the Brookhaven portion of the Study Area both in the riparian buffer and within City-owned parks. This Plan recommends using the accumulated funds to remove invasive species and re-vegetate to healthy forest densities. Directing these funds to riparian areas will benefit watershed health

without a direct expense to the City. A Standard Operating Procedure (SOP) has been developed as part of this project to guide the removal of invasive species and the replanting densities appropriate for riparian buffer areas. This SOP as well as two other related procedures is located in Appendix D.

3.6.2. PUBLIC EDUCATION AND OUTREACH AND PUBLIC INVOLVEMENT

Educating and engaging the public in the City's efforts to protect and restore the watershed is an important component of any watershed program. Currently, the City's focus has been on providing information through the City's website and engaging the community through events such as the stormdrain marking days and stream cleanup days on Nancy Creek. Future outreach opportunities and topics that complement these ongoing efforts are recommended below. The list below also includes references to example educational materials, most of which can be customized for the City's media formats.

- **Pick up pet waste.** Pet waste contributes to high levels of fecal coliform bacteria and is unsightly. Homeowners should pick up after their pets to protect water quality. The Atlanta Regional Commission's Clean Water Campaign has several brochures and text that can be used. http://www.cleanwatercampaign.com/Residents/pet-waste
- **Report sewer issues.** Alert homeowners to call DeKalb County if they see or smell wastewater at 770-270-6243.
- **Proper disposal of Fats, Oils, and Grease (FOG).** DeKalb County notes that FOG is the leading cause of sanitary sewer overflows. Homeowners should properly dispose of FOG in the kitchen to protect the health of streams and lakes in the Study Area. The Clean Water Campaign has brochures and text that can be used. http://www.cleanwatercampaign.com/docs/attention_fog.pdf
- **Properly dispose of yard debris.** Yard debris should not be dumped down the storm drain or in a stormwater drainage pathway. Property owners are responsible for their yard contractors and should confirm waste is disposed of properly. The Atlanta Regional Commission's Clean Water Campaign has helpful yard maintenance tips. http://www.cleanwatercampaign.com/Residents/lawn-and-yard-care
- **Maintain vegetated riparian buffer areas.** The Standard Operating Procedure (SOP) in Appendix D includes information on how to improve and expand riparian buffers.
- **Remove invasive species from yards.** The Standard Operating Procedure (SOP) in Appendix D includes information on how to identify and eradicate invasive species. Seeds from residential yards are carried by birds and wildlife to other parts of the city; therefore even properties that do not have riparian buffer can protect the buffer by removing invasive species.
- **Play safe.** Humans and pets should avoid contact with local waterbodies for three days following heavy rains. Fecal coliform levels are often highest following rain events, so this precaution is to avoid high levels that could result in illness.
- **Residential Rain Gardens.** Rain gardens allow stormwater to infiltrate instead of flowing into pipes and into streams and lakes. There are a number of guidance documents available online written for homeowners. Homeowners should consult a landscape architect or the local garden center for help with appropriate plant selection. http://dnr.wi.gov/topic/shorelandzoning/documents/rgmanual.pdf or http://www.cleanwateratlanta.org/environmentaleducation/reclaim.htm
- **Streambank stabilization for private property**. Several homeowners at the public meetings requested guidance on how to properly restore unstable streams on private property. There are several guidance documents online. One that was developed by EPD in 2000 is available online here: https://epd.georgia.gov/sites/epd.georgia.gov/files/related_files/site_page/Guidelines_Streambank_Restoration_GSWCC_Revised_2000.pdf

Another opportunity for community engagement is working with a school or community group to update the State of the Lake Report. The Murphey Candler Lake State of the Lake Report, in Appendix A, presents water quality data collected in summer 2015. Additional water quality data will improve the conclusions drawn about overall water quality in Murphey Candler Lake. The sampling procedures and equipment are appropriate for volunteer groups and/or high school students.

3.6.3. INFRASTRUCTURE INVENTORY AND CONDITION ASSESSMENT

The City is currently working on a five-year inventory and condition assessment to collect and update information on existing stormwater infrastructure, much of which is buried underground. When drainage systems fail, they can pose a threat to public safety such as a road collapse. Of lesser concern, inventory failures also often contribute excess sediment to local waterbodies, such as the drainage issue at Kittredge Magnet School (Figure 3-11) resulting from a clogged and damaged stormwater inlet.

Figure 3-11. Stormwater Drainage Issue Contributing TSS to the Study Area

Maintaining the network of pipes and stormwater structures is a challenge with Brookhaven's aging stormwater system. Following completion of the condition assessment, the City will prioritize and execute repairs on the oldest and most damaged portions of the system. Investing in infrastructure rehabilitation will protect the watershed as well as public health and safety. Funds for the projects recommended in this Plan will need to be balanced with the need for funding for infrastructure rehabilitation projects.

3.6.4. INSPECTION OF STORMWATER MANAGEMENT FACILITIES

As part of the City's MS4 permit, the City is inspecting 20 percent of known stormwater management facilities (both public and private) every year, such that every stormwater facility should be inspected once every 5 years. The City has initiated this inspection program and as maintenance issues are identified, the City will either schedule maintenance for City-owned facilities or alert the private property owner that they are responsible for the needed maintenance. Depending on the complexity of the maintenance, ownership, and availability of funds, it may take several years for a property owner to complete the necessary maintenance.

Based on the inspections performed as part of this study, about half of the ponds inspected required some sort of maintenance. Some ponds, 16 percent of those inspected, only required minor maintenance, which was typically vegetation maintenance. While proper maintenance will improve watershed conditions, many of the stormwater management facilities in the Nancy Creek watershed were designed prior to current stormwater management requirements. Even if these structures are well maintained, they are not likely to provide sufficient benefits to watershed health. Only four of the inspected structures are well maintained and designed in a manner consistent with current requirements. As a result, the WTM model did not account for pollutant reductions from the existing stormwater management facilities because they were generally not designed to modern standards and/or needed maintenance.

The inspection program is focused on ensuring existing facilities are appropriately maintained and overtime will provide some benefit to watershed health. Studies in specific portions of the watershed are described later in this Chapter that will evaluate opportunities to retrofit existing stormwater management facilities to maximize their effectiveness.

3.6.5. CITY MAINTENANCE ACTIVITIES

The City and its contractors are responsible for maintaining City-owned properties including two parks that are located within the Study Area: Murphey Candler Park and Blackburn Park. The City requested the development of three SOPs to guide maintenance activities in a manner that would protect the watershed. Working with City staff and the stakeholders group, the following three SOPs were identified:

- SOP #1. Performing Maintenance in an Established Vegetated Buffers;
- SOP #2. Removing Invasive Species from and Replanting the Vegetated Buffer; and
- SOP #3. Caring for Newly Established Riparian Buffers.

These SOPs are intended to guide work performed in and around riparian buffer areas within Brookhaven. While the target audience for these SOPs is City staff and/or their contractors, the practices outlined are appropriate for any property owner living along a waterbody. These SOPs are located in Appendix D.

3.6.6. REGIONAL WATERSHED COORDINATION

The Study Area includes portions of four jurisdictions in addition to Brookhaven. One of the intentions for this Plan was to cultivate a shared interest in the health of Nancy Creek and the Study Area through collaboration. Moving forward, this Plan suggests annual meetings to discuss the Nancy Creek Watershed with representatives from Brookhaven, Chamblee, Doraville, Dunwoody, and Sandy Springs. The annual meetings can provide an opportunity to share water quality data, discuss upcoming watershed projects, and explore potential regional funding sources.

3.6.7. IMPLEMENTATION TRACKING

This Plan recommends projects that will be implemented over the next 50 years, or more. The projects are identified based on current watershed conditions and expectations for the future. Tracking progress by collecting new data and revising this Plan is recommended every 10 years. New monitoring data and updated modeling can be used to measure the progress toward this Plan's goals.

In addition to updating the Plan every 10 years, it is important to continue reviewing the data collected by DeKalb County Watershed Management at the three sampling stations within the Study Area on an annual basis. This recommendation is consistent with the City's Impaired Waters Plan. If substantial changes are seen in the annual water quality data, the timing of the update to this Plan may be adjusted to reflect improved conditions or new pollutants of concern.

CHAPTER 4: IMPLEMENTATION PLAN

This Chapter presents the information needed to schedule and budget for the projects and studies recommended in this Plan. The information in this Chapter includes an overview of the methodology used to estimate planning level costs for the identified projects and studies as well as the ultimate estimated total costs for implementation (i.e., construction, maintenance, and long-term maintenance). A list of viable funding and financing sources is presented with a list of grants that are tailored to the recommended projects. This Chapter also presents the methodology developed to rank the projects presented in Chapter 3 to help prioritize implementation.

The implementation plan outlines the top projects based on the project ranking and public input anticipated for the first 10 years. Additionally, there is a short-term work plan that includes a greater level of detail for projects that suggested within the first 5 years. Ultimately, the City will adjust the timing based on funding and other City priorities.

4.1. IMPLEMENTATION COSTS

Planning level implementation costs are estimated for each of the recommended projects and studies identified in Chapter 3. The planning level costs are used to calculate the cost to benefit ratio, which is an important metric used to compare projects to each other. The basis for the planning level costs for both the 43 recommended projects and the 28 recommended retrofit assessments is described below. Planning level costs are helpful for long-range budgeting but are not the same as more detailed engineering costs that are developed based on a specific project design.

4.1.2. RECOMMENDED PROJECT COST ESTIMATION METHODOLOGY AND ASSUMPTIONS

The planning level costs include three components: construction costs, detailed study/ permitting/ engineering costs, and ongoing maintenance costs following construction. The construction costs are based on unit costs. The detailed study, permitting, engineering and the maintenance costs are calculated based on a percentage of the construction costs. Land acquisition costs are not estimated at this time as these are more appropriately calculated during a detailed study or design phase. However, land acquisition costs may be significant if a project is not on City-owned land or if an easement cannot be obtained. Contingency costs are not included due to the planning level nature of these estimates.

4.1.2.1. CAPITAL CONSTRUCTION COSTS

Unit costs for construction are based on actual and estimated construction costs from recent similar projects and from literature research. The costs for new and retrofit BMPs, trash racks, and stream enhancement projects are outlined below.

New and Retrofit Stormwater BMPs: Costs for new and retrofit stormwater BMPs are based on the land use and hydraulic soil group most dominant in the drainage area for that BMP, as shown in Table 4-1. The most dominant land use is based on the City's land use GIS information and the drainage basin served by that feature, delineated as part of this Plan. The hydraulic soil group reflects the most common soil within the project's drainage basin, using the NRCS soils data. The cost estimates assume the selected BMP is capable of removing 80 percent of the TSS pollutant load, consistent with the Georgia Stormwater Management Manual [xv], to support the 35 percent TSS load reduction goal for this Plan.

Table 4-1. Unit Costs for Capital Construction of New and Retrofit BMPs by Land Use and Soil Type

Land Use	Hydraulic Soil Group	Unit Cost per Acre of Impervious Area
Commercial Land Use	A or B	$60,000
	C or D	$90,000
Multi-Family and High Density Residential Land Use	A or B	$80,000
	C or D	$130,000
Medium Density Residential	A or B	$30,000
	C or D	$50,000
Roadway	A or B	$30,000
	C or D	$40,000

Notes:
All BMPs were assumed to remove 80% of the TSS pollutant loads consistent with the Georgia Stormwater Management Manual [xv].
The hydrologic soil group is based on the soil's runoff potential. They range from "A" which are typically sandy to "D" which includes clay. The most dominant soil type in the Brookhaven portion of the Study Area is type "B".

The unit costs are the highest for commercial and multifamily land uses due to the high potential for physical constraints (e.g., small pervious areas) which typically forces more expensive BMPs (often underground). Unit costs for areas dominated by C or D soil types are also relatively more expensive as these more clay-like soils have limited infiltration capacity.

Trash Racks: A capital cost of $50,000 per trash rack is assigned to each proposed trash rack based on previous professional experience.

Stream-Related Projects: Stream-related projects include stream restoration, stream stabilization, shoreline restoration, and buffer restoration projects. The unit costs, presented in Table 4-2, are based on recent project experience per linear or square foot of restoration. There is a great deal of variation in the intensity (and cost) of stream restoration projects, therefore the definitions below are provided to add clarity to the unit costs used for this Plan.

- Stream restoration costs are based on typical costs for rehabilitation of urban streams, including reconstructing channels, stabilizing slopes, implementing controls to maintain or restore floodplain connectivity.
- Shoreline restoration costs are based on typical costs for intensive shoreline restoration, including stabilization of existing shoreline soils, soft armoring with planting (native shrubs and trees) and seeding, and some hard armoring including rip rap or stone blocks.
- Buffer restoration costs are based on typical costs for buffer restoration including site preparation (e.g., removal of downed trees, removal of invasive species) and planting (native trees, shrubs and grasses).

Table 4-2. Unit Costs for Capital Construction of Stream-Related Projects

Restoration Type	Unit Cost
Stream Restoration	$200 / linear foot
Streambank Restoration	$200 / linear foot
Shoreline Restoration	$6 / square foot
Buffer Restoration	$1.50 / square foot

4.1.2.2. DETAILED STUDY, ENGINEERING AND PERMITTING COSTS

The projects outlined in this Plan are presented at a conceptual level and will need to be designed and permitted before they can be constructed. While the capital construction cost is usually much larger than engineering and permitting costs, all costs are important when planning and budgeting. These costs may include a detailed site assessment (i.e., survey), engineering design, and project permitting analysis or documentation. Study, engineering, and permitting costs are assumed to be approximately 25% of the capital construction cost for all project types.

4.1.2.3. PLANNING LEVEL ANNUAL OPERATIONS AND MAINTENANCE COSTS

The stakeholders stressed the importance of maintenance and a proper maintenance plan prior to construction of any new stormwater controls. Therefore, the future annual operations and maintenance (O&M) costs are estimated for each type of proposed structural management measures. Table 4-3 shows the planning level O&M costs as a percentage of the capital construction cost. The annual maintenance costs are simply the capital construction cost multiplied by the percentage factor in Table 4-3 based on the type of project and professional experience.

Table 4-3. Basis for Planning Level Operation and Maintenance Costs by Project Type

Structural Management Measure Type	Percent of Construction Cost Applied to Determine O&M Cost
Structural BMPs (new and retrofit)	5%
Trash Racks	3%
Stream Restoration (stream restoration, stream stabilization)	2%
Shoreline Restoration	5%
Buffer Restoration	3%

4.1.2.4. TOTAL ANNUALIZED COSTS FOR PROPOSED PROJECTS

The total annualized cost is calculated as an input for determining the cost effectiveness, one of the ranking criteria described in the next section. The total annualized cost is the sum of the total annual maintenance cost (Section 4.1.2.3) and the total annualized fixed costs. The fixed costs include construction (Section 4.1.2.1), study (5 percent), and permitting and engineering cost (Section 4.1.2.2). The fixed costs were annualized assuming an annual interest rate of four percent over an assumed loan period of 25 years. The costs are annualized to facilitate the relative comparison of different projects.

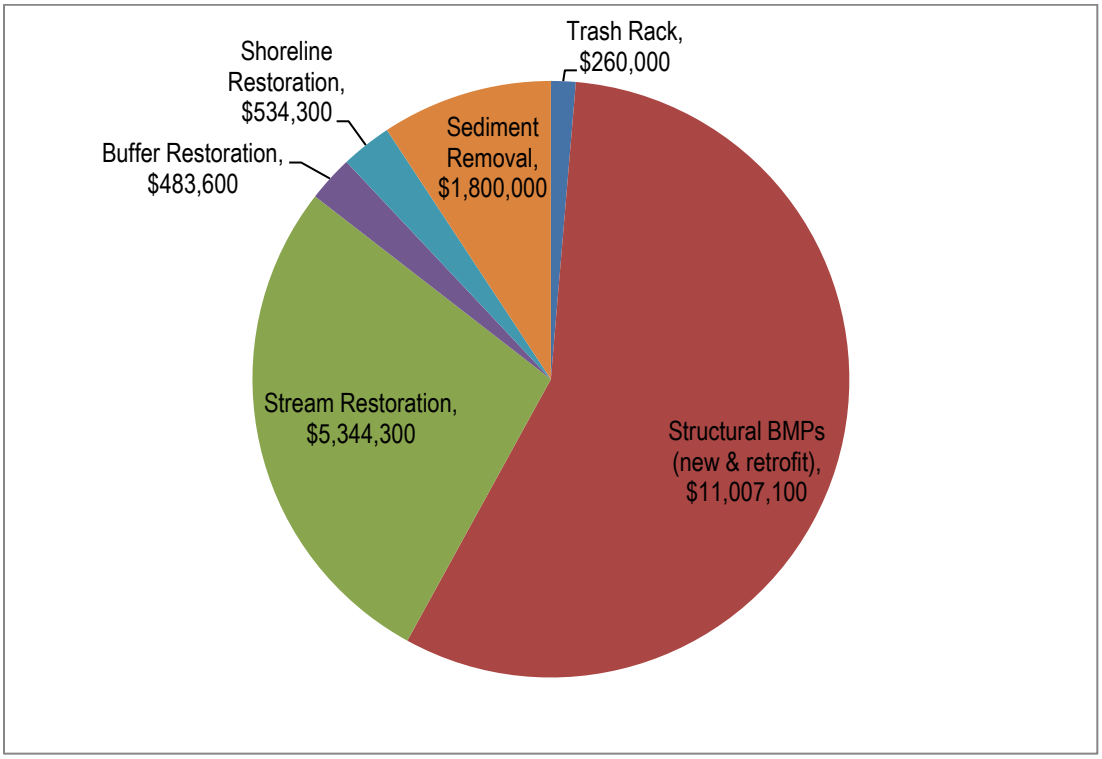
4.1.2. PLANNING LEVEL COSTS FOR THE RECOMMENDED PROJECTS

The planning level costs are estimated for the 43 recommended projects following the methodology above. The total fixed cost (capital construction, planning, design, and permitting) associated with the recommended projects is $19.4 million. Table 4-4 shows the distribution of the type of projects and the total fixed cost for those projects. Structural BMPs, both new and retrofit, represent the largest fixed cost with 57 percent of the planned expenditures but there are also significantly more BMPs recommended then other projects. Stream restoration accounts for the second highest total fixed cost with more than 25 percent of the planning level costs.

Table 4-4. Summary of Total Fixed Cost by Project Type

Project Type	# Recommended Projects	Total Fixed Cost	% of Total Cost
Trash Rack	4	$260,000	1%
Structural BMPs (New and Retrofit)	21	$11,007,000	57%
Stream Restoration	12	$5,344,000	28%
Buffer Restoration	4	$484,000	2%
Shoreline Restoration	1	$534,000	3%
Sediment Removal	1	$1,800,000	9%
Total	**43**	**$19,429,000**	**100%**

Figure 4-1. Total Fixed Cost by Project Type



4.1.3. RECOMMENDED RETROFIT ASSESSMENT COST ESTIMATION METHODOLOGY AND ASSUMPTIONS

The costs to complete the retrofit assessments are estimated by calculating 5 percent of potential implementation costs based on unit costs per impervious acre for Brookhaven's dominant land use (medium density residential) and soil type (hydrologic soil group B), which is $30,000 per impervious acre as shown in Table 4-1. These costs are based on the impervious area to be treated and not based on the total impervious area for each recommended assessment area.

Based on the methodology presented above, the estimated planning-level cost to complete a retrofit assessment for approximate 270 acres of impervious area in Brookhaven is $327,000.These assessments will identify additional projects to treat runoff from unmanaged impervious area. The individual study areas are presented in Table 4-5 by subwatershed, as it will be more cost effective to complete the assessments in groups. The Nancy Creek Mainstem subwatershed (NC-7) is subdivided into two groups, upper and lower, due to the shape of the watershed and the acreage recommended for assessments.

The implementation costs of potential projects that will be identified in the retrofit assessments is estimated in order to quantify the magnitude of future funding needed to meet the Plan's goals. The methodology used to calculate the total fixed costs to implement projects identified in the retrofit assessments is the same methodology for calculating BMP costs. The costs include capital costs, detailed studies, and engineering and permitting costs. Implementation costs do not include long-term operations and maintenance funding estimates. The total estimated implementation cost for these projects is approximately $21.5 million. The estimated cost for the projects recommended by the future assessments is gross and is only intended for planning purposes.

Table 4-5. Summary of Impervious Area Retrofit Assessment Costs by Subwatershed

Subwatershed	IA Study Areas Included	Planning Level Retrofit Assessment Cost
NC-4	IA-8	$7,000
NC-5	IA-5, IA-23	$55,000
NC-6	IA-1, IA-13, IA-14, IA-18	$86,000
NC-7 Upper	IA-10, IA-15, IA-17, IA-22, IA-24, IA-25, IA-26, IA-27	$37,000
NC-7 Lower	IA-3, IA-6, IA-9, IA-11, IA-12, IA-16, IA-21	$82,000
NC-8	IA-4, IA-5, IA-7, IA-19, IA-20, IA-28	$60,000
	TOTAL	$327,000

4.2. GRANT FUNDING AND FINANCING

Paying for the recommended projects is an important component of any implementation plan. This Plan recommends $19.8 million in project implementation ($19.4) and retrofit assessments ($0.4) that will likely double the overall Plan implementation costs. The projects in this Plan represent a significant investment for Brookhaven. This section outlines a number of applicable grant funding sources and also outlines some options for funding and financing the implementation of this Plan.

4.2.1. GRANT FUNDING

The City of Brookhaven is interested in using grant funds to accelerate project implementation. Increasing the City's competitiveness for grant funding was an original driver for the development of this Plan.

A literature search was conducted to target local and federal grant funds that matched the projects recommended in this Plan. All of the grant funding opportunities are competitive and typically require some local match contribution. The grants listed below include those where the City must be the applicant but also include options for non-profit entities and private land owners, as some of the recommended projects are on non-City owned land. This is not an exhaustive list of grants and it is important to note that the project priorities for most grants change from year to year. The identified grant sources have been tied to the most eligible projects recommended in this Plan based on the current grant criteria. It is important to talk with each grant agency prior to completing an application.

319(h) Grants: Federal funding source managed by Georgia EPD[xviii]. This is a competitive grant that award up to 60 percent federal share with a 40 percent local match. The maximum grant award is currently $400,000. Additional points are awarded for

implementing a project identified in a watershed improvement plan and providing more than a 40 percent local match. Projects are not likely to be funded unless they directly address an impaired water from the state's list. The City must be the applicant but may partner with other entities. The application deadline is typically in November with a pre-application meeting required before September. The 319(h) grants are best suited for the recommended projects along Nancy Creek that address sediment loads and habitat impairment. Eligible projects include: NC5-002, NC5-003, NC7-001, NC7-002, NC7-003, NC7-004, NC7-005, NC7-006, NC7-007 and NC8-005.

Five Star & Urban Water Restoration Program: The National Fish and Wildlife Foundation offers competitive grants with a 50 percent local match required. Grant funding is a mix of private and federal funds. Awards are small, typically $30,000[xix]. The project must meet five specific criteria: on-the-ground restoration, minimum of 5 community partners, environmental outreach, measurable results, and sustainability. A city or a 501(c) can apply. Grants are typically due in February. Most of the projects in this Plan are eligible if the partners are identified. This is a good funding source for the lower cost projects tied to schools as there are a number of logical partners. Possible projects include: NC4-007, NC4-011, NC4-012, NC4-013, NC4-014, NC7-002, NC7-003, NC7-004, and NC8-002.

Captain Planet Foundation Small Grant and Eco-Tech Program Grant: Competitive grant programs for schools with an annual operating budget less than $3 million[xx]. Preference is given to applicants with matching funds up to 50 percent. The Small Grant Program offers $500 to $2,500 for student-based projects that improve the environment. Typically the Small Grants are due in September. The Eco-Tech grant awards $2,500 to schools or non-profit organizations to engage children in STEM fields (Science, Technology, Engineering, and Math) that use innovation or nature-based designs, or use new technology. The EcoTech Grant Program applications are typically due in March. DeKalb County School System's operating budget is too high; however, the project recommended for Our Lady of the Assumption Catholic Church (NC8-002) may be eligible.

To support implementation, the projects that were deemed the most eligible for grant funding are described in Table 4-6. The table identifies the project, describes the projects, the funding source, and highlights how the project meets the grant eligibility criteria.

Table 4-6. Grant Funding Sources and Potential Project Eligibility

Project Number	Project Description	Grant and Eligibility Summary
NC7-002	Stream Restoration of North Fork Nancy Creek from the spillway to confluence with Nancy Creek.	319(h) grant eligible project. Reduces sediment load into Nancy Creek to address fish biota impairment. The City met with EPD on this project in 2015. Recommend offering a 50 percent local match to receive higher points than the minimum 40 percent match.
NC7-006	Stream Restoration of Nancy Creek from Murphey Candler Park to Ashford Dunwoody.	319(h) grant eligible project. Reduces sediment load in Nancy Creek to address fish biota impairment. This project extends the benefit from NC7-002. Recommend a 50 percent local match.
NC4-008	Channel restoration and drainage improvements at Kittredge Magnet School to address erosion and sedimentation upstream of Murphey Candler Lake.	Five Star & Urban Waters Restoration Program grant eligible. Partners include DeKalb County Schools, Kittredge, Murphey Candler Park Conservancy, Brookhaven, and the PTA. Students could calculate volume of eroded sediment and assist with planting and post-construction monitoring.
NC8-002	Opportunities to integrate one or more bioretention facilities at the Our Lady of the Assumption Catholic Church and School. Can be integrated into science curriculum.	Captain Planet, either small grant or eco-tech program. Students can assist with planning and design and monitor plant health. Grant could support funding of one small BMP.

Although not tied to a specific project recommended in this Plan, the Georgia Department of Natural Resources (DNR) has a Recreational Trails Program (RTP) grant[xxi] that will fund project s that add and/or maintain outdoor recreational facilities. These funds could be used to accelerate the removal of invasive species along the trail at Murphey Candler Park or used to fund creation of the planned trail along Nancy Creek in Murphey Candler Park. The grant requires a 20 percent local match and will fund projects with total costs between $32,000 and $125,000.

The US Army Corps of Engineers (Corps) also can participate in funding local projects but their participation typically requires a Congressional authorization and a subsequent appropriation. An authorization is direction from Congress on policies and priorities the Corps should pursue. Often this happens through the Water Resource Development Act (WRDA) bill or more recently the Water Resources Reform and Development Act of 2014[xxii]. WRDA bills' do not provide funds to conduct activities. Potential projects for study or construction are submitted by the Corps annually to Congress in February and are considered for inclusion in the next Congressional Authorization. Once the funds are authorized, they must also be appropriated. Federal funding appropriations are provided in the annual Energy and Water Development Appropriations Act or other appropriation acts. The appropriations must be made for both the planning phase funding and the construction phase funding. There are a number of different continuing authorizations that could be use if funds were appropriated and authorized. The most applicable to the projects recommended in this Plan is the Section 206 ecosystem restoration program. Per conversations with regional Corps representatives, there are no appropriated funds for Section 206 however there are funds appropriated to Section 219 for Water Infrastructure Projects. While there are no strong matches with projects recommended within this Plan and this funding source, these funds may be able to offset planned expenditures for other infrastructure projects that will help with implementation of this Plan. There is also an opportunity for the City to work with Congress to get an appropriation and authorization in the future. While these opportunities take time to mature, the regional scope of this Plan increases the opportunity and access to such funds.

4.2.2. FUNDING AND FINANCING OPTIONS

While grants can leverage existing funding sources and accelerate Plan implementation, grants will need to be combined with other funding and financing alternatives. The main source of funding for implementation of recommended projects is expected to be the City's existing stormwater utility. Property owners in Brookhaven pay a monthly fee that is based on their impervious area that is placed into an enterprise fund dedicated to stormwater management. Any of the projects identified in this Plan could be implemented with stormwater utility funds. It is important to note, however that there is competition for these funds with other stormwater priorities including infrastructure rehabilitation, flood mitigation projects in other watersheds, and watershed improvement projects in other watersheds.

Stormwater Utility Fee: Brookhaven has a Stormwater Utility Fee that collects approximately $2.6M annually. This fee funds salaries, operating expenses, regulatory compliance, and infrastructure rehabilitation. The stormwater utility is an enterprise fund and there are restrictions on the type of projects that can be funded with this revenue stream. All of the recommended projects and assessments identified in this Plan, if allocated, can be funded with the stormwater fee; however there is competition for funds with other stormwater infrastructure projects.

Based on a review of the stormwater utility budget, the short-term work plan presented later in this Plan assumes that approximately $250,000 per year will be allocated for Plan implementation. The initial projects identified in this Plan represent approximately $14M in capital projects. At a rate of $250,000 per year, it would take 56 years to implement all of the recommendations. This timeline does not account for the O&M costs that accrue after a project is completed or the projects that will be recommended in the retrofit assessment studies. These additional costs will extend the implementation timeframe at the planned rate of investment.

Additional sources of funding are needed. Other funding and financing mechanisms can be used in combination with the stormwater utility fee to accelerate implementation. The City could also consider increasing the current fee of $4 per month for the average single-family household (3,000 square feet of impervious area). Currently, stormwater utility fees in Georgia range from $1.05 per month in Fayette County to $8.00 per month in Holly Springs, both for 3,000 square feet of impervious area.

Brookhaven, as well as communities across Georgia, may need to pay higher stormwater fees in order to meet state water quality standards and restore impacted streams.

SPLOST: A Special Purpose Local Options Sales Tax (SPLOST) is another possible source of funds for Plan implementation. In Georgia, a county may propose an additional 1-cent sales tax to raise funds for public works projects. There are a number of important restrictions and requirements for a SPLOST to be legal in Georgia, one of which is that passage requires a voter referendum. DeKalb County is currently proposing a SPLOST that will be included on the November 2016 ballot. If Brookhaven participates in the SPLOST, they will receive funds for specified projects passed as part of the SPLOST. All of the projects recommended in this Plan would be eligible for SPLOST funding.

In addition to more common funding sources, the City can explore opportunities to leverage private investments in the watershed. Examples of public-private partnership concepts are below.

Encouraging private property owners to install BMPs: The stormwater utility ordinance outlines the City's credit policy, which provides credit to developed lands that have implemented practices to reduce their stormwater contributions to the City's system. The BMPs must be designed and installed in a manner consistent with the Georgia Stormwater Management Manual. As outlined in Chapter 2, there are very few BMPs in the watershed that would be eligible for a credit as outlined in the ordinance. Several of the projects recommended in this Plan are located on private property. In some cases, it may be cost-beneficial for the property owner to install a recommended stormwater BMP and then receive the credit on their monthly stormwater fee. This is likely true for commercial properties which generally have large areas of impervious cover. In some cases, the payback period for the construction of the BMP and corresponding reduction in the stormwater fees may encourage private property owners to construct BMPs that benefit the watershed.

Restoring Urban Forests with the City's Tree Recompense Fund: The City's Tree Preservation and Replacement Ordinance allows developers to pay a fee into the City's Tree Recompense Fund if they cannot identify appropriate planting sites. By ordinance, the tree recompense fund may be used to purchase and install trees on city-owned land, maintain city trees, or promote a healthy urban forest. Several of the recommended projects include the removal of invasive species in riparian buffer areas and the replanting to achieve healthy forest densities. The City could choose to direct the tree recompense funds to the removal of invasive species in the City parks and along the Nancy Creek watershed and then direct recompense trees in subsequent years to fill voids and achieve healthy riparian canopies. Leveraging these private funds in this manner will accelerate implementation of this Plan.

4.2.2.1. FINANCING

Financing is another mechanism to accelerate implementation of this Plan. Low-interest loans and revenue bonds are commonly used by municipalities to expedite completion of public works projects. As with any loan, the principal loan amount plus interest will be paid over time. The payment terms can often be negotiated based on the type of project and funds available.

Clean Water State Revolving Fund Loans[xxiii]: The Georgia Environmental Finance Authority (GEFA) administers the Federal Clean Water State Revolving Fund (SRF) loan in Georgia. Stormwater projects are eligible. There are a number of eligibility requirements but several key provisions include; must be a qualified local government in good standing, must have an active service delivery strategy, and must be in compliance with the MNGWPD Plan as demonstrated through an audit. The interest rates based on the payment terms are presented in Table 4-7. In addition there is a 1 percent closing fee on all loans.

Table 4-7. May 2016 GEFA Loan Program Interest Rates

Timeframe	5 year	10 year	15 year	20 year	25 year	30 year	Maximum Loan
Clean Water SRF	0.50%	0.94%	1.50%	2.09%	2.46%	2.72%	$25,000,000

As an example, if the City wanted to expedite $2,000,000 of the capital projects identified in this Plan with a 10 year loan; the City would pay $210,000 per year for the 10 year period plus the $20,000 closing fee. The debt service on the loan would represent the majority of the budget available for stormwater projects for the subsequent 10 year period.

General Obligation Bonds: General obligation bonds can be issued by the City and are backed by the City's taxing power. Georgia places a number of restrictions on the issuance of general obligation bonds including the positive outcome of a referendum. Additionally, the debt may not exceed 10 percent of the total assessed value of property subject to taxation in the City. Issuing a General Obligation bond exclusively for the implementation of projects recommended in this Plan would be more time consuming and no less costly than the loan alternative above. If the City is considering a General Obligation Bond for another public purpose; adding some of the projects from this Plan to the bond may present a more cost-effective alternative as closing fees would be paid for or shared with the other public purpose.

4.3. PROJECT RANKING METHODOLOGY

Given the financial commitment associated with the recommended projects, the implementation plan is phased. A 100 point scoring system is used in order to guide the implementation order of the 43 recommended projects presented in Chapter 3. The ranking methodology results in an initial project list that will be reviewed and adjusted for the recommended implementation plan.

There are four main ranking criteria: pollutant removal, cost benefit, ease of implementation, and additional benefits. All of these except cost benefit include sub-criteria, as listed in Table 4-8. These criteria were guided by a series of discussions with the city staff and the stakeholders. The ranking scores were assigned based on available GIS data and from observations made during field visits. This evaluation establishes the relative importance of each project within the City which informs the implementation schedule presented later in this Chapter.

Table 4-8. Ranking Criteria for Watershed Improvement Projects

Ranking Criteria	Sub-Criteria	Sub-Criteria Description	Point Range
Pollutant Removal (30 points)	TSS Removal	Important study goal and received most points. Relative scores ranged from 1 to 10 points for each pollutant based on a linear distribution for the pollutant reduction calculated by the WTM future conditions model results.	1 – 10
	Phosphorus Removal		1 – 10
	Nitrogen Removal		1 – 10
Cost Benefit (Planning Level Cost / TSS Reduction) (25 points)		Planning level costs were calculated as described in the previous section. The annualized planning level costs divided by the annual TSS removal (lb/year) estimated from the WTM models. The points were distributed linearly from 1 – 25.	1 – 25
Ease of Implementation (25 points)	Total Project Cost (design, permitting, construction)	Total project cost less than $250,000 Total project cost greater than $250,000 and less than $500,000 Total project cost greater than $500,000	5 2.5 0
	Ownership	City-owned property (5 points) Ownership is blended (another public entity or public/ private mix. Easement agreements or acquisition needed (2.5 points) Privately-owned property (0 points).	10 5 0
	Maintenance Burden	Low relative maintenance burden (5 points) Moderate maintenance burden (2.5 points) High maintenance burden (0 points)	5 2.5 0
	Potential Permitting Requirements	Minimal to no permitting required (5 points) Some permitting likely/ max be complex (2.5 points) Complicated permitting likely (0 points)	5 2.5 0

Ranking Criteria	Sub-Criteria	Sub-Criteria Description	Point Range
	Visibility to Community	Site is located in a high visibility area (10 points) Site is less visible but benefits are highly visible (7.5 points) Site is located in a moderate visibility area (5 points) Site is less visible but benefits are moderately visible (2.5 points) Site is located in a low visibility area (0 points)	10 7.5 5 2.5 0
	Wildlife Diversity Benefits	Provides strong wildlife diversity and migration opportunities (5 points) Somewhat improves wildlife diversity (2.5 points) Provides little to no enhancement in wildlife diversity (0 points)	5 2.5 0
Additional Benefits (20 points)	Compatibility with City Plans	Associated with planned or recommended projects (5 points) Could be tied to a planned project or study (2.5 points) Not related to a planned projects or study (0 points)	5 2.5 0

The 28 impervious area retrofit assessments are not ranked and are anticipated to be completed as the opportunity arises. For example, if there is a planned City project or a redevelopment project near a recommended study area the City may choose to simultaneously perform the retrofit assessments identified in that subwatershed. Similarly, if a stream restoration project is planned then a retrofit assessment for the subwatershed could be paired with the restoration to identify additional controls to protect the stream restoration project.

4.4 INITIAL PROJECT RANKING

The initial project ranking is presented in Table 4-9, using the ranking methodology described above. The initial ranking is intended to give general guidance for the implementation of projects and is not intended to be rigid. For example, with stream restoration projects it is typically best to start upstream and move downstream. Some project prioritization adjustments are recommended in the short-term work plan based on City interests or to improve the project sequence.

Table 4-9. Initial Project Ranking Based on Ranking Criteria

Rank	Project Number	Project Type	Pollutant Removal			Cost Benefit	Ease of Implementation				Additional Benefits			Total Score
			TSS	TP	N		Cost	Ownership	Maintenance	Permitting	Visibility	Wildlife	Compatibility	
1	NC4-006	New BMP	3	6	7	16	5	10	5	5	7.5	0	5	69.5
2	NC4-012	New BMP	3	7	7	16	5	10	5	5	5	0	2.5	65.5
3	NC4-013	New BMP	2	3	4	16	5	10	5	5	7.5	0	5	62.5
4	NC5-002	New BMP	4	10	10	3	0	10	5	5	10	0	5	62
5	NC4-010	Stream Restoration	10	3	1	25	0	5	2.5	0	7.5	5	0	59
6	NC4-011	New BMP	1	1	1	16	5	10	5	5	7.5	0	5	56.5
7	NC7-003	Buffer Restoration	3	7	7	16	5	0	2.5	2.5	5	5	0	53
8	NC4-008	Stream Restoration	3	1	1	25	5	5	2.5	2.5	2.5	5	0	52.5
9	NC7-002	Stream Restoration	2	1	1	12	5	10	2.5	0	10	5	2.5	51
10	NC7-006	Stream Restoration	9	2	1	12	0	5	2.5	0	7.5	5	5	49
11	NC7-004	New BMP	2	4	4	11	5	2.5	2.5	5	5	0	0	41
12	NC6-007	New BMP	1	2	2	16	5	0	5	5	2.5	2.5	0	41
13	NC4-005	Shoreline Restoration	1	1	2	1	0	10	5	2.5	10	2.5	5	40
14	NC6-004	New BMP	4	10	10	6	0	0	5	5	0	0	0	14
15	NC7-007	New BMP	5	10	8	2	0	0	2.5	5	0	5	2.5	40
16	NC6-009	Stream Restoration	3	1	1	17	5	0	2.5	0	5	5	0	39.5
17	NC4-001	Trash Rack	1	1	1	9	5	5	0	5	7.5	2.5	2.5	39.5
18	NC4-002	Trash Rack	1	1	1	9	5	5	0	5	7.5	2.5	2.5	39.5
19	NC4-003	Trash Rack	1	1	1	9	5	5	0	5	7.5	2.5	2.5	39.5
20	NC4-004	Trash Rack	1	1	1	9	5	5	0	5	7.5	2.5	2.5	39.5
21	NC6-001	Stream Restoration	5	1	1	17	2.5	5	2.5	0	0	5	0	39
22	NC6-002	Stream Stabilization	4	1	1	17	2.5	5	2.5	0	2.5	2.5	0	38
23	NC8-004	Stream Restoration	3	1	1	15	5	0	2.5	0	2.5	5	2.5	37.5
24	NC8-005	Stream Restoration	9	2	1	15	0	0	2.5	0	2.5	5	0	37
25	NC4-007	New BMP	1	1	1	9	5	5	5	5	5	0	0	37
26	NC8-002	New BMP	2	3	3	11	5	0	5	5	2.5	0	0	36.5
27	NC4-015	New BMP	2	4	3	2	0	10	2.5	0	2.5	5	5	36
28	NC4-017	New BMP	2	4	3	2	0	10	2.5	0	2.5	5	5	36
29	NC6-008	New BMP	1	2	2	16	5	0	2.5	5	0	2.5	0	36
30	NC7-001	Buffer	4	4	3	12	2.5	0	2.5	2.5	2.5	2.5	0	35.5

Rank	Project Number	Project Type	Pollutant Removal			Cost Benefit	Ease of Implementation				Additional Benefits			Total Score
			TSS	TP	N		Cost	Ownership	Maintenance	Permitting	Visibility	Wildlife	Compatibility	
		Restoration												
31	NC4-014	New BMP	1	2	2	10	5	5	2.5	5	2.5	0	0	35
32	NC4-018	New BMP	2	3	2	2	0	10	2.5	0	2.5	5	5	34
33	NC4-016	Sediment Removal	1	1	1	1	0	10	5	0	10	0	5	34
34	NC6-003	New BMP	2	5	5	6	2.5	0	5	5	2.5	0	0	33
35	NC5-003	Streambank Stabilization	3	1	1	12	2.5	0	2.5	0	5	2.5	2.5	32
36	NC6-005	New BMP	1	1	1	16	5	0	5	2.5	0	0	0	31.5
37	NC7-005	Stream Restoration	4	1	1	12	2.5	0	2.5	0	2.5	5	0	30.5
38	NC4-009	BMP Retrofit	2	4	3	5	2.5	0	5	5	0	2.5	0	29
39	NC4-019	BMP Retrofit	2	4	3	6	2.5	0	2.5	5	0	2.5	0	27.5
40	NC8-003	Buffer Restoration	1	1	1	5	5	0	2.5	2.5	2.5	5	0	25.5
41	NC5-001	Buffer Restoration	1	1	1	4	5	0	2.5	2.5	2.5	5	0	24.5
42	NC8-001	Buffer Restoration	1	1	2	5	5	0	2.5	2.5	0	5	0	24
43	NC6-006	New BMP	1	2	2	2	0	0	2.5	2.5	2.5	2.5	0	17

Highlights from the ranked list of projects include:

- All of the projects that coordinate with the Site Specific Parks Plans (NC4-006, NC4-011, NC4-012, NC4-013, NC7-002, and NC5-002) ranked in the top 10 projects.
- The trash racks downstream of I-285 did not rank highly because the relative pollutant removal is low. However, these projects will reduce the long-term maintenance burden on City staff and volunteers and improve the overall health of Murphey Candler Lake. Given these considerations, the trash racks are recommended in the first 10 years.
- The shoreline restoration project ranks 13 out of 43 because the estimated pollutant removal is relatively low. However, this project is considered a City maintenance project and is recommended in the short-term work plan.
- Sediment removal from Murphey Candler Lake ranks 33 out of 43. The low rank is because the pollutant removal benefits to the watershed are low and it is an expensive project with significant permitting requirements. Despite the low relative ranking, dredging of the upper reaches and east cove of the Lake is recommended within the next 10 years and then approximately every 30 years following as part of normal lake maintenance.
- The “sediment trap” BMPs NC4-015, NC4-017, and NC4-018 rank relatively low (27, 28, and 32 respectively). These projects will reduce the intervals between Lake dredging but don’t rate as highly as other projects because they don’t have a large overall impact on the watershed, as they will treat only a portion of the flow during storm events. Due to other priorities, these are not recommended in the first 10 years unless they are associated with a park project or a grant opportunity becomes available.

