

APPENDIX A: MURPHEY CANDLER STATE OF THE LAKE REPORT 2015

Murphey Candler Lake

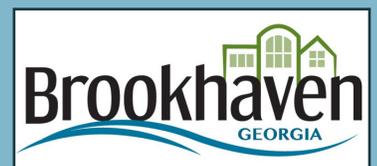
State of the Lake Report

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



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 phosphorus, 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



Good

Meeting the goal 80% of the time or more



Fair

Meeting the goal 50 - 80% of the time

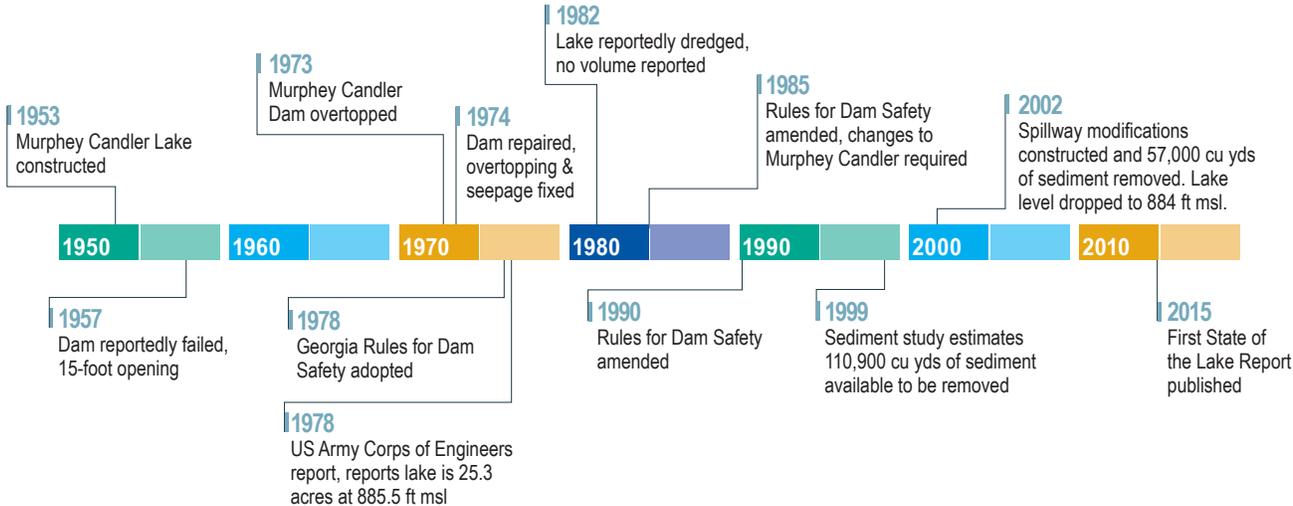


Poor

Not meeting the goal more than 50% of the time

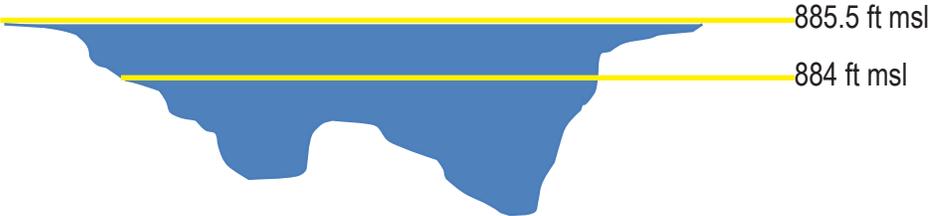
HISTORY OF MURPHEY CANDLER LAKE

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

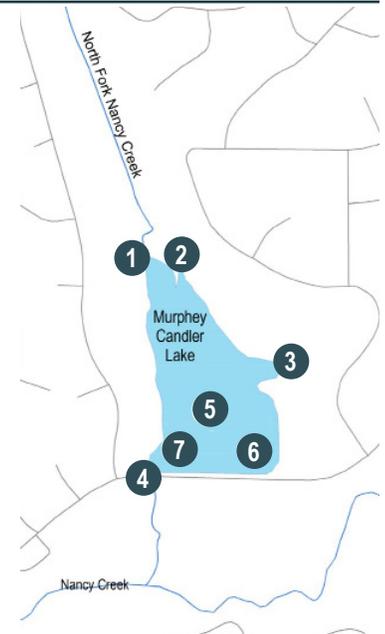
WATER QUALITY IN MURPHEY CANDLER LAKE

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



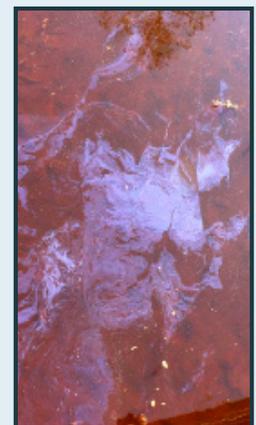
Water Quality Data Summary

- **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.