4.5. IMPLEMENTATION PLAN

The implementation plan identifies the projects that Brookhaven that had strong support from the community and City leaders and/or provided higher benefits as defined in the ranking methodology. The implementation plan suggests projects to be implemented over the next 10 years, recognizing the dynamic nature of the watershed might change the timeframe and/or projects identified.

The implementation plan was phased to reflect the anticipated funding of $250,000 per year from the City. Several of the projects in the implementation plan are anticipated to receive grant funding. If grant funding is not secured, the projects may be postponed. Outside financing is recommended to support dredging of Murphey Candler Lake. The City estimates this project will cost $1.8M and financing was included to provide the funding needed for this project. One alternate project is shown at the end of the 10 year timeframe. If additional funds are secured or projects cost less than budgeted to implement, this project is recommended as an alternate.

The implementation plan in Table 4-10, outlines implementation progress for 15 of the 43 recommended projects (includes the alternate project). The total City investment in the Study Area is anticipated at just over $2.3 million with a grant funding goal of approximately $350,000 and an equivalent commitment from private property owners.

Table 4-10. Implementation Plan

Year	Project Number	Project Description	Total Fixed Costs (Note 1)			Project Rank
			City	Grant*	Other	
Year 1	NC4-005	Shoreline restoration design. Design in Year 1 and construct in Years 2 and 3.	$123,300			13
	NC4-011	Bioretention at Murphey Candler pool parking lot. Design, permit, and construct Year 1.	$14,300			6
	NC4-014	Work with Kittredge Magnet School to repair damaged inlet and evaluate enhancing infiltration.	$0		$ 39,000	31
Year 2	NC4-005	Shoreline restoration, east shore restoration.	$205,500			13
	NC4-008	Work with Kittredge Magnet School to stabilize drainage channel. Evaluate grant funding opportunities.	$0	$2,500	$128,800	8
	NC4-006	Design of tiered bioretention cell along East Nancy Creek Drive in Murphey Candler Park.	$37,200			1
Year 3	NC4-005	Shoreline restoration, west shore restoration.	$205,500			13
	NC4-006	Construction of tiered bioretention cell along East Nancy Creek Drive in Murphey Candler Park.	$124,000			1
Year 4	NC7-002	Design stream restoration of North Fork Nancy Creek from dam to Nancy Creek.	$35,650	$35,600		9
	NC4-016	Preparations and initial planning for dredging	$0			33
Year 5	NC7-002	Construct stream restoration of North Fork Nancy Creek from dam to Nancy Creek.	$43,000	$43,000		9
	NC4-016	Secure funding, initiate permitting tasks, loan closing fees.	$180,000			33
Year 6	NC4-016	Dredging of Murphey Candler Lake. Assumes a 25 year GEFA loan with permitting and closing costs in Year 5. *Costs are limited to first 10 years of loan.	$786,300*			33
Year 7	NC4-012, NC4-013, NC5-002	Park Specific Master Plan related projects in Murphey Candler Park and Blackburn Park. Assumes implement 5 percent of total recommended projects. Adjust to park project timing. May be expedited based on the park bond.	$91,520			2, 3, 4
Year 8	NC7-006	Stream restoration of Nancy Creek from Murphey Candler Park to Ashford Dunwoody. This is Phase I of a 2 phase project, only along Park land.	$271,700	$271,700		10
Year 9	NC4-001 & NC4-002	Trash racks at I-285. Install two of four.	$130,000			17, 18
Year 10	NC4-003 & NC4-004	Trash racks at I-285. Install two of four.	$130,000			19, 20
ALT	NC4-010	Stream restoration of North Fork Nancy Creek from I-285 to Murphey Candler Lake. Address bank erosion and sedimentation to Lake.	$612,300			5
		TOTAL	$2,333,070	$352,850	$361,500	

4.6. SHORT-TERM WORK PLAN

The short-term work plan in Table 4-11 provides more details on the interim actions needed to support the projects recommended in the implementation plan. These interim actions are intended as guidance and are not a prescriptive set of actions that must be completed by the City. Project schedules will likely change in response to dynamic watershed conditions and changes to City priorities.

Table 4-11. Example Short-term Work Plan

Year	Activity	Rank	Estimated City Budget Needs
Year 1	NC4-005: Design and Permit Shoreline Restoration	13	$120,000
	NC4-011: Design, Permit and Construct	6	$14,300
	NC4-008: Coordinate with Kittredge Magnet School for BMP repair	8	$0
	NC4-014: Support Grant Application for channel restoration	31	$0
	NC7-002: Write and Submit 319(h) Grant Application	9	$0
Year 2	NC4-005: Construct east shore restoration projects	13	$207,000
	NC7-002: Resubmit 319(h) Grant Application, if necessary	9	$0
	NC4-006: Design and permit tiered bioretention area	1	$39,325
Year 3	NC4-005: Construct west shore restoration projects	13	$207,000
	NC4-006: Construct tiered bioretention area	1	$117,975
	NC7-002: Anticipated award of 319(h) Grant	9	$0
Year 4	NC7-002: Design & Permit Restoration NF Nancy to Nancy	9	$35,650
	NC4-016: Make arrangements for dirt relocation at Lynwood Park and Field 11	33	$0
Year 5	NC7-002: Construct Restoration NF Nancy to Nancy	9	$43,000
	NC4-016: Secure funding for dredging from GEFA or other	33	$180,000
		Total City Funds	$964,240

4.7. MEASURING PROGRESS TOWARD GOALS

Measuring the progress toward the Plan goals maintains support and assesses whether changes to prioritized list of projects are needed. There are three proposed methods for measuring the progress in this Plan: a count of completed projects, review of water quality trend data, and updating the Murphey Candler State of the Lake Report.

Completion of Recommended Projects: Each project has an estimated benefit that is included in Appendix B. As projects are implemented, the total estimated benefit can be estimated and reported. Information on the benefits to the watershed can be shared with the public through existing communication channels.

Water Quality Trend Data: The City's Impaired Waters Plan recommends securing water quality data from DeKalb County Watershed Management Department and reviewing it annually to see if water quality trends are improving or declining. In addition to meeting a regulatory requirement, this review may guide the implementation of recommended projects in this Plan.

State of the Lake Report Updates: The City can partner with a non-profit organization and/or school to collect the data needed annually to update the Murphey Candler Lake State of the Lake report. Additional data will help draw better conclusions about the health of Murphey Candler Lake and document any measured benefit in lake health following the implementation of recommended projects.

With any planning study, it is advisable to update the data and analysis every ten years. The update is an opportunity to assess stream health and update the model with information on completed projects or significant land use changes in the watershed. New projects will likely be identified and the update can be paired with the impervious area retrofit assessments recommended in this Plan.

DEFINITIONS

Best Management Practices (BMPs): A structure or engineered control devices and systems (e.g. retention ponds) designed to treat polluted stormwater. Also includes operational or procedural practices (e.g. minimizing use of chemical fertilizers and pesticides).

Chlorophyll-a: Chlorophyll is the pigment that makes plants and algae green and allows plants and algae to photosynthesize. Chlorophyll-*a* is the measure of chlorophyll that is "active" or living. Chlorophyll-*a* is tested in lakes to determine the presence of living algae. Too much algae can create a cloudy appearance in lakes and can also deplete the dissolved oxygen needed by fish and aquatic life. Chlorophyll levels are typically highest in the summer, when these samples were taken. There is currently no state-wide lake standard for chlorophyll-*a*, but there are 6 lakes with individual standards, ranging from 10 to 24 mg/m3. Chlorophyll levels can be accelerated by excess nutrients (phosphorus and nitrogen) with sources including human and animal wastes, soil erosion, and runoff from fertilized lawns.

Drainage Basin: An area from which all precipitation flows to a single stream or set of streams. Also called a watershed.

Eutrophic: One of the four Carlson Trophic State's that is used to describe lake health. Eutrophic lakes very productive and fertile; low clarity/shallow secchi; high chlorophyll and phosphorus concentrations.

Fecal Coliform Bacteria: Fecal coliform bacteria are microscopic organisms found in the intestines of warm blooded animals. The presence of fecal coliform bacteria is considered an indicator of the possibility of disease-carrying organisms and is regulated by the state. The winter standard (November – April) is less than 1,000 colonies/ 100 mL and the summer standard is 200 colonies/100 mL. The summer standard is lower as there is greater risk of human ingestion in the warmer months. Because fecal coliform bacteria are living organisms their counts are not easy to predict. For example, the direct sunlight in the main body of the lake may kill the bacteria, which could explain why these levels were lower. Sources of fecal coliform could include sanitary sewer overflows, wildlife waste, and pet waste.

Hydrologic Unit Code (HUC): These codes are a way to identify the drainage basins in the US. The codes are nested from largest (regions) to smallest (cataloguing units). The larger the number, the smaller the drainage basin being described. Hydrologic unit codes are assigned by the US Geological Survey (USGS).

Hypereutrophic: One of the four Carlson Trophic State's that is used to describe lake health. Hypereutrophic lakes are extremely productive with noxious surface scums of algae and low survivability of aquatic life.

Impaired Waters (aka 303(d) list): The 303(d) list of impaired waters is produced by the Georgia EPD annually and assigns a 1 to 5 numerical classification to the streams that have been monitored. The numbers indicate whether the stream met state standards or was considered impaired. For impaired streams the classifications also indicate whether a Total Maximum Daily Load (TMDL) study has been prepared or not.

Impervious Cover: Any surface in the landscape that cannot effectively absorb or infiltrate rainfall. This includes driveways, roads, parking lots, rooftops, and sidewalks. When natural landscapes are intact, rainfall is absorbed into the soil and vegetation. Also called impervious area.

Mesotrophic: One of the four Carlson Trophic State's that is used to describe lake health. Mesotrophic lakes are moderately productive; intermediate clarity, chlorophyll and phosphorus concentration.

Municipal Separate Storm Sewer System (MS4): MS4 refers to conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, and storm drains) which is owned or operated by a state, city, town, county, district, association, or other public body (created by or pursuant to state law). The EPA promulgated rules that require Phase I ("medium" and "large") communities to implement a stormwater management

program to control polluted stormwater discharges. The Phase II rules extend coverage to “small” system which must adopt programs that fall under six minimum control measures. Brookhaven is considered a Phase II community.

Oligotrophic – One of the four Carlson Trophic State’s that is used to describe lake health. Oligotrophic lakes are nutrient poor and low productivity; high transparency (deep secchi depth), low chlorophyll-a, low phosphorus.

Sanitary Sewer Overflow (SSO): A condition in which untreated sewage is discharged from a sanitary sewer into the environment prior to reaching sewage treatment facilities. When caused by rainfall it is also known as wet weather overflow. SSOs can be caused by a number of factors including grease and other blockages as well as infiltration of rainfall into aging pipe systems.

Stormwater: Water that originates during precipitation events and snow/ice melt. Stormwater can soak into the soil (infiltrate), be held on the surface and evaporate, or runoff and end up in nearby streams, rivers, or other water bodies (surface water).

Subwatershed: A drainage area that is a smaller unit than a watershed.

Total Maximum Daily Load (TMDL): A regulatory term in the U.S. Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

Total Phosphorus: Phosphorus is a nutrient that is important for plant growth. Too much phosphorus, however, can lead to excess plant and algae growth. Common sources include human and animal wastes, soil erosion, and runoff from fertilized lawns. There is currently no state-wide lake standard for Total Phosphorus.

Trophic State: The total weight of biomass in a given water body at the time of measurement. Because they are of public concern, the Carlson index uses the algal biomass as an objective classifier of a lake or other water body's trophic status.

Watershed: An area of land that drains to a specific point on a waterbody.

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[iii] State of Georgia Tier 2 TMDL Implementation Plan, Revision #1: Peachtree Creek, Nancy Creek and Others Watersheds Chattahoochee River Basin.
[iv] Total Maximum Daily Load Evaluation for Twenty-Five Stream Segments in the Chattahoochee River Basin For Sediment (Biota Impacted).
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APPENDIX A: MURPHEY CANDLER STATE OF THE LAKE REPORT 2015

Murphey Candler Lake

State of the Lake Report

WINTER 2016

A lake is the landscape's most beautiful and expressive feature. It is earth's eye; looking into which the beholder measures the depth of his own nature.

– Henry David Thoreau, Walden

Brookhaven GEORGIA

MURPHEY CANDLER LAKE
STATE OF THE LAKE REPORT

This report presents a scientific assessment of water quality conditions in Murphey Candler Lake based on data collected in the summer of 2015. Murphey Candler Lake sits at the center of the City of Brookhaven's Murphey Candler Park, an important regional destination. Visitors enjoy a scenic trail that loops around the Lake, recreation on the ball fields downstream of the Lake's dam, and peaceful views near the lake shoreline. The health of the Lake is important to the health of the City's Park.

This State of the Lake Report outlines current water quality and habitat conditions as well as recommendations for future actions to protect and improve the Lake. The City of Brookhaven hopes to work with the community to collect additional data in the future to better understand trends and benefits associated with improvement projects in and around the Lake.

The overall conditions in Murphey Candler Lake were assessed based on the four long-term goals for the Nancy Creek Watershed Improvement Plan. The results summarized here are explained in greater detail throughout this report.

Murphey Candler Lake falls short of meeting the four established goals; however these goals are ambitious. The four goals represent the community's vision for steady improvements over the next 50 years. The projects needed to meet these long-term goals are identified in the City's Nancy Creek Watershed Improvement Plan.

GOAL #1: Meet state water quality standards or targets.

Only 38% of the water quality samples for fecal coliform bacteria, total phospohrus, and chlorophyll-*a* met the state standard or water quality target. See page 3 for more details.

GOAL #2: Restore vegetated buffers to reduce the loss of land through erosion.

Only 26% of the total shoreline is classified as "stable" and the average overall shoreline stability rating is "threatened". See page 4 for more details.

GOAL #3: Improve streams to "sub-optimal" condition.

Murphey Candler Lake is currently classified as "eutrophic" due to high levels of chlorophyll-a and phosphorus. This is below the equivalent rating to "sub-optimal" for lakes ("mesotrophic"). See page 5 for more details.

GOAL: Protect aesthetics and wildlife diversity.

Murphey Candler Lake is surrounded by 135-acres of park that provides diverse wildlife habitat. Suburban stormwater runoff and invasive plant species threaten the quality of habitat within the Park. See page 4 for more details.

Legend

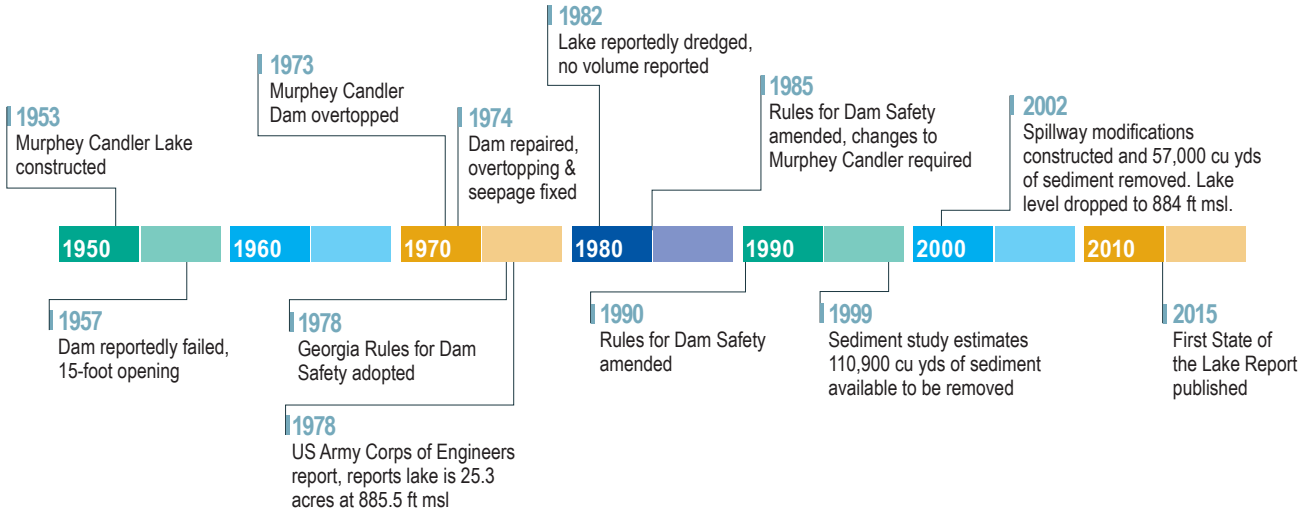
Meeting the goal 80% of the time or more

Meeting the goal 50 - 80% of the time

Not meeting the goal more than 50% of the time

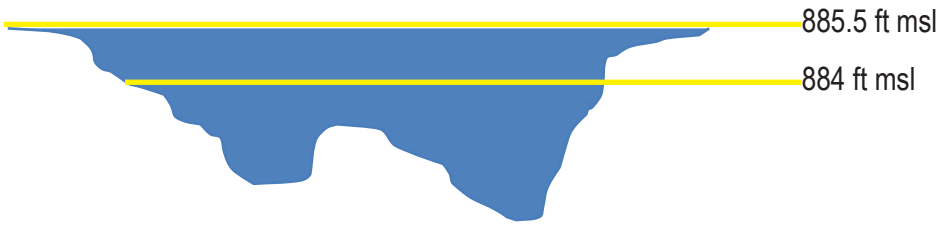
HISTORY OF MURPHEY CANDLER LAKE

Murphey Candler Lake was constructed in 1953 where two rivers (North Fork Nancy Creek and an unnamed stream) flowed together. Although the dam was constructed in 1953, the oldest known historical record about the dam was an inspection in 1978 shortly after the passage of the Georgia Rules for Dam Safety. Based on available historical documents, the lake level was lowered in 2002 from 885.5 feet above mean sea level (ft msl) in 1978 to the current lake level of 884 ft msl. This 1.5 foot change in lake level was to comply with 1990 changes to the Georgia Rules for Dam Safety.



Why Does the Lake Level Matter?

To protect public safety, the state sets and periodically adjusts requirements for the amount of water that must be safely passed through a dam without overtopping the dam during critical storm events. As shown in the timeline above, changes in these regulations resulted in a 1.5 foot change in water level from 1978 to 2002. The graphic below highlights the impact this lowering has on the appearance of the lake both in terms of the size and sediment accumulation.



Quick Facts

Area: 20 acres

Lake Level: 884 ft msl

Park Area: 135 acres

Watershed: 1,320 acres

Constructed: 1953

Dam Type: Earthen

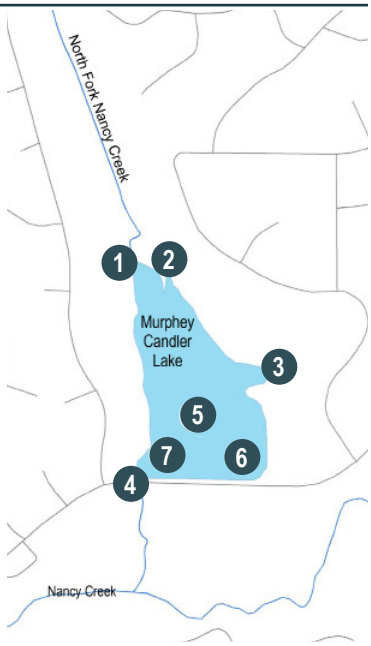
WATER QUALITY IN MURPHEY CANDLER LAKE

Water chemistry samples were collected during the summer of 2015 at three lake sample locations and four river sample locations to characterize water quality in Murphey Candler Lake. Only 38 percent of the samples met state standards or guidelines, as shown in the table below.

Parameter	Standard/ Guideline	River Samples				Lake Samples		
		1	2	3	4	5	6	7
Fecal Coliform (col/100mL)	summer std = 1,000 winter std = 200	1,600	700	90	1,400	6	6	5
Total Phosphorus (ug/mL)	24 [1]	63	137	BRL	73	63	57	64
Chlorophyll-*a* (mg/m^3)	20 [1]	BRL	5.94	BRL	26.2	24.4	49.5	28.9

Notes:
1. Guideline based on trophic status, not state based standard
BRL = below reportable limits
Green = meets standard/ guideline; Yellow = 1 to 2 times standard/ guideline; Red = 2 times standard/ guideline or more

Sampling Locations



Water Quality Data Summary

- **Fecal coliform levels in the four river samples exceeded state standards**. Possible sources include sanitary sewer overflows, wildlife waste, and pet waste. It is advisable to keep pets out of the lake for three days following a rain event to avoid possible illness.

- **Chlorophyll-a levels in the lake are high**, indicating the presence of algae that creates a cloudy appearance and can impact fish health. Chlorophyll-a levels can be stimulated with higher levels of phosphorus and nitrogen.

- **Total phosphorus levels in the lake are high.** Sources of phosphorus include human and animal wastes, soil erosion, and runoff from fertilized lawns.

What is the oily sheen on the Lake?

The shiny, orange-tinted substance is iron bacteria. It is a natural byproduct and is not harmful. It is found more frequently in still water.

To confirm it is not oil, put a stick in the substance. If it breaks apart, it is not oil but rather iron bacteria.

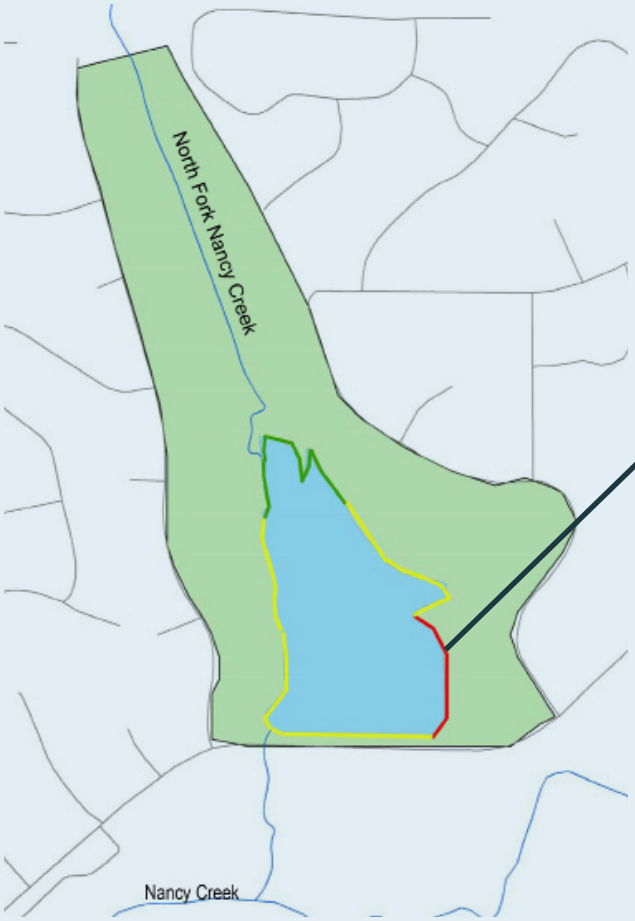
SHORELINE AND HABITAT CONDITIONS

Shoreline stability ratings were calculated based on the slope, vegetative cover, and the erosion potential. Each shoreline reach was rated as stable, threatened, or poor.

An overall shoreline rating was calculated based on the length and score assigned to each individual section of shore. Overall, the shoreline is considered “threatened”. Only 26 percent of the shoreline is classified as stable, most of this is in the northern portion of the Lake.

Murphey Candler Park offers 135 acres of diverse wildlife including water, wetlands, and upland forested areas. Invasive plant species are encroaching into areas of the park including english ivy, kudzu, and chinese privet. These invasive species threaten the native plant species including those that stabilize the shoreline of the lakes. Removal of invasive species and replacing these species with native plants will provide the habitat needed to support wildlife.

Murphey Candler Lake Shoreline Assessment

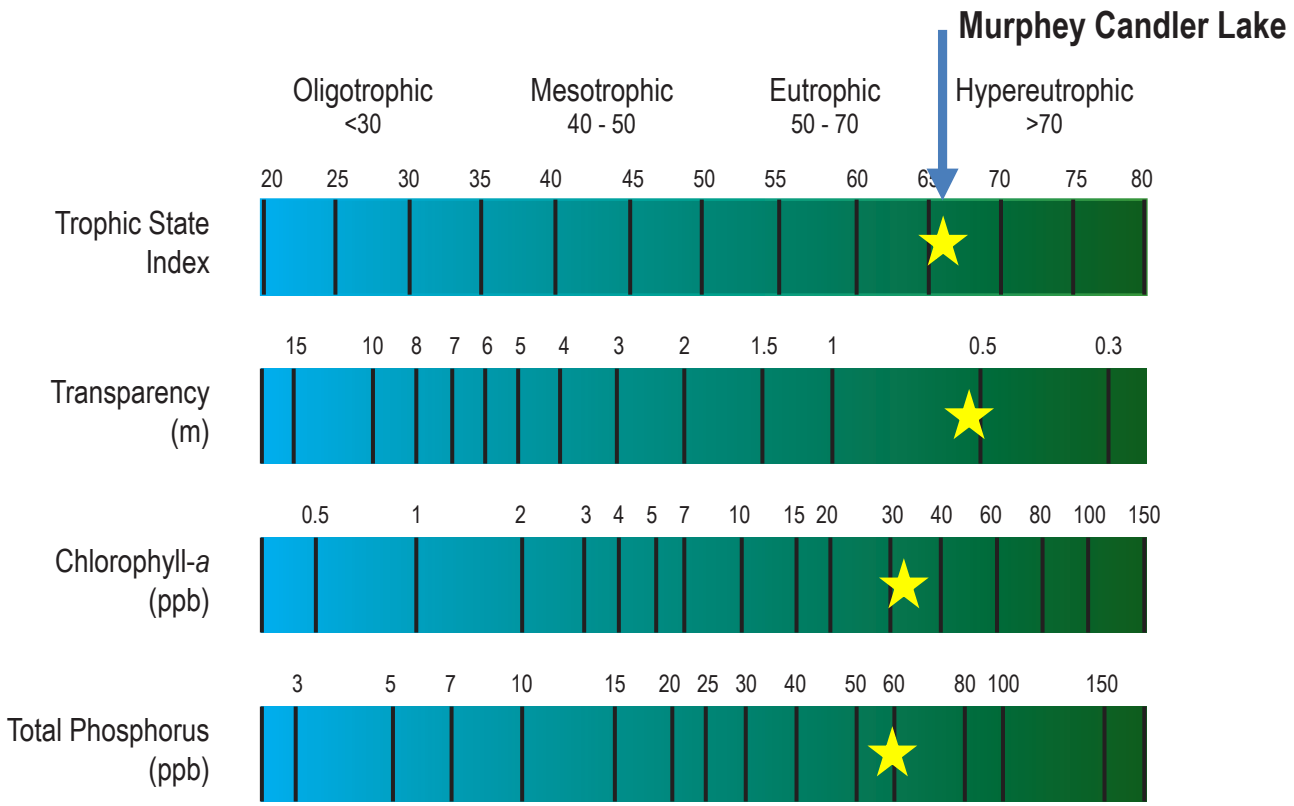


Shoreline Restoration Example

Current Shoreline Area, “the Beach”

Restoration Alternative

TROPHIC STATE OF MURPHEY CANDLER LAKE



The biological well-being of a lake is commonly measured using the four-level trophic state scale (Carlson, 1977). The trophic state level is determined based on the rate of algae growth, as determined primarily by chlorophyll-*a* and total phosphorus. Oligotrophic lakes are very clear and favored by swimmers. Eutrophic lakes offer exceptional fish habitat due to the availability of food sources (algae). If too much algae accumulates (higher end of the eutrophic range and hypereutrophic) the algae can reduce the dissolved oxygen levels that fish need to survive. Hypereutrophic lakes are characterized by large algae blooms or algae mats.

The trophic state for Murphey Candler Lake is “eutrophic” based on the high levels of chlorophyll-a and phosphorus. While algae may not be visible throughout Murphey Candler Lake, the average transparency is less than 2 feet (0.5 meters). This cloudiness is typical in lakes with high chlorophyll-*a* values indicating small floating algae.

A eutrophic classification is typical for a suburban watershed lake that is 60+ years old. Conditions will decline without actions to limit nutrients that contribute to phosphorus growth. Implementing actions to reduce sediment and nutrient loads to the Lake could help the Lake achieve mesotrophic status overtime.

MOVING FORWARD

The City of Brookhaven developed the Nancy Creek Watershed Improvement Plan with the intention of implementing projects overtime to improve the watershed, which includes Murphey Candler Lake. Some of the recommendations from the Plan that are relevent to the Lake include:

- **Shoreline Restoration.** The City is completing this project as well as a Murphey Candler Park Master Plan to concurrently. These studies will guide the future restoration of the shoreline areas.
- **Implement Recommendations from the Nancy Creek Watershed Improvement Plan.** This State of the Lake Report is part of the Watershed Improvement Plan, which will include a list of short and long-term projects to improve water quality to meet community objectives and state standards.
- **Identify Community Partners.** Additional data will improve the accuracy of the conclusions and recommendations. It will also show whether implemented projects are improving water quality. The City can work with community partners to collect and update this report bi-annually.
- **Coordinate Watershed Improvements across the Region.** Stormwater runoff from neighboring jurisdictions, I-285, and other areas drains into Murphey Candler Lake. The City of Brookhaven initiated the Nancy Creek Watershed Improvement Plan to look at the health of the watershed from a regional perspective. The City hopes to be a leader and work with other groups on improving watershed health.

Steps Homeowners and Visitors Can Take to Protect Murphey Candler Lake

- **Be Mindful of Trash and Debris.** Trash including plastic bottles, fishing gear, and plastic wrappers is harmful to the environment and unsightly. The study indicates that much of the trash is coming from the immediate area and not from adjacent communities.
- **Practice Lake-Sensitive Landscaping.** Fertilizers can encourage algae growth and accelerate eutrophication. Only use fertilizers when a soil test indicates that they are needed. Follow the application instructions to limit any stormwater runoff that drains to the lake.
- **Pick up Pet Waste and Report Odors.** To reduce the levels of fecal coliform entering and exiting the lake, it is important to pick up after your pets and call DeKalb County Watershed at 770-270-6243 if you suspect a sanitary sewer issue in or around the park.
- **Remove Invasive Species.** Invasive species such as English ivy, kudzu, chinese privet, and bamboo can cause irreparable harm to native trees and understory plants. The trees along the buffer protect the shoreline from erosion. Damage to these trees from invasive species could accelerate shore
- **Plant Native Species.** Native species should be planted to prevent erosion and prevent encroachment from invasive species.

APPENDIX B: PROJECT SHEETS

Project ID#: NC4-001

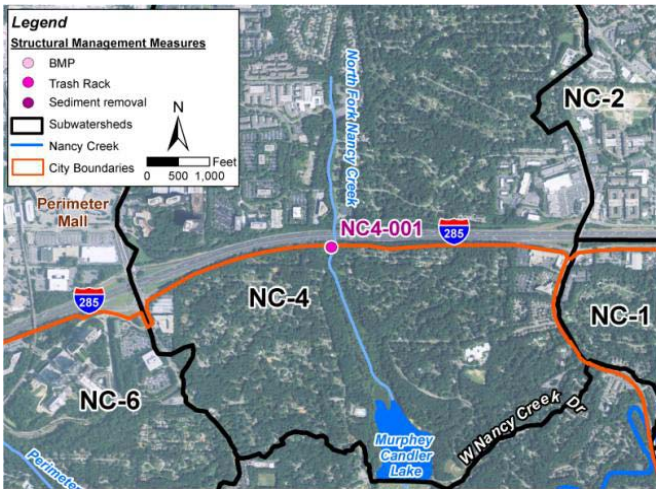
Sub-watershed: NC4 North Fork Nancy

Practice Type: Trash Rack

Description: Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers:
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: GDOT

Existing Conditions: Trash and debris from I-285 flow downstream into Murphey Candler Lake.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 10

Contributing Impervious Area (ac): 10

Primary Hydrologic Soil Group (HSG) in DA:

Annual Total Nitrogen Reduction (lb/yr): 11.77

Annual Total Phosphorus Reduction (lb/yr): 1.28

Annual Total Suspended Solids Reduction (lb/yr): 685.77

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 12,500	
Planning Level Capital Cost ($): 50,000	
Planning Level Total Cost ($): 65,000	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 5,700	
Implementation Notes: Safe access to the trash racks is needed to maintain. GDOT is identifying access to make repairs to their damaged headwalls. Permits may be required depending on how they are anchored. Access easements will be needed.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 1,500	
Annual Maintenance Notes: Remove trash and debris monthly and after each major rain event.	

PROJECT RANKING		
Rank:	17	Total Score: 39.5
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	9	
Ease of Implementation:	15	Total Cost Score: 5 Ownership Score: 5 Maintenance Burden Score: 0 Potential Permitting Requirements Score: 5
Additional Benefits:	12.5	Visibility to Community Score: 7.5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 2.5

Additional Comments

Project ID#: NC4-002

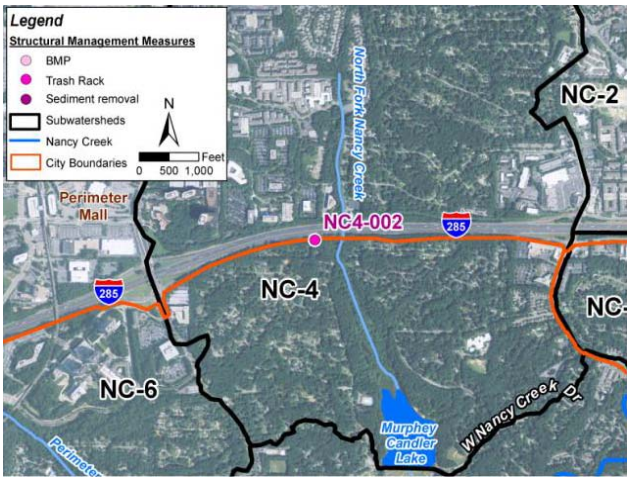
Sub-watershed: NC4 North Fork Nancy

Practice Type: Trash Rack

Description: Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers:
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: GDOT	
Existing Conditions: Trash and debris from I-285 flow downstream into Murphey Candler Lake.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 10
Contributing Impervious Area (ac): 10
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 11.77
Annual Total Phosphorus Reduction (lb/yr): 1.28
Annual Total Suspended Solids Reduction (lb/yr): 685.77

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 12,500	
Planning Level Capital Cost ($): 50,000	
Planning Level Total Cost ($): 65,000	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 5,700	
Implementation Notes: Safe access to the trash racks is needed to maintain. GDOT is identifying access to make repairs to their damaged headwalls. Permits may be required depending on how they are anchored. Access easements will be needed.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 1,500	
Annual Maintenance Notes: Remove trash and debris monthly and after each major rain event.	

PROJECT RANKING		
Rank:	18	Total Score: 39.5
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	9	
Ease of Implementation:	15	Total Cost Score: 5 Ownership Score: 5 Maintenance Burden Score: 0 Potential Permitting Requirements Score: 5
Additional Benefits:	12.5	Visibility to Community Score: 7.5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 2.5

Additional Comments

Project ID#: NC4-003

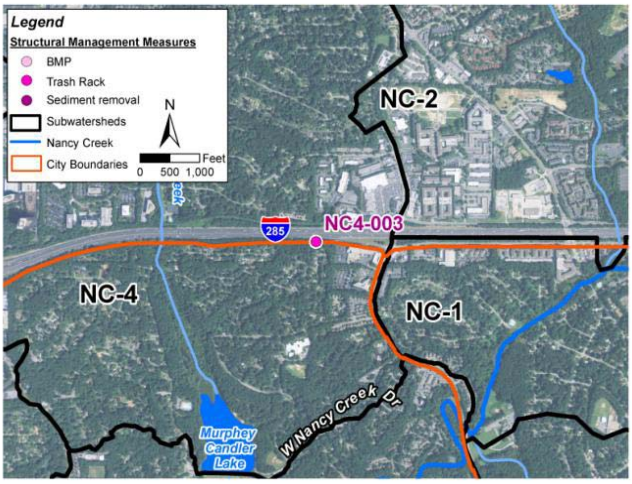
Sub-watershed: NC4 North Fork Nancy

Practice Type: Trash Rack

Description: Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers:
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: GDOT	
Existing Conditions: Trash and debris from I-285 flow downstream into Murphey Candler Lake.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 10
Contributing Impervious Area (ac): 10
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 11.77
Annual Total Phosphorus Reduction (lb/yr): 1.28
Annual Total Suspended Solids Reduction (lb/yr): 685.77

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 12,500	
Planning Level Capital Cost ($): 50,000	
Planning Level Total Cost ($): 65,000	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 5,700	
Implementation Notes: Safe access to the trash racks is needed to maintain. GDOT is identifying access to make repairs to their damaged headwalls. Permits may be required depending on how they are anchored. Access easements will be needed.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 1,500	
Annual Maintenance Notes: Remove trash and debris monthly and after each major rain event.	

PROJECT RANKING		
Rank:	19	Total Score: 39.5
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	9	
Ease of Implementation:	15	Total Cost Score: 5 Ownership Score: 5 Maintenance Burden Score: 0 Potential Permitting Requirements Score: 5
Additional Benefits:	12.5	Visibility to Community Score: 7.5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 2.5

Additional Comments

Project ID#: NC4-004

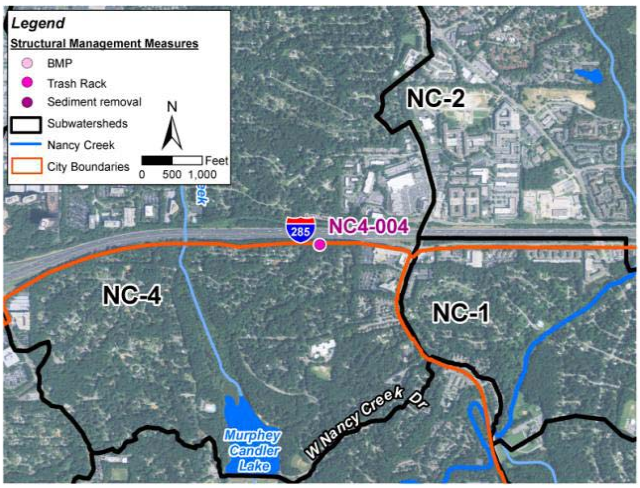
Sub-watershed: NC4 North Fork Nancy

Practice Type: Trash Rack

Description: Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers:
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: GDOT

Existing Conditions: Trash and debris from I-285 flow downstream into Murphey Candler Lake.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 10

Contributing Impervious Area (ac): 10

Primary Hydrologic Soil Group (HSG) in DA:

Annual Total Nitrogen Reduction (lb/yr): 11.77

Annual Total Phosphorus Reduction (lb/yr): 1.28

Annual Total Suspended Solids Reduction (lb/yr): 685.77

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 12,500	
Planning Level Capital Cost ($): 50,000	
Planning Level Total Cost ($): 65,000	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 5,700	
Implementation Notes: Safe access to the trash racks is needed to maintain. GDOT is identifying access to make repairs to their damaged headwalls. Permits may be required depending on how they are anchored. Access easements will be needed.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 1,500	
Annual Maintenance Notes: Remove trash and debris monthly and after each major rain event.	

PROJECT RANKING		
Rank:	20	Total Score: 39.5
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	9	
Ease of Implementation:	15	Total Cost Score: 5 Ownership Score: 5 Maintenance Burden Score: 0 Potential Permitting Requirements Score: 5
Additional Benefits:	12.5	Visibility to Community Score: 7.5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 2.5

Additional Comments

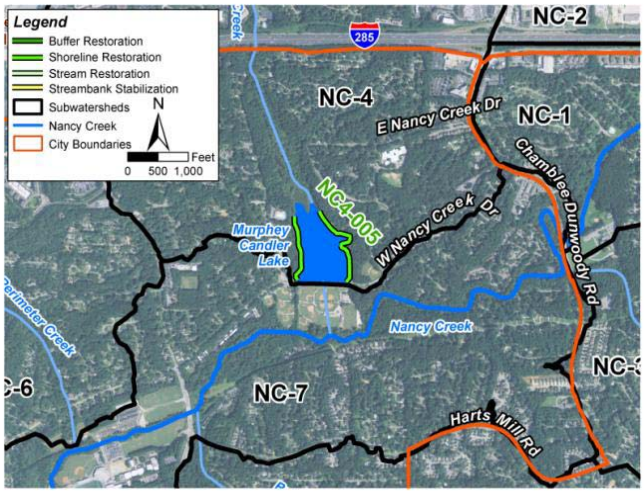
Project ID#: NC4-005

Sub-watershed: NC4 North Fork Nancy

Practice Type: Shoreline Restoration

Description: Restore 3,400 linear feet of shoreline around Murphey Candler Lake (shore classified as "poor" or "threatened").

Watershed Goal(s) Supported:
1. Meet state water quality standards:
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City	
Existing Conditions: Existing shoreline conditions are bare or sparsely vegetated and eroding in many areas.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 18.82
Annual Total Phosphorus Reduction (lb/yr): 2.58
Annual Total Suspended Solids Reduction (lb/yr): 618

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 102,750	
Planning Level Capital Cost ($): 411,000	
Planning Level Total Cost ($): 534,300	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 54,800	
Implementation Notes: Coordinate shoreline restoration with planned Parks Master Plan projects. Projects need to be designed and permitted prior to installation. Permits include state buffer variance.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 20,600	
Annual Maintenance Notes: Maintain newly planted vegetation and remove any invasive species. Replace vegetation, as needed.	

PROJECT RANKING		
Rank:	13	TSS Score: 40
Pollutant Removal Score:	4	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 2
Cost Benefit Score:	1	
Ease of Implementation:	17.5	Total Cost Score: 0 Ownership Score: 10 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 2.5
Additional Benefits:	17.5	Visibility to Community Score: 10 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 5

Additional Comments

Project ID#: NC4-006

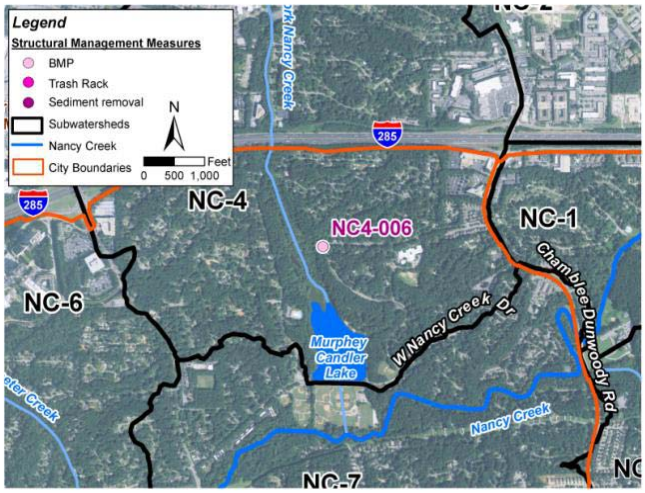
Sub-watershed: NC4 North Fork Nancy

Practice Type: New BMP

Description: New bioretention area at the bend in East Nancy Creek Drive in Murphey Candler Park. Recommend three-tiered and tie in adjacent catch basin drainage as well as direct road drainage before draining to the stream.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: City

Existing Conditions: During high flows stormwater bypasses the catch basin and entering the park eroding a path toward the stream.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 13.88

Contributing Impervious Area (ac): 4.13

Primary Hydrologic Soil Group (HSG) in DA: B

Annual Total Nitrogen Reduction (lb/yr): 112.25

Annual Total Phosphorus Reduction (lb/yr): 15.03

Annual Total Suspended Solids Reduction (lb/yr): 3605.06

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 31,000	
Planning Level Capital Cost ($): 124,000	
Planning Level Total Cost ($): 161,200	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 16,500	
Implementation Notes: Coordinate with planned Park Specific Plan projects. Bioretention will need to be designed and permitted before construction. A land disturbance permit and state buffer variance will be required.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 6,200	
Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	1	Total Score: 69.5
Pollutant Removal Score:	16	TSS Score: 3 Phosphorus Score: 6 Nitrogen Score: 7
Cost Benefit Score:	16	
Ease of Implementation:	25	Total Cost Score: 5 Ownership Score: 10 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	12.5	Visibility to Community Score: 7.5 Wildlife Diversity Score: 0 Compatibility with other City Plans: 5

Additional Comments

Project ID#: NC4-007

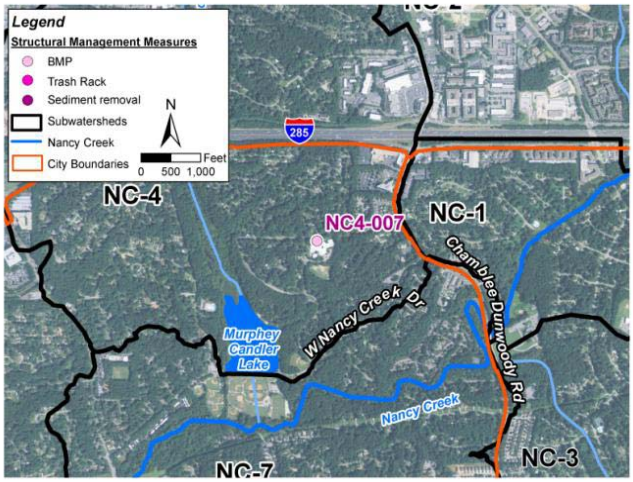
Sub-watershed: NC4 North Fork Nancy

Practice Type: New BMP

Description: New bioretention or enhanced swale area in front of Kittredge Magnet School.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: DeKalb Public Schools	
Existing Conditions: No stormwater controls for existing school. Opportunity to infiltrate rooftop runoff.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 0.82
Contributing Impervious Area (ac): 0.17
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 4.68
Annual Total Phosphorus Reduction (lb/yr): 0.63
Annual Total Suspended Solids Reduction (lb/yr): 150.25

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 2,250	
Planning Level Capital Cost ($): 9,000	
Planning Level Total Cost ($): 11,700	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 1,200	
Implementation Notes: Work with DeKalb County Public Schools to add stormwater management with future improvements. Integrate with the school science curriculum.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 500	
Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	25	Total Score: 37
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	9	
Ease of Implementation:	20	Total Cost Score: 5 Ownership Score: 5 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	5	Visibility to Community Score: 5 Wildlife Diversity Score: 0 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC4-008

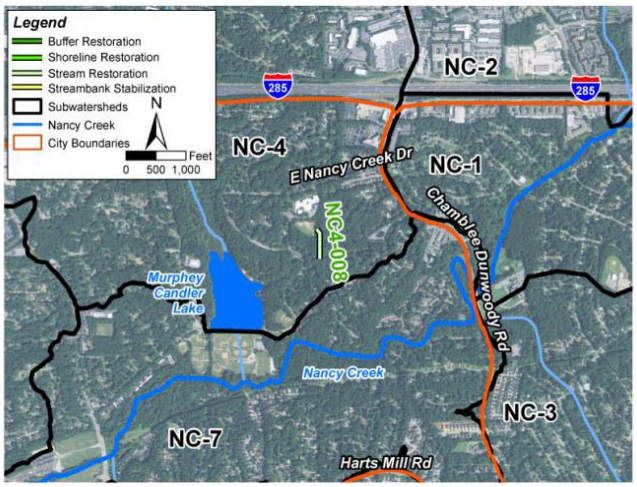
Sub-watershed: NC4 North Fork Nancy

Practice Type: Stream Restoration

Description: Restoration of 390 linear feet of eroding drainage channel at Kittredge Magnet School leading into a tributary to Murphey Candler Lake. Associated with NC4-014.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: DeKalb Public Schools

Existing Conditions: Severe erosion of drainage channel conveying stormwater from Kittridge Magnet School to an unnamed tributary to Murphey Candler Lake.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 0.00

Contributing Impervious Area (ac): 0.00

Primary Hydrologic Soil Group (HSG) in DA:

Annual Total Nitrogen Reduction (lb/yr): 3.65

Annual Total Phosphorus Reduction (lb/yr): 1.29

Annual Total Suspended Solids Reduction (lb/yr): 3650.76

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 25,250	
Planning Level Capital Cost ($): 101,000	
Planning Level Total Cost ($): 131,300	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 10,400	
Implementation Notes: Work with DeKalb County Public Schools on needed maintenance.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 2,000	
Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	8	Total Score: 52.5
Pollutant Removal Score:	5	TSS Score: 3 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	25	
Ease of Implementation:	15	Total Cost Score: 5 Ownership Score: 5 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 2.5
Additional Benefits:	7.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC4-009

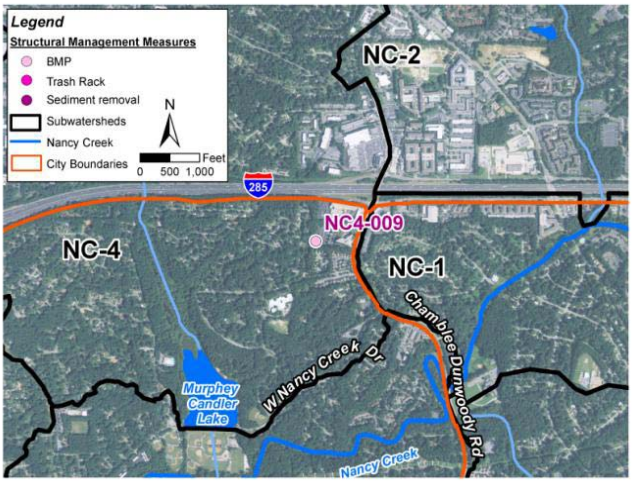
Sub-watershed: NC4 North Fork Nancy

Practice Type: BMP Retrofit

Description: Retrofit an existing office stormwater area to retain stormwater and provide water quality treatment and address drainage issue in downstream residential area.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: Private Property

Existing Conditions: Existing stormwater area not designed to retain water. Located upstream of a residential area.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 8.39

Contributing Impervious Area (ac): 3.80

Primary Hydrologic Soil Group (HSG) in DA: B

Annual Total Nitrogen Reduction (lb/yr): 49.84

Annual Total Phosphorus Reduction (lb/yr): 9.32

Annual Total Suspended Solids Reduction (lb/yr): 2529.83

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 76,000	
Planning Level Capital Cost ($): 304,000	
Planning Level Total Cost ($): 395,200	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 40,500	
Implementation Notes: Inform private property owner of stormwater utility fee benefits from upgrading existing stormwater controls.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 15,200	
Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	38	Total Score: 29
Pollutant Removal Score:	9	TSS Score: 2 Phosphorus Score: 4 Nitrogen Score: 3
Cost Benefit Score:	5	
Ease of Implementation:	12.5	Total Cost Score: 2.5 Ownership Score: 0 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	2.5	Visibility to Community Score: 0 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC4-010

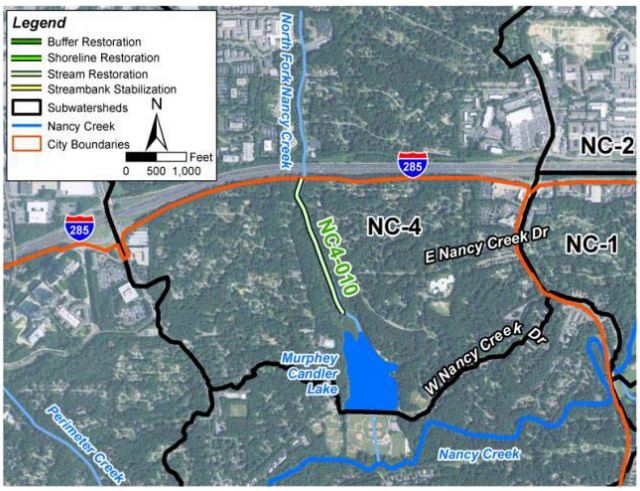
Sub-watershed: NC4 North Fork Nancy

Practice Type: Stream Restoration

Description: Restore approximately 3,400 linear feet of North Fork Nancy Creek from I-285 to Murphey Candler Lake that is classified as poor and threatened.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City and Private Property	
Existing Conditions: Stream incised with banks reaching 16 feet above normal water level in locations. Stream habitat conditions rated "poor."	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 17.09
Annual Total Phosphorus Reduction (lb/yr): 6.02
Annual Total Suspended Solids Reduction (lb/yr): 17092.52

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 117,750	
Planning Level Capital Cost ($): 471,000	
Planning Level Total Cost ($): 612,300	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 48,600	
Implementation Notes: Work on private property will require easements. Stream restoration will need to be properly designed and permitted. Federal, state, and local permits will be required.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 9,400	
Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	5	Total Score: 59
Pollutant Removal Score:	14	TSS Score: 10 Phosphorus Score: 3 Nitrogen Score: 1
Cost Benefit Score:	25	
Ease of Implementation:	5	Total Cost Score: 0 Ownership Score: 5 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	12.5	Visibility to Community Score: 7.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC4-011

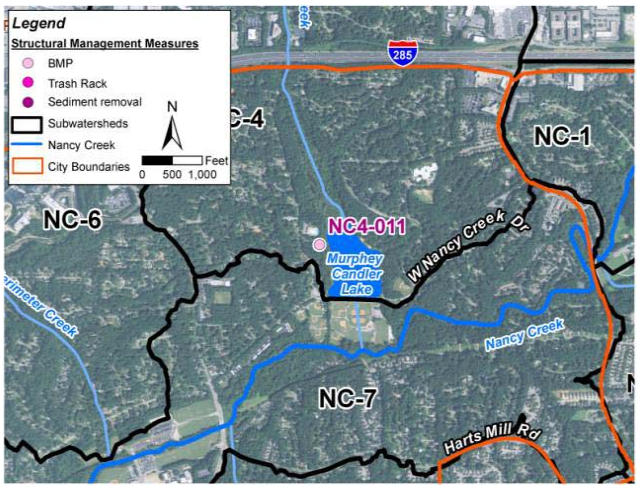
Sub-watershed: NC4 North Fork Nancy

Practice Type: New BMP

Description: Provide additional stormwater management with the planned revisions to the parking lot adjacent to Murphey Candler Pool. Options include several bioretention areas, enhanced swales, or street trees.

Watershed Goal(s) Supported:

1. Meet state water quality standards:
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: City

Existing Conditions: No stormwater controls for existing pool.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 1.44

Contributing Impervious Area (ac): 0.37

Primary Hydrologic Soil Group (HSG) in DA: B

Annual Total Nitrogen Reduction (lb/yr): 10.16

Annual Total Phosphorus Reduction (lb/yr): 1.36

Annual Total Suspended Solids Reduction (lb/yr): 326.26

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 2,750	
Planning Level Capital Cost ($): 11,000	
Planning Level Total Cost ($): 14,300	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 1,500	
Implementation Notes: Integrate stormwater design with the design, permitting, and construction of the planned park improvements.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 600	
Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	6	Total Score: 56.5
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	16	
Ease of Implementation:	25	Total Cost Score: 5 Ownership Score: 10 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	12.5	Visibility to Community Score: 7.5 Wildlife Diversity Score: 0 Compatibility with other City Plans: 5

Additional Comments

Project ID#: NC4-012

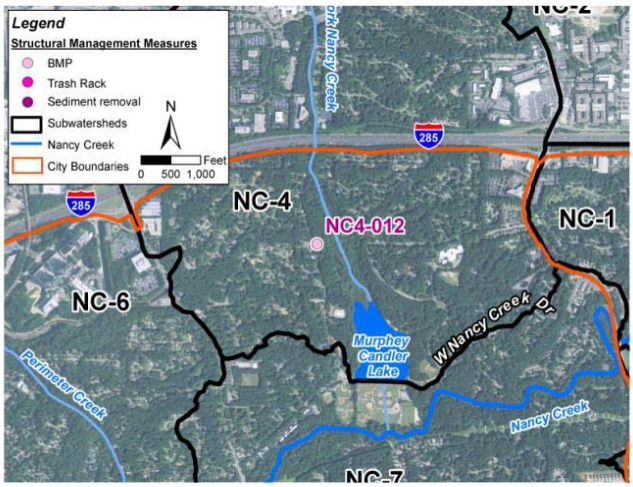
Sub-watershed: NC4 North Fork Nancy

Practice Type: New BMP

Description: Address existing drainage issues with the planned sidewalk extension. Add bioswales upstream and downstream of the catch basin.

Watershed Goal(s) Supported:

1. Meet state water quality standards:
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City	
Existing Conditions: Erosion downstream of existing catch basin within Murphey Candler Park.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 13.79
Contributing Impervious Area (ac): 4.55
Primary Hydrologic Soil Group (HSG) in DA: B
Annual Total Nitrogen Reduction (lb/yr): 123.61
Annual Total Phosphorus Reduction (lb/yr): 16.55
Annual Total Suspended Solids Reduction (lb/yr): 3969.97

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 34,250	
Planning Level Capital Cost ($): 137,000	
Planning Level Total Cost ($): 178,100	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 18,300	
Implementation Notes: Integrate stormwater design with the design, permitting, and construction of the planned park improvements.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 6,900	
Annual Maintenance Notes: Maintain vegetation and sheet flow drainage. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	2	Total Score: 65.5
Pollutant Removal Score:	17	TSS Score: 3 Phosphorus Score: 7 Nitrogen Score: 7
Cost Benefit Score:	16	
Ease of Implementation:	25	Total Cost Score: 5 Ownership Score: 10 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	7.5	Visibility to Community Score: 5 Wildlife Diversity Score: 0 Compatibility with other City Plans: 2.5

Additional Comments

Project ID#: NC4-013

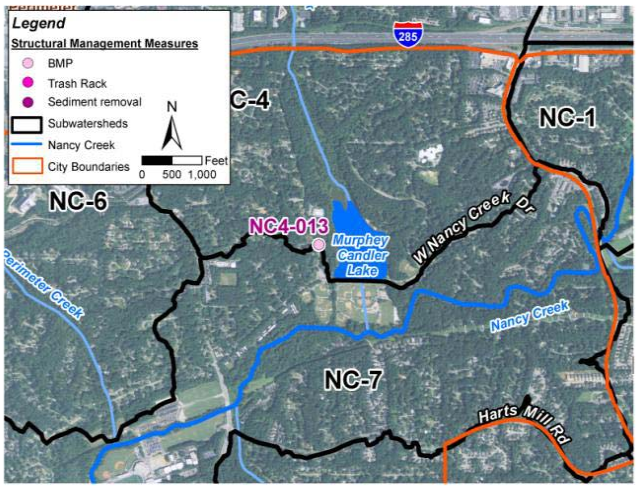
Sub-watershed: NC4 North Fork Nancy

Practice Type: New BMP

Description: Provide additional stormwater management with the planned revisions to the parking area along Candler Lake West. Options include several bioretention areas, enhanced swales, or street trees.

Watershed Goal(s) Supported:

1. Meet state water quality standards:
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: City

Existing Conditions: Drainage area has few existing stormwater controls.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 5.29

Contributing Impervious Area (ac): 2.16

Primary Hydrologic Soil Group (HSG) in DA: B

Annual Total Nitrogen Reduction (lb/yr): 58.67

Annual Total Phosphorus Reduction (lb/yr): 7.86

Annual Total Suspended Solids Reduction (lb/yr): 1884.2

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 16,250	
Planning Level Capital Cost ($): 65,000	
Planning Level Total Cost ($): 84,500	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 8,700	
Implementation Notes: Integrate stormwater design with the design, permitting, and construction of the planned park improvements.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 3,300	
Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	3	Total Score: 62.5
Pollutant Removal Score:	9	TSS Score: 2 Phosphorus Score: 3 Nitrogen Score: 4
Cost Benefit Score:	16	
Ease of Implementation:	25	Total Cost Score: 5 Ownership Score: 10 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	12.5	Visibility to Community Score: 7.5 Wildlife Diversity Score: 0 Compatibility with other City Plans: 5

Additional Comments

Project ID#: NC4-014

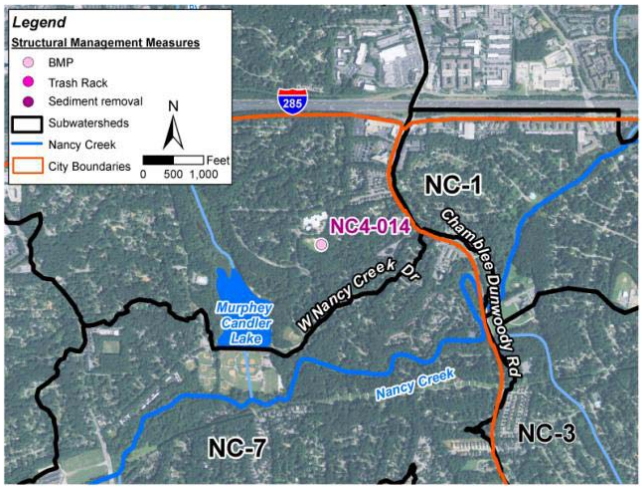
Sub-watershed: NC4 North Fork Nancy

Practice Type: New BMP

Description: Provide stormwater management through underground detention associated with upgrades to the existing recreational field and repair to existing drainage at Kittredge Magnet School. Associated with NC4-008.

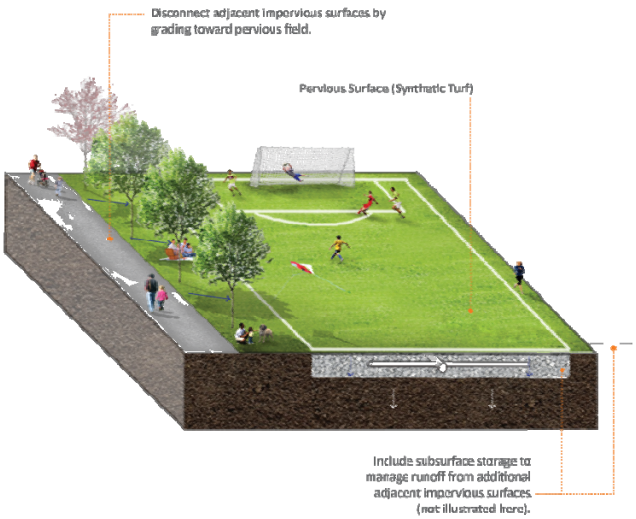
Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: DeKalb Public Schools	
Existing Conditions: School has no stormwater controls. The inlet at the edge of the recreational field is damaged. The field is muddy after rains.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 4.95
Contributing Impervious Area (ac): 1.04
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 28.23
Annual Total Phosphorus Reduction (lb/yr): 3.78
Annual Total Suspended Solids Reduction (lb/yr): 906.77

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 13,000	
Planning Level Capital Cost ($): 52,000	
Planning Level Total Cost ($): 67,600	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 6,900	
Implementation Notes: Work with DeKalb County Public Schools on needed maintenance. Evaluate installation of additional stormwater controls.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 2,600	
Annual Maintenance Notes: Maintain sheet flow onto field. If an underground tank is installed, it will need to be pumped periodically. If a multi-purpose pond is installed, the special soil mixture will need to be replaced.	

PROJECT RANKING		
Rank:	31	Total Score: 35
Pollutant Removal Score:	5	TSS Score: 1 Phosphorus Score: 2 Nitrogen Score: 2
Cost Benefit Score:	10	
Ease of Implementation:	17.5	Total Cost Score: 5 Ownership Score: 5 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 5
Additional Benefits:	2.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 0 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC4-015

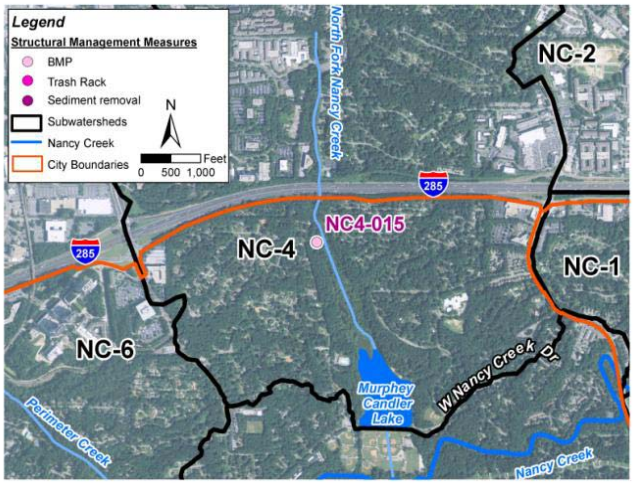
Sub-watershed: NC4 North Fork Nancy

Practice Type: New BMP

Description: Create an offline pond area to trap sediment upstream of Murphey Candler Lake, catching drainage from North Fork Nancy Creek. Location to be refined based on planned park survey.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City	
Existing Conditions: Sediment accumulation in Murphey Candler Lake is a concern and expensive to remove. Upstream controls will reduce sediment accumulation.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 90.14
Contributing Impervious Area (ac): 27.98
Primary Hydrologic Soil Group (HSG) in DA: B
Annual Total Nitrogen Reduction (lb/yr): 42.83
Annual Total Phosphorus Reduction (lb/yr): 8.01
Annual Total Suspended Solids Reduction (lb/yr): 2173.39

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 209,750	
Planning Level Capital Cost ($): 839,000	
Planning Level Total Cost ($): 1,090,700	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 111,800	
Implementation Notes: Offline ponds will need to be carefully designed, permitted, and constructed. Include paved access in trail re-design to allow for construction and maintenance. Federal, state, and local permits needed.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 42,000	
Annual Maintenance Notes: Remove accumulated sediment in offline pond area annually or as needed.	

PROJECT RANKING		
Rank:	27	Total Score: 36
Pollutant Removal Score:	9	TSS Score: 2 Phosphorus Score: 4 Nitrogen Score: 3
Cost Benefit Score:	2	
Ease of Implementation:	12.5	Total Cost Score: 0 Ownership Score: 10 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	12.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 5

Additional Comments

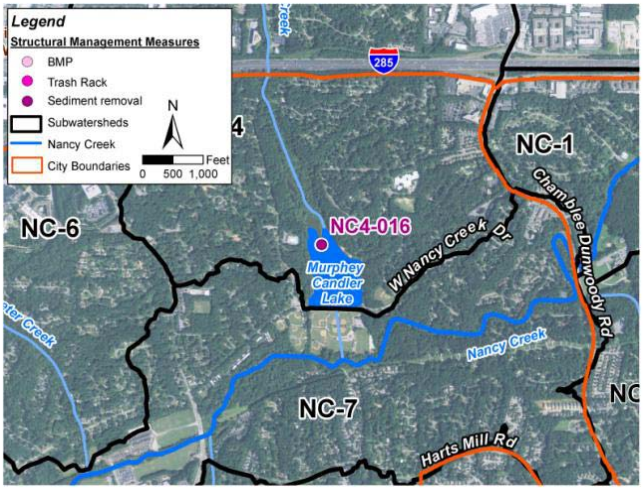
Project ID#: NC4-016

Sub-watershed: NC4 North Fork Nancy

Practice Type: Sediment Removal

Description: Maintenance dredging of accumulated sediment in the northern and eastern coves in Murphey Candler Lake.

Watershed Goal(s) Supported:
1. Meet state water quality standards:
2. Restore stream buffers:
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City	
Existing Conditions: Sediment accumulation in Murphey Candler Lake is visible in the upper coves and eastern cove.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr):
Annual Total Phosphorus Reduction (lb/yr):
Annual Total Suspended Solids Reduction (lb/yr):

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($):	
Planning Level Capital Cost ($):	
Planning Level Total Cost ($): $1.8 million (see additional notes	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($):	
Implementation Notes: Includes "maintenance" dredging of 12,000 cubic yards of accumulated sediment. Federal, state, and local permits required. Dredged materials may be dried and used on Field 11 and at Lynwood Park.	
Annual Maintenance Costs (post-construction based on capital cost) ($):	
Annual Maintenance Notes: Remove accumulated sediment on average once every 20 to 30 years.	

PROJECT RANKING		
Rank:	32	Total Score: 34
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	1	
Ease of Implementation:	12.5	Total Cost Score: 0 Ownership Score: 10 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	17.5	Visibility to Community Score: 10 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 5

Additional Comments
There are no modeled benefits to sediment removal; therefore the cost/benefit ratio could not be calculated and a value of 1 was assigned. The costs were estimated by the City and verified as part of the Plan development process.

Project ID#: NC4-017

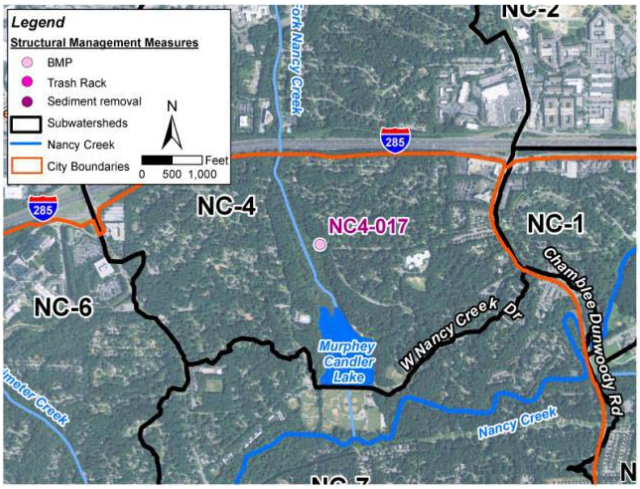
Sub-watershed: NC4 North Fork Nancy

Practice Type: New BMP

Description: Offline pond area to trap sediment upstream of Murphey Candler Lake, catching drainage from unnamed tributary on the NE side of the lake. Location to be refined based on planned park survey.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: City

Existing Conditions: Sediment accumulation in Murphey Candler Lake is a concern and expensive to remove. Upstream controls will reduce sediment accumulation.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 84.60

Contributing Impervious Area (ac): 28.20

Primary Hydrologic Soil Group (HSG) in DA: B

Annual Total Nitrogen Reduction (lb/yr): 43.17

Annual Total Phosphorus Reduction (lb/yr): 8.07

Annual Total Suspended Solids Reduction (lb/yr): 2191

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 211,500	
Planning Level Capital Cost ($): 846,000	
Planning Level Total Cost ($): 1,099,800	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 112,700	
Implementation Notes: Offline ponds will need to be carefully designed, permitted, and constructed. Include paved access in trail re-design to allow for construction and maintenance. Federal, state, and local permits needed.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 42,300	
Annual Maintenance Notes: Remove accumulated sediment in offline pond area annually or as needed.	

PROJECT RANKING		
Rank:	28	Total Score: 36
Pollutant Removal Score:	9	TSS Score: 2 Phosphorus Score: 4 Nitrogen Score: 3
Cost Benefit Score:	2	
Ease of Implementation:	12.5	Total Cost Score: 0 Ownership Score: 10 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	12.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 5

Additional Comments

Project ID#: NC4-018

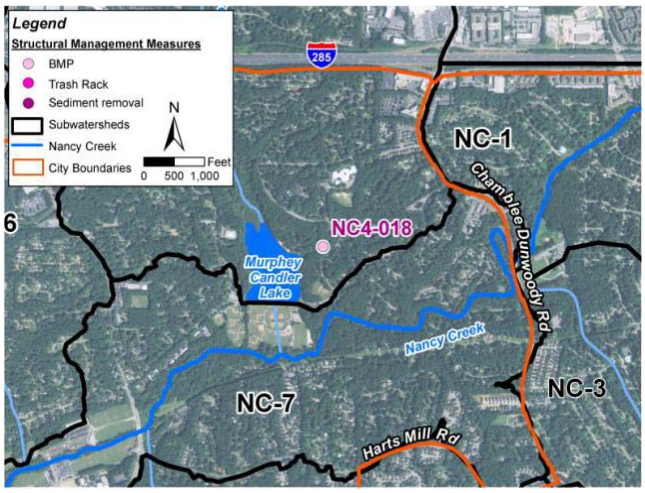
Sub-watershed: NC4 North Fork Nancy

Practice Type: New BMP

Description: Offline pond area to trap sediment upstream of Murphey Candler Lake, catching drainage from the unnamed tributary draining to the east cove. Location to be refined based on planned park survey.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: City

Existing Conditions: Sediment accumulation in Murphey Candler Lake is a concern and expensive to remove. Upstream controls will reduce sediment accumulation.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 78.03

Contributing Impervious Area (ac): 22.08

Primary Hydrologic Soil Group (HSG) in DA: B

Annual Total Nitrogen Reduction (lb/yr): 33.8

Annual Total Phosphorus Reduction (lb/yr): 6.32

Annual Total Suspended Solids Reduction (lb/yr): 1715.41

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 165,500	
Planning Level Capital Cost ($): 662,000	
Planning Level Total Cost ($): 860,600	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 88,200	
Implementation Notes: Offline ponds will need to be carefully designed, permitted, and constructed. Include paved access in trail re-design to allow for construction and maintenance. Federal, state, and local permits needed.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 33,100	
Annual Maintenance Notes: Remove accumulated sediment in offline pond area annually or as needed.	

PROJECT RANKING		
Rank:	32	Total Score: 34
Pollutant Removal Score:	7	TSS Score: 2 Phosphorus Score: 3 Nitrogen Score: 2
Cost Benefit Score:	2	
Ease of Implementation:	12.5	Total Cost Score: 0 Ownership Score: 10 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	12.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 5

Additional Comments

Project ID#: NC4-019

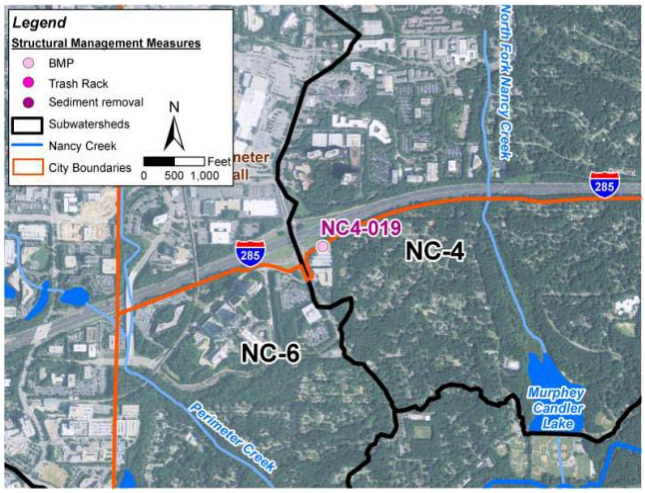
Sub-watershed: NC4 North Fork Nancy

Practice Type: BMP Retrofit

Description: Retrofit existing detention pond serving commercial building to provide water quality and perform needed maintenance.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers:
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics:



GENERAL SITE INFORMATION
Owner: Private Property
Existing Conditions: Existing pond requires maintenance. Opportunity to retrofit and enhance water quality benefits.

SITE PHOTOS

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 4.84
Contributing Impervious Area (ac): 3.46
Primary Hydrologic Soil Group (HSG) in DA: B
Annual Total Nitrogen Reduction (lb/yr): 45.36
Annual Total Phosphorus Reduction (lb/yr): 8.48
Annual Total Suspended Solids Reduction (lb/yr): 2301.97

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 52,000	
Planning Level Capital Cost ($): 208,000	
Planning Level Total Cost ($): 270,400	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 27,700	
Implementation Notes: Private property owner responsible for maintenance. City could partner to improve pond to achieve modern design requirements.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 10,400	
Annual Maintenance Notes: Remove accumulated sediment form a new forebay created as part of the pond retrofit annually or as needed. Maintain vegetation per maintenance agreement.	

PROJECT RANKING		
Rank:	39	TSS Score: 27.5
Pollutant Removal Score:	9	TSS Score: 2 Phosphorus Score: 4 Nitrogen Score: 3
Cost Benefit Score:	6	
Ease of Implementation:	10	Total Cost Score: 2.5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 5
Additional Benefits:	2.5	Visibility to Community Score: 0 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC5-001

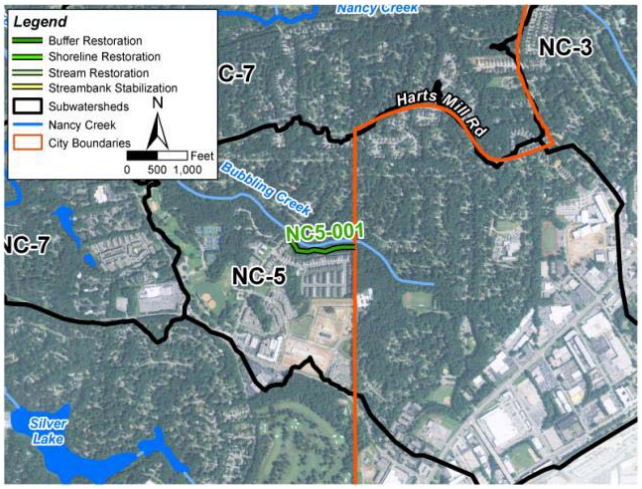
Sub-watershed: NC5 Bubbling Creek

Practice Type: Buffer Restoration

Description: Invasive species are threatening stream buffer health and causing downed trees. Remove invasive species and replant to healthy forest density.

Watershed Goal(s) Supported:

1. Meet state water quality standards:
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Invasive species are overwhelming the vegetated riparian buffer and resulting in tree losses. Primarily chinese privet and english ivy.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 8.31
Annual Total Phosphorus Reduction (lb/yr): 1.14
Annual Total Suspended Solids Reduction (lb/yr): 259.78

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 11,750	
Planning Level Capital Cost ($): 47,000	
Planning Level Total Cost ($): 61,100	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 5,300	
Implementation Notes: HOA owns approximately half of the stream buffer and the other half privately owned. Permanent easements needed. HOA may partner for maintenance beyond 3 years.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 1,400	
Annual Maintenance Notes: Perform maintenance invasive species removal at least annually for the first three years.	