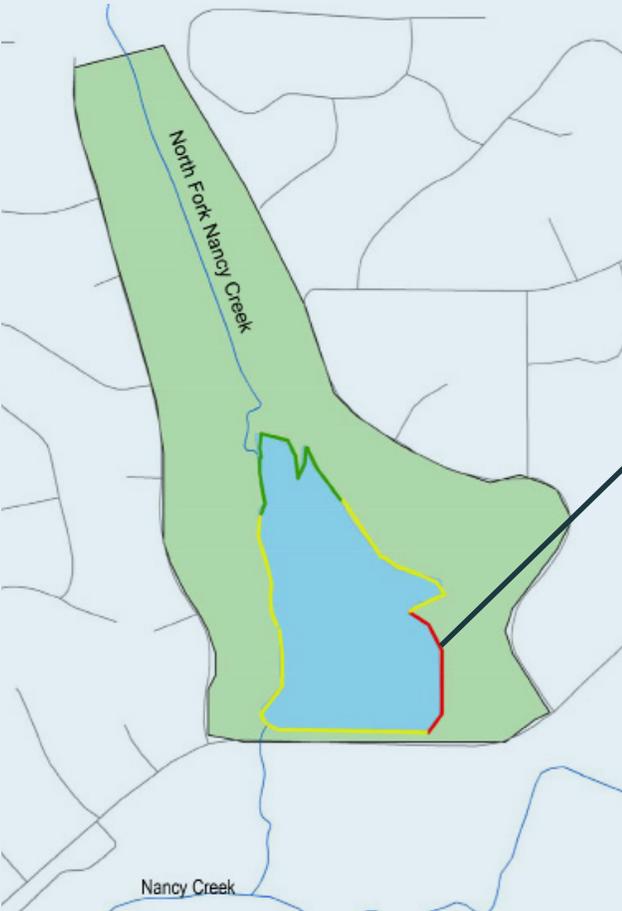
SHORELINE AND HABITAT CONDITIONS

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



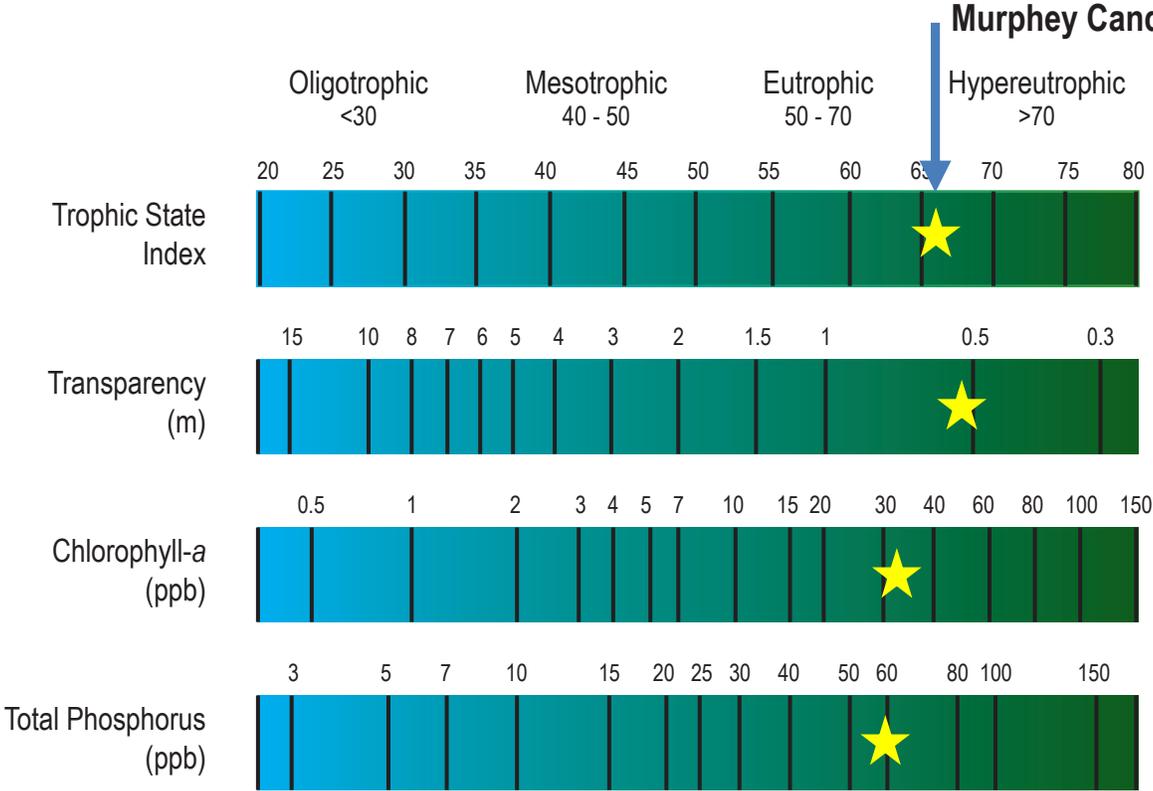
Shoreline Restoration Example

Current Shoreline Area, "the Beach"



Restoration Alternative

TROPIC 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 relevant 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	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: No 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: GDOT	
<p>Existing Conditions: Trash and debris from I-285 flow downstream into Murphey Candler Lake.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): 10	
Contributing Impervious Area (ac): 10	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 1,500		
<p>Annual Maintenance Notes: Remove trash and debris monthly and after each major rain event.</p>		
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	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: No 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: GDOT	
<p>Existing Conditions: Trash and debris from I-285 flow downstream into Murphey Candler Lake.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): 10	
Contributing Impervious Area (ac): 10	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 1,500		
<p>Annual Maintenance Notes: Remove trash and debris monthly and after each major rain event.</p>		
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	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: No 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: GDOT	
<p>Existing Conditions: Trash and debris from I-285 flow downstream into Murphey Candler Lake.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): 10	
Contributing Impervious Area (ac): 10	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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
<p>Planning Level Planning/Design/Permitting Cost (\$): 12,500</p>		
<p>Planning Level Capital Cost (\$): 50,000</p>		
<p>Planning Level Total Cost (\$): 65,000</p>		
<p>Annual Cost/Benefit Ratio (Planning Level Annualized Capital \$/ annual TSS removal) (\$): 5,700</p>		
<p>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.</p>		
<p>Annual Maintenance Costs (post-construction based on capital cost) (\$): 1,500</p>		
<p>Annual Maintenance Notes: Remove trash and debris monthly and after each major rain event.</p>		