PROJECT RANKING		
Rank:	41	TSS Score: 24.5
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	4	
Ease of Implementation:	10	Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 2.5
Additional Benefits:	7.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC5-002

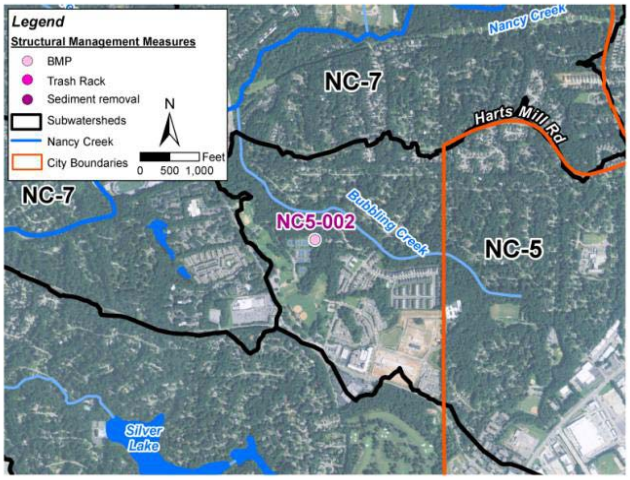
Sub-watershed: NC5 Bubbling Creek

Practice Type: New BMP

Description: Integrate new BMPs with planned improvements at Blackburn Park including field renovations, building improvements, and parking enhancements.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: City

Existing Conditions: Drainage area has very few stormwater controls. Opportunity to infiltrate stormwater with planned improvements.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 17.37

Contributing Impervious Area (ac): 7.79

Primary Hydrologic Soil Group (HSG) in DA:

Annual Total Nitrogen Reduction (lb/yr): 180.31

Annual Total Phosphorus Reduction (lb/yr): 24.13

Annual Total Suspended Solids Reduction (lb/yr): 5516.9

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 253,000	
Planning Level Capital Cost ($): 1,012,000	
Planning Level Total Cost ($): 1,315,600	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 134,800	
Implementation Notes: Integrate stormwater design with the design, permitting, and construction of the planned park improvements.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 50,600	
Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	4	Total Score: 62
Pollutant Removal Score:	14	TSS Score: 4 Phosphorus Score: 10 Nitrogen Score: 10
Cost Benefit Score:	3	
Ease of Implementation:	20	Total Cost Score: 0 Ownership Score: 10 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	15	Visibility to Community Score: 10 Wildlife Diversity Score: 0 Compatibility with other City Plans: 5

Additional Comments

Project ID#: NC5-003

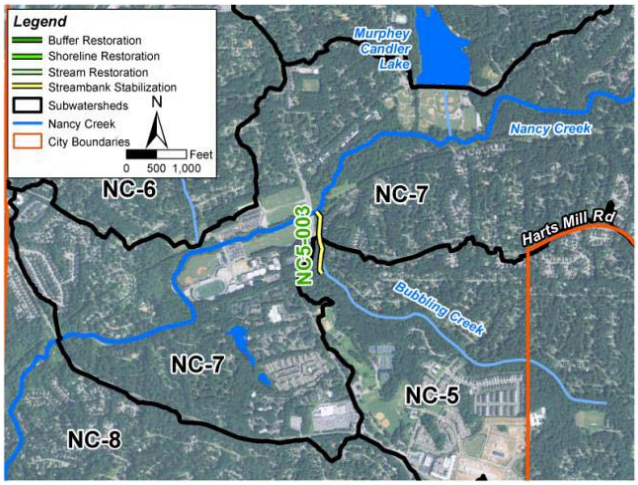
Sub-watershed: NC5 Bubbling Creek

Practice Type: Streambank Stabilization

Description: Significant stream erosion in compact suburban area. Stabilize streambanks and enhance floodplain connectivity. Improve transition to Nancy Creek.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: Private Property

Existing Conditions: Significant stream erosion with banks over 12 feet in areas. Habitat rated "marginal".

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 0.00

Contributing Impervious Area (ac): 0.00

Primary Hydrologic Soil Group (HSG) in DA:

Annual Total Nitrogen Reduction (lb/yr): 11.39

Annual Total Phosphorus Reduction (lb/yr): 2.5

Annual Total Suspended Solids Reduction (lb/yr): 4608.56

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 63,250	
Planning Level Capital Cost ($): 253,000	
Planning Level Total Cost ($): 328,900	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 28,700	
Implementation Notes: Stream stabilization must be properly designed, permitted, and constructed. Federal, state, and local permits will be required. Easements needed for private property.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 7,600	
Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	35	Total Score: 32
Pollutant Removal Score:	5	TSS Score: 3 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	12	
Ease of Implementation:	5	Total Cost Score: 2.5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	10	Visibility to Community Score: 5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 2.5

Additional Comments

Project ID#: NC6-001

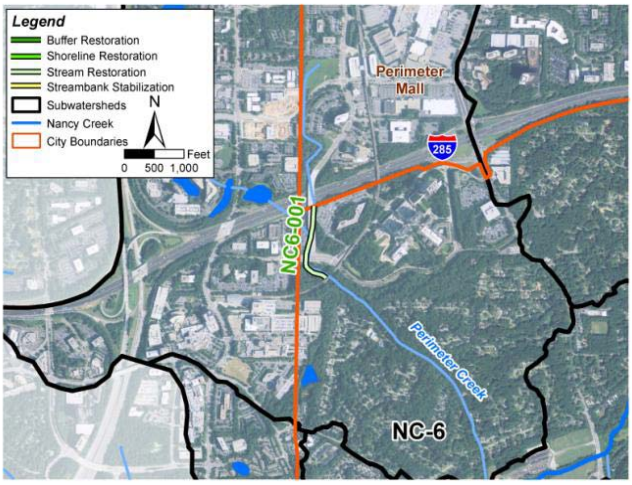
Sub-watershed: NC6 Perimeter Creek

Practice Type: Stream Restoration

Description: Restore stream and add grade control structures to mitigate velocity and protect infrastructure adjacent to the stream. Protect wide buffers, where exist. Partner with MARTA and private property owners.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City, Public, and Private Property	
Existing Conditions: Stream habitat conditions rated "sub-marginal". No riffles. Sedimentation dominated conditions in this section. Some bank erosion.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 7.01
Annual Total Phosphorus Reduction (lb/yr): 2.47
Annual Total Suspended Solids Reduction (lb/yr): 7007.14

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 71,250	
Planning Level Capital Cost ($): 285,000	
Planning Level Total Cost ($): 370,500	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 29,400	
Implementation Notes: Work on private property will require easements. Stream restoration will need to be properly designed and permitted. Federal, state, and local permits will be required.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 5,700	
Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	21	Total Score: 39
Pollutant Removal Score:	7	TSS Score: 5 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	17	
Ease of Implementation:	10	Total Cost Score: 2.5 Ownership Score: 5 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	5	Visibility to Community Score: 0 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC6-002

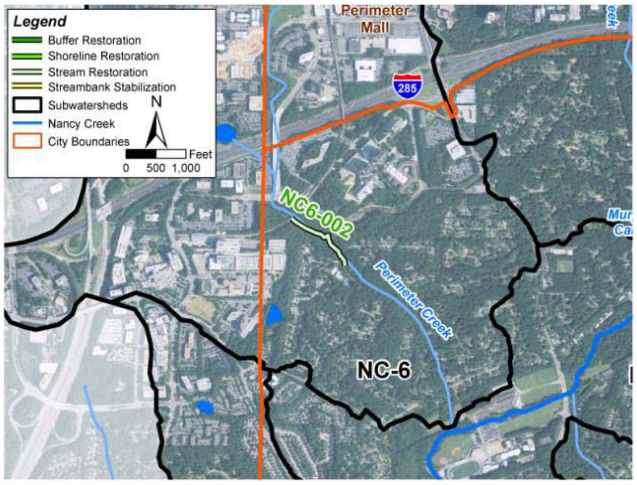
Sub-watershed: NC6 Perimeter Creek

Practice Type: Stream Stabilization

Description: Restore and/or maintain stream buffers to protect stream habitat. Some areas require stabilization, especially near infrastructure.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Public and Private Property	
Existing Conditions: Narrow stream buffers resulting in some bank erosion. Habitat conditions "marginal".	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 6.76
Annual Total Phosphorus Reduction (lb/yr): 2.38
Annual Total Suspended Solids Reduction (lb/yr): 6760.93

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 68,750	
Planning Level Capital Cost ($): 275,000	
Planning Level Total Cost ($): 357,500	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 28,400	
Implementation Notes: Work on private property will require easements. Stream restoration will need to be properly designed and permitted. Federal, state, and local permits will be required.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 5,500	
Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	22	Total Score: 38
Pollutant Removal Score:	6	TSS Score: 4 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	17	
Ease of Implementation:	10	Total Cost Score: 2.5 Ownership Score: 5 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC6-003

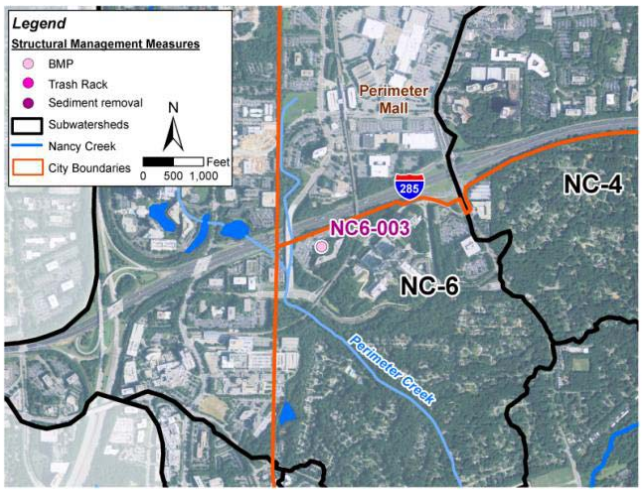
Sub-watershed: NC6 Perimeter Creek

Practice Type: New BMP

Description: Existing large building served by ineffective stormwater management. Opportunities to integrate bioretention areas and street trees to increase stormwater management and reduce velocities in creek.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Existing large building and parking lot with limited stormwater management.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 8.89
Contributing Impervious Area (ac): 3.91
Primary Hydrologic Soil Group (HSG) in DA: B
Annual Total Nitrogen Reduction (lb/yr): 90.69
Annual Total Phosphorus Reduction (lb/yr): 12.65
Annual Total Suspended Solids Reduction (lb/yr): 3014.07

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 78,250	
Planning Level Capital Cost ($): 313,000	
Planning Level Total Cost ($): 406,900	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 41,700	
Implementation Notes: Inform private property owner of stormwater utility fee benefits from upgrading existing stormwater controls.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 15,700	
Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	34	Total Score: 33
Pollutant Removal Score:	12	TSS Score: 2 Phosphorus Score: 5 Nitrogen Score: 5
Cost Benefit Score:	6	
Ease of Implementation:	12.5	Total Cost Score: 2.5 Ownership Score: 0 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	2.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 0 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC6-004

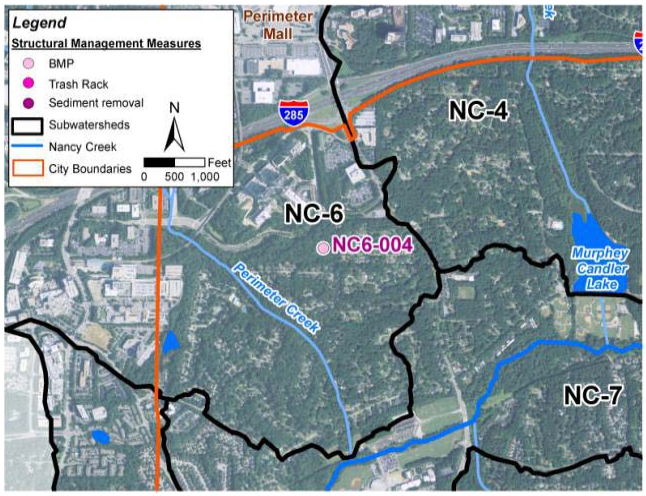
Sub-watershed: NC6 Perimeter Creek

Practice Type: New BMP

Description: Large undeveloped parcel, likely to develop. Consider partnership opportunity to expand stormwater required for development to reduce stormwater velocity and volume.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: Private Property

Existing Conditions: Large undeveloped parcel in an area with few existing stormwater controls.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 19.09

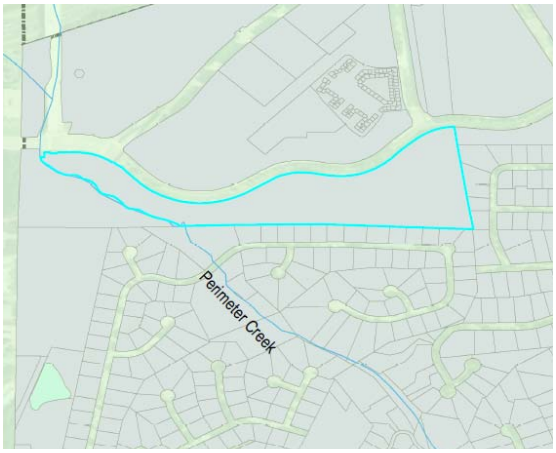
Contributing Impervious Area (ac): 6.52

Primary Hydrologic Soil Group (HSG) in DA: B

Annual Total Nitrogen Reduction (lb/yr): 187.56

Annual Total Phosphorus Reduction (lb/yr): 25.31

Annual Total Suspended Solids Reduction (lb/yr): 5873.49



IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 130,500	
Planning Level Capital Cost ($): 522,000	
Planning Level Total Cost ($): 678,600	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 69,500	
Implementation Notes: Partnerships with private property owners will require easements and maintenance agreements. Federal and state permits may be required in addition to local permits.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 26,100	
Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.	

PROJECT RANKING		
Rank:	13	Total Score: 40
Pollutant Removal Score:	24	TSS Score: 4 Phosphorus Score: 10 Nitrogen Score: 10
Cost Benefit Score:	6	
Ease of Implementation:	10	Total Cost Score: 0 Ownership Score: 0 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	0	Visibility to Community Score: 0 Wildlife Diversity Score: 0 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC6-005

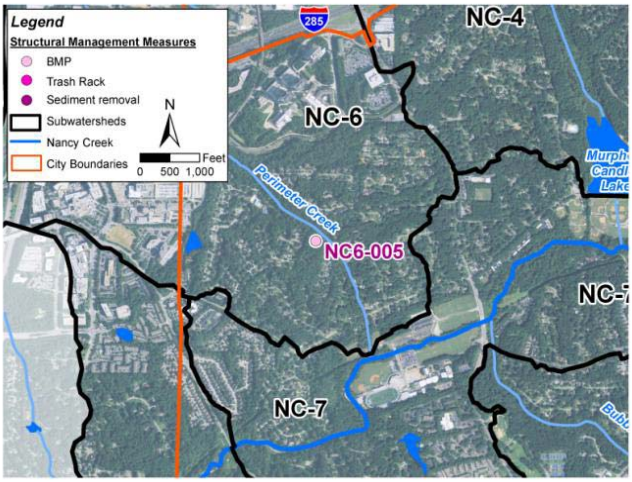
Sub-watershed: NC6 Perimeter Creek

Practice Type: New BMP

Description: Landlocked parcel adjacent to Perimeter Creek. Check tax status and consider securing for stormwater control structure. Would need construction and maintenance access agreements.

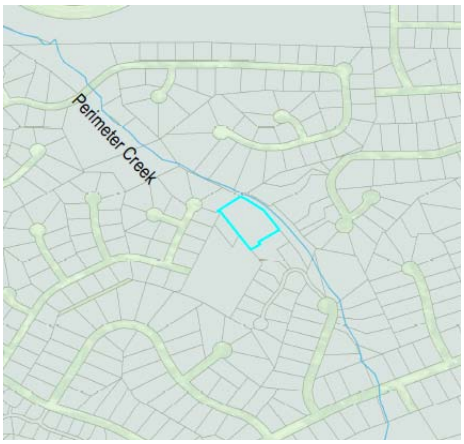
Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Landlocked parcel adjacent to Perimeter Creek, likely undevelopable.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 3.00
Contributing Impervious Area (ac): 0.63
Primary Hydrologic Soil Group (HSG) in DA: B
Annual Total Nitrogen Reduction (lb/yr): 18.12
Annual Total Phosphorus Reduction (lb/yr): 2.45
Annual Total Suspended Solids Reduction (lb/yr): 567.45



IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 4,750	
Planning Level Capital Cost ($): 19,000	
Planning Level Total Cost ($): 24,700	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 2,600	
Implementation Notes: Partnerships with private property owners will require easements and maintenance agreements. Federal and state permits may be required in addition to local permits.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 1,000	
Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.	

PROJECT RANKING		
Rank:	36	Total Score: 31.5
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	16	
Ease of Implementation:	12.5	Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 2.5
Additional Benefits:	0	Visibility to Community Score: 0 Wildlife Diversity Score: 0 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC6-006

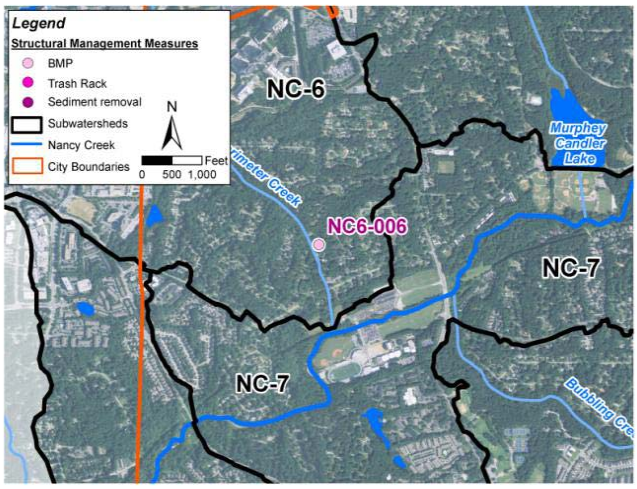
Sub-watershed: NC6 Perimeter Creek

Practice Type: New BMP

Description: Consider new BMP on HOA-owned land to replace existing inline structure on private property.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Existing stormwater management provided by a weir on the upstream end of a culvert, which would not currently be permitted.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 51.42
Contributing Impervious Area (ac): 14.81
Primary Hydrologic Soil Group (HSG) in DA: B
Annual Total Nitrogen Reduction (lb/yr): 425.95
Annual Total Phosphorus Reduction (lb/yr): 57.48
Annual Total Suspended Solids Reduction (lb/yr): 13338.77

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 111,000	
Planning Level Capital Cost ($): 444,000	
Planning Level Total Cost ($): 577,200	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 59,100	
Implementation Notes: Partnerships with private property owners will require easements and maintenance agreements. Federal and state permits may be required in addition to local permits.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 22,200	
Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.	

PROJECT RANKING		
Rank:	43	Total Score: 17
Pollutant Removal Score:	5	TSS Score: 1 Phosphorus Score: 2 Nitrogen Score: 2
Cost Benefit Score:	2	
Ease of Implementation:	5	Total Cost Score: 0 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 2.5
Additional Benefits:	5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC6-007

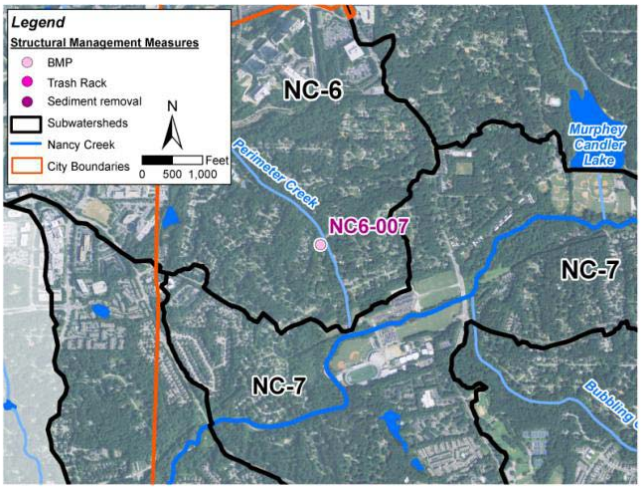
Sub-watershed: NC6 Perimeter Creek

Practice Type: New BMP

Description: Evaluate relocation of the existing non-functioning BMP in residential yard to HOA owned property. Design to provide water quality and quantity benefits.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: Private Property

Existing Conditions: Existing stormwater management pond in front yard of residential property is overgrown and does not appear to receive flow.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 4.08

Contributing Impervious Area (ac): 0.86

Primary Hydrologic Soil Group (HSG) in DA: B

Annual Total Nitrogen Reduction (lb/yr): 24.66

Annual Total Phosphorus Reduction (lb/yr): 3.33

Annual Total Suspended Solids Reduction (lb/yr): 772.21

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 6,500	
Planning Level Capital Cost ($): 26,000	
Planning Level Total Cost ($): 33,800	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 3,500	
Implementation Notes: Partnerships with HOA will require easements and maintenance agreements. Project will require state and local permits. May require federal permits.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 1,300	
Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.	

PROJECT RANKING		
Rank:	12	Total Score: 41
Pollutant Removal Score:	5	TSS Score: 1 Phosphorus Score: 2 Nitrogen Score: 2
Cost Benefit Score:	16	
Ease of Implementation:	15	Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 5 Potential Permitting Requirements Score: 5
Additional Benefits:	5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC6-008

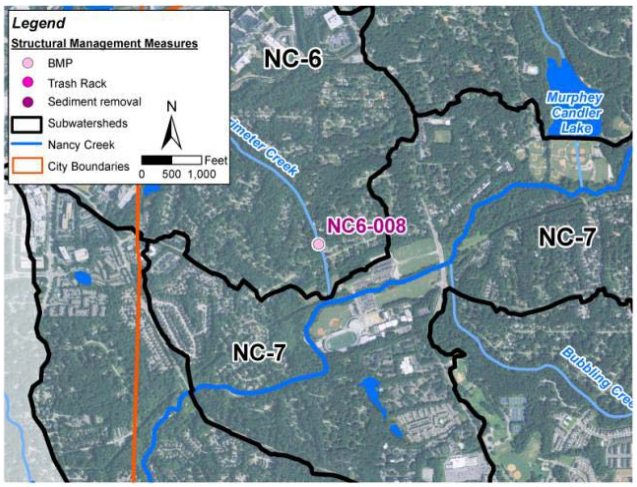
Sub-watershed: NC6 Perimeter Creek

Practice Type: New BMP

Description: Landlocked parcel adjacent to Perimeter Creek. Check tax status and consider securing for stormwater control structure. Would need construction and maintenance access agreements.

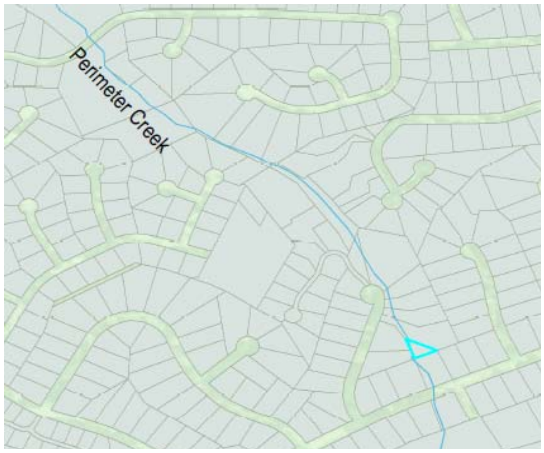
Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Landlocked parcel adjacent to Perimeter Creek, likely undevelopable.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 3.43
Contributing Impervious Area (ac): 0.75
Primary Hydrologic Soil Group (HSG) in DA: A/B
Annual Total Nitrogen Reduction (lb/yr): 21.68
Annual Total Phosphorus Reduction (lb/yr): 2.93
Annual Total Suspended Solids Reduction (lb/yr): 678.87



IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 5,750	
Planning Level Capital Cost ($): 23,000	
Planning Level Total Cost ($): 29,900	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 3,100	
Implementation Notes: Partnerships with private property owners will require easements and maintenance agreements. Federal and state permits may be required in addition to local permits.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 1,200	
Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.	

PROJECT RANKING		
Rank:	29	Total Score: 36
Pollutant Removal Score:	5	TSS Score: 1 Phosphorus Score: 2 Nitrogen Score: 2
Cost Benefit Score:	16	
Ease of Implementation:	12.5	Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 5
Additional Benefits:	2.5	Visibility to Community Score: 0 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC6-009

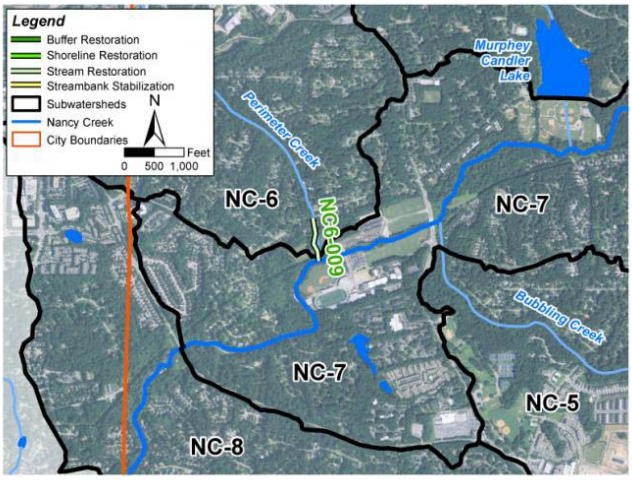
Sub-watershed: NC6 Perimeter Creek

Practice Type: Stream Restoration

Description: Stabilize and/or restore property along Perimeter Creek just upstream of the confluence with Nancy Creek. Buffer encroachment has resulted in significant bank erosion.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: Private Property

Existing Conditions: Stream habitat conditions rated "sub-marginal". Almost no vegetated buffer. Bank erosion and sedimentation prevalent.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac):

Contributing Impervious Area (ac):

Primary Hydrologic Soil Group (HSG) in DA:

Annual Total Nitrogen Reduction (lb/yr): 3.65

Annual Total Phosphorus Reduction (lb/yr): 1.28

Annual Total Suspended Solids Reduction (lb/yr): 3648.83

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 37,000	
Planning Level Capital Cost ($): 148,000	
Planning Level Total Cost ($): 192,400	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 15,300	
Implementation Notes: Work on private property will require easements. Special coordination with existing gas line. Stream restoration will need to be properly designed and permitted. Federal, state, and local permits will be required.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 3,000	
Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	16	TSS Score: 39.5
Pollutant Removal Score:	5	TSS Score: 3 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	17	
Ease of Implementation:	7.5	Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	10	Visibility to Community Score: 5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC7-001

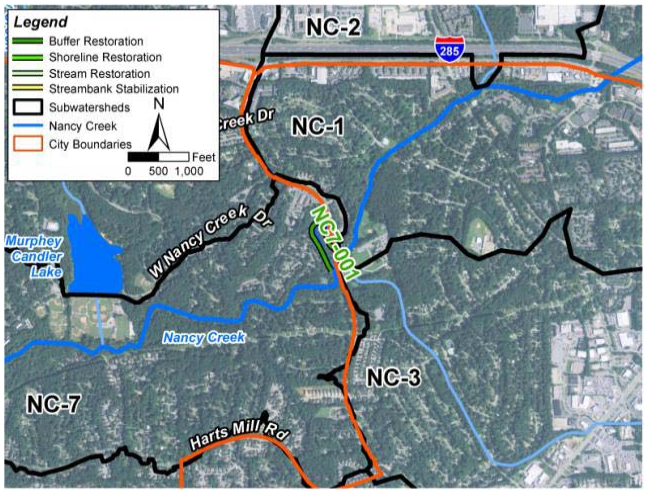
Sub-watershed: NC7 Nancy Creek

Practice Type: Buffer Restoration

Description: Restore the vegetated buffer zone in the D'Youville community to the extent available to protect banks from erosion that is starting to occur.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: Private Property

Existing Conditions: Stream habitat conditions rated "poor". Stream buffer is currently mowed and eroding. Habitat scores also influenced by the existing low head dam.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac):

Contributing Impervious Area (ac):

Primary Hydrologic Soil Group (HSG) in DA:

Annual Total Nitrogen Reduction (lb/yr): 52.06

Annual Total Phosphorus Reduction (lb/yr): 8.27

Annual Total Suspended Solids Reduction (lb/yr): 6769.97

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 93,000	
Planning Level Capital Cost ($): 372,000	
Planning Level Total Cost ($): 483,600	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 42,200	
Implementation Notes: Provide technical assistance to the HOA and forward opportunities for recompense projects.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 11,200	
Annual Maintenance Notes: Maintain newly planted vegetation and remove any volunteer invasive species. Replace vegetation, as needed.	

PROJECT RANKING		
Rank:	30	Total Score: 35.5
Pollutant Removal Score:	11	TSS Score: 4 Phosphorus Score: 4 Nitrogen Score: 3
Cost Benefit Score:	12	
Ease of Implementation:	7	Total Cost Score: 2.5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 2.5
Additional Benefits:	5.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC7-002

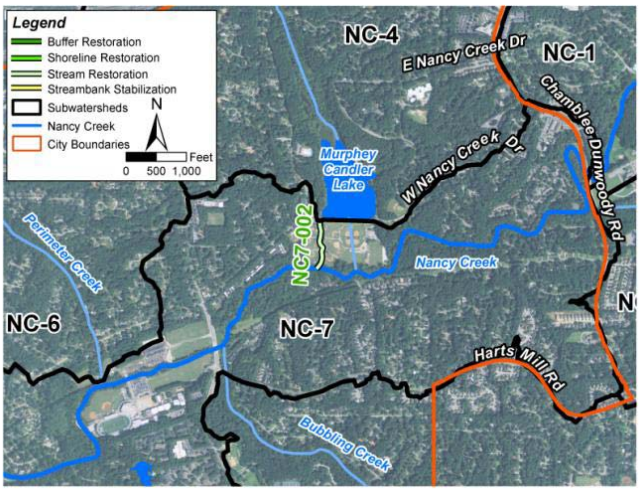
Sub-watershed: NC7 Nancy Creek

Practice Type: Stream Restoration

Description: North Fork Nancy Creek from the spillway to confluence with Nancy Creek. Address erosion with grade control and improve buffer within confines of existing recreation area. Integrate planned trail and bridge.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City	
Existing Conditions: Stream erosion severe at confluence with Nancy Creek, 15 foot tall banks. Stream buffer is compromised. Flows regulated by releases from Murphey Candler Dam.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 2.75
Annual Total Phosphorus Reduction (lb/yr): 0.97
Annual Total Suspended Solids Reduction (lb/yr): 2748.25

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 40,750	
Planning Level Capital Cost ($): 163,000	
Planning Level Total Cost ($): 211,900	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 16,900	
Implementation Notes: Stream stabilization must be properly designed, permitted, and constructed. Federal, state, and local permits will be required. Coordination needed with recreational sports' leagues.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 3,300	
Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	9	Total Score: 51
Pollutant Removal Score:	4	TSS Score: 2 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	12	
Ease of Implementation:	17.5	Total Cost Score: 5 Ownership Score: 10 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	17.5	Visibility to Community Score: 10 Wildlife Diversity Score: 5 Compatibility with other City Plans: 2.5

Additional Comments

Project ID#: NC7-003

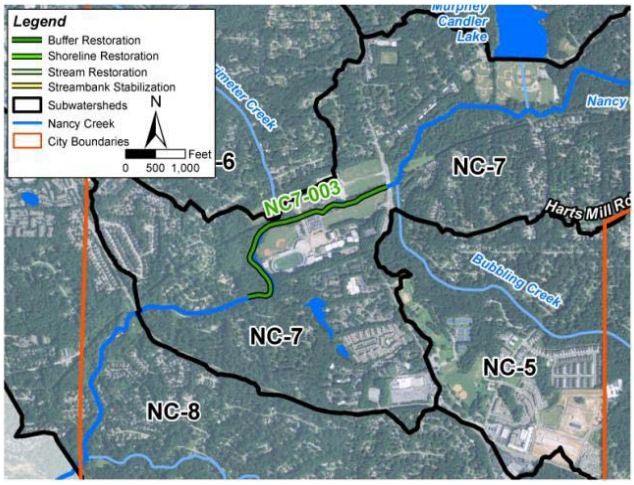
Sub-watershed: NC7 Nancy Creek

Practice Type: Buffer Restoration

Description: Support ongoing restoration of the stream buffer along the Marist campus.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Stream habitat conditions rated "poor". Limited buffer with hard armoring and invasive species present.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 118.67
Annual Total Phosphorus Reduction (lb/yr): 16.26
Annual Total Suspended Solids Reduction (lb/yr): 3777.6

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 37,250	
Planning Level Capital Cost ($): 149,000	
Planning Level Total Cost ($): 193,700	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 16,900	
Implementation Notes: Provide technical assistance to Marist and forward opportunities for recompense projects.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 4,500	
Annual Maintenance Notes: Maintain newly planted vegetation and remove any volunteer invasive species. Replace vegetation, as needed.	

PROJECT RANKING		
Rank:	7	Total Score: 53
Pollutant Removal Score:	17	TSS Score: 3 Phosphorus Score: 7 Nitrogen Score: 7
Cost Benefit Score:	16	
Ease of Implementation:	10	Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 2.5
Additional Benefits:	10	Visibility to Community Score: 5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC7-004

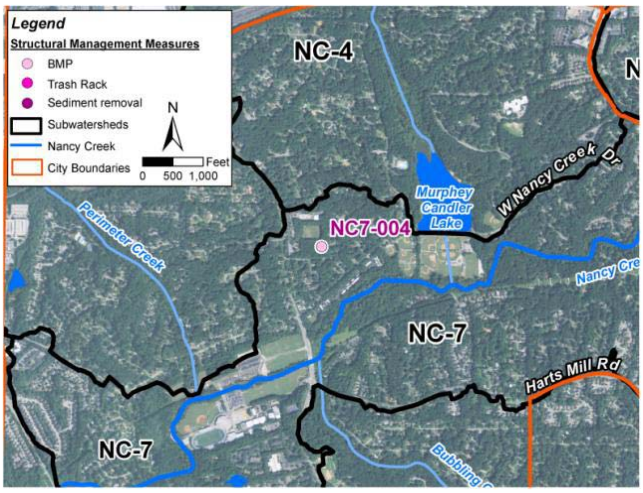
Sub-watershed: NC7 Nancy Creek

Practice Type: New BMP

Description: Integrate stormwater improvements and recreation field enhancements at Montgomery Elementary School. Consider underground detention under field as an option.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: DeKalb Public Schools

Existing Conditions: Existing school has no stormwater management. Recreational fields are wet and muddy following rains.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 8.60

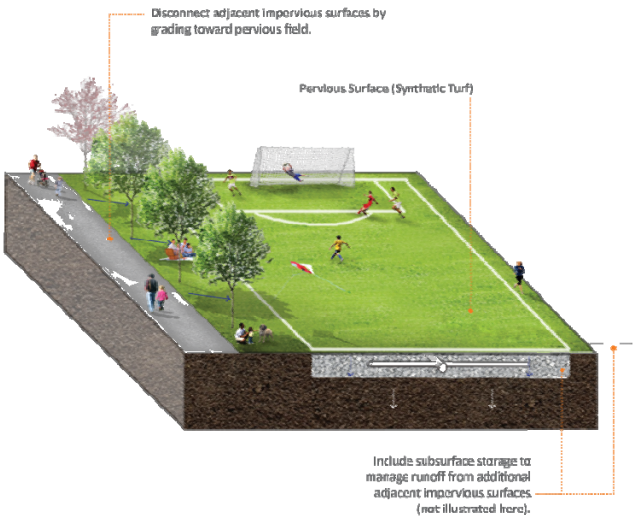
Contributing Impervious Area (ac): 1.93

Primary Hydrologic Soil Group (HSG) in DA:

Annual Total Nitrogen Reduction (lb/yr): 61.2

Annual Total Phosphorus Reduction (lb/yr): 8.2

Annual Total Suspended Solids Reduction (lb/yr): 1905.9

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 24,250	
Planning Level Capital Cost ($): 97,000	
Planning Level Total Cost ($): 126,100	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 13,000	
Implementation Notes: Work with DeKalb County Public Schools on needed maintenance. Evaluate installation of additional stormwater controls.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 4,900	
Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	11	Total Score: 41
Pollutant Removal Score:	10	TSS Score: 2 Phosphorus Score: 4 Nitrogen Score: 4
Cost Benefit Score:	11	
Ease of Implementation:	15	Total Cost Score: 5 Ownership Score: 2.5 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 5
Additional Benefits:	5	Visibility to Community Score: 5 Wildlife Diversity Score: 0 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC7-005

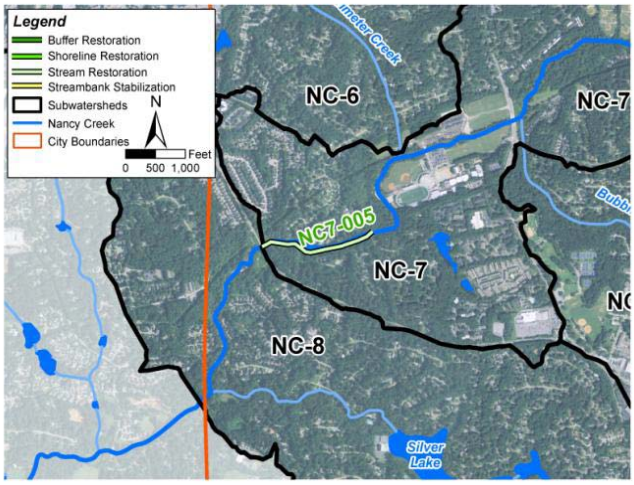
Sub-watershed: NC7 Nancy Creek

Practice Type: Stream Restoration

Description: Restoration of Nancy Creek from Marist to Johnson Ferry Road.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Stream habitat conditions rated "poor". Bank erosion and sedimentation dominated. Buffers compromised in areas.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 6.46
Annual Total Phosphorus Reduction (lb/yr): 2.28
Annual Total Suspended Solids Reduction (lb/yr): 6463.11

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 96,000	
Planning Level Capital Cost ($): 384,000	
Planning Level Total Cost ($): 499,200	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 39,700	
Implementation Notes: Stream stabilization must be properly designed, permitted, and constructed. Federal, state, and local permits will be required. Easements needed for private property.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 7,700	
Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	37	Total Score: 30.5
Pollutant Removal Score:	6	TSS Score: 4 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	12	
Ease of Implementation:	5	Total Cost Score: 2.5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	7.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC7-006

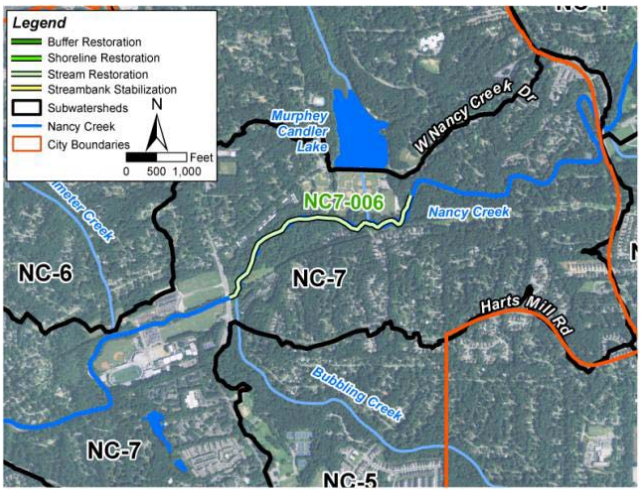
Sub-watershed: NC7 Nancy Creek

Practice Type: Stream Restoration

Description: Restoration of Nancy Creek from the football field in Murphey Candler Park to Ashford Dunwoody Road. Includes stream in Murphey Candler Park along with private property. Coordinate with planned greenway trail.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City and Private Property	
Existing Conditions: Stream habitat conditions rated "poor". Bank erosion and sedimentation dominated. Buffers compromised in areas.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 14.07
Annual Total Phosphorus Reduction (lb/yr): 4.95
Annual Total Suspended Solids Reduction (lb/yr): 14074.69

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 209,000	
Planning Level Capital Cost ($): 836,000	
Planning Level Total Cost ($): 1,086,800	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 86,300	
Implementation Notes: Stream stabilization must be properly designed, permitted, and constructed. Federal, state, and local permits will be required. Easements needed for private property. Coordination with recreational leagues.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 16,700	
Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	10	TSS Score: 49
Pollutant Removal Score:	12	TSS Score: 9 Phosphorus Score: 2 Nitrogen Score: 1
Cost Benefit Score:	12	
Ease of Implementation:	7.5	Total Cost Score: 0 Ownership Score: 5 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	17.5	Visibility to Community Score: 7.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 5

Additional Comments

Project ID#: NC7-007

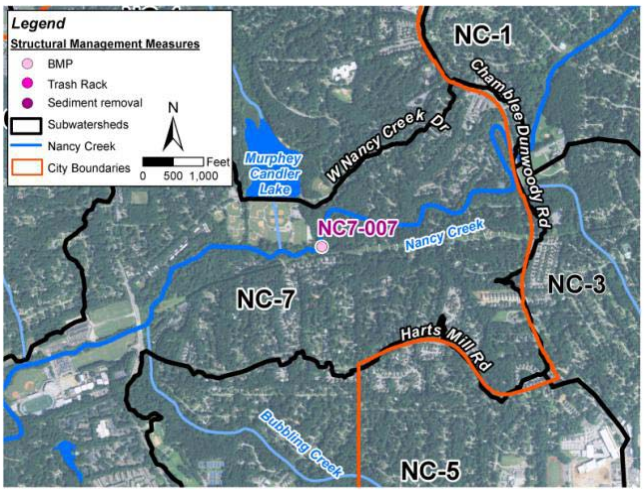
Sub-watershed: NC7 Nancy Creek

Practice Type: New BMP

Description: Large BMP that is overgrown and does not appear to be receiving flow. Convert into a constructed wetland to capture stormflows adjacent to Nancy Creek. Intended to function like a constructed wetland.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Existing stormwater management feature requires maintenance and appears to be under-utilized.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac): 288.79
Contributing Impervious Area (ac): 81.57
Primary Hydrologic Soil Group (HSG) in DA: B
Annual Total Nitrogen Reduction (lb/yr): 141.26
Annual Total Phosphorus Reduction (lb/yr): 26.39
Annual Total Suspended Solids Reduction (lb/yr): 6949.35

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 611,750	
Planning Level Capital Cost ($): 2,447,000	
Planning Level Total Cost ($): 3,181,100	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 326,000	
Implementation Notes: Partnerships with private property owners will require easements and maintenance agreements. Federal, state, and local permits will be required.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 122,400	
Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.	

PROJECT RANKING		
Rank:	15	Total Score: 40
Pollutant Removal Score:	23	TSS Score: 5 Phosphorus Score: 10 Nitrogen Score: 8
Cost Benefit Score:	2	
Ease of Implementation:	7.5	Total Cost Score: 0 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 5
Additional Benefits:	7.5	Visibility to Community Score: 0 Wildlife Diversity Score: 5 Compatibility with other City Plans: 2.5

Additional Comments

Project ID#: NC8-001

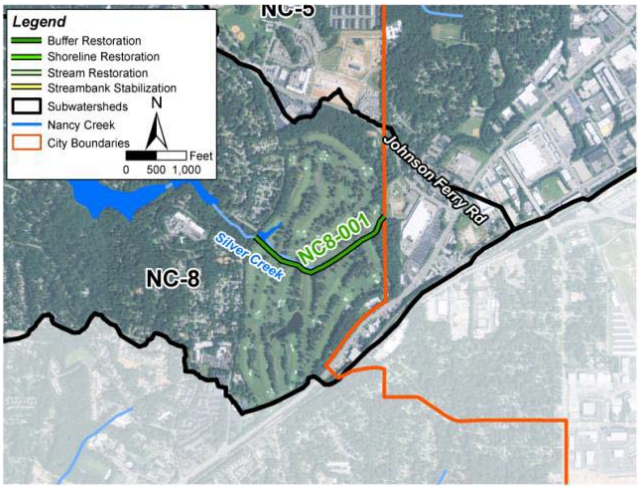
Sub-watershed: NC8 Silver Lake

Practice Type: Buffer Restoration

Description: Improve vegetated buffer along Silver Creek with golf course appropriate vegetation to help protect against stream bank erosion.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Stream habitat conditions rated "sub-marginal". Stream buffer is mowed to creek banks resulting in some erosion.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 19.11
Annual Total Phosphorus Reduction (lb/yr): 2.62
Annual Total Suspended Solids Reduction (lb/yr): 623.83

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 22,500	
Planning Level Capital Cost ($): 90,000	
Planning Level Total Cost ($): 117,000	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 10,200	
Implementation Notes: Provide technical assistance to the golf course and forward opportunities for recompense projects.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 2,700	
Annual Maintenance Notes: Maintain newly planted vegetation and remove any volunteer invasive species. Replace vegetation, as needed.	

PROJECT RANKING		
Rank:	42	TSS Score: 24
Pollutant Removal Score:	4	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 2
Cost Benefit Score:	5	
Ease of Implementation:	10	Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 2.5
Additional Benefits:	5	Visibility to Community Score: 0 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC8-002

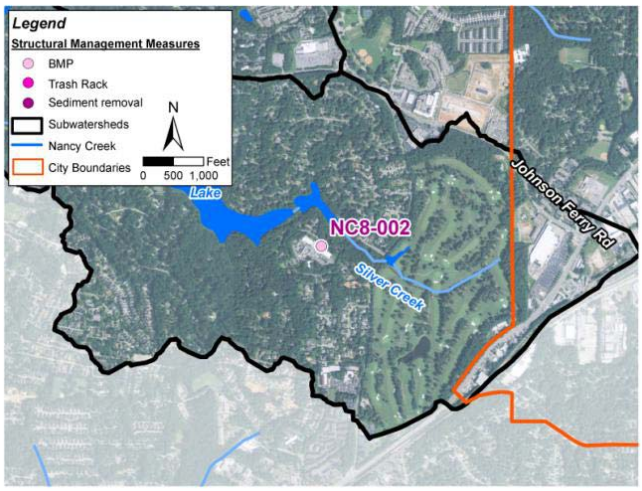
Sub-watershed: NC8 Silver Lake

Practice Type: New BMP

Description: Opportunities to integrate one or more bioretention facilities at the Our Lady of the Assumption Catholic Church. Integrate project into school science curriculum.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition:
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION

Owner: Private Property

Existing Conditions: Existing school with no stormwater management. Opportunity to infiltrate stormwater runoff.

SITE PHOTOS

WATER QUALITY MODELING DATA

Contributing Drainage Area (ac): 7.31

Contributing Impervious Area (ac): 1.75

Primary Hydrologic Soil Group (HSG) in DA:

Annual Total Nitrogen Reduction (lb/yr): 53.87

Annual Total Phosphorus Reduction (lb/yr): 7.21

Annual Total Suspended Solids Reduction (lb/yr): 1719.79

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 21,750	
Planning Level Capital Cost ($): 87,000	
Planning Level Total Cost ($): 113,100	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 11,600	
Implementation Notes: Inform private property owner of stormwater utility fee benefits from upgrading existing stormwater controls. Integrate into school science curriculum.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 4,400	
Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.	

PROJECT RANKING		
Rank:	26	TSS Score: 36.5
Pollutant Removal Score:	8	TSS Score: 2 Phosphorus Score: 3 Nitrogen Score: 3
Cost Benefit Score:	11	
Ease of Implementation:	15	Total Cost Score: 5 Ownership Score: 2.5 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 5
Additional Benefits:	2.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 0 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC8-003

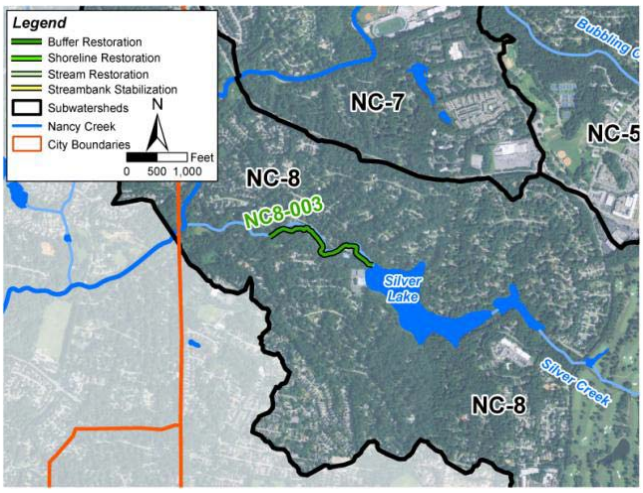
Sub-watershed: NC8 Silver Lake

Practice Type: Buffer Restoration

Description: Restore the stream buffers downstream of Silver Lake Dam to the extent possible and limit future buffer intrusions.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Stream habitat conditions rated "sub-marginal". Stream buffers impacted by recreational facilities and multiple driveway culverts.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 18.2
Annual Total Phosphorus Reduction (lb/yr): 2.49
Annual Total Suspended Solids Reduction (lb/yr): 594.05

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 21,500	
Planning Level Capital Cost ($): 86,000	
Planning Level Total Cost ($): 111,800	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 9,800	
Implementation Notes: Work on private property will require easements. Stream restoration will need to be properly designed and permitted. Federal, state, and local permits will be required.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 2,600	
Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	40	TSS Score: 25.5
Pollutant Removal Score:	3	TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	5	
Ease of Implementation:	10	Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 2.5
Additional Benefits:	7.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

Project ID#: NC8-004

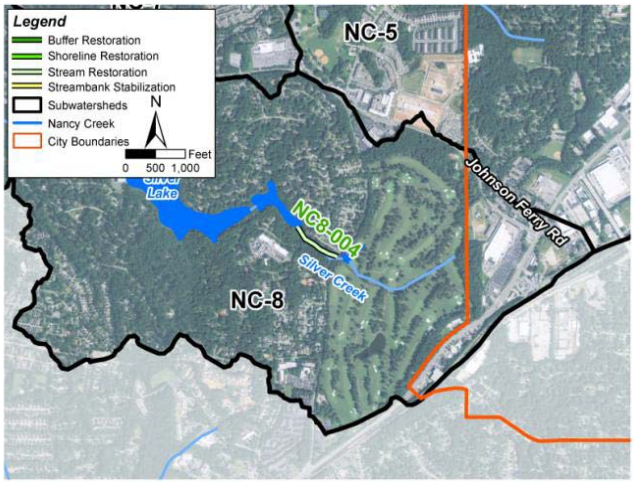
Sub-watershed: NC8 Silver Lake

Practice Type: Stream Restoration

Description: Restore stream and protect utilities upstream of Little Silver Lake. Coordinate with the ongoing Ashford Dunwoody Road corridor study and any recommended projects.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Stream habitat conditions rated "sub-marginal". Erosion and sedimentation in the segment upstream of Little Silver Lake.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 3.59
Annual Total Phosphorus Reduction (lb/yr): 1.26
Annual Total Suspended Solids Reduction (lb/yr): 3586.86

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 42,500	
Planning Level Capital Cost ($): 170,000	
Planning Level Total Cost ($): 221,000	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 17,500	
Implementation Notes: Work on private property will require easements. Stream restoration will need to be properly designed and permitted. Federal, state, and local permits will be required.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 3,400	
Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	23	TSS Score: 37.5
Pollutant Removal Score:	5	TSS Score: 3 Phosphorus Score: 1 Nitrogen Score: 1
Cost Benefit Score:	15	
Ease of Implementation:	7.5	Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	10	Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 2.5

Additional Comments

Project ID#: NC8-005

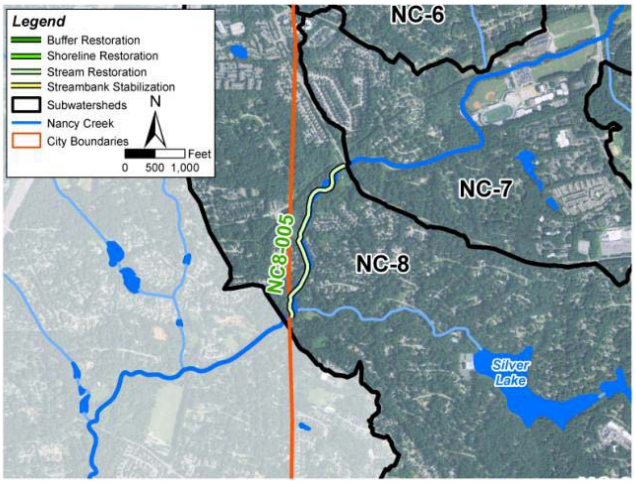
Sub-watershed: NC8 Silver Lake

Practice Type: Stream Restoration

Description: Restore Nancy Creek from Johnson Ferry to the Brookhaven city limits.

Watershed Goal(s) Supported:

1. Meet state water quality standards: Yes
2. Restore stream buffers: Yes
3. Improve streams to sub-optimal condition: Yes
4. Wildlife diversity and aesthetics: Yes



GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Stream habitat conditions rated "poor". Bank erosion and sedimentation dominated. Buffers compromised in areas.	

WATER QUALITY MODELING DATA
Contributing Drainage Area (ac):
Contributing Impervious Area (ac):
Primary Hydrologic Soil Group (HSG) in DA:
Annual Total Nitrogen Reduction (lb/yr): 13.81
Annual Total Phosphorus Reduction (lb/yr): 4.86
Annual Total Suspended Solids Reduction (lb/yr): 13806.03

IMPLEMENTATION INFORMATION	EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost ($): 163,250	
Planning Level Capital Cost ($): 653,000	
Planning Level Total Cost ($): 848,900	
Annual Cost/Benefit Ratio (Planning Level Annualized Capital $/ annual TSS removal) ($): 67,400	
Implementation Notes: Work on private property will require easements. Stream restoration will need to be properly designed and permitted. Federal, state, and local permits will be required.	
Annual Maintenance Costs (post-construction based on capital cost) ($): 13,100	
Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.	

PROJECT RANKING		
Rank:	24	TSS Score: 37
Pollutant Removal Score:	12	TSS Score: 9 Phosphorus Score: 2 Nitrogen Score: 1
Cost Benefit Score:	15	
Ease of Implementation:	2.5	Total Cost Score: 0 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0
Additional Benefits:	7.5	Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 0

Additional Comments

APPENDIX C: SUBWATERSHED SUMMARIES

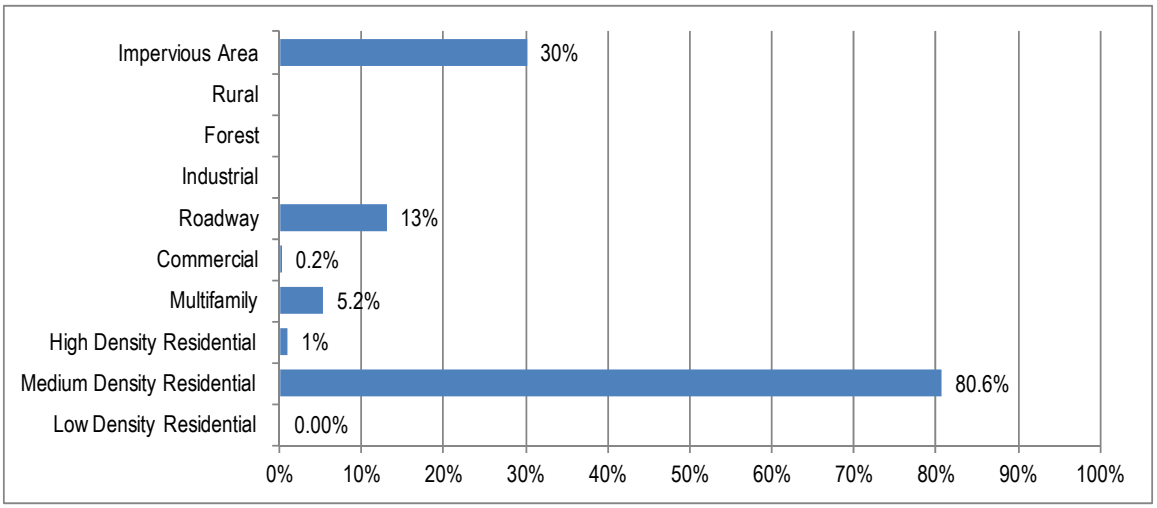
APPENDIX C: SUBWATERSHED SUMMARIES

This Appendix presents the existing conditions and recommendations for five of the subwatersheds; North Fork Nancy Creek (NC4), Bubbling Creek (NC5), Perimeter Creek (NC6), Nancy Creek Mainstem (NC7), and Silver Creek (NC8).

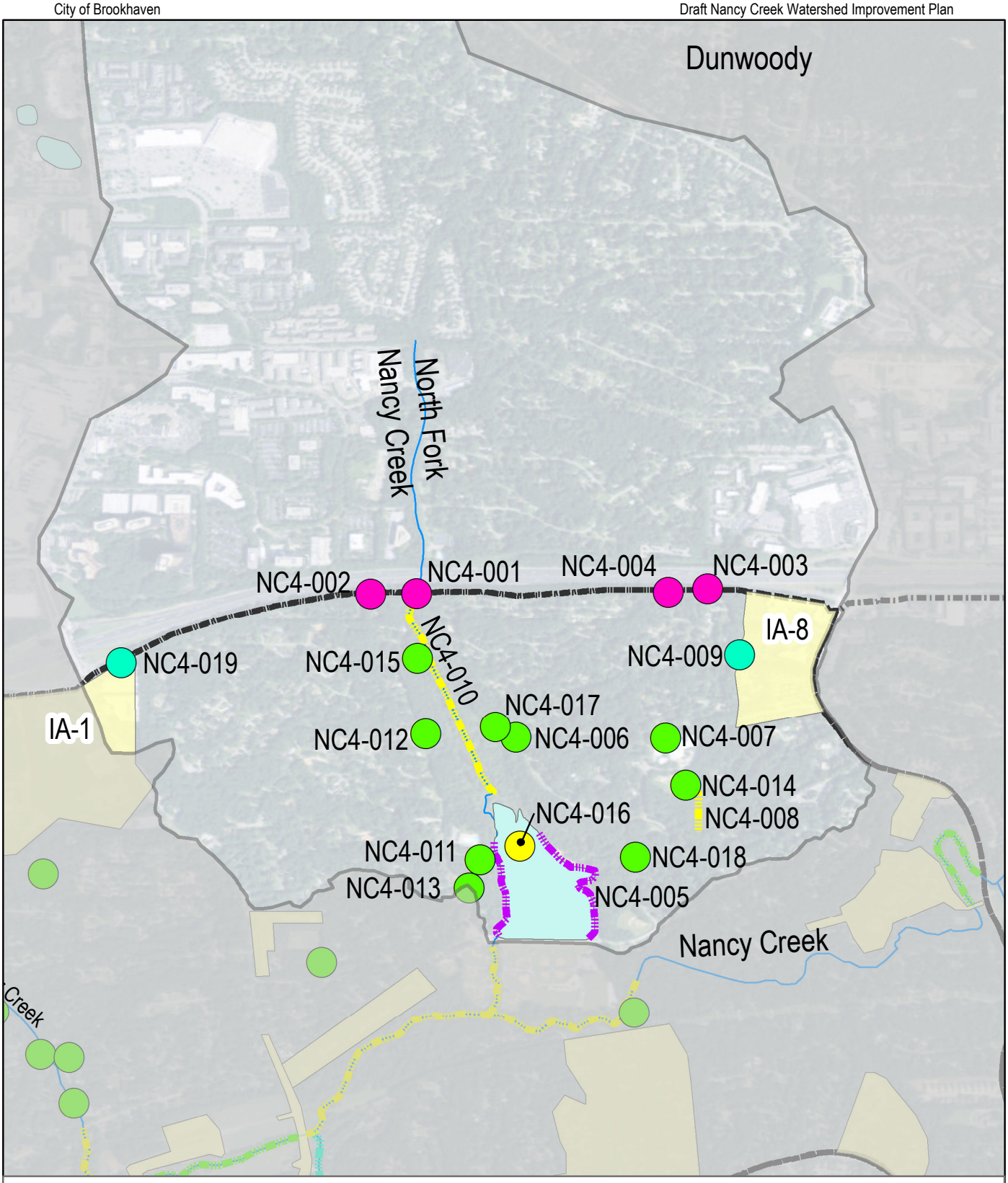
C.1. NC4: NORTH FORK NANCY CREEK

North Fork Nancy Creek flows south from Dunwoody into Brookhaven. This subwatershed includes Murphey Candler Lake and Park. The subwatershed is approximately 1,540 acres of which 470 acres, or about 30.5 percent, are within Brookhaven. Within Brookhaven, the watershed is primarily comprised of medium density residential land use followed by roadway and commercial areas as shown in Figure C-1. The overall impervious cover for the Brookhaven portion of the subwatershed is approximately 30 percent.

Figure C-1. North Fork Nancy Creek Subwatershed Land Use



The baseline conditions model shows that the TSS and nutrient loads are above those in a typical medium density residential watershed and the stream habitat is considered poor. There are 19 recommended projects and one recommended future retrofit assessment in this subwatershed, shown in Figure C-2. These recommended projects reduce the TSS load by 15.8 percent. The recommended projects are listed in Table C-1 and the recommended retrofit assessments are listed in Table C-2.



BMP Retrofit
New BMP
Trash Rack
Sediment Removal

Recommended Linear Projects
Buffer Restoration
Shoreline Restoration
Stream Restoration
Streambank Stabilization
Retrofit Assessments
Waterbody

Streams
N. Fork Nancy
Cities

0 0.05 0.1 0.2 0.3 0.4 Miles

N

SWP&E
Sustainable Water Planning and Engineering, LLC

Nancy Creek Watershed Improvement Plan

Figure C-2: North Fork Nancy Creek (NC4) Recommended Projects and Assessments

Table C-1. Recommended Watershed Improvement Projects for the North Fork Nancy Creek Subwatershed

Number	Project Type	Owner	Description	Goals Supported				Rank
				1	2	3	4	
NC4-001	Trash Rack	GDOT	Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.	Y			Y	17
NC4-002	Trash Rack	GDOT	Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.	Y			Y	18
NC4-003	Trash Rack	GDOT	Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.	Y			Y	19
NC4-004	Trash Rack	GDOT	Trash rack to capture debris/trash from I-285 runoff. Recommend a floating trash rack downstream of the culvert to capture floatables and debris from the catch basins and associated drainage channels.	Y			Y	20
NC4-005	Shoreline Restoration	City	Restore 3,400 linear feet of shoreline around Murphey Candler Lake (shore classified as “poor” or “threatened”).		Y		Y	13
NC4-006	New BMP	City	New bioretention area at the bend in East Nancy Creek Drive in Murphey Candler Park. Recommend three-tiered and tie in adjacent catch basin drainage as well as direct road drainage before draining to the stream.	Y	Y		Y	1
NC4-007	New BMP	DeKalb Public Schools	New bioretention or enhanced swale area in front of Kittredge Magnet School.	Y	Y	Y	Y	25
NC4-008	Stream Restoration	DeKalb Public Schools	Restoration of 390 linear feet of eroding drainage channel at Kittredge Magnet School leading into a tributary to Murphey Candler Lake. Associated with NC4-014.	Y	Y	Y	Y	8
NC4-009	BMP Retrofit	Private Property	Retrofit an existing office stormwater structure to retain stormwater and provide water quality treatment and address drainage issue in downstream residential area.	Y	Y		Y	38
NC4-010	Stream Restoration	City and Private Property	Restore approximately 3,400 linear feet of North Fork Nancy Creek from I-285 to Murphey Candler Lake that is classified as “poor” and “threatened”.	Y	Y	Y	Y	5
NC4-011	New BMP	City	Provide additional stormwater management with the planned revisions to the parking lot adjacent to Murphey Candler Pool. Options include several bioretention areas, enhanced swales, or street trees.		Y		Y	6

Number	Project Type	Owner	Description	Goals Supported				Rank
				1	2	3	4	
NC4-012	New BMP	City	Address existing drainage issues with the planned sidewalk extension. Add bioswales upstream and downstream of the catch basin.		Y		Y	2
NC4-013	New BMP	City	Provide additional stormwater management with the planned revisions to the parking area along Candler Lake West. Options include several bioretention areas, enhanced swales, or street trees.		Y		Y	3
NC4-014	New BMP	DeKalb Public Schools	Provide stormwater management through underground detention associated with upgrades to the existing recreational field and repair to existing drainage at Kittredge Magnet School. Associated with NC4-008.	Y	Y		Y	31
NC4-015	New BMP	City	Create an offline pond area to trap sediment upstream of Murphey Candler Lake, catching drainage from North Fork Nancy Creek. Location to be refined based on planned park survey.	Y	Y		Y	27
NC4-016	Sediment Removal	City	Maintenance dredging of accumulated sediment in the northern and eastern coves in Murphey Candler Lake.				Y	33
NC4-017	New BMP	City	Offline pond area to trap sediment upstream of Murphey Candler Lake, catching drainage from unnamed tributary on the NE side of the lake. Location to be refined based on planned park survey.	Y	Y		Y	28
NC4-018	New BMP	City	Offline pond area to trap sediment upstream of Murphey Candler Lake, catching drainage from the unnamed tributary draining to the east cove. Location to be refined based on planned park survey.	Y	Y		Y	32
NC4-019	BMP Retrofit	Private Property	Retrofit existing detention pond serving commercial building to provide water quality and perform needed maintenance.	Y				39

In addition to the projects identified above, one area within this subwatershed has a high level of impervious cover, listed in Table C-2. A future evaluation of this area to identify candidate retrofit sites, contributes toward reaching the 35 percent TSS reduction goal.

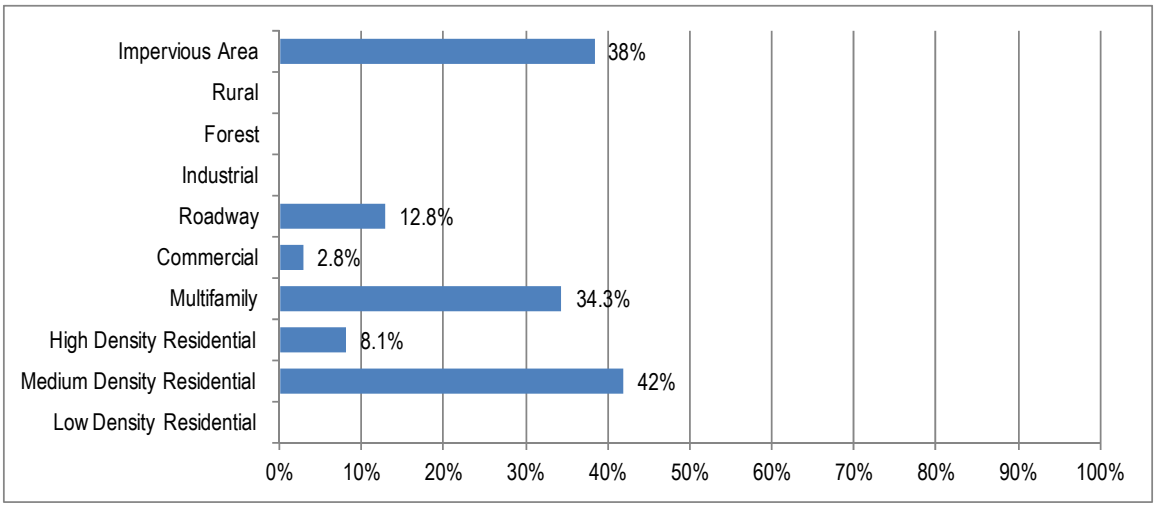
Table C-2. Retrofit Assessments Recommended for the North Fork Nancy Creek Subwatershed

Number	Total Area (acres)	Impervious Area (acres)	% Impervious Area	Unmanaged Impervious Area to Treat (acres)	Description
IA-8	22.8	9.1	39.8%	4.6	Northeast area of subwatershed with concentration of office and commercial land use.

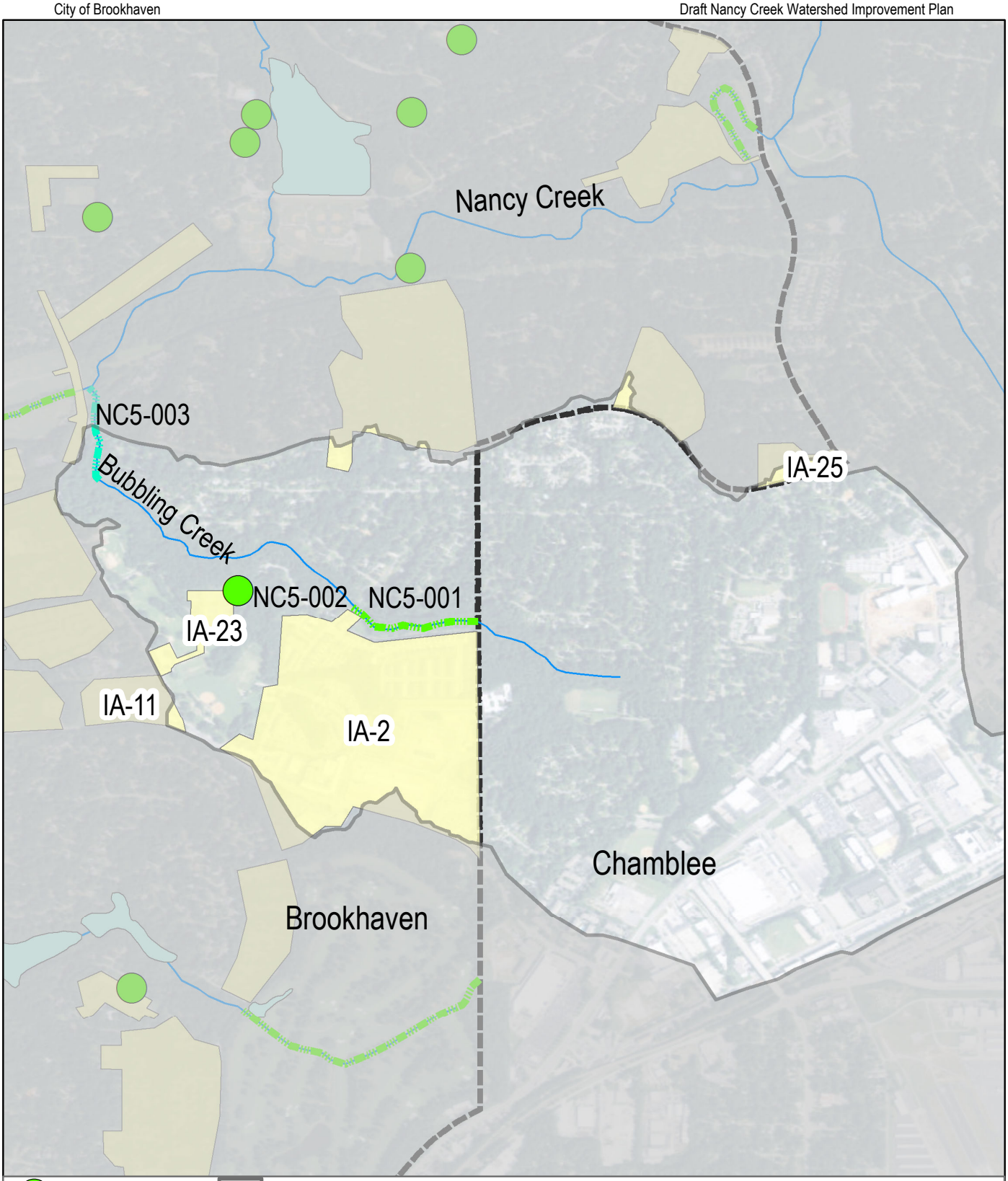
C.2. NC5: BUBBLING CREEK

Bubbling Creek flows northwest from Chamblee into Brookhaven. This subwatershed includes Blackburn Park. The subwatershed is the smallest in the Study Area with approximately 840 acres of which 280 acres, or about 33 percent, is located within Brookhaven. Within Brookhaven, the subwatershed is primarily comprised of low and medium density residential land use followed by roadway, high density residential and commercial areas (Figure 3-6). The overall impervious cover for the Brookhaven portion of the subwatershed is approximately 38 percent, which is the highest within Brookhaven.

Figure C-3. Bubbling Creek Subwatershed Land Use



The baseline conditions model show that the TSS and nutrient loads were above those in a typical medium density residential watershed and the stream habitat is considered sub-optimal with stretches of marginal habitat in the upstream and downstream portions of the subwatershed. There are three recommended projects and two recommended future retrofit assessments in this subwatershed, shown in Figure C-4. These recommended projects reduce the TSS load by 5.4 percent. The recommended projects are summarized in Table C-3 and the recommended retrofit assessments are listed in Table C-4.



New BMP
Bubbling Creek
Cities

Recommended Stream Projects
Buffer Restoration
Streambank Stabilization
Retrofit Assessments
Waterbody
Streams

0 0.05 0.1 0.2 0.3 0.4 Miles

N

Nancy Creek Watershed Improvement Plan

Figure C-4: Bubbling Creek (NC5) Recommended Projects and Assessments

SWP&E
Sustainable Water Planning and Engineering, LLC

Table C-3. Recommended Watershed Improvement Projectsfor the Bubbling Creek Subwatershed

Number	Project Type	Owner	Description	Goals Supported				Rank
				1	2	3	4	
NC5-001	Buffer Restoration	Private Property	Invasive species are threatening stream buffer health and causing downed trees. Remove invasive species and replant to healthy forest density.		Y	Y	Y	41
NC5-002	New BMPs	City	Integrate new BMPs with planned improvements at Blackburn Park including field renovations, building improvements, and parking enhancements.	Y	Y	Y	Y	4
NC5-003	Streambank Stabilization / Buffer Restoration	Private Property	Significant stream erosion in compact suburban area. Stabilize streambanks and enhance floodplain connectivity. Improve transition to Nancy Creek.	Y	Y	Y	Y	35

In addition to the projects identified above, two areas within this subwatershed have a high level of impervious cover, listed in Table C-4. A future evaluation of these areas to identify candidate retrofit sites, contributes toward reaching the 35 percent TSS reduction goal.

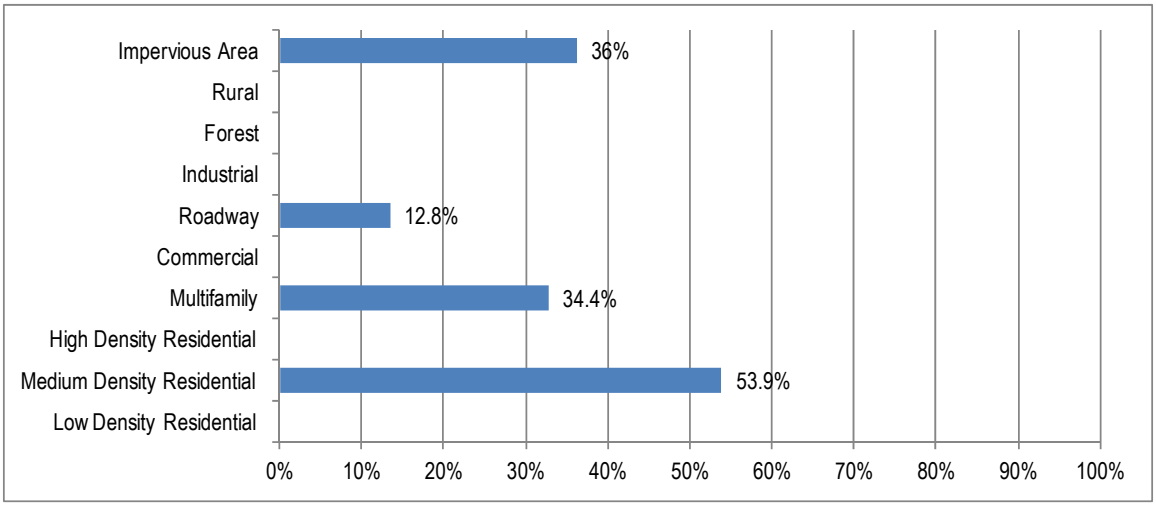
Table C-4. Retrofit Assessments Recommended for the Bubbling Creek Subwatershed

Number	Total Area (acres)	Impervious Area (acres)	% Impervious Area	Unmanaged Impervious Area to Treat (acres)	Description
IA-2	98.5	36.9	37.4%	37	Upper reaches of the subwatershed within Brookhaven, south of Bubbling Creek. Includes a small area in NC-8 subwatershed. Second largest recommended retrofit assessment area.
IA-23	6.4	2.5	38.5%	0.1	Middle portion of the subwatershed and includes the commercial area near Blackburn Park. Impervious area to treat is low because of a recommended project in this area. If that project doesn't treat all of the runoff, additional projects would be needed.

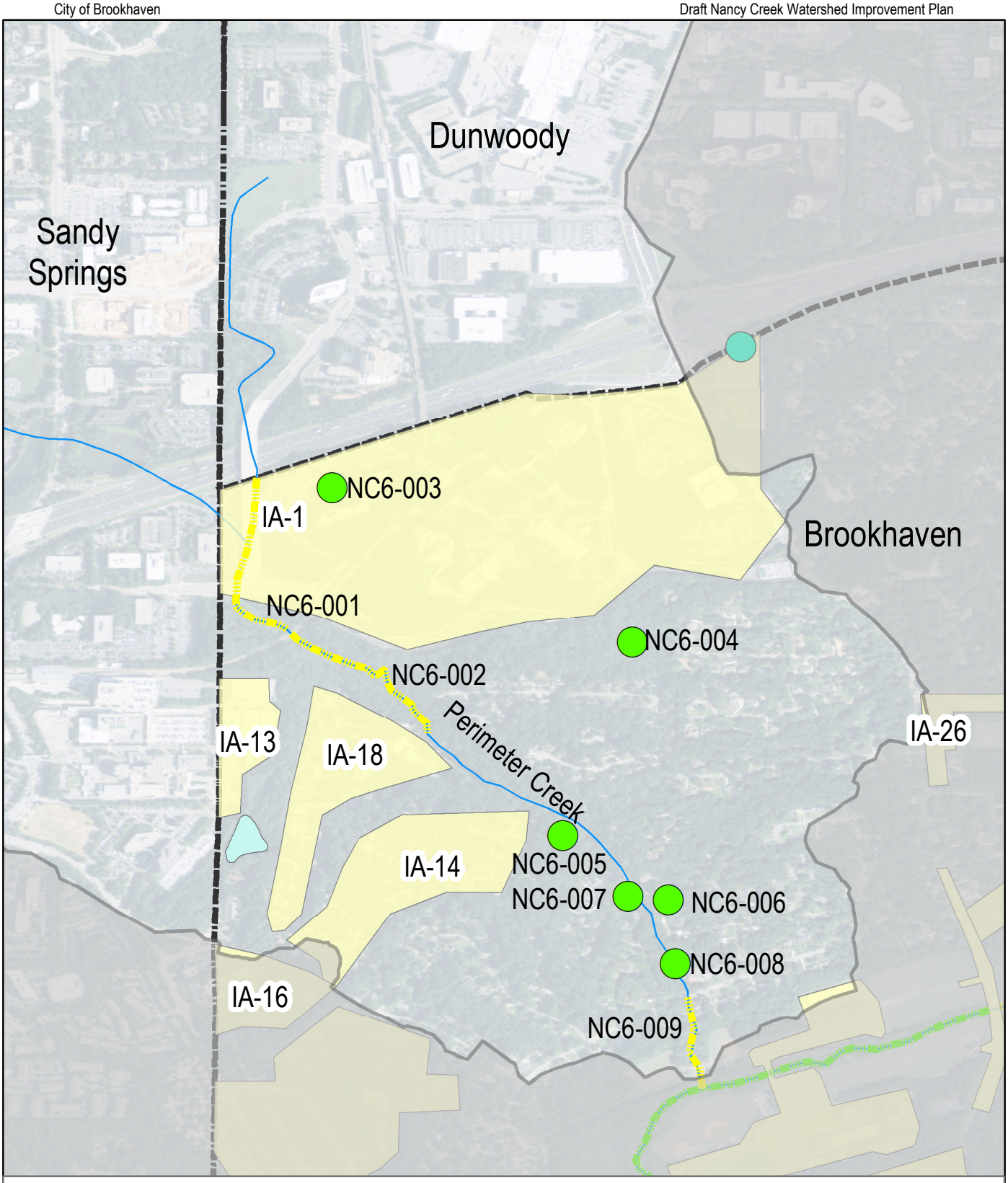
C.3. NC6: PERIMETER CREEK

Perimeter Creek flows south from Dunwoody and Sandy Springs into Brookhaven where it flows southeast to its confluence with Nancy Creek on the Marist campus. The headwaters for Perimeter Creek are located at Perimeter Mall and most of the surrounding commercial area drains to Perimeter Creek. The Perimeter Creek subwatershed is 1,800 acres in size with 440 acres or 24.4 percent located within Brookhaven. The subwatershed, in Brookhaven, is primarily medium-density residential and multi-family with some roadway land uses. Figure 3-8 shows the land cover for the Perimeter Creek subwatershed. The overall impervious cover within Brookhaven is 37 percent.

Figure C-5. Perimeter Creek Subwatershed Land Use



The baseline conditions model shows that the TSS and nutrient loads are above those in a typical medium density residential watershed. Within Brookhaven, the Perimeter Creek subwatershed has the highest TSS load per acre. The stream habitat is considered sub-marginal with stretches of marginal and one reach with sub-optimal habitat. The sub-marginal reaches include the most upstream and most downstream portions. The reach with sub-optimal habitat conditions is in a residential area where wider stream buffers protect the stream integrity. There are nine recommended projects and four recommended future retrofit assessments in this subwatershed, shown in Figure C-6. These recommended projects reduce the TSS load by 13.9 percent. The recommended projects are listed in Table C-5 and the recommended retrofit assessments are listed in Table C-6.