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	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: No 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: GDOT	
<p>Existing Conditions: Trash and debris from I-285 flow downstream into Murphey Candler Lake.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): 10	
Contributing Impervious Area (ac): 10	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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
<p>Planning Level Planning/Design/Permitting Cost (\$): 12,500</p>	
<p>Planning Level Capital Cost (\$): 50,000</p>	
<p>Planning Level Total Cost (\$): 65,000</p>	
<p>Annual Cost/Benefit Ratio (Planning Level Annualized Capital \$/ annual TSS removal) (\$): 5,700</p>	
<p>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.</p>	
<p>Annual Maintenance Costs (post-construction based on capital cost) (\$): 1,500</p>	
<p>Annual Maintenance Notes: Remove trash and debris monthly and after each major rain event.</p>	
PROJECT RANKING	
<p>Rank: 20</p>	<p>Total Score: 39.5</p>
<p>Pollutant Removal Score: 3</p>	<p>TSS Score: 1 Phosphorus Score: 1 Nitrogen Score: 1</p>
<p>Cost Benefit Score: 9</p>	
<p>Ease of Implementation: 15</p>	<p>Total Cost Score: 5 Ownership Score: 5 Maintenance Burden Score: 0 Potential Permitting Requirements Score: 5</p>
<p>Additional Benefits: 12.5</p>	<p>Visibility to Community Score: 7.5 Wildlife Diversity Score: 2.5 Compatibility with other City Plans: 2.5</p>
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: No 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 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: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 20,600		
<p>Annual Maintenance Notes: Maintain newly planted vegetation and remove any invasive species. Replace vegetation, as needed.</p>		
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	
<p>Sub-watershed: NC4 North Fork Nancy</p>	
<p>Practice Type: New BMP</p>	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
<p>Owner: City</p>	
<p>Existing Conditions: During high flows stormwater bypasses the catch basin and entering the park eroding a path toward the stream.</p>	
WATER QUALITY MODELING DATA	
<p>Contributing Drainage Area (ac): 13.88</p>	
<p>Contributing Impervious Area (ac): 4.13</p>	
<p>Primary Hydrologic Soil Group (HSG) in DA: B</p>	
<p>Annual Total Nitrogen Reduction (lb/yr): 112.25</p>	
<p>Annual Total Phosphorus Reduction (lb/yr): 15.03</p>	
<p>Annual Total Suspended Solids Reduction (lb/yr): 3605.06</p>	