BMP Retrofit
New BMP
Recommended Stream Projects
Buffer Restoration
Stream Restoration
Retrofit Assessments
Waterbody
Streams
Perimeter Creek
Cities

0 0.05 0.1 0.2 0.3 0.4 Miles

N

Nancy Creek Watershed Improvement Plan

Figure C-6: Perimeter Creek (NC6) Recommended Projects and Assessments

SWP&E Sustainable Water Planning and Engineering, LLC

Table C-5. Recommended Watershed Improvement Projects for Perimeter Creek Subwatershed

Number	Project Type	Owner	Description	Goals Supported				Rank
				1	2	3	4	
NC6-001	Stream Restoration	City, Public, Private Property	Restore stream and add grade control structures to mitigate velocity and protect infrastructure adjacent to the stream. Protect wide buffers, where they exist. Partner with MARTA and private property owners.	Y	Y	Y	Y	21
NC6-002	Stream Stabilization	Public, Private Property	Restore and/or maintain stream buffers to protect stream habitat. Some areas will require stabilization, especially near infrastructure.	Y	Y	Y	Y	22
NC6-003	New BMP	Private Property	Existing large building served by ineffective stormwater management. Opportunities to integrate bioretention areas to increase stormwater management and reduce velocities in creek.	Y	Y	Y	Y	34
NC6-004	New BMP	Private Property	Large undeveloped parcel likely to develop. Consider partnership opportunity to expand stormwater required for development to reduce stormwater velocity and volume.	Y	Y		Y	14
NC6-005	New BMP	Private Property	Landlocked parcel adjacent to Perimeter Creek. Check tax status and consider securing for stormwater control structure. Would need construction and maintenance access agreements.	Y	Y	Y	Y	36
NC6-006	New BMP	Private Property	Consider new BMP to replace existing inline structure on private property to HOA owned land.	Y	Y		Y	43
NC6-007	New BMP	Private Property	Evaluate relocating existing non-functioning BMP in residential yard to HOA owned property. Design to provide water quality and quantity benefits.	Y	Y		Y	12
NC6-008	New BMP	Private Property	Landlocked parcel adjacent to Perimeter Creek. Check tax status and consider securing for stormwater control structure. Would need construction and maintenance access agreements.	Y	Y	Y	Y	29
NC6-009	Stream Restoration	Private Property	Stabilize and/or restore property along Perimeter Creek just upstream of the confluence with Nancy Creek. Buffer encroachment has resulted in significant bank erosion.	Y	Y	Y	Y	16

In addition to the projects identified above, four areas within this subwatershed have a high level of impervious cover, listed in Table C-6. A future evaluation of these areas to identify candidate retrofit sites, contributes toward reaching the 35 percent TSS reduction goal.

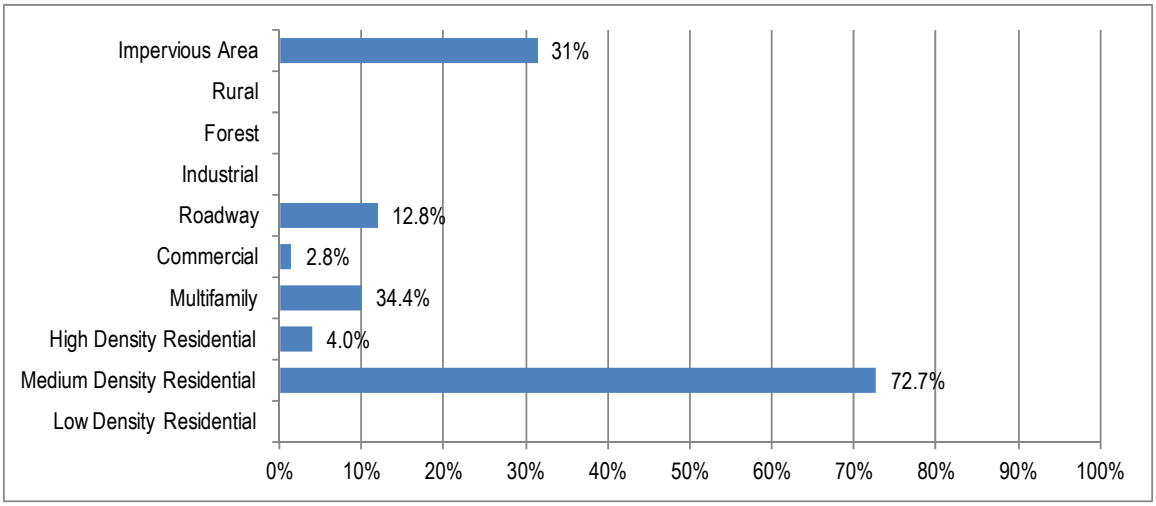
Table C-6. Retrofit Assessments Recommended for the Perimeter Creek Subwatershed

Number	Total Area (acres)	Impervious Area (acres)	% Impervious Area	Unmanaged Impervious Area to Treat (acres)	Description
IA-1	123.3	50.2	40.8%	43	Largest area recommended for retrofit assessment. Located in the northwest corner of the City, bounded by I-285 and Perimeter Summit Boulevard.
IA-13	6.9	5.1	74.7%	5.2	Study area with the highest impervious area percentage. Located adjacent to Sandy Springs and includes the eastern portion of St. Joseph's Hospital.
IA-14	21.7	4.8	22.3%	4.9	Medium-density residential area located in the western portion of the subwatershed.
IA-18	17.8	4.2	23.5%	4.2	Medium-density residential area located in the western portion of the subwatershed.

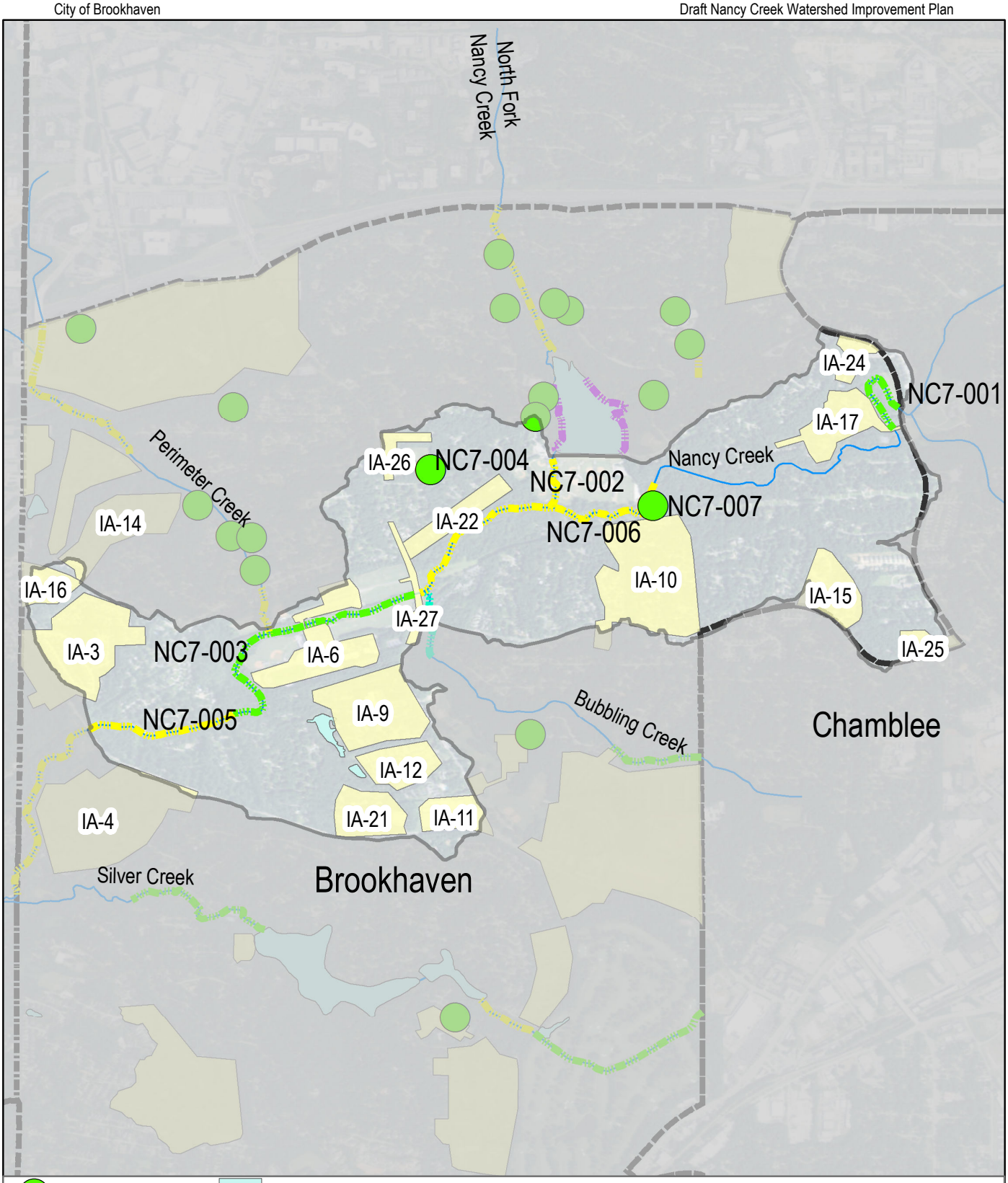
C.4. NC7: NANCY CREEK MAINSTEM

The Nancy Creek mainstem subwatershed includes the area immediately adjacent to Nancy Creek running from the eastern border at Chamblee-Dunwoody Road to Johnson Ferry Road. This subwatershed includes the recreational fields located in the southern portion of Murphey Candler Park. The subwatershed is approximately 900 acres, of which 890 acres are located within Brookhaven, or 98.8 percent of this subwatershed. The subwatershed (Figure C-8) is primarily comprised of medium-density residential land use followed by roadway, multi-family, high density residential land-use, and commercial area. The impervious cover in the Nancy Creek mainstem subwatershed is 31 percent.

Figure C-7. Nancy Creek Mainstem Subwatershed Land Use



The baseline conditions model shows that the TSS and nutrient loads are above those in a typical medium density residential watershed. Over one-third of the assessed stream miles are located in this subwatershed. The stream habitat ranges from the lowest habitat score (poor) to the highest habitat score (sub-optimal) in the Study Area. The most upstream Nancy Creek reach within Brookhaven rates as poor for habitat conditions primarily because the buffer is almost entirely cleared and a low-head dam within the reach causes significant impacts to the habitat rating based on the state's scoring protocols. Wider stream buffers in the upper portions of the subwatershed downstream of the low head dam produce higher habitat scores. The habitat scores decline as tributaries joined the mainstem and infrastructure intrudes into the protected stream buffer. There are seven recommended projects and fifteen areas recommended for future retrofit assessments in this subwatershed, shown in Figure C-8. The recommended projects reduce the TSS load by 7.8 percent. The recommended projects are listed in Table C-7 and the recommended retrofit assessments are listed in Table C-8.



New BMP

Recommended Linear Projects

Buffer Restoration

Shoreline Restoration

Stream Restoration

Streambank Stabilization

Retrofit Assessments

Waterbody

Streams

Nancy Creek Mainstem

Cities

N

0 0.1 0.2 0.4 0.6 0.8 Miles

Nancy Creek Watershed Improvement Plan

Figure C-8: Nancy Creek Mainstem (NC7) Recommended Projects and Assessments

SWP&E Sustainable Water Planning and Engineering, LLC

Table C-7. Recommended Watershed Improvement Projects for the Nancy Creek Mainstem Subwatershed

Number	Project Type	Owner	Description	Goals Supported				Rank
				1	2	3	4	
NC7-001	Streambank Stabilization	Private Property	Restore the vegetated buffer zone in the D'Youville community to the extent available to protect banks from erosion that is starting to occur.	Y	Y	Y	Y	30
NC7-002	Stream Restoration	City	North Fork Nancy Creek from the spillway to confluence with Nancy Creek. Address erosion with grade control and improve buffer within confines of existing recreation. Integrate planned trail and bridge.	Y	Y	Y	Y	9
NC7-003	Buffer Restoration	Private Property	Support ongoing restoration of the stream buffer along the Marist campus.	Y	Y	Y	Y	7
NC7-004	New BMP	DeKalb Public Schools	Integrate stormwater improvements and recreation field enhancements at Montgomery Elementary School. Underground detention under field an option.	Y	Y	Y	Y	11
NC7-005	Stream Restoration	Private Property	Restoration of Nancy Creek from Marist to Johnson Ferry Road.	Y	Y	Y	Y	37
NC7-006	Stream Restoration	City, Private Property	Restoration of Nancy Creek from the football field in Murphey Candler Park to Ashford Dunwoody Road. Includes stream in Murphey Candler Park along with private property. Coordinate with planned greenway trail.	Y	Y	Y	Y	10
NC7-007	New BMP	Private Property	Large BMP that is overgrown and does not appear to be receiving flow. Convert into a constructed wetland to capture stormflows adjacent to Nancy Creek. Intended to function like a constructed wetland.	Y	Y	Y	Y	15

In addition to the projects identified above, 15 areas within this subwatershed have a high level of impervious cover, listed in Table C-8. A future evaluation of these areas to identify candidate retrofit sites, contributes toward reaching the 35 percent TSS reduction goal.

Table C-8. Retrofit Assessments Recommended for the Nancy Creek Mainstem Subwatershed

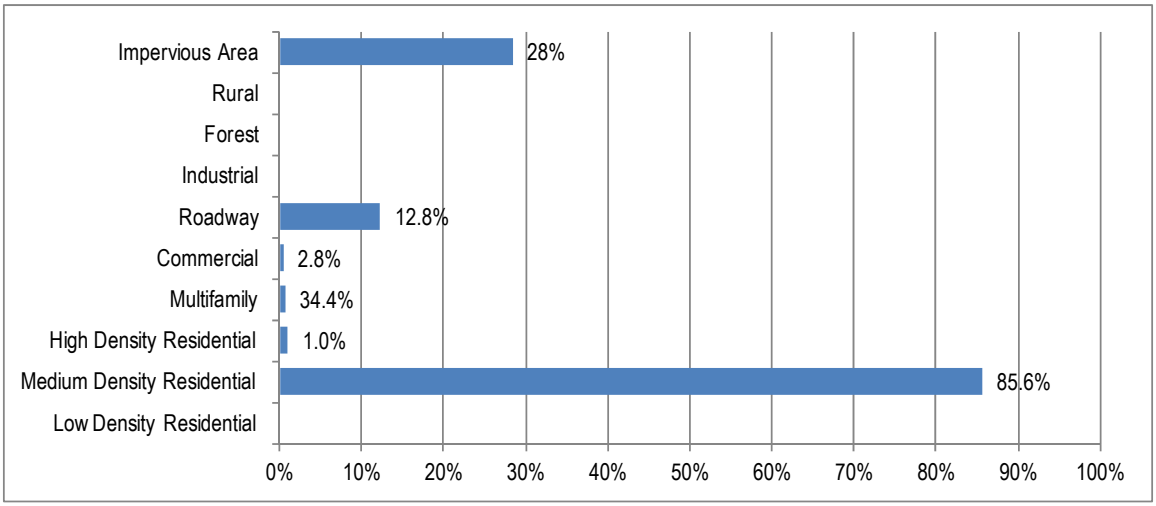
Number	Total Area (acres)	Impervious Area (acres)	% Impervious Area	Unmanaged Impervious Area to Treat (acres)	Description
IA-3	39.1	14.5	37.2%	14.5	High density residential area located between S Johnson Ferry Road and Old Johnson Ferry Road.
IA-6	23.3	11.4	49.1%	11.4	Marist campus. Coordinate with ongoing improvements to school facilities and integrate with the Environmental Sciences curriculum.
IA-9	28.1	7.9	28.0%	7.9	Area includes the Ashford Dunwoody YMCA complex and adjacent properties.

Number	Total Area (acres)	Impervious Area (acres)	% Impervious Area	Unmanaged Impervious Area to Treat (acres)	Description
IA-10	47.0	7.8	16.5%	7.5	Residential area located south of Nancy Creek and North of Harts Mill Road.
IA-11	9.7	6.9	71.4%	6.9	Commercial area at the intersection of Ashford Dunwoody Road and Johnson Ferry Road.
IA-12	11.9	6.5	54.8%	6.5	Multi-family complex off Ashford Dunwoody Road south of YMCA and across from Blackburn Park.
IA-15	14.0	4.8	34.4%	4.3	Residential area located north of Harts Mill Road in the eastern portion of the subwatershed.
IA-16	8.2	4.7	56.8%	4.7	Commercial/ medical area off Old Johnson Ferry Road.
IA-17	16.0	4.5	27.9%	4.1	Located in the upper reaches of the watershed in the D'Youville residential community.
IA-21	13.4	2.8	20.9%	2.8	Residential area north of Johnson Ferry Road and west of Ashford Dunwoody Road.
IA-22	10.5	2.5	23.9%	2.5	Strip of impervious area along West Nancy Creek Drive to the east of Ashford Dunwoody Road.
IA-24	5.0	2.3	45.9%	2.0	Located in the upper reaches of the subwatershed in a residential area off Chamblee Dunwoody Road north of Nancy Creek.
IA-25	5.4	2.1	39.0%	2.0	High density residential area at the intersection of Chamblee Dunwoody and Harts Mill Road.
IA-26	4.2	1.6	38.5%	0.8	Located along Ashford Dunwoody Road near and including Montgomery Elementary School. Integrate with educational opportunities.
IA-27	4.3	1.1	24.9%	1.1	Strip located along Ashford Dunwoody Road south of West Nancy Creek Drive. Coordinate with the ongoing Ashford Dunwoody Road corridor study and any recommended projects.

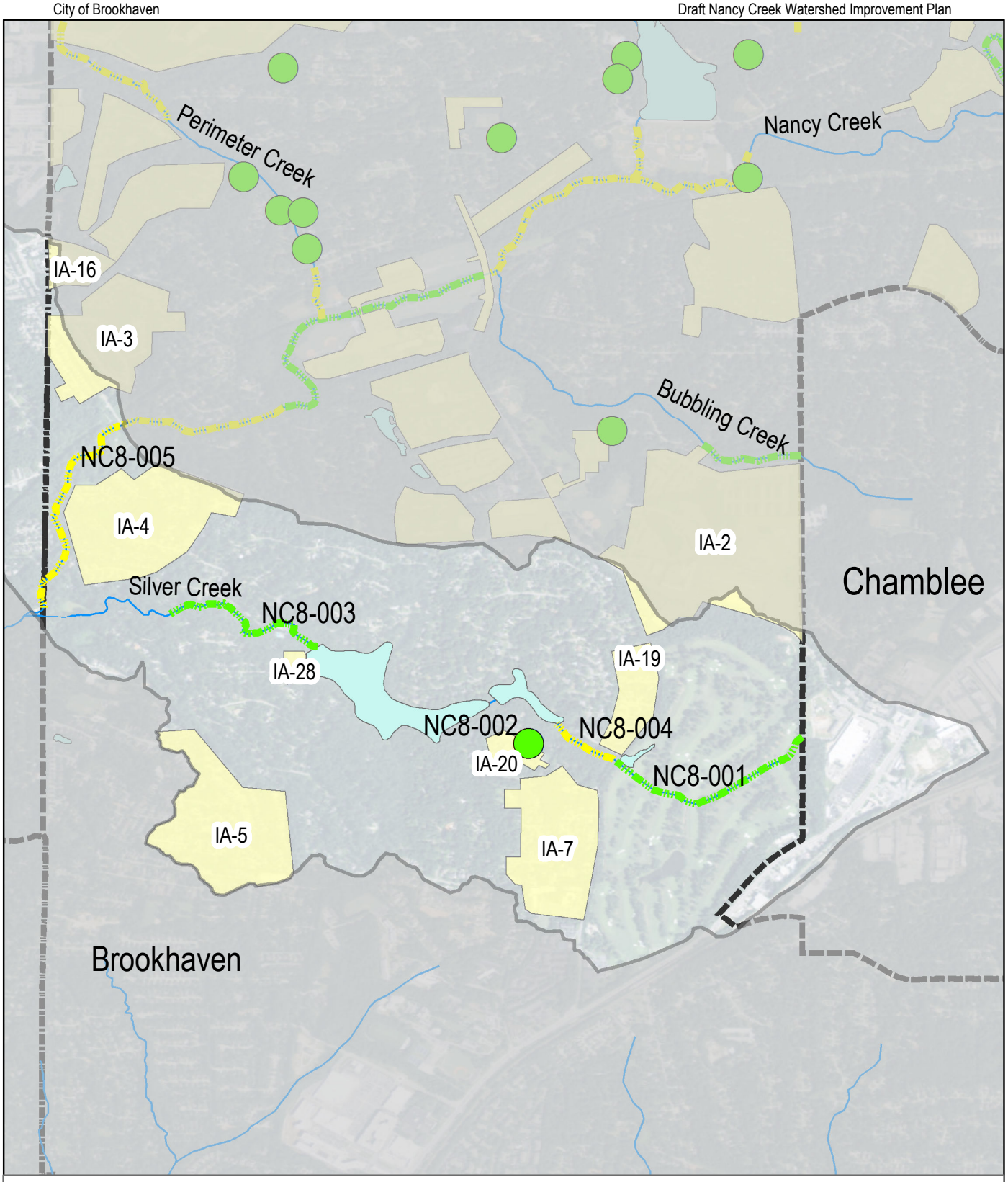
C.5. NC8: SILVER CREEK

Silver Creek originates in Chamblee and flows west and north to the confluence with Nancy Creek just upstream of the Brookhaven city limits. The Silver Creek subwatershed includes the Peachtree Golf Club, Silver Lake, and Little Silver Lake. Silver Lake and Murphey Candler Lake are of similar size with classified Category I dams; however, Silver Lake is privately owned whereas Murphey Candler Lake is owned by the City. The subwatershed is 1,220 acres of which 940 acres or 76.9% are located within Brookhaven. Within Brookhaven, the subwatershed is primarily medium density residential land with some roadway areas as shown in Figure C-9. The overall impervious cover for the Brookhaven portion of the subwatershed is approximately 28 percent.

Figure C-9. Silver Creek Subwatershed Land Use



The baseline conditions model shows that the TSS and nutrient loads are above those in a typical medium density residential watershed and the stream habitat is considered sub-marginal with a small segment with a sub-optimal rating just upstream of the confluence with Nancy Creek. This subwatershed is heavily influenced by several low-head dams located within the Peachtree Golf Course, Silver Creek, and Little Silver Creek. Downstream of the Silver Lake Dam, the stream buffer is limited with recreational areas and numerous crossings for residential access. There are five recommended projects and six areas recommended for future retrofit assessments in this subwatershed, shown in Figure C-10. The identified projects reduce the TSS load by 3.7 percent. The recommended projects are listed in Table C-9 and the recommended retrofit assessments are listed in Table C-10.



Silver Creek
New BMP
Recommended Linear Projects
Buffer Restoration
Stream Restoration
Retrofit Assessments
Waterbody
Streams
Cities

N

0 0.075 0.15 0.3 0.45 0.6 Miles

Nancy Creek Watershed Improvement Plan

Figure C-10: Bubbling Creek Mainstem (NC8) Recommended Projects and Assessments

SWP&E
Sustainable Water Planning and Engineering, LLC

Table C-9. Watershed Improvement Projects Identified in the Silver Creek Subwatershed

Number	Project Type	Owner	Description	Goals Supported				Rank
				1	2	3	4	
NC8-001	Buffer Restoration	Private Property	Improve vegetated buffer along Silver Creek with golf course appropriate vegetation to help protect against stream bank erosion.	Y	Y	Y	Y	42
NC8-002	New BMP	Private Property	Opportunities to integrate one or more bioretention facilities at the Our Lady of the Assumption Catholic Church. Can be integrated into science curriculum.	Y	Y		Y	26
NC8-003	Buffer Restoration	Private Property	Restore the stream buffers downstream of Silver Lake Dam to the extent possible and limit future buffer intrusions.	Y	Y	Y	Y	40
NC8-004	Stream Restoration	Private Property	Restore stream and protect utilities upstream of Little Silver Lake. Coordinate with the ongoing Ashford Dunwoody Road corridor study and any recommended projects.	Y	Y	Y	Y	23
NC8-005	Stream Restoration	Private Property	Restore Nancy Creek from Johnson Ferry to the Brookhaven city limits.	Y	Y	Y	Y	24

In addition to the projects identified above, six areas within this subwatershed have a high level of impervious cover, listed in Table C-10. A future evaluation of these areas to identify candidate retrofit sites, contributes toward reaching the 35 percent TSS reduction goal.

Table C-10. Retrofit Assessments Recommended for the Silver Creek Subwatershed

Number	Total Area (acres)	Impervious Area (acres)	% Impervious Area	Unmanaged Impervious Area to Treat (acres)	Description
IA-4	49.9	13.2	26.4%	13.2	Medium density residential area on both sides of Mill Creek to the south of Nancy Creek.
IA-5	49.9	12.6	25.2%	12.6	High density residential area bounded by Silver Lake Drive and Windsor Parkway and includes Lynwood Park. Coordinate study with planned park improvements.
IA-7	39.4	9.8	25.0%	9.8	Area bounded by Ashford Dunwoody Road and Lanier Drive NE and includes multi-family and institutional land uses.
IA-19	14.6	3.6	24.5%	3.6	Medium density residential area to the west of Ashford Dunwoody Road and north of Silver Creek.
IA-20	5.1	2.8	52.2%	0	Area surrounding the Our Lady the Assumption Catholic Church. Impervious area to treat is zero because of recommended project in this area. If that project doesn't treat all of the runoff, additional projects should be recommended.
IA-28	2.5	0.7	30.3	0.8	Area includes the Brittany Swim and Tennis Club, adjacent to Silver Lake.

APPENDIX D: STANDARD OPERATING PROCEDURES

Brookhaven GEORGIA	Performing Maintenance in an Established Riparian Buffer	SOP #	1
		Revision #	0
		Implementation Date	May 2016
Page #	1 of 8	Last Reviewed/Update Date	
SOP Owner	Public Works	Approval	

Standard Operating Procedure (SOP)

1. Purpose

Describe the best municipal practices for performing maintenance in established riparian buffers within the City of Brookhaven. Established and undisturbed vegetative buffers protect the integrity of local water resources and reduce erosion resulting in the loss of land. These best management practices are intended to guide routine maintenance activities within established riparian buffers with the goal of reducing disturbances.

2. Scope

Riparian buffers are vegetated areas that provide a number of benefits to the health and wellbeing of local waterbodies. The City has a vested interest in protecting the integrity and functionality of riparian buffers to reduce stormwater pollution, minimize stream erosion and loss of land, and protect water quality. This SOP provides details on how to improve and protect the function of riparian buffers. Although intended for use by City maintenance crews, this SOP may also be helpful to Homeowners Associations (HOAs) or other private property owners interested in protecting the integrity of their riparian buffer.

There are both City and State regulations that govern activities within the riparian buffer. This SOP covers routine maintenance activities that are not associated with an active land disturbance permit. Any project that disturbs land requires a land disturbance permit and will adhere to the terms of the permit as set forth by the Community Development Department and City Arborist. The land disturbance permit will outline the requirements specific to the project and site versus the general information covered in this SOP. Examples of activities that require a land disturbance permit and are therefore not covered by this SOP include, but are not limited to:

- Stream restoration or stabilization including placement of rip-rap;
- Removal of items from the buffer that involve earth moving equipment (e.g., pavement removal);
- Removal of tree stumps; or
- Anything that involves a body of water (creek, spring, stream, lake, etc.) will require a number of permits.

Section 5 of this SOP outlines the protocols for performing common maintenance activities within a riparian buffer. Terminology and abbreviations used throughout this SOP are defined in Section 7.

This SOP is one of a series of three SOPs developed as part of the Nancy Creek Watershed Improvement Plan. The coordinating SOPs include "Removing Invasive Species from the Riparian Buffer and Replanting" (SOP 2) and "Caring for Newly Established Riparian Buffers" (SOP 3).

3. Pertinent Regulations

Land Disturbance (Chapter 14, Article II, Section 14-27 through 14-38): Any project involving land disturbance requires a land disturbance permit from the City's Community Development Department, compliant with the Georgia Soil and Water Conservation on Commission's practices.

Tree Protection and Replacement (Chapter 14, Article II, Section 14-39): The purpose of the Tree Ordinance is to promote tree canopy preservation and tree replacement as an integral part of the land development and construction process in the City. The goal is to maintain a sustainable tree canopy, which provides many aesthetic, environmental, and economic benefits to the City and its citizens.

Stream Buffer Protection Ordinance (Chapter 14, Article II, Section 14-44): The purpose of this ordinance is to protect the environment and the public's health, safety, and land welfare; to minimize public and private losses due to erosion, siltation and water pollution; and to maintain stream water quality by provisions designed to:

1) Create buffer zones and impervious setbacks along the streams of the City of Brookhaven for the protection of water resources; and,
2) Establish buffer and setback zone requirements to minimize land development and land disturbance, and require authorization for these activities.

The stream buffer protection ordinance is triggered by a land development activity and controls the riparian area extending 75 feet from the point of wrested vegetation.

Georgia Erosion and Sedimentation Control Act (Rule 391-3-7-.05): Establishes variance requirements for the disturbance of the riparian buffer extending 25 feet from the point of wrested vegetation. A state stream buffer variance must be obtained if a project includes land disturbance in the 25 foot riparian buffer. If a City stream buffer variance is needed, a state buffer variance is also likely needed.

4. Responsibilities

The Parks and Recreation Department will be responsible for overseeing that best management practices are followed by crews responsible for maintenance in riparian buffer areas on park-owned property. They will also be responsible for ensuring that contractors who perform maintenance in riparian buffers follow these procedures and industry best practices.

The City Engineer will provide technical support related to water quality and the relationship of this SOP with the Nancy Creek Watershed Improvement Plan. The City Engineer will also ensure that maintenance along City roadways that falls within riparian buffer areas follows these guidelines.

The Community Development Department is responsible for issuing land disturbance permits and may be consulted if there are questions about whether a permit is needed for maintenance and/or restoration activities.

The City Arborist will provide guidance and insight to ensure City maintenance operations are consistent with the City's Tree Protection and Replacement Ordinance.

5. Procedure

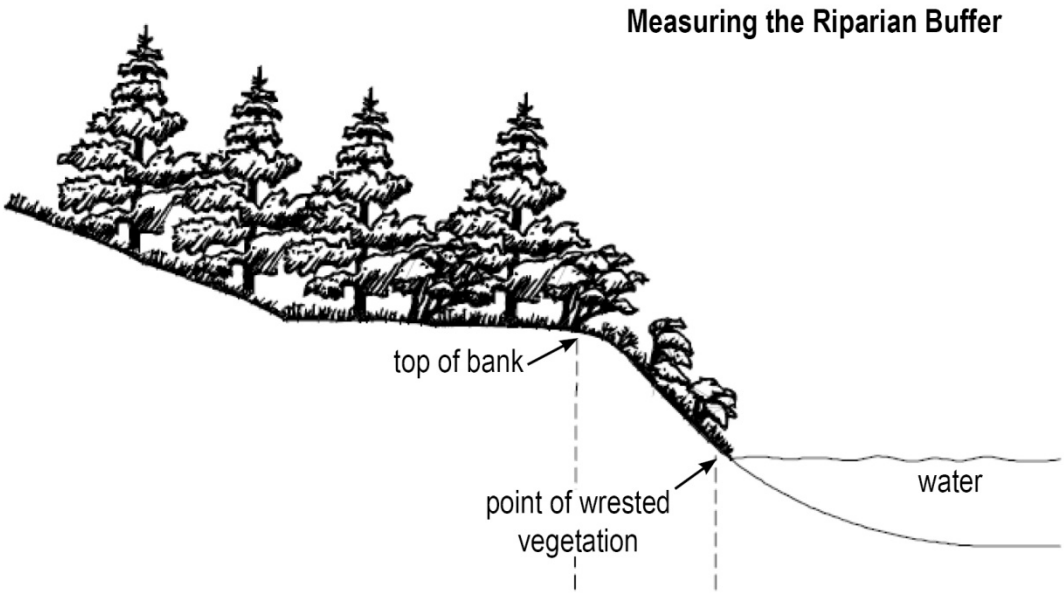
The maintenance activities outlined in this SOP include delineating the riparian buffer area, tree pruning, tree removal, thinning of the tree canopy, removal of invasive vegetation, and mowing and general yard maintenance.

Delineating the Protected Riparian Buffer Area

Before beginning any maintenance activity near a waterbody, the riparian buffer must be temporarily marked so that all personnel can visually see where the buffer is in relation to the maintenance activities. Technically the buffer is measured from the point of wrested vegetation. However, determining the point of wrested vegetation requires proper training. To facilitate maintenance activities and provide the proper protections, the riparian buffer can be measured from the top of the bank. The top of bank is generally further from the centerline of the stream than the point of wrested vegetation and much easier to locate in the field, see Figure SOP1.1. To demark the riparian buffer area:

- Place a tape measure at the top of bank and measure away from the stream at a perpendicular angle.
- Mark the location of the 50 foot and 75 foot buffers with a visible object such as flagging tape, flags, or safety cones.
- Ensure all maintenance crews understand the location of the buffers and review the activities that can be performed in each buffer zone prior to initiating work.
- Remove the temporary demarcation after maintenance activities are complete.

Figure SOP1.1. Measuring the Buffer Width from the Top of Bank



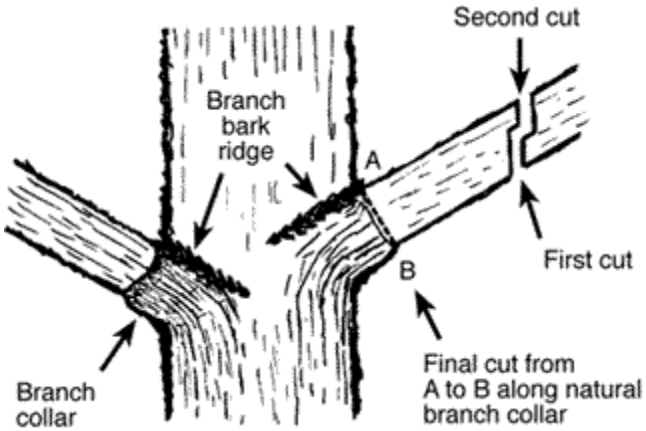
Tree Pruning

Riparian buffers are intended to be natural areas and pruning is generally not necessary. However, as most city-owned riparian buffers are associated with parks and pedestrian trails; some limited pruning may be needed to provide for visitor safety. Examples of pruning for the safety of park visitors include selectively removing low level tree branches over sidewalks or damaged or dead branches that could fall onto an area used by the public. All pruning and trimming of trees will comply with the City's Tree Protection and Replacement Ordinance. Qualified personnel under the direction of the City arborist and/or by a contractor with appropriate credentials will perform pruning and trimming. If not done properly, pruning can be very damaging to a tree.

Some important considerations for pruning operations:

- Pruning should be confined to the removal of broken, rubbing, damaged or dead branches, or branches that need to be removed for clearance over a trail (i.e., branches lower than 8 feet over a trail).
- Never remove more than 20% of the total leaf area of the crown at one time. If lower branches need to be removed to increase clearance over a trail, it may need to be pruned in stages and over several years.
- Retain at least 2/3 of the tree height in live branches.
- Prune when the trees are dormant in the late fall and winter months to reduce sap loss and stress on the tree.
- Pruning cuts should only remove the branch and not cut into the stem or trunk to which the branch is attached. Cutting into the trunk or stem increases the chances of decay and disease.
- Branches should be pruned following a three cut process to prevent the branch from falling midway through the cut and tearing bark as it falls (see diagram).

Figure SOP1.2. Three Cut Pruning Process



1. The first cut should be made approximately 12-15 inches up from the branch bark ridge and the branch collar. The branch collar is the small bump that wraps around the base of the branch where the branch protrudes from the trunk, typically seen on the bottom side of the branch. The cut is made from the bottom of the branch upward, but should not cut through the limb.
2. The second cut will be further away from the trunk than the first cut and cut through the limb. A stub will remain.
3. The third cut will remove the stub just outside the branch bark ridge but without cutting the branch collar.

- Do not paint or use a wound dressing product to cover over pruning cuts. These inhibit the healing process.
- For small branches (< 1" diameter) pruning shears can be used. For medium size branches (1" to 2" diameter) use lopping shears (anvil or bypass). For anything larger than 2" use a tree saw.

- Disinfect the tools after pruning each tree to prevent the possible spread of disease from one tree to another. Even if a tree does not look diseased, a small amount of isopropyl alcohol or other disinfectant should be used to protect trees from disease.

Tree Removal

In a riparian buffer, trees play a critical role as they provide shade cover and organic material needed in a healthy stream ecosystem. In a natural forest, dying trees are part of natural succession. Dead standing trees (snags) and fallen trees (logs or downed woody debris) provide habitat for wildlife and nutrients for younger plants. Only in extreme circumstances should vegetation within the riparian buffer be removed. Prior to removing trees (dead or alive), the City Arborist should be consulted to confirm that the tree should be removed, the method for removal, and whether the removed tree can remain in the buffer as habitat (i.e., not diseased). Examples of when tree removal in the riparian buffer may be deemed appropriate include:

- The tree is a threat to the public's health, safety or welfare, which cannot be addressed with trimming or pruning (e.g., the tree is precarious and could fall on an active recreational area).
- The tree is an invasive species and a certified arborist or the City Arborist determines that it is a threat to the riparian buffer ecosystem. If the tree is removed, additional vegetation may need to be planted to stabilize stream banks. SOP #2 includes information on the replanting density goals for riparian buffers.
- The tree is diseased and a certified arborist or the City Arborist determines that the disease could spread to neighboring trees.
- The tree is damaging the stream, causing erosion and/or localized flooding concerns. Typically, in this case the tree has fallen and is causing damage to the stream bank.

If vegetation must be removed to protect public safety, the following considerations should be followed:

- Root balls should remain intact if at all possible. Tree roots stabilize the buffer from erosion and provide valuable habitat benefits. The only reasons to remove the root ball are if it has a contagious disease or if it is an invasive species that may regrow. If the root ball must be removed, a land disturbance permit is needed.
- Woody materials should generally remain in the riparian buffer. Snags and logs on the ground provide nutrients for other vegetation and food and shelter for woodland organisms. If public safety dictates that the tree be removed, sections of the tree can be placed within the buffer as downed woody debris. Generally, coverage of 15 to 20 percent of downed woody debris on the ground is sufficient to serve wildlife needs. Larger pieces of downed woody debris are more beneficial as they last longer, hold more moisture, and provide habitat for a wider array of organisms. Ideally, a diverse mix of age, diameter, and type of downed woody debris is most beneficial.
- Fallen limbs and woody debris in the stream provide habitat and nutrients needed for a healthy aquatic ecosystem. If fallen limbs or trees are causing erosion, they should be removed. With proper guidance from a professional trained in ecosystem restoration, some woody debris from downed trees may be placed as habitat in the stream. Permits may be needed depending on the nature of these activities.

Large trees should be removed by a professional tree removal company under the direction of a professional arborist, not by City staff. City staff should ensure that all obstacles are identified prior to tree removal and that a perimeter zone is established to protect the public.

Thinning the Tree Canopy

The thinning of the tree canopy is generally not recommended in a riparian buffer area. Riparian buffer ecosystems should include a blend of: canopy or shade trees, sub-canopy or understory trees, understory shrubs, and ground cover which could be vegetation, leaf litter, or mulch. Preferably, these layers reflect a variety of ages so that the forest is constantly renewed over time. Thinning of the tree canopy to provide for sight lines to rivers or lakes should only be performed under consultation with the City arborist to ensure the integrity of the buffer ecosystem is preserved, and should follow these guidelines:

- Thinning must preserve the benefits that the buffer zone provides in terms of reducing runoff, preventing erosion, filtering stormwater pollutants, and providing habitat.
- To gain sightlines and vistas, pruning vegetation should be attempted before thinning. If pruning is not sufficient, the removal of dead, dying, or diseased trees should be removed next before thinning of healthy trees.
- No more than 25% of any plant should be pruned as part of thinning at any time, as pruning more will threaten survivability.
- Thinning should never be used as a justification to clear the understory in a riparian buffer. The understory is part of a healthy riparian buffer that provides nutrient removal, soil stabilization, and habitat. Removing the entire understory is not recommended as it weakens forest succession, reduces riparian buffer functionality, and may accelerate the encroachment of invasive species.
- If creating sight lines or vistas is necessary, thinning, *not* clear-cutting, of vegetation should be performed.
- Thinning should not include practices such as “topping” or removing the top portions of the tree at a specific elevation. Likewise, “lion tailing” which is the removal of too many interior branches leaving only a few full long branches that resemble a lion’s tail, is not a recommended thinning practice.
- Thinning should be done in coordination with the City arborist in riparian buffer areas.

Removal of Invasive Vegetation

Invasive plants can cause significant damage within a riparian buffer area. SOP 2 in this series includes more specific details regarding the identification and removal of invasive plants, and the replanting of native plants. In order to remove invasive vegetation:

- Establish a multi-year removal program in targeted areas that includes initial removal and several years of monitoring and removal.
- Clean equipment regularly and between maintenance sites will minimize the spread of seed across the City.
- Prevent the spread of invasive species through homeowner education is an important element in reducing the introduction of new invasive species.
- Proper disposal of invasive species will minimize the risk of the species spreading to other parts of the City.

SOP 2 in this series outlines the invasive species removal methods appropriate for the riparian buffer area.

Mowing and General Yard Maintenance

Grass is allowed in the impervious area setback of the riparian buffer, which is the zone from 50 feet to 75 feet from the top of bank. In many areas, development activities occurred prior to the current riparian buffer regulations and the

landscaping extends closer to the stream. SOP 3 in this series outlines the steps to maintaining newly planted buffer areas. This SOP focuses on the maintenance in existing areas that the City intends to maintain as landscaped areas.

- Excess lawn cuttings should be removed from the property and properly disposed of in a yard waste bag or otherwise taken to a yard waste compost facility. Yard trimmings and leaves should never be placed in the riparian buffer or in stormwater drainage areas. Yard debris has high concentrations of nutrients which can cause eutrophication in streams.
- Blown leaves should be collected and properly disposed of in a yard waste bag or otherwise taken to a yard waste compost facility. Leaves should never be blown down the storm drain and, as with lawn cuttings, should not be placed in the riparian buffer.
- Yard debris may be properly composted; however a compost area must be properly maintained. A compost bin is not synonymous with depositing yard debris in the buffer.
- Chemical use should be avoided in the established riparian buffer. In the impervious area setback, chemical application is acceptable only when manufacturer's directions are followed. Chemical use should only be used in the protected riparian buffer (0 to 50 feet) under the guidance of the City arborist and only applied by a licensed herbicide applicator.
- Ideally, the first 50 feet of the riparian buffer should be left in a natural vegetated state. Undisturbed buffer should never be converted to landscaped areas. Re-vegetating riparian buffers will enhance water quality protection. For details, please refer to SOP 3 in this series.

6. References

Backyard Buffers: Protecting Habitat and Water Quality. Department of Community Affairs.

Guidelines for Streambank Restoration. Georgia Soil and Water Conservation Commission. Revised March/2000.

7. Definitions

Canopy Tree: A tree that reaches 35 feet in height or larger when mature.

Land Disturbance: Any land or vegetation change, including, but not limited to, clearing, grubbing, stripping, removal of vegetation, dredging, grading, excavating, transporting and filling of land, that does not involve construction, paving or any other installation of impervious cover.

Riparian: Belonging or related to the bank of a river, stream, lake, pond, or impoundment.

Setback: The area extending beyond the protected buffer applicable to that waterbody.

Shrub: A woody plant that is smaller than a tree and has several main stems arising at or near the ground. A large shrub can reach 10 feet of height or greater at maturity. A small shrub can reach up to 10 feet in height at maturity.

SOP: Standard Operating Procedure or a document that outlines the proper steps to perform a stated task.

State waters: Any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells, and other bodies of surface or subsurface water, natural or artificial, lying within or forming a part of the boundaries of the state, which are not entirely confined and retained completely upon a parcel. Ephemeral streams are not considered state waters for the purpose of the Stream Buffer Protection ordinance.

Stream: Any natural, running water flowing continuously or intermittently in a channel on or below the surface of the ground, except that an ephemeral stream is not a stream.

Stream Channel: The confining cut of ground surface that contains the base flow of a stream and is identified at a point where the water flow has wrested the vegetation.

Sub-Canopy Tree: An immature canopy tree, a stunted canopy tree, or other co-dominant tree or an understory tree.

Top of bank: The upper boundary of the bank is the first observable break in the slope of the bank. The bank is the portion of the land surface which normally abuts and confines a water body. It occurs between the water body and the upland.

Understory tree: A tree that matures to a height of 12 feet to 35 feet.

Waters of the State: "State Waters" means any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells, and other bodies of surface or subsurface water, natural and artificial, lying within or forming a part of the boundaries of the State which are not entirely confined and retained completely upon the property of a single individual, partnership, or corporation

Wrested vegetation: The point adjacent to the edge of the base flow of a stream or the water surface of a lake where vegetation has been moved or wrested as a result of normal stream flow or wave action. This is the point from which the protective buffer should be measured.

Brookhaven GEORGIA	Removing Invasive Species from the Riparian Buffer and Replanting	SOP #	2
		Revision #	0
		Implementation Date	May 2016
Page #	1 of 27	Last Reviewed/Update Date	
SOP Owner	Public Works	Approval	

Standard Operating Procedure (SOP)

1. Purpose

Describe the best municipal practices for removing invasive species from the riparian buffers within Brookhaven and replanting the buffer, if necessary, to healthy forest densities. Undisturbed vegetative buffers help protect the integrity of local water resources and reduce erosion resulting in the loss of land. Invasive species can displace the native vegetation and threaten natural communities, reducing the benefits provided by riparian buffers. This SOP outlines the steps to properly removing invasive species and planting to restore the riparian buffer.

2. Scope

Vegetated buffers provide a number of benefits to the health and wellbeing of local waterbodies. The City has a vested interest in protecting the integrity and functionality of riparian buffers to reduce stormwater pollution, minimize stream erosion and loss of land, and protect water quality. The goal of this SOP is to eradicate the most ecologically-damaging vegetation, those that threaten the health of native vegetation, and replant to create a healthy urban forest. A three-year program is outlined in this SOP including initial removal followed by two years of maintenance removal activities and planting, as needed. Inspections and maintenance may be needed beyond this point, but are considered beyond the scope of this SOP.

The activities outlined in this SOP are governed by both City and State regulations. Invasive species removal and replanting activities must be done in close coordination with the Community Development Department and City Arborist.

Section 5 of this SOP outlines the protocols for identifying and removing invasive species, and replanting within a riparian buffer. Terminology and abbreviations used throughout this SOP are defined in Section 7.

This SOP is the second in a series of three SOPs developed as part of the Nancy Creek Watershed Improvement Plan. The coordinating SOPs include “Performing Maintenance in Established Riparian Buffers“ (SOP 1) and “Caring for Newly Established Riparian Buffers“ (SOP 3).

3. Pertinent Regulations

Land Disturbance (Chapter 14, Article II, Section 14-27 through 14-38): Any project involving land disturbance requires a land disturbance permit from the City's Community Development Department, compliant with the Georgia Soil and Water Conservation on Commission's practices. For invasive species removal projects land disturbance could include the use of mechanical equipment to remove vegetation and/or to haul vegetation to the street for disposal.

Tree Protection and Replacement (Chapter 14, Article II, Section 14-39): The purpose of the Tree Ordinance is to promote tree canopy preservation and tree replacement as an integral part of the land development and construction process in the City. The goal is to maintain a sustainable tree canopy, which provides many aesthetic, environmental, and economic benefits to the City and its citizens.

Stream Buffer Protection Ordinance (Chapter 14, Article II, Section 14-44): The stated purpose of this ordinance is to protect the environment and the public's health, safety, and welfare; to minimize public and private losses due to erosion, siltation and water pollution; and to maintain stream water quality by provisions designed to:

1) Create buffer zones and impervious setbacks along the streams of the City of Brookhaven for the protection of water resources; and,
2) Establish buffer and setback zone requirements to minimize land development and land disturbance, and require authorization for those activities.

The stream buffer protection ordinance is triggered by a land development activity (i.e., land disturbance permit) and controls the riparian area extending 75 feet from the point of wrested vegetation.

Georgia Erosion and Sedimentation Control Act (Rule 391-3-7-.05): Establishes variance requirements for the disturbance of the riparian buffer extending 25 feet from the point of wrested vegetation. A state stream buffer variance must be obtained if a project includes land disturbance in the 25 foot riparian buffer. If a City stream buffer variance is needed, a state buffer variance is also likely needed.

4. Responsibilities

The Parks and Recreation Department (Parks Department) will be responsible for overseeing that best management practices are followed by crews responsible for invasive species removal in riparian buffer areas on park-owned property. They will also be responsible for ensuring that contractors who perform invasive species removal in riparian buffers follow these procedures and industry best practices.

The City Engineer will provide technical support related to water quality and the relationship of this SOP with the Nancy Creek Watershed Improvement Plan. The City Engineer will also ensure that maintenance along City roadways that falls within riparian buffer areas follows these guidelines.

The Community Development Department is responsible for issuing land disturbance permits and may be consulted if there are questions about whether a permit is needed for planned removal and replanting activities.

The City Arborist will provide guidance and insight to ensure City maintenance operations are consistent with the City's Tree Protection and Replacement Ordinance.

5. Procedure

Invasive plants can cause significant damage within a riparian buffer area. There is no "quick fix" to removing these species, especially if they are well established in an area. This SOP outlines a three-year program that includes an initial removal along with two years of maintenance removals and planting to achieve healthy forest densities. This SOP is designed to eradicate the targeted invasive species through a targeted and thorough effort in a small restoration plot area (approximately 10,000 square feet). This targeted effort is seen as more effective than removing some of the invasive species from a larger land area. Unless invasive species are eradicated from the area, the invasive species are likely to return. The recommended 10,000 square foot restoration plot is manageable for volunteer groups and City staff. If a larger area is desired, multiple adjacent restoration plots may be assigned. This SOP requires a minimum three-year commitment to any assigned restoration plot.

The three-year removal and replanting program is illustrated in Figure SOP2.1 below and includes planning and initial removal of invasive species, maintenance removal and planting to healthy forest densities, and another maintenance removal along with maintenance of any new plants. Project timelines may need to be extended beyond the three years depending on the severity of the invasive species in the restoration plot.

Figure SOP2.1. Three-Year Invasive Species Removal and Replanting Timeline

Year 1: Planning and Initial Removal

Year 1 of the three-year program includes developing a plan specific to the assigned restoration plot and the initial removal activities. The planning steps are the most critical for the successful and safe eradication of invasive species. The planning includes an assessment of the assigned restoration plot and development of an Invasive Species Removal Plan that must be approved by the City Arborist prior to removal. The Invasive Species Removal Plan documents important decisions regarding the removal techniques based on the conditions within the restoration plot. This section also outlines appropriate removal techniques and the conditions in which they are applicable.

Initial Planning

Initial planning includes walking the restoration plot in order to determine the invasive species that need to be removed and identify other important details that impact activities within the restoration plot.

Identify the Invasive Species to Remove

The first step of any removal effort is to identify which species will be removed from the assigned restoration plot. Guidance from the Georgia Exotic Pest Plant Council (GA EPPC) is the basis for the targeted species outlined in this SOP as described below.

The GA EPPC maintains a list of invasive plants that is separated into 4 primary categories with 1 sub-category that describe the risk associated with the different plant species. Some exotic plants are very damaging to native plant communities (Category 1) whereas some exotic plants have naturalized and have not displaced native plants (Category 4). The GA EPPC categories include:

Category 1 - Exotic plant that is a serious problem in Georgia natural areas by extensively invading native plant communities and displacing native species.

Category 1 Alert - Exotic plant that is a not yet a serious problem in Georgia natural areas, but that has significant potential to become a serious problem.

Category 2 - Exotic plant that is a moderate problem in Georgia natural areas through invading native plant communities and displacing native species, but to a lesser degree than category 1 species.

Category 3 - Exotic plant that is a minor problem in Georgia natural areas, or is not yet known to be a problem in Georgia but is known to be a problem in adjacent states.

Category 4 - Exotic plant that is naturalized in Georgia but generally does not pose a problem in Georgia natural areas or a potentially invasive plant in need of additional information to determine its true status.

The removal goal for this SOP is to eradicate all Category 1 plants within the assigned restoration plot. The list of Category 1 plants is periodically updated and should be consulted as part of the planning process (http://www.gaeppc.org/list/), but common Category I plants at the time of this SOP, listed by type, include:

<u>Tree</u>
- Tree-of-heaven
- Mimosa
- Chinaberry
- Princesstree
- Chinese tallowtree

<u>Shrub</u>
- Autumn olive
- Chinese privet***
- Multiflora rose

<u>Herbaceous</u>
- Japanese climbing fern
- Marsh dayflower
- Japanese stiltgrass

<u>Vine</u>
- English ivy***
- Japanese honeysuckle
- Kudzu***
- Chinese wisteria

<u>Aquatics</u>
- Alligatorweed
- Common water hyacinth
- Hydrilla

*** known invasive species seen in Brookhaven riparian buffers

A table with pictures and descriptions for each of the Category 1 invasive species is located in Appendix A. There are additional resources online available to assist with identification listed in the reference section. This SOP assumes that the users are familiar with common plant terminologies and identification practices.

Characterize the Restoration Plot

Every invasive species removal project is assigned a unique restoration plot that has difference characteristics including, but not limited to; the type, density, and age of invasive species present; the presence of sensitive features within the plot; and other site specific conditions that might impact removal. The characterization is important to properly plan the removal activities but also must be documented in an Invasive Species Removal Plan (Removal Plan) . The Removal Plan, outlined in the next section, must be approved by the City arborist prior to starting the removal activities.

The characterization is based on a walkthrough of the assigned restoration plot. Specific elements to note include:

- Presence of state waters and/or waters of the US and corresponding riparian buffer areas. Removal techniques will vary in areas adjacent to waterbodies.
- Types of invasive species present and their densities. Removal techniques may vary for dense thickets, vines, and mature trees.
- Age of invasive species. Removal techniques will be different for young, small invasive plants versus those with larger root masses.
- Presence of specimen trees or other important habitats. Tree save fencing will demark sensitive areas to protect during invasive species removal. The characterization will identify any such aras in the restoration plot.
- Other considerations. There may be other considerations particular to the restoration plot such as limited access, proximity to a recreational area/trail, or steep terrain that will need to be considered in the Removal Plan.

Removal Plan

The City Arborist must approve the Removal Plan prior to removal of any invasive species. The Removal Plan is not intended to be a cumbersome or comprehensive document but should outline a logical plan for invasive species removal that complies with all applicable laws and is consistent with this SOP. For professional removal projects, this Removal Plan may also be the Scope of Work for the project. For a City staff or volunteer removal project, brief descriptions of planned activities and timing are sufficient. The required components of the Removal Plan are listed below and explained in further detail in this section.

- Summary of the restoration plot characterization. This includes information about the types of invasive species, their distribution across the restoration plot and information regarding their age and density. A map of the restoration plot highlighting important attributes is required.
- Planned removal techniques. The Removal Plan should outline the planned application of the common removal techniques outlined in this SOP, specific to the type and characteristics of the invasive species and other site conditions within the restoration plot.
- Schedule. A schedule of planned activities for removal and the subsequent maintenance removal should be included.

- Access plans. Access to the site should be approved by the City arborist with a clear understanding of the type of vehicles or equipment that may be using the access path. Plans for restoration of any access paths must also be included.
- Disposal plans. Most of the invasive species targeted by this SOP are prolific. Seeds or roots or cuttings left within the work zone can hinder the goal of eradication. A plan for the proper disposal of collected materials should be described. Allowable disposal methods are presented later in this SOP.
- Safety plans. The plan should outline the safety equipment and precautions that will be taken. If chemicals will be used, the procedures for safety of personnel and the environment must be outlined. If work is to be performed near a recreational area, precautions to protect the public must be provided. Safety plan provisions are discussed later in this SOP.
- Compliance with local, state, and federal regulations. Acknowledgement of pertinent local, state, and federal regulations that impact the proposed removal must be outlined as well as specifics regarding how the project will comply with these requirements. For example, tree save fence will be installed around specimen trees to ensure the removal doesn't damage these trees in violation of the City's Tree Protection and Replacement Ordinance.

The City Arborist will provide a notice to proceed via email once the Removal Plan is complete.

Removal Methods

Depending on the particular species, severity of the infestation, and the proximity to water, there are manual, chemical, and biological methods for invasive species removal. Mechanical treatments involve the removal of the plant, typically through cutting or pulling. Chemical methods include using herbicides to kill the plant or inhibit the growth. The best technique or combination of techniques depends on the species and the site constraints. The different removal techniques are described in tables under Removal later in this section.

When considering the use of chemical methods, it is important to carefully weigh the overall environmental impact of the chemicals against the overall environmental of the removal project. Within protected riparian buffers, very limited use of chemical removal methods is recommended. Chemicals should be carefully selected and applied to minimize the risk of chemicals entering local waterbodies or causing harm to the buffer functions. Chemical health and safety considerations and application method considerations are explained later in this SOP.

Schedule

Removal of invasive species is a multiple year endeavor and the commitment is needed on the front end to complete the transformation. A schedule including a plan for maintenance must be included in the Removal Plan. An example three-year maintenance and planting schedule is outlined below.

Phase 1: Invasive Removal Initiated

- Begin invasive species removal strategy
- Apply seed in any areas with open, disturbed soil

Phase 2: Additional Removal Strategies Implemented, Additional Planting

- Continue invasive species removal strategy (pulling, cutting, check on suffocating techniques, targeted herbicide application)
- Tree and shrub planting to achieve desired planting density

Phase 3: Planting Warranty Inspection, Inspection for Eradication Success

- Inspect new plants for survivorship and replace as needed
- Identify any areas where eradication has not yet been successful or any new areas of invasive species.
- Continue any invasive species removal strategy as needed

Depending on the nature of the removal methods, the phases may not represent a year. The intent of this SOP is to achieve eradication in a three-year period for a small restoration plot, but the schedule in the Removal Plan should be tailored to the restoration plot.

If the invasive species removal is performed using Tree Recompense Funds, the area must be free from invasive species at the end of Year 3. Payments will be released for Year 2 and 3 based on performance as determined by the City Arborist. The City may also elect to use the Tree Recompense Fund for invasive species removal activities and allow developers to perform tree recompense activities in the restoration plot. The contractors should coordinate to ensure their efforts are complementary.

If the invasive species removal is performed by a volunteer group, he City Arborist may request a letter of commitment to maintain the area to prevent additional invasive species infestations.

Bi-annual inspections following Year 3 should be performed by the City or a volunteer group to confirm that invasive species are not re-populating in the riparian buffer.

Access

Proper access will be needed to transport people, equipment, and materials into the restoration plot and to haul away removed invasive plants. The access route must be outlined in the Removal Plan. The restoration of the access path and any provisions to protect sensitive areas (i.e., streams, steep soils, or wetlands) must also be outlined in the Removal Plan.

Proper Disposal of Invasive Plants

Invasive species must be properly disposed of to ensure they do not spread. A proper disposal method must be identified in an approved Removal Plan prior to initiating work. Three techniques for proper disposal are outlined below. Other techniques may be approved by the City Arborist based on the conditions in a specific restoration plot. The techniques used in a restoration plot may vary based on the particular invasive species and whether or not the plant has flowers or seeds.

- Bagging. If the invasive species has flowers or seeds, it should be placed “head first” into a heavy contractor-grade plastic bag at the weeding site. Care should be taken when transporting invasive species that have flowers or seeds and this material should not be composted as seeds can often survive pulling and transport, spreading to unimpacted areas. Properly bagged invasive species should be disposed of at a municipal landfill.
- Air Dried. If an invasive species does not have flowers or seeds and does not have rhizomes or the ability to spread if a small portion of the plant survives, the removed vegetation can be air dried.
- Chipping. Chipping is allowed for woody plants that don’t reproduce vegetatively; therefore the wood chips will not cause the spread of the invasive species. Seeds or flowers should never be chipped.

Composting is never allowed for invasive species. Seeds and flowers can sustain the composting and/or segments of roots may sprout and re-infest the area. Placing invasive species that have seeds or flowers in yard waste bags for

collection is also not allowed as it will result in the spread of that invasive species. Do not mix invasive species debris with yard waste which is shredded, composted and used for mulch in public areas. If not properly composted, invasive species can easily spread to other parts of the City.

Safety and Proper Chemical Handling

Use of chemicals in a riparian buffer should be limited and avoided to the extent practical to protect overall water quality and also to protect the native vegetation that is currently protecting the riparian buffer. If chemicals will be used for the removal of invasive species, application permits may be needed and the manufacturer's instructions must be followed. It is a violation of federal law to use an herbicide in a manner inconsistent with its label. All safety precautions must be followed and protective gear employed as the health and safety of the applicator is a strong concern. Notification should be provided to the Parks Department and City Arborist in advance of any herbicide application and they may require placement of public notices in the park for those who are sensitive to such applications.

Compliance with Local, State, and Federal Regulations

The most applicable local, state, and federal regulations are listed in Section 3 of this SOP. The Removal Plan should outline the relevant regulations to the restoration plot and include actions planned to provide compliance. Permits, if needed, will need to be secured prior to initiating any removal activity.

A stream buffer variance is needed if there is land disturbance within the 75-foot City stream buffer or the 25-foot state water quality buffer. If manual pulling is performed, a land disturbance permit is likely not needed. If mechanized equipment or vehicles to haul out removed vegetation will be used, a land disturbance permit will likely be needed and therefore buffer variances may also be needed.

Invasive Species Removal

The different mechanical, chemical, and removal techniques allowed in Brookhaven are outlined below. The list includes the applicability of each removal technique and includes an example. The appropriate techniques for the restoration plot will be outlined in the approved Removal Plan.

Mechanical Removal of Invasive Species:

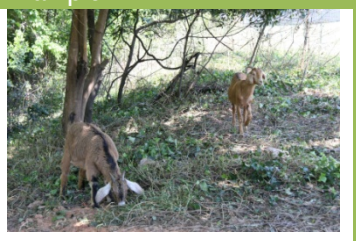
Technique	Example
Hand Pull Application: small vines, herbaceous plants, seedlings < 1 inch in diameter Removing the entire plant, including the roots, by manual pulling. Even small pieces of the root system can allow the plant to regenerate. Pulling is easiest after a rain event when the ground is damp.	
Uprooting Application: vines, shrubs, saplings <3 inches in diameter A small digging fork may be used to extract the root system. Shovels are not recommended as they may cut the root system, leaving it in the ground to re-grow. Tools for larger woody plants include a Weed Wrench ™, Root Jack, or Root Talon. These tools are designed to remove the plant and entire root system. Pulling works on many invasive species and during all seasons. Uprooting is highly effective when the entire plant is removed. Pulling is easiest after a rain event	

Technique	Example
when the ground is damp.	
Suffocation (aka Cardboard and Mulch) Application: herbaceous plants Cover over invasive ground cover with either black plastic (staked or weighted in place) or a thick layer of cardboard covered in mulch. The cardboard will eventually decompose whereas the plastic will need to be removed in about 2 years. This technique suffocates all vegetation (invasive or native) in an area, so replanting will be very important or invasive species may re-establish.	
Air Stripping Application: climbing vines This practice includes cutting vines that are growing up the trunk of a tree or a shrub. The vine is cut near the base of the plant, separating the vine from the root system. The vine is left to decompose in place. The root must either be pulled or treated with herbicide (cut and paint) to prevent re-generation.	
Repetitive Cutting Application: trees, shrubs, saplings > 2 inches in diameter, large vines Continual cutting of herbs and vines may create sufficient stress to eliminate the plant. Cutting uses loppers, saws, and chain saws. Cutting is most effective when combined with chemical application. Cutting is best done prior to seed production. In order to be effective, continual cutting is needed. It may take several years to sufficiently disrupt the plants photosynthesis cycle. Cutting with a forest rake or bush hog or equivalent is not recommended in this SOP. The majority of the Category I invasive species in Georgia prefer recently disturbed areas. Clearing small areas in this fashion provides a fertile growing area for invasive species and removes any native groundcover that may have been present in that area.	

Chemical Removal of Invasive Species:

Technique	Example
Foliar Chemical Applications Applications: herbaceous plants, shrubs Foliar chemical applications are appropriate for small scale or isolated invasive species problems. Typically the herbicide is applied from a backpack or handheld spray bottle. All herbicides should be mixed and applied following the manufacturer's directions. Chemical applications should not be done on windy days as the spray can drift from invasive species and impact nearby native plants. The spray should thoroughly wet the leaves and be applied when rain is not in the forecast for the next 24 to 48 hours. Spraying is most effective when the plants are actively growing; for example when they are flowering or beginning to form fruit.	
Cut Stem or Cut and Paint Applications: For plants that are too big to pull, either the cut stem or cut and paint techniques are effective. The top of the plant is cut and then an herbicide is applied to the cut stem. Higher concentrations of herbicide are needed for this than recommended for foliar applications; following manufacturer's recommendations for concentration and application. This technique is most effective in late summer and autumn. Stumps should be cut close to the ground and herbicide applied shortly after cutting with either a sponge, paint brush, or spray bottle. Delaying the herbicide application can limit effectiveness. Dye may be added to the herbicide solution to make tracking plants that have been treated easier to spot.	
Girdle or "Hack and Squirt" Applications: For some larger invasive trees and shrubs, these techniques allow herbicide to be more effectively applied without topping the tree to a stump. To girdle a tree, the bark and vascular tissue under the bark are removed and a ring cut near the base of the plant around the entire circumference. An herbicide solution is immediately applied to the girdle following manufacturers' instructions. The hack and squirt method involves making uniform cuts in the trunk of a tree or shrub, that create little "cups". The cups are immediately filled with an herbicide solution following manufacturers' instructions.	

Biological Control of Invasive Species:

Technique	Example
Animal Grazing Application: herbaceous plants, seedlings, saplings, small vines, shrubs Grazing by animals is a form of biological control that effectively cuts plants back. It is a useful method in steep or hard to access areas, to reduce soil disturbance and soil erosion that machines can cause or when chemicals cannot be used. Grazers can be effective to reduce seed dispersal. Seeds rarely survive their chewing and digestive systems. Different animals have different feeding preferences. Some animals like goats will eat many types of woody plants. Goats are therefore a non-selective control and will eat other, potentially desirable	

species unless confined to small areas of invasive species. When using grazers, herbivore selection, seasonal timing and grazing intensity should be considered. Like cutting, grazers are most effective when follow-up grazing occurs after re-growth or when combined with other techniques.	

Year 2: Removal Maintenance and Replanting

Year 2 includes the removal of invasive species that have grown since the original removal in Year 1. Often small pieces of roots remain in the soil or new seeds will sprout therefore maintenance removals are critical to achieving eradication. If only small plants have sprouted, manually pulling may be the only treatment technique needed. The same treatment techniques used for the initial removal may be employed for the maintenance removal phase. If changes will be made to the maintenance outlined in the Removal Plan, these should be shared with the City Arborist for concurrence prior to removal.

The major activity in Year 2 is planting to achieve healthy forest densities. A Planting Plan must be approved by the City Arborist before proceeding. Guidelines for determining the existing forest density and the needs for additional plantings are outlined below. A sample list of native plant material for consideration is included in Appendix B. The recommended forest densities and the native plants recommended can also be guided by healthy forested areas in and around Brookhaven.

Replanting Density Guidelines

The goal for the riparian buffer is to have 100 percent coverage with native plants. Following invasive species removal, the remaining vegetation coverage can be calculated using the following formula. If the formula does not yield 100 percent coverage, then additional native vegetation should be planted to achieve 100 percent coverage.

Category	Proportions	Square Foot Value per Category	Notes
Large Trees	40% *	200 square foot	No more than 20% pines. Minimum 10 feet tall and 1.5" caliper
Small Trees	25%	100 square foot	Minimum 6 to 8 feet tall
Shrubs	20%	25 square foot	Minimum 3 gallon size.
Forbs	15%	25 square foot	Grasses, ground cover, perennials. Minimum 1 gallon size.

* Diversity of trees and shrubs is important. No more than 25% should be of the same species.

Example Calculation:
A buffer area of 50 feet in width and 200 feet in length requires 100% re-vegetation after invasive species removal.

Coverage Requirement = 50 feet * 200 feet = 10,000 square feet coverage

- Large Trees = 10,000 * 40% = 4,000 square foot/ 200 square foot per tree = 20 large trees
- Small Trees = 10,000 * 25% = 2,500 square foot/ 100 square foot per tree = 25 small trees
- Shrubs = 10,000 * 20% = 2,000 square foot/ 25 square foot per tree = 80 shrubs
- Forbs = 10,000 * 15% = 1,500 square foot/ 25 square foot per tree = 60 plants

The trees should be distributed and blended across the area to create a healthy forested area. The shrubs may be planted in small groupings of 4 to 6 plants. Any areas that are disturbed should be seeded with a native grass mixture (same species). A list of plants appropriate for riparian buffer areas is included in Appendix A. Plants not included on this list or within the City's Tree Protection and Replacement Ordinance must be approved by the City Arborist.

The Planting Plan should outline the practices planned to care for the plants following installation. The newly installed plants will need to be watered and may need nutrients until they are established. If the trees are planted with funds from the Tree Recompense Fund, the contractor shall provide a one-year warranty on plant survival. If the trees are planted as part of a tree recompense project, the warranty period and terms will be provided by the City Arborist as part of the permit process.

Year 3: Maintenance Removal and Plant Maintenance

Similar to Year 2, the restoration plot should be inspected and any invasive species that have grown should be removed. If only small plants have sprouted, manually pulling may be the only treatment technique needed. If changes will be made to the maintenance activities outlined in the Removal Plan, these should be shared with the City Arborist for concurrence prior to removal.

Plant maintenance is an ongoing activity from planting until the plant is fully established. The plant warranty is intended to promote proper care and maintenance until the new plants are established. If any plants need to be replaced, this shall be done no later than Year 3, unless approval is provided by the City Arborist for an extended schedule. Any plants established in Year 3 will also have a one-year warranty.

6. References

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Methods for Disposing Non-Native Invasive Plants. University of New Hampshire.
http://extension.unh.edu/resources/files/resource000988_rep1720.pdf

7. Definitions

Canopy Tree: A tree that reaches 35 feet in height or larger when mature.

Forbs: Herbaceous flowering plant that is not a grass, sedge, or rush.

Invasive Species: Nonnative organisms whose introductions cause or are likely to cause adverse environmental, economic, and/or human health impacts. For purposes of this document, these are nonnative species that threaten the diversity or abundance of native species or the ecological stability of infested areas, or commercial, agricultural, aquacultural, or recreational activities dependent on such areas.

Land Disturbance: Any land or vegetation change, including, but not limited to, clearing, grubbing, stripping, removal of vegetation, dredging, grading, excavating, transporting and filling of land, that does not involve construction, paving or any other installation of impervious cover.

Native Species: A species naturally present and reproducing within the state or that naturally expands from its historic range into the state.

Nonnative Species: Any species or other viable biological material that enters an ecosystem outside of its historic range, including organisms transferred from one country to another. Species introduced or spread from one region of the U.S. to another outside their normal range are nonnative. Also called introduced, exotic, alien, foreign, nonindigenous species, immigrant, transplants.

Planting Plan: A plan for installing native plants in a restoration plot in order to meet healthy forest densities. This plan is approved by the City Arborist prior to planting.

Removal Plan: A plan that outlines specific aspects of the removal of invasive species from a restoration plot. This plan must be approved by the City Arborist prior to removal.

Restoration Plot: An area of land assigned for removal of invasive species. Recommended units are 10,000 square feet, although multiple contiguous units may be assigned.

Riparian: Pertaining to, situated or dwelling on the margin of a river or other water body.

Setback: The area extending beyond the protected buffer applicable to that waterbody.

Shrub: A woody plant that is smaller than a tree and has several main stems arising at or near the ground. A large shrub reaches 10 feet of height or greater at maturity. A small shrub can reach up to 10 feet in height at maturity.

SOP: Standard Operating Procedure or a document that outlines the proper steps to perform a stated task.

State Waters: Any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells, and other bodies of surface or subsurface water, natural or artificial, lying within or forming a part of the boundaries of the state, which are not entirely confined and retained completely upon a parcel. Ephemeral streams are not considered state waters for the purpose of the Stream Buffer Protection ordinance.

Stream: Any natural, running water flowing continuously or intermittently in a channel on or below the surface of the ground, except that an ephemeral stream is not a stream.

Stream Channel: The confining cut of ground surface that contains the base flow of a stream and is identified at a point where the water flow has wrested the vegetation.

Sub-Canopy Tree: An immature canopy tree, a stunted canopy tree, or other co-dominant tree or an understory tree.

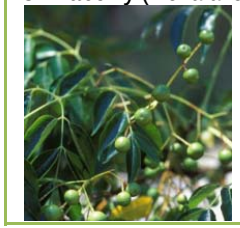
Trophic Layer: Different levels of low-growing grasses, forbs (non-woody flowering plants other than grasses), small trees, bushes and/or shrubs, and canopy cover from medium to larger trees existing in a buffer.

Understory Tree: A tree that matures to a height of 12 feet to 35 feet.

Waters of the State: "State Waters" means any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells, and other bodies of surface or subsurface water, natural and artificial, lying within or forming a part of the boundaries of the State which are not entirely confined and retained completely upon the property of a single individual, partnership, or corporation.

Wrested Vegetation: The point adjacent to the edge of the base flow of a stream or the water surface of a lake where vegetation has been moved or wrested as a result of normal stream flow or wave action. This is the point from which the protective buffer should be measured.

Appendix A: Category 1 Invasive Species of Georgia (February 2016)

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
Tree of Heaven (Ailanthus altissima	General Information Rapidly growing small deciduous tree up to 80 ft in height and 6 ft in diameter. Forms in dense thickets and can displace native vegetation. Tree of Heaven can survive in poor soils and is a prolific seed producer. Tree of Heaven can reproduce from both seed and root sprouts.	The most effective way to control tree of heaven is to pull seedlings by hand before the tap root develops. If the plant has matured, cutting alone will only help temporarily by reducing its ability to spread. Sprouts may emerge up to 50 feet from the nearest stem, so resprouts can be common. For larger trees and stands, a combination of mechanical and chemical controls will be needed.
	Foliage Distinctive leaves are found in odd-numbered groupings (pinnately compound) on branches about 1 to 4 feet in length with 11 to 41 leaflets. When crushed, the leaves have a bad odor.	
	Flower Yellow flowers bloom in early summer. Each tree may produce several hundred flowers.	
	Fruit Each fruit contains a single seed. Seeds mature in late summer to early fall and form dense, pink clusters that persist through winter. Each cluster contains hundreds of seeds.	
Mimosa (Albizia julibrissin)	General Information Mimosa is a small tree that grows 10 to 50 ft tall, often with multiple trunks. Mimosa trees prefer disturbed ground, especially on the edges of forest or waterbodies.	Mimosa is difficult to remove because the seeds are long-lived and can resprout from remaining roots. Mechanical methods include cutting the entire tree down with a chainsaw, preferably when it has begun to flower. Chemical treatments can be used with mechanical techniques to reduce the risk of resprout. Maintenance will be needed to remove resprouts.
	Foliage The delicate-looking leaves are found in odd numbered groupings (bi-pinnately compound). The leaves turn yellow in the fall.	
	Flower Fragrant pink flowers bloom in early summer.	
	Fruit Mimosa's flat seed pod fruit develop in late summer.	
Chinaberry (*Melia azedarach*) 	General Information Chinaberry is a deciduous tree that grows to 50 feet tall with a trunk of 2 feet in diameter. Invades disturbed areas including along roads and forest edges. Chinaberry can form in dense thickets and restrict the growth of native vegetation.	Trees can be cut down using a chain saw but because they typically resprout after being cut, this is a less desirable alternative. However, cutting followed by treatment with herbicide can be effective.
	Foliage The leaves are alternate in odd numbered groupings (bi-pinnately compound) and about 1 to 2 feet in length.	

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	Flower Flowers are showy, lavender and occur in the spring.	
	Fruit Fruit are hard, green to yellow, stalked berries that can be dangerous on walkways and are poisonous to humans and small animals. Seeds are spread by birds.	
Princesstree (Paulownia tomentosa) 	General Information A deciduous tree that grows up to 60 feet tall and 2 foot in diameter. The tree can be mistaken for northern catalpa (catalpa speciosa), a native tree. Princesstree bark is grey-brown and rough. Princesstree is an aggressive tree and invades disturbed natural areas. Seeds can be dispursed by the wind up to 2 miles away.	Small sprouts and seedlings should be removed to prevent seed formation and when fruit are not present. Bag and dispose of plants in a dumpster. Large trees likely require a cut stump treatment.
	Foliage Large heart-shaped leaves that have a fuzzy/ hairy surface on both sides. The leaves are arranged opposite along the stem.	
	Flower In the spring, there are large, fragrant light pink flowers in upright clusters.	
	Fruit The abundant fruit is light green in the summer and turns dark brown in the winter. The seed capsules look like pecans and split in half during late winter and release up to 2000 tiny seeds.	
Chinese Tallowtree (*Triadica sebifera*) 	General Information Chinese Tallowtree is a deciduous tree that can grow to 60 foot tall and 3 feet in diameter. Chinese Tallowtree typically invades wet areas, such as streambanks, ditches, and wetlands. It is a serious threat because it can displace native vegetation and alter soil conditions with the high level of tannins in the leaf litter. It is toxic to animals and humans and the white sap may be a skin irritant.	Chinese tallowtree is effectively controlled by manual pulling of small seedlings. Seedlings should be pulled before they produce seed. The entire root must be removed, or broken fragments of root may resprout. Girdling or cut and paint techniques are required for larger saplings and trees. Because tallowtree spreads by suckering, resprouts after removal are common.
	Foliage Leaves are alternate, heart-shaped, 2-3 inches long with a long, pointed tip.	
	Flower Flowering occurs from April to June. The flowers are yellowish and occur on 8 inch long, dangling spikes.	

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	Fruit Three-compartment fruit that turns from green to black are found in clusters at the end of branches. Fruit mature to black and then open to reveal the white wax covered seeds, 3 seeds per capsule.	
	Shrub	
Autumn Olive (*Elaeagnus umbellata*) 	General Information A deciduous shrub with thorny branches growing from 3 to 20 feet in height. Invades woodland edges and disturbed areas. Autumn olive can form a dense shrub layer that displaces native species and impede movement by human or wildlife.	Remove small sprouts by hand pulling or uprooting. Cut stem or cut and paint techniques are effective but eye protection is important due to multiple thorny sprouts. Treatment prior to seed formation is most effective. Animal grazing can be effective if repetitive or if roots are subsequently removed.
	Foliage Leaves are alternate and typically 2 to 3 inches long and 1 inch wide. The leaf edges are undulate. Leaves are bright green to green gray in color on the top side and silver scaly with small hairs on the underside.	
	Flowers Small, yellowish tubular flowers bloom form in abundant clusters of 5 to 10 flowers near the stem. Blooms from February to June.	
	Fruit Fruits are round, red, juicy drupes which have very small silvery scales. Each drupe contains one seed. Fruit ripens from August to November.	
Chinese privet (*Ligustrum sinese*) 	General Information A semi-evergreen shrub or small tree that grows to 20 feet in height. Trunks usually occur as multiple stems with many long, leafy branches. There are several similar species. Chinese privet is very tolerant and forms dense thickets that shade out and exclude native understory species. They are often found in riparian areas. Chinese privet is highly invasive and grows rapidly from seed or from root and stump sprouts.	Control methods include cutting, grazing, and seedling removal. Cutting is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Stems should be cut at least once per growing season as close to ground level as possible. Repeated mowing, cutting, or grazing will control the spread of Chinese privet but may not eradicate it. Manual removal of young seedlings is very effective.
	Foliage Leaves are opposite, oblong, 1-2.4 inches long, and 0.2-0.6 inches wide. Foliage can have short hairs (be pubescent) along the underside of the midvein. The leaves have smooth edges.	
	Flowers Flowering occurs from April to June, when loose bunches (panicles) of white to cream flowers develop at the end of the branch clusters. Pollen can cause an allergic reaction in some people.	