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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 6,200		
<p>Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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: <ol style="list-style-type: none"> 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: NA	
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		
<p>Implementation Notes: Work with DeKalb County Public Schools to add stormwater management with future improvements. Integrate with the school science curriculum.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 500		
<p>Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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: <ol style="list-style-type: none"> 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: Severe erosion of drainage channel conveying stormwater from Kittridge Magnet School to an unnamed tributary to Murphey Candler Lake.	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>Implementation Notes: Work with DeKalb County Public Schools on needed maintenance.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 2,000		
<p>Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.</p>		
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	
<p>Description: Retrofit an existing office stormwater area to retain stormwater and provide water quality treatment and address drainage issue in downstream residential area.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
<p>Existing Conditions: Existing stormwater area not designed to retain water. Located upstream of a residential area.</p>	
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		
<p>Implementation Notes: Inform private property owner of stormwater utility fee benefits from upgrading existing stormwater controls.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 15,200		
<p>Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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	
<p>Existing Conditions: Stream incised with banks reaching 16 feet above normal water level in locations. Stream habitat conditions rated "poor."</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 9,400		
<p>Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.</p>		
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: No 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City	
Existing Conditions: No stormwater controls for existing pool.	
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		
<p>Implementation Notes: Integrate stormwater design with the design, permitting, and construction of the planned park improvements.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 600		
<p>Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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	
<p>Description: Address existing drainage issues with the planned sidewalk extension. Add bioswales upstream and downstream of the catch basin.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: No 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 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		
<p>Implementation Notes: Integrate stormwater design with the design, permitting, and construction of the planned park improvements.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 6,900		
<p>Annual Maintenance Notes: Maintain vegetation and sheet flow drainage. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: No 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City	
Existing Conditions: Drainage area has few existing stormwater controls.	
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		
<p>Implementation Notes: Integrate stormwater design with the design, permitting, and construction of the planned park improvements.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 3,300		
<p>Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 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: NA	
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		
<p>Implementation Notes: Work with DeKalb County Public Schools on needed maintenance. Evaluate installation of additional stormwater controls.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 2,600		
<p>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.</p>		
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	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City	
<p>Existing Conditions: Sediment accumulation in Murphey Candler Lake is a concern and expensive to remove. Upstream controls will reduce sediment accumulation.</p>	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 42,000		
<p>Annual Maintenance Notes: Remove accumulated sediment in offline pond area annually or as needed.</p>		
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: No 2. Restore stream buffers: No 3. Improve streams to sub-optimal condition: No 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: NA	
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) (\$):		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): NA		
<p>Annual Maintenance Notes: Remove accumulated sediment on average once every 20 to 30 years.</p>		
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		
<p>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.</p>		

Project ID#: NC4-017	
Sub-watershed: NC4 North Fork Nancy	
Practice Type: New BMP	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: City	
<p>Existing Conditions: Sediment accumulation in Murphey Candler Lake is a concern and expensive to remove. Upstream controls will reduce sediment accumulation.</p>	
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
<p>Planning Level Planning/Design/Permitting Cost (\$): 211,500</p>		
<p>Planning Level Capital Cost (\$): 846,000</p>		
<p>Planning Level Total Cost (\$): 1,099,800</p>		
<p>Annual Cost/Benefit Ratio (Planning Level Annualized Capital \$/ annual TSS removal) (\$): 112,700</p>		
<p>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.</p>		
<p>Annual Maintenance Costs (post-construction based on capital cost) (\$): 42,300</p>		
<p>Annual Maintenance Notes: Remove accumulated sediment in offline pond area annually or as needed.</p>		
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 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): 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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 33,100		
<p>Annual Maintenance Notes: Remove accumulated sediment in offline pond area annually or as needed.</p>		
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: No 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: No 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Existing pond requires maintenance. Opportunity to retrofit and enhance water quality benefits.	
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		
<p>Implementation Notes: Private property owner responsible for maintenance. City could partner to improve pond to achieve modern design requirements.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 10,400		
<p>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.</p>		
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	
<p>Description: Invasive species are threatening stream buffer health and causing downed trees. Remove invasive species and replant to healthy forest density.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: No 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	
<p>Existing Conditions: Invasive species are overwhelming the vegetated riparian buffer and resulting in tree losses. Primarily chinese privet and english ivy.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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	

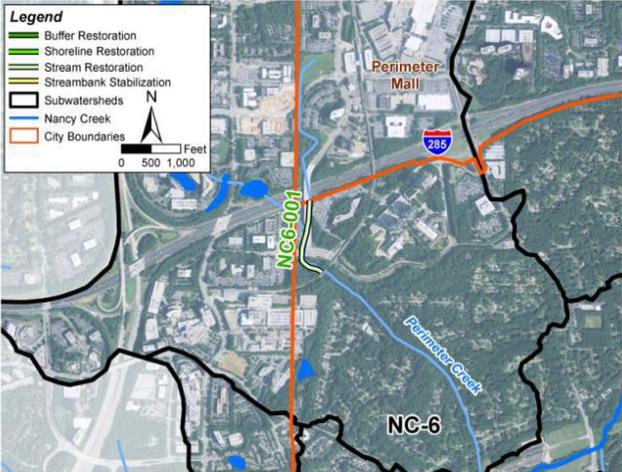
IMPLEMENTATION INFORMATION		EXAMPLE OF RECOMMENDED PROJECT
<p>Planning Level Planning/Design/Permitting Cost (\$): 11,750</p>		
<p>Planning Level Capital Cost (\$): 47,000</p>		
<p>Planning Level Total Cost (\$): 61,100</p>		
<p>Annual Cost/Benefit Ratio (Planning Level Annualized Capital \$/ annual TSS removal) (\$): 5,300</p>		
<p>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.</p>		
<p>Annual Maintenance Costs (post-construction based on capital cost) (\$): 1,400</p>		
<p>Annual Maintenance Notes: Perform maintenance invasive species removal at least annually for the first three years.</p>		
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: <ol style="list-style-type: none"> 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: Drainage area has very few stormwater controls. Opportunity to infiltrate stormwater with planned improvements.	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): 17.37	
Contributing Impervious Area (ac): 7.79	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>Implementation Notes: Integrate stormwater design with the design, permitting, and construction of the planned park improvements.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 50,600		
<p>Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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	
<p>Description: Significant stream erosion in compact suburban area. Stabilize streambanks and enhance floodplain connectivity. Improve transition to Nancy Creek.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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: Significant stream erosion with banks over 12 feet in areas. Habitat rated "marginal".	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>Implementation Notes: Stream stabilization must be properly designed, permitted, and constructed. Federal, state, and local permits will be required. Easements needed for private property.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 7,600		
<p>Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.</p>		
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	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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	
<p>Existing Conditions: Stream habitat conditions rated "sub-marginal". No riffles. Sedimentation dominated conditions in this section. Some bank erosion.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 5,700		
<p>Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.</p>		
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: <ol style="list-style-type: none"> 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: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 5,500		
<p>Annual Maintenance Notes: Monitor bank stability and any newly planted vegetation until established.</p>		
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: <ol style="list-style-type: none"> 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		
<p>Implementation Notes: Inform private property owner of stormwater utility fee benefits from upgrading existing stormwater controls.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 15,700		
<p>Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Large undeveloped parcel in an area with few existing stormwater controls.	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 26,100		
<p>Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.</p>		
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: <ol style="list-style-type: none"> 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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 1,000		
<p>Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.</p>		
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 22,200		
<p>Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.</p>		
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	
<p>Description: Evaluate relocation of the existing non-functioning BMP in residential yard to HOA owned property. Design to provide water quality and quantity benefits.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
<p>Existing Conditions: Existing stormwater management pond in front yard of residential property is overgrown and does not appear to receive flow.</p>	
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		
<p>Implementation Notes: Partnerships with HOA will require easements and maintenance agreements. Project will require state and local permits. May require federal permits.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 1,300		
<p>Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.</p>		
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	
<p>Description: Landlocked parcel adjacent to Perimeter Creek. Check tax status and consider securing for stormwater control structure. Would need construction and maintenance access agreements.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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	
<p>Existing Conditions: Landlocked parcel adjacent to Perimeter Creek, likely undevelopable.</p>	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 1,200		
<p>Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.</p>		
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: <ol style="list-style-type: none"> 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". Almost no vegetated buffer. Bank erosion and sedimentation prevalent.	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 3,000		
<p>Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.</p>		
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	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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	
<p>Existing Conditions: Stream habitat conditions rated "poor". Stream buffer is currently mowed and eroding. Habitat scores also influenced by the existing low head dam.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>Implementation Notes: Provide technical assistance to the HOA and forward opportunities for recompense projects.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 11,200		
<p>Annual Maintenance Notes: Maintain newly planted vegetation and remove any volunteer invasive species. Replace vegetation, as needed.</p>		
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	
<p>Description: North Fork Nancy Creek from the spillway to confluence with Nancy Creek. Address bank erosion with stream restoration of 800 linear feet of stream including grade control and improve floodplain connectivity within the confines of existing recreation area. Integrate planned trail and bridge.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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	
<p>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.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 3,300		
<p>Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.</p>		
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: <ol style="list-style-type: none"> 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: NA	
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		
<p>Implementation Notes: Provide technical assistance to Marist and forward opportunities for recompense projects.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 4,500		
<p>Annual Maintenance Notes: Maintain newly planted vegetation and remove any volunteer invasive species. Replace vegetation, as needed.</p>		
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	
<p>Description: Integrate stormwater improvements and recreation field enhancements at Montgomery Elementary School. Consider underground detention under field as an option.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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	
<p>Existing Conditions: Existing school has no stormwater management. Recreational fields are wet and muddy following rains.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): 8.60	
Contributing Impervious Area (ac): 1.93	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>Implementation Notes: Work with DeKalb County Public Schools on needed maintenance. Evaluate installation of additional stormwater controls.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 4,900		
<p>Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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: <ol style="list-style-type: none"> 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: NA	
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		
<p>Implementation Notes: Stream stabilization must be properly designed, permitted, and constructed. Federal, state, and local permits will be required. Easements needed for private property.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 7,700		
<p>Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.</p>		
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	
<p>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.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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	
<p>Existing Conditions: Stream habitat conditions rated "poor". Bank erosion and sedimentation dominated. Buffers compromised in areas.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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	