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	Fruit The abundant fruits are spherical and 0.3-0.5 inches long. Fruit begins green, ripens to dark purple to black in the fall and persist into winter. Mature plants can produce hundreds of fruits. Birds and other wildlife eat the fruit and disperse the seeds. Seed soil viability is about one year.	
Multiflora rose (*multiflora rosa*) 	General Information A multi-stemmed, thorny, perennial shrub that grows up to 15 feet tall. Stems are green to red and form arches with stiff, curved thorns. Develops impenetrable thickets on forest edges that restrict human and wildlife movement. Reproduces by seeds and by rooting at the tips of its drooping branches. Tolerates a wide variety of conditions.	Repeated cutting is appropriate for small thickets or in environmentally sensitive areas. Repeated cutting will control the spread but will not eradicate multiflora rose. Hand cutting is both difficult and time consuming due to the long arching stems and prolific thorns. The cut stump method may be needed for denser thickets.
	Foliage Leaves are found on small branches with 7 to 9 leaves on each (pinnately compound). The leaves are oblong and 1 to 1.5 inches long with serrated edges.	
	Flowers Small, 5-petaled flowers that are white to pink in color present in abundant clusters in the spring.	
	Fruit Small, red rose hips remain throughout the winter. Birds and other wildlife eat the fruit and disperse the seeds. Seeds remain viable for a number of years.	
Herbaceous		
Japanese climbing fern (*Lygodium japonicum*) 	General Information Japanese climbing fern is a perennial climbing fern that can grow to 90 feet tall. Vines are thin, wiry in nature with colors that vary from green to orange to black. The vines usually die back in the winter. Japanese climbing fern is common in disturbed areas and is generally scattered throughout the landscape. It can form dense mats that smother understory vegetation. It spreads via creeping rhizomes. Prior year's dead vines provide a trellis for reestablishment.	Remove when plants are young to prevent spore formation. Bag and dispose of removed plants in a dumpster. Clean shoes, clothes, and equipment before leaving infested areas. Tiny spores can be spread by clothing. Herbicides may need to be applied to leaves in July to September, before spore release.
	Foliage The fronds (leaves of a fern) are opposite, compound, usually triangular in shape, 3-6 in. (8-15 cm) long, 2-3 in. (5-8 cm) wide and finely dissected.	
	Flower This plant does not produce flowers.	

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	Fruit Fertile fronds bear sporangia that produce tiny, wind-dispersed spores. Plants are also spread by rhizomes.	
Marsh dayflower (*Murdannia keisak*) 	General Information Marsh dayflower is an annual, emergent plant that invades wetlands and along streams and can grow immersed in water. Plant stems are succulent and form roots at the nodes that grow prostrate along the ground. Stems can grow 12 to 30 inches long. Marsh dayflower forms dense mats that out-compete native vegetation.	
	Foliage Leaves are alternate, lance-shaped, and up to 3 inches long.	
	Flowers From September to November small, pink, 3-petaled flowers occur singly or in small clusters at the apex of the stems and in the leaf axils.	
	Fruit The fruit is a capsule that contains several small seeds.	
Japanese stiltgrass (*Microstegium vimineum*) 	General Information Japanese stiltgrass is a delicate, sprawling, annual grass that grows from 0.5 to 3.5 feet tall. The stems can root at the nodes. Japanese stiltgrass commonly invades forested floodplains, forest edges, and along trails. It is very shade tolerant and can completely displace native vegetation.	Hand pulling may need to be followed by an herbicide application. For larger areas, cutting followed by an herbicide application may be required. Early summer self-pollinated seeds are hidden in the leaf sheaves. Clean shoes, clothes, and equipment of tiny seeds before leaving an infested area. Treatment will likely need to be repeated for several years.
	Foliage The leaves are pale-green, alternate, lance-shaped, 1-3 inches long, asymmetrical with a shiny, off-center midrib. Upper and lower leaf surface is slightly pubescent. A silvery line runs down the center of the blade. Stems usually droop.	
	Flowers Flowering begins in September, when delicate flower stalks develop in the axils of the leaves or at the top of the stems.	
	Fruit Fruit is produced from late September through early October. Prolific seeder, each plant produces 100 to 1,000 seeds that can remain viable in the soil for 3 years. Spread on trails by hikers shoes.	
Vine		

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
English ivy (*Hedera helix*) 	General Information English ivy is an evergreen perennial climbing vine that attaches to bark of trees, brickwork and other surfaces by root-like structures that exude a glue-like substance to aid in adherence. English ivy is an aggressive invader threatening all levels of forested and open areas as it grows along the ground and up trees into the forest canopy. Vines block sunlight from the host tree's foliage, impeding photosynthesis. An infested tree will exhibit decline for years before it dies. The weight of vines also makes trees susceptible to blowing over in storms. This plant has been confirmed as a reservoir for bacterial leaf scorch which affects a wide variety of trees.	Cut climbing or trailing vines as close to the root collar as possible. Smaller vines can be removed manually or with the help of a small digging tool. Any portions of the root system not removed will potentially resprout. Mulching can be effective for small infestations. The mulch should stay in place for at least 2 growing seasons. Cut stump treatments may be needed for larger vines that are too big to pull.
	Foliage Leaves are alternate, dark green, waxy, somewhat leathery; extremely variable leaf forms, from unlobed to 3-5 lobed; typically green with whitish veins.	
	Flowers Flowering occurs in late summer to early fall, typically under full sun conditions; flowers are small, greenish-yellow and occur in globular starburst type inflorescence at tips of flowering stems.	
	Fruit Fruits are black with a fleshy outer layer and stone-like seeds. New plants grow easily from cuttings or stem fragments that make contact with the soil.	
Japanese honeysuckle (*Lonicera japonica*) 	General Information Japanese honeysuckle is a woody perennial, evergreen to semi-evergreen vine that can be found either trailing or climbing to over 80 feet long. Japanese honeysuckle can girdle small saplings by twining around them, and can form dense mats in the canopies of trees, shading everything below.	Because Japanese honeysuckle is so difficult to control when it is established, control programs often kill 100-percent of the plants in the surrounding area. Removing above ground stems by cutting or pulling will temporarily weaken but not kill the plant. Japanese honeysuckle will resprout from subterranean buds and roots as well as from cut branchlets.
	Foliage Leaves are opposite, pubescent, oval and 1-2.5 in. (2.5-6.4 cm) long. Margins are usually entire but young leaves may be lobed or toothed.	
	Flowers Flowering occurs from April to July, when showy, fragrant, tubular, whitish-pink flowers develop in the axils of the leaves. The flowers turn cream-yellow as they age.	
	Fruit The small shiny globular fruits turn from green to black as they ripen. Each fruit contains 2-3 small brown to black ovate seeds.	

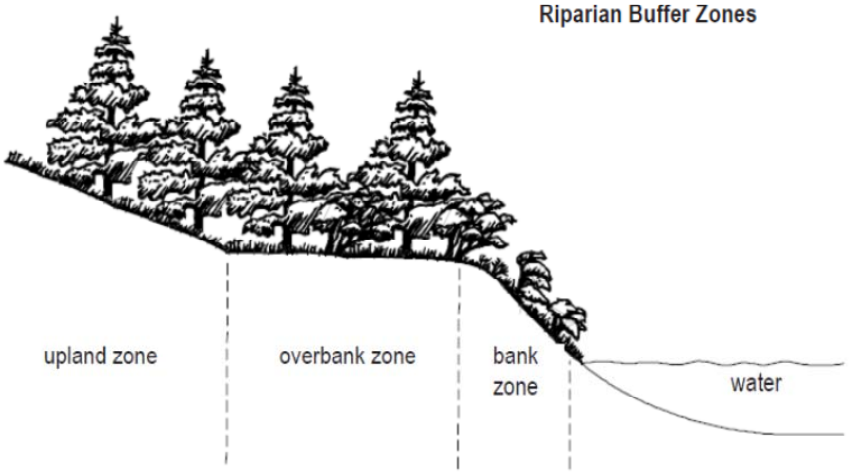
Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
Kudzu *(Pueraria montana var. lobata)*	General Information Kudzu is a climbing, deciduous vine capable of reaching lengths of over 100 feet in a single season. Its fleshy tap roots can reach 7 inches wide and grow to 9 feet deep. These roots can weigh up to 400 lbs. Kudzu prefers open, disturbed areas such as roadsides, right-of-ways, forest edges, and old fields. Kudzu often grows over, shades out and kills all other vegetation, including trees. It was widely planted throughout the eastern United States in an attempt to control erosion. Kudzu establishes plants by forming roots at nodes where vines come into contact with soil.	Cutting vines and runners above the ground level every two weeks, starting early in the season will weaken the crown and prevent resumption of photosynthesis. Later in the season, the intervals between cuttings can be reduced. Cutting does not kill the roots but can control the spread. For young or resprouting kudzu, cutting combined with digging out the root crown with a Pulaski or similar tool is effective. The cut stump method is effective in areas where the vines are located around non-target plants or where vines have grown into the canopy.
	Foliage Leaves are alternate, compound (with three, usually lobed, leaflets), hairy underneath and up to 5.4 inches long.	
	Flowers Flowering occurs in midsummer, when 0.5 inch long, purple, fragrant flowers hang, in clusters, in the axils of the leaves.	
	Fruit Fruit are brown, hairy, flat, with seed pods about 3 inches long and 0.3 inches wide. Each pod can contain 3-10 hard seeds.	
Chinese wisteria (*Wisteria sinensis*)	General Information Chinese wisteria is a deciduous woody vine capable of growing to a height of 40 feet. Thick stems can be up to 10 inches in diameter with smooth, gray-brown bark. When looking down on the vine, it twines in a counter clockwise direction around the host. Wisteria can displace native vegetation and kill trees and shrubs by girdling them. The vine has the ability to change the structure of a forest by killing trees and altering the light availability to the forest floor.	For small populations, mechanical control methods can be effective but are labor intensive. Cut the vines close to the root collar to discontinue growth, reduce seed production, and eventually exhaust the plant. Wisteria will resprout, so repeated cuttings are recommended every two weeks. A Pulaski, weed wrench or other tool should be used to remove the entire plant and roots. Cut vines must be removed from the site to prevent resprouting. The cut stump method may be used for large stands of established vines. The vines should be cut close to the ground. Retreatment may be needed if resprouting occurs.
	Foliage Alternate, pinnately compound (7-13 leaflets) leaves are tapered at the tip with wavy edges. Leaflets are approximately 3 inches long.	
	Flowers Lavender, purple or white flowers are fragrant, very showy and abundant and occur in long, dangling clusters in the spring.	
	Fruit Seeds are contained in flattened, hairy, 6 in. (15.2 cm) long, bean-like pods. Invasions often occur around previous plantings.	
Aquatics		
Alligatorweed (*Alternanthera*	General Information Alligatorweed is an emergent or rooted floating plant that invades aquatic	Herbicides must be used to eliminate alligator weed and sometimes is done in combination with water level

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
philoxeroides)	areas and adjoining uplands. Plants have hollow stems and can grow to 3 feet tall. Alligatorweed roots in wet soils or shallow water and grows out into waterways. It can also grow terrestrially, forming smaller, tougher leaves. The thick mats can displace native vegetation and wildlife habitat, clog waterways, restrict oxygen levels of water, increase sedimentation, interfere with irrigation and prevent drainage.	management. Any herbicide application in a riparian buffer should carefully consider any negative impacts to local waterbodies.
	Foliage Opposite, elliptical leaves are thick but non-succulent and are up to 4 inches long.	
	Flowers Flowering occurs during the summer with white, clover-like heads in the axils of the leaves.	
	Fruit Fruits are very small, and single-seeded.	
Common water hyacinth (Eichhornia crassipes)	General Information Common water hyacinth is a free floating aquatic plant that invades aquatic areas. Plants can grow to 3 feet tall. Water hyacinth can quickly form dense floating mats of vegetation. Populations can double in size in two weeks. These dense mats restrict light to the underwater environment, reduce the light availability for submersed plants and aquatic invertebrates, and deplete the oxygen levels.	A small infestation can be controlled by hand pulling but typically herbicides are needed. Plans to use herbicides must be carefully evaluated to avoid unintended damage to other aquatic organisms. Certain fish species can also reduce populations. Care must be taken to protect native fish species. Chinese grass carp that are sterile are sometimes stocked to avoid outcompeting native fish species.
	Foliage The leaves are oval to elliptical, thick, up to 6 in. (15 cm) wide and waxy with spongy petioles. Leaves curve inward at the edges.	
	Flowers The very showy blue-purple flowers are born on upright spikes. Each flower has six petals with the uppermost having a yellow patch.	
	Fruit This plant reproduces chiefly by vegetative means.	
Hydrilla (Hydrilla verticillata)	General Information Hydrilla is a submersed, rooted aquatic plant that can grow in water up to depths of 20 feet. Plants can survive in depths up to 40 feet in non-turbid water. Hydrilla forms dense mats at the surface of the water. The dense mats can restrict native vegetation, irrigation practices, recreation, hydroelectric production, and water flow. It can invade most slow-moving or still water systems.	Mechanical controls including harvesting is effective for small initial populations. All parts of the plant should be removed and properly disposed. Special harvesters are available for larger infestations. Seasonal drawdowns can also be effective in controlling hydrilla , especially when the drawdown occurs in the fall when tubers are developing.
	Foliage Leaves are whorled in bunches of 3-8, but most often with whorls of 5. The	

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	midribs of the leaves are reddish in color with the undersides having small, raised teeth. Leaves are 0.2-0.8 inches long, less than 0.1 in. (2 mm) wide and have serrated margins. Flowers Only the female flowers of this dioecious plant have been found in the United States, which means no viable seed are produced. Fruit Turions (stem tubers) are bud-like structures which can drop off the plant and successfully survive freezing or drought. Tubers from the rhizomes are another way these plants reproduce and increase their invasive potential.	If the infestation is larger, herbicidal or biological controls may be evaluated. The impact on waterbodies should be carefully measured against the benefits associated with removal.

Appendix B: Native Plant List for Replanting

Figure SOP2.2. Riparian Buffer Zones for Plant List Tables



Large Trees (40% of the buffer)

Common Name	Scientific Name	Bank Zone	Overbank Zone	Upland Zone	Hardiness
Red Maple	*Acer rubrum*	✓	✓	✓	Good
River Birch	*Betula nigra*	✓	✓	✓	Good
Shagbark Hickory	*Carya ovate*		✓	✓	Good
Sugarberry	*Celtis laevigata*	✓	✓	✓	Good
Persimmon	*Diospyros virginiana*		✓	✓	Good
American Beech	*Fagus grandifloria*		✓	✓	Good
White Ash	*Fraxinus Americana*		✓	✓	Good
Green Ash	*Fraxinus pennsylvanica*	✓	✓	✓	Good
Sweetgum	*Liquidambar styraciflua*	✓	✓	✓	Good
Tulip Poplar	*Liriodendron tulipifera*		✓	✓	Good
Southern Magnolia	*Magnolia grandiflora*		✓	✓	Good
Black Gum	*Nyssa sylvatica*		✓	✓	Good
Loblolly Pine	*Pinus taeda*		✓	✓	Good
Virginia Pine	*Pinus virginiana*			✓	Good
Sycamore	*Platanus occidentalis*	✓	✓	✓	Good
White Oak	*Quercus alba*		✓	✓	Good
Southern Red Oak	*Q. falcate*		✓	✓	Good
Overcup Oak	*Q. lyrata*	✓	✓	✓	Good
Swamp Chestnut Oak	*Q. michauxii*	✓	✓	✓	Good
Red Oak	*Q. rubra*		✓	✓	Good
Shumard Oak	*Q. shumardii*	✓	✓	✓	Good
Water Oak	*Q. nigra*	✓	✓	✓	Good
Willow Oak	*Q. phellos*	✓	✓	✓	Good
Black Willow	*Salix nigra*	✓	✓		Good
Bald Cypress	*Taxodium distichum*		✓		Good

Small Trees (25%)

Common Name	Scientific Name	Bank Zone	Overbank Zone	Upland Zone	Hardiness
Florida Maple	*Acer barbatum*		✓	✓	Good
Red Buckeye	*Aesculus pavia*		✓	✓	Good
Serviceberry	*Amelanchier canadensis*		✓	✓	Fair
Ironwood	*Carpinus caroliniana*	✓	✓	✓	Good
Redbud	*Cercis Canadensis*		✓	✓	Good
Dogwood	*Cornus florida*		✓	✓	Good
Hawthorn	*Crataegus phaenopyrum, Crataegus spp.*		✓	✓	Good
Carolina Silverbell	*Halesia Carolina*		✓	✓	Fair
American Holly	*Ilex opaca*		✓	✓	Good
Sweetbay	*Magnolia virginiana*	✓	✓	✓	Good
Southern Crabapple	*Malus angustifloria*			✓	Good
Hophornbeam	*Ostrya virginiana*		✓	✓	Good
Sourwood	*Oxydendrum arboretum*			✓	Good

Shrubs (20%)

Common Name	Scientific Name	Bank Zone	Overbank Zone	Upland Zone	Hardiness
Buckeye	*Aesculus sylvatica*		✓	✓	Good
Tag Alder	*Alnus serrulata*	✓	✓		Good
Red Chokeberry	*Aronia arbutifolia*	✓	✓	✓	Fair
Pawpaw	*Asimina triloba*		✓	✓	Fair
Sweetshrub	*Calycanthus floridus*		✓	✓	Good
American Beautyberry	*Callicarpa americana*		✓	✓	Good
Buttonbush	*Cephalanthus occidentalis*	✓	✓		Good
Sweet Pepperbush	*Clethra alnifolia*	✓	✓	✓	Good
Silky Dogwood	*Cornus amonum*	✓	✓		Good
American Strawberry Bush	*Euonymous americanus*		✓	✓	Good
Witchhazel	*Hamamelis virginiana*		✓	✓	Good
Inkberry	*Ilex glabra*		✓		Fair
Oak-leaf Hydrangea	*Hydrangea quercifolia*		✓	✓	Good
Florida Anise	*Illicium floridanum*		✓	✓	Good
Small Anise	*I. parviflorum*		✓	✓	Good
Possumhaw	*Ilex deciduas*	✓	✓		Good
Winterberry	*I.verticillata*	✓	✓		Good
Itea, Virginia Sweetspire	*Itea virginica*	✓	✓		Good
Mountain Laurel	*Kalmia latifolia*		✓		Poor
Spice Bush	*Lindera benzoin*		✓		Good
Dog Hobble	*Leucothoe spp.*	✓	✓		Poor
Wax Myrtle	*Myrica cerifera*		✓	✓	Good
American Devilwood	*Osmanthus americanus*		✓	✓	Fair
Chickasaw and Hog Plum	*Prunus angustifolia, P. umbellate*		✓	✓	Good
Wild Plum	*P. americana*		✓	✓	Good
Piedmont Azalea, other natives (not Jap. Evergreen azaleas)	*Rhododendron canescens, R. periclymenoides, R. flammeum, R.*		✓	✓	Fair

Common Name	Scientific Name	Bank Zone	Overbank Zone	Upland Zone	Hardiness
	calendulaceum, R. viscosum, etc.				
Dwarf Rhododendron	*Rhododendron minus*		✓		Fair
Smooth or Winged Sumac	*Rhus glabra, R. copallinum*			✓	Good
Elderberry	*Sambucus Canadensis*	✓	✓		Good
Maple-leaf Viburnum	*Viburnum acerifolium*		✓	✓	Fair
Swamphaw Viburnum	*Viburnum nudum, V. cassinoides*	✓	✓		Good

Forbs, Ground Covers, Perennials (15%)

Common Name	Scientific Name	Bank Zone	Overbank Zone	Upland Zone	Hardiness
Sensitive fern	*Onoclea sensibilis*		✓		Fair
Cinnamon fern	*Osmunda cinnamomea*		✓		Fair
Royal fern	*Osmunda regalis*		✓		Fair
Christmas fern	*Polystichum acrostichoides*		✓		Fair
Virginia Chain fern	*Woodwardia virginica*		✓		Fair
Butterflyweed	*Asclepias tuberose*		✓	✓	Fair
New England Aster	*Aster novae-angliae*		✓	✓	Fair
Turtlehead	*Chelone lyonii*		✓	✓	Fair
Lanceleaved Coreopsis	*Coreopsis lanceolata*		✓	✓	Fair
Bleeding heart	*Dicentra eximia*		✓	✓	Fair
Heardy ageratum	*Eupatorium coelestinum*		✓	✓	Fair
Joe-Pye Weed	*Eupatorium fistulosum*		✓	✓	Fair
Wild Geranium	*Geranium maculatum*		✓	✓	Fair
Narrow-leaved sunflower	*Helianthus angustifolius*		✓		Fair
Hibiscus (NOT shrub althea)	*Hibiscus coccineus, H. moscheutus*		✓		Fair
Gayfeather	*Liatris spicata, L. aspera*		✓	✓	Fair
Cardinal flower	*Lobelia cardinalis*		✓		Fair
Great Lobelia	*Lobelia siphilitica*		✓		Fair
Partridgeberry	*Mitchella repens*		✓		Fair
Evening Primrose	*Oenothera speciosa, O. fruticosa*		✓		Fair
False Dragonhead, Obedient Plant	*Physostegia virginiana*		✓	✓	Fair
Salomon's Seal	*Polygonatum biflorum*		✓		Fair
Goldstrum Black-Eyed Susan	*Rudbeckia fulgida "Goldsturm"*		✓	✓	Good
Black-Eyed Susan	*Rudbeckia hirta*		✓	✓	Good
False Solomon's Seal	*Smilacina racemosa*		✓	✓	Fair
Goldenrod	*Solidago spp.*		✓	✓	Fair
Stoke's Aster	*Stokesia laevis*		✓	✓	Fair
Foamflower	*Tiarella cordifolia*		✓		Poor
Spiderwort	*Tradescantia virginiana*		✓	✓	Fair
Ironweed	*Vernonia noveboracensis*		✓	✓	Good
Yellow-root	*Xanthorhiza simplicissima*	✓	✓		Good

Suggested Grass Species and Seeding Rates

Common Name	Scientific Name	Type	Seeding Rate (lbs/acre)
Big Bluestem	*Andropogon gerardii*	Warm	25
Side-Oats Grama	*Bouteloua curtipendula*	Warm	20
Wild Rye	*Elymus virginicus, E. canadensis*	Cool	20
Switchgrass	*Panicum virgatum*	Warm	10
Little Bluestem	*Schizachyrium scoparium*	Warm	14.5
Indian Grass	*Sorghastrum nutans*	Warm	22
Eastern Gamagrass	*Tripsacam dactyloides*	Warm	22

Notes:

1. Seeding rates based on pure live seed.
2. Plant species selected are based on commercial availability.
3. Other commercial mixtures can be used.
4. Use annual rye as a cover crop (or another approved cover crop) when seeding during the dormant season.
5. The hardiness rating as noted is based on the individual species' ability to survive adverse conditions during the initial establishment period.

Brookhaven GEORGIA	Caring for Newly Established Riparian Buffers	SOP #	3
		Revision #	0
		Implementation Date	May 2016
Page #	1 of 10	Last Reviewed/Update Date	
SOP Owner	Public Works	Approval	

Standard Operating Procedure (SOP)

1. Purpose

This SOP outlines best practices for special preparations prior to planting and special maintenance activities immediately following replanting that are needed to care for newly established riparian buffers. Established and undisturbed vegetative buffers protect the integrity of local water resources and reduce erosion resulting in the loss of land. In some locations, existing riparian buffers have been compromised. Proper care must be taken when revegetating compromised buffers to maximize survival, including proper soil preparation and post-planting maintenance activities.

SOP 2 in this series includes information on supplemental planting in forested riparian buffer areas including a list of native plants and desired planting densities. This SOP outlines the special preparations prior to planting and immediately following replanting within a riparian buffer area.

2. Scope

Riparian buffers are vegetated areas that provide a number of benefits to the health and wellbeing of local waterbodies. The City has a vested interest in protecting the integrity and functionality of riparian buffers to reduce stormwater pollution, minimize stream erosion and loss of land, and protect water quality. This SOP provides details on caring for newly planted and restored riparian buffer areas which may include lake shorelines as well as stream restoration or buffer restoration projects.

The activities outlined in this SOP are governed by both City and State regulations, outlined in Section 3. Section 5 of this SOP outlines the protocols for establishing new riparian buffers including soil preparation, proper planting procedure, newly planted plant care and maintenance. Terminology and abbreviations used throughout this SOP are defined in Section 7.

This SOP is one of a series of three SOPs developed as part of the Nancy Creek Watershed Improvement Plan. The coordinating SOPs include “Performing Maintenance in Established Riparian Buffers” (SOP 1) and “Removing Invasive Species from the Riparian Buffer and Replanting” (SOP 2).

3. Pertinent Regulations

Land Disturbance (Chapter 14, Article II, Section 14-27 through 14-38): Any project involving land disturbance requires a land disturbance permit from the City's Community Development Department, compliant with the Georgia Soil and Water Conservation on Commission's practices. Maintenance activities may require a land disturbance permit.

Tree Protection and Replacement (Chapter 14, Article II, Section 14-39): The purpose of the Tree Ordinance is to promote tree canopy preservation and tree replacement as an integral part of the land development and construction process in the City. The goal is to maintain a sustainable tree canopy, which provides many aesthetic, environmental, and economic benefits to the City and its citizens.

Stream Buffer Protection Ordinance (Chapter 14, Article II, Section 14-44): The purpose of this ordinance is to protect the environment and the public's health, safety, and land welfare; to minimize public and private losses due to erosion, siltation and water pollution; and to maintain stream water quality by provisions designed to:

1) Create buffer zones and impervious setbacks along the streams of the City of Brookhaven for the protection of water resources; and,
2) Establish buffer and setback zone requirements to minimize land development and land disturbance, and require authorization for these activities.

The stream buffer protection ordinance is triggered by a land development activity and controls the riparian area extending 75 feet from the point of wrested vegetation.

Georgia Erosion and Sedimentation Control Act (Rule 391-3-7-.05): Establishes variance requirements for the disturbance of the riparian buffer extending 25 feet from the point of wrested vegetation. A state buffer variance is required if a project includes land disturbance within the 25 foot riparian buffer. If a City stream buffer variance is required, a state buffer variance is likely needed.

4. Responsibilities

The Parks and Recreation Department will be responsible for overseeing that best management practices are followed in newly planted riparian buffer areas within City parks. They are also responsible for engaging other City staff as needed.

The City Engineer will provide technical support related to water quality and the relationship of this SOP with the Nancy Creek Watershed Improvement Plan. The City Engineer will work with the Parks Department to fund riparian buffer restoration and maintenance projects where there is a water quality benefit.

The Community Development Department is responsible for issuing land disturbance permits, which may be required for activities covered under this SOP.

The City Arborist will provide guidance and insight to ensure City maintenance operations are consistent with the City's Tree Protection and Replacement Ordinance. The City Arborist will serve as a technical advisor for these projects.

5. Procedure

This SOP outlines how to prepare a riparian buffer area for plantings and the proper procedures for care and maintenance of newly planted vegetation in riparian buffers to maximize survivability and achieve desired vegetation densities. The SOP assumes that the correct plants are specified and that are were planted in accordance with best practices and at the appropriate time of year. This SOP outlines the maintenance activities that are necessary to establish vegetation within a riparian buffer. Specific plants may require additional attention.

Planting Soil Preparations

Preparing the soil for planting is critical to the ultimate success of the riparian buffer plantings. Proper soil preparations are ideally initiated up to a year prior to the planting of new trees and shrubs; however, there are techniques to expedite this timeframe.

A soil analysis is helpful in determining the need for soil amendments. This should be done early in the project planning phase. The number, distribution, and depth of soil samples should follow the laboratory recommendations. If recommendations are not available, take two soil samples every 100 feet along the planned planting area within the buffer to a depth of three to six inches. Samples should be labeled with the sample location marked on a map.

The laboratory results will recommend the types and amounts of soil amendments needed to support native riparian buffer plants. In many cases, amending the soil is unnecessary. Always check results from the soil analysis before adding amendments.

In some cases, the existing riparian buffer soils are unsuitable for planting and new soil will need to be brought onsite prior to planting. For example, severely eroded banks will need to be addressed following design recommendations from a professional prior to planting. Additional soil analysis to assess the texture, drainage, and compaction are likely needed. If new soils are needed, a professional landscape architect should be consulted.

General guidelines for soil preparations include:

- Banks will need to be regraded to address erosion and/or compaction.
- For slopes less than 3:1, containerized plants can be used.
- If soil is very poor due to compaction, erosion, anaerobic conditions, or others, it may need to be scraped and replaced with new soil.
- Ensure plantings have an adequate depth of good quality, uncompacted soil to grow in. The quality of the soil should be determined by the soil analysis. The soil depth should be adequate for the depth of the root system of the species being planted.
- A soil analysis should be done on any new soil being used in the buffer to ensure the texture, pH and nutrient levels are appropriate for the intended purpose.

Erosion and Sediment Control

Sediment and erosion control devices should always be used when doing work on the bank. Temporary controls such as silt fencing can be used during the buffer restoration work. Longer term controls vary depending on the steepness of the slope, the types of soils on site and the severity of the erosion.

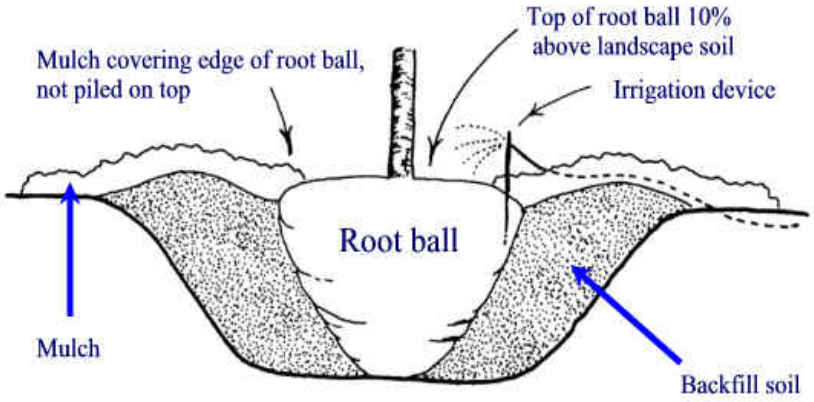
For slopes 3:1 or greater: erosion control blankets can be used that are specified for the steepness of the slope. Plantings should consist of plugs, live stakes and/or hydroseed. Always follow manufacturer's recommendations when using any erosion or sediment control products.

Proper Planting

General guidance for proper planting of trees and shrubs is summarized below. Guidance from a landscape architect or instructions from the nursery should always be followed.

- When planting near the edge of the water avoid the use of heavy equipment. If the ground is wet or soft, light equipment with low pressure tires or rubber tracks is preferable. Mats may be needed to protect the ground from equipment.
- Arrange the plants to create a gradual edge versus a sharp line, to mimic natural conditions.
- Planting holes must be 2 to 3 times as wide as the diameter of the root ball, shown in Figure SOP3.1. The hole should be as deep as the root ball is high. The top of the root ball should be at grade or a maximum of 1 inch above it.

Figure SOP3.1. Measuring the Buffer Width from the Top of Bank



- After placing and positioning the rooted plant, fill the hole with the original and/or improved soil (based on recommendations from the soil test). The hole should be filled completely but carefully so as to not damage the roots. Fill the hole with water while backfilling with soil to ensure there are no air pockets and reduce the chance of the soil settling.
- Ideally, the tree canopy is planted first. The understory trees are typically not sun tolerant and should be planted after some canopy has established. Changes in light conditions should be factored in if the area is not planted in phases.
- Plants should be chosen that are found in riparian buffer plant communities native to the region. However, the site conditions should also be taken into consideration. Existing soil conditions, plants, hydrology, sun and shade levels, and local plant-specific diseases and pests should all be accounted for when deciding what plants will thrive at a particular site. Survivability of the plants is the first step towards creating a healthy plant community in the long term.
- Listing of native plants that are suited for the region can be found in the City's Tree Protection and Replacement Ordinance and also in SOP #2.
- Late fall to early winter is the best time to plant trees and shrubs. The plant layout is best done in the late spring to early fall when leaves are on the trees, as it is easier to gauge light conditions.

Live Stake Plantings

Live stakes are another valuable technique to restore or enhance a riparian buffer. A "Live Stake" is a dormant cutting of dogwood, alder, or native willow. The stem cutting is taken from shrubs and trees during their dormant season and inserted directly into stream banks. The live stakes will eventually grow into shrubs and trees, providing an effective root network in stream banks. Typically, a three foot stake is planted two feet into the ground when it is dormant (November to March). Geotextile fabric is often used with live stakes, providing bank stabilization while the live stakes mature.

Protection

Protect newly planted riparian buffers from sources of damage, such as routine landscaping activities, human activity, and wildlife activity, until they become established.

Fencing and/or Signage

Pedestrian, domestic animals, and wildlife activity can be very damaging to a newly planted buffer. Temporary signage should be installed to alert the public that the area has been recently revegetated and pedestrian traffic is not allowed. The signage should specifically restrict dogs from newly planted areas. Wildlife deterrence may also be needed to protect newly planted buffers. The type of fencing is dependent on the location and type of wildlife expected. For example, signs that disallow feeding wildlife (such as geese) are also important to protect young plants. Temporary signage is preferred as it can be removed when it is no longer needed.

Tree Shelters and Grid Wires

Tree shelters or tree tubes provide protection for young trees and should be maintained until the tree reaches approximately 2 inches in diameter. Among other benefits, tree shelters protect young trees from deer or other wildlife. Grid wires or strings may be needed to cover newly planted areas to deter birds and geese from eating the plants and/or walking on the young plants. The grid wires must be large enough to avoid trapping small animals and birds (>3/4 inch mesh), but yet small enough (< 3 inch square openings and 24" tall or greater) so that it deters geese. The maintenance activities include:

- Repair/ replace broken stakes or tree tubes
- Straighten stakes and tree if the tree starts to lean
- Check the inside of the tree shelter periodically to ensure plant health. Tree shelters may be removed from trees once the tree has grown to the height of the tree shelter
- Repair or replace damaged sections of grid wires or other deterrents used

Maintenance

Proper and routine maintenance during the first three years after planting or restoring a vegetated buffer is important to establishing the planted native species and preventing encroachment of invasive species. The maintenance activities during the first three years following a riparian buffer planting include mulching, watering, weeding, and monitoring growth. The SOPs for these activities are below. If the buffer planting followed the removal of invasive species, an additional two years for total of five years is appropriate. In addition to routine monitoring, it is recommended that riparian buffer areas be checked following high water events for the first year.

Mulching

In forested riparian areas, leaves, twigs, and other organic material naturally fall and protect the forest floor from erosion and invasive species as well as provide needed nutrients. Until the forest is established, mulch is used as a surrogate to provide these benefits.

Mulching is an easy and effective maintenance practice for newly planted areas as it suppresses weeds and invasive species, helps retain moisture, keeps the soil cool, and adds organic matter to the soil. The most desirable mulch in a riparian buffer is a 2 to 4-inch layer of composted wood chips. Compost or other leaf mulch can be added on top of or underneath the composed wood chips.

The guidelines for each category of vegetation are provided below.

- Identify the mulch perimeter. For trees, the mulch circle should extend to the end of the drip line (below the tips of the tree branches) or a three feet diameter circle, whichever is greater. For shrubs, a minimum two to three foot diameter around the shrub should be mulched.
- Clear weeds and grass from the area prior to mulching.
- Spread a three to four inch deep layer of organic mulch in the mulch perimeter.
- Keep mulch away from the tree trunk and/or crown of the shrub to prevent crown rot or insect damage.
- Maintain mulch thickness for at least 3 years following planting, and then as needed.

- In high traffic areas, the mulch ring should remain permanently to reduce compaction and injury to the root system.

Straw is not recommended for mulching, although it is commonly used, because it can introduce unwanted seeds to the new buffer area. Composted wood chips are preferable to non-composted as some decomposition of the organic material has already begun and there are less likely to be issues with unintentional transfer of diseases.

Watering

Proper watering is very important to the survival of new plants. New plants do not have a mature root system and cannot survive dry periods, especially during the hotter summer months. This is also true for drought-tolerant native species. Plans for watering should be established during the planning stages of any re-vegetation project. In areas where water access is limited, soil amendments and/or compost can be applied with deep mulching to minimize water requirements.

- Water trees and shrubs at the time of planting
- Do not depend on rainfall to be sufficient for new plants
- Water trees and shrubs during the first year and the first two summers to achieve 1 inch per week of water (rainfall and watering combined).
- Summer watering should ensure 1 inch per week of rainfall and ideally be done in the early morning hours

While sufficient water is critical to plant success and root growth, overwatering can lead to erosion and gullies. Watch the impact of watering and immediately stabilize any eroded paths with compacted dirt, geotextile fabrics and mulch.

Weed Control

Preventing and removing weeds is critical to establishing a healthy riparian buffer. Newly planted trees and seedlings are vulnerable and can readily be outcompeted by invasive plant species. Hand pulling of weeds is preferable in the riparian buffer, especially when caught early. Catching weeds prior to setting seed will reduce the extent and challenges for removal.

Herbicides may be needed in the first few years following planting to reduce the encroachment of weeds and invasive plants into the newly planted buffer. The improper use of herbicides can affect the health of the newly planted vegetation as well as overall water quality. A targeted use of herbicides, in close coordination with the City Arborist, is acceptable. If herbicides are used, the directions must be followed and precautions must be taken to minimize spray drift, over use and impacting non-target species.

Early intervention and maintenance should prevent the establishment of weeds. However, if invasive weeds out-compete young grasses and overwhelm an area during early establishment, mowing may be helpful. Mowing should happen before weeds get taller than 18” and only after nesting season (after August 15th). Mowing in replanted buffers must be approved first by the City Arborist.

Monitoring Growth

Annually, or more regularly, an assessment of the growth of the riparian buffer species will need to be conducted. Pictures should be taken annually from the same location and perspective to better track the growth and success of the area. If plants are not surviving, they may need to be replaced. It is important to track progress and take quick action in the early years.

If needed, natural fertilizers such as lime or wood ash may be added to encourage healthy growth. These applications should be made only after consultation with the City Arborist or other certified landscape architect.

6. References

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Transplanting Woody Plants.
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7. Definitions

Canopy Tree: A tree that reaches 35 feet in height or larger when mature.

Forbs: Herbaceous flowering plant that is not a grass, sedge, or rush.

Invasive species: Nonnative organisms whose introductions cause or are likely to cause adverse environmental, economic, and/or human health impacts. For purposes of this document, these are nonnative species that threaten the diversity or abundance of native species or the ecological stability of infested areas, or commercial, agricultural, aquacultural, or recreational activities dependent on such areas.

Land Disturbance: Any land or vegetation change, including, but not limited to, clearing, grubbing, stripping, removal of vegetation, dredging, grading, excavating, transporting and filling of land, that does not involve construction, paving or any other installation of impervious cover.

Native species: A species naturally present and reproducing within the state or that naturally expands from its historic range into the state.

Nonnative species: Any species or other viable biological material that enters an ecosystem outside of its historic range, including organisms transferred from one country to another. Species introduced or spread from one region of the U.S. to another outside their normal range are nonnative. Also called introduced, exotic, alien, foreign, nonindigenous species, immigrant, transplants.

Riparian: Pertaining to, situated or dwelling on the margin of a river or other water body.

Setback: The area extending beyond the protected buffer applicable to that waterbody.

Shrub: A woody plant that is smaller than a tree and has several main stems arising at or near the ground. A large shrub can reach 10 feet of height or greater at maturity. A small shrub can reach up to 10 feet in height at maturity.

SOP: Standard Operating Procedure or a document that outlines the proper steps to perform a stated task.

State waters: Any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells, and other bodies of surface or subsurface water, natural or artificial, lying within or forming a part of the boundaries of the state, which are not entirely confined and retained completely upon a parcel. Ephemeral streams are not considered state waters for the purpose of the Stream Buffer Protection ordinance.

Stream: Any natural, running water flowing continuously or intermittently in a channel on or below the surface of the ground, except that an ephemeral stream is not a stream.

Stream Channel: The confining cut of ground surface that contains the base flow of a stream and is identified at a point where the water flow has wrested the vegetation.

Sub-Canopy Tree: An immature canopy tree, a stunted canopy tree, or other co-dominant tree or an understory tree.

Top of bank: The upper boundary of the bank is the first observable break in the slope of the bank. The bank is the portion of the land surface which normally abuts and confines a water body. It occurs between the water body and the upland area.

Trophic Layer: Different levels of low-growing grasses, forbs (non-woody flowering plants other than grasses), small trees, bushes and/or shrubs, and canopy cover from medium to larger trees existing in a buffer.

Understory tree: A tree that matures to a height of 12 feet to 35 feet.

Waters of the State: "State Waters" means any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells, and other bodies of surface or subsurface water, natural and artificial, lying within or forming a part of the boundaries of the State which are not entirely confined and retained completely upon the property of a single individual, partnership, or corporation

Wrested vegetation: The point adjacent to the edge of the base flow of a stream or the water surface of a lake where vegetation has been moved or wrested as a result of normal stream flow or wave action. This is the point from which the protective buffer should be measured.