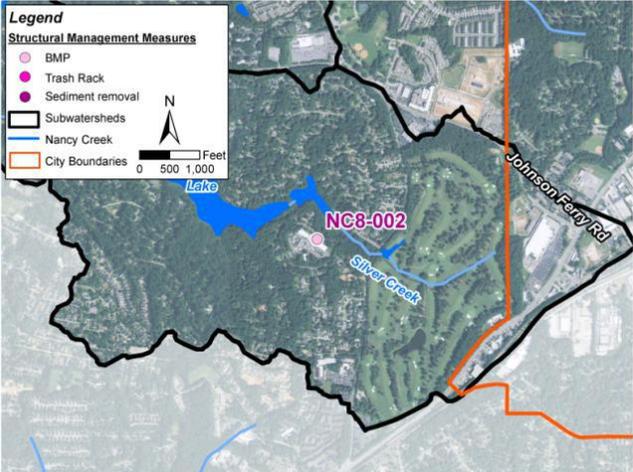
IMPLEMENTATION INFORMATION		EXAMPLE OF RECOMMENDED PROJECT
<p>Planning Level Planning/Design/Permitting Cost (\$): 209,000</p>		
<p>Planning Level Capital Cost (\$): 836,000</p>		
<p>Planning Level Total Cost (\$): 1,086,800</p>		
<p>Annual Cost/Benefit Ratio (Planning Level Annualized Capital \$/ annual TSS removal) (\$): 86,300</p>		
<p>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.</p>		
<p>Annual Maintenance Costs (post-construction based on capital cost) (\$): 16,700</p>		
<p>Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.</p>		
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: <ol style="list-style-type: none"> 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		
<p>Implementation Notes: Partnerships with private property owners will require easements and maintenance agreements. Federal, state, and local permits will be required.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 122,400		
<p>Annual Maintenance Notes: Maintenance agreement needed to outline requirements for selected stormwater practice.</p>		
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	
<p>Description: Improve vegetated buffer along Silver Creek with golf course appropriate vegetation to help protect against stream bank erosion.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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	
<p>Existing Conditions: Stream habitat conditions rated "sub-marginal". Stream buffer is mowed to creek banks resulting in some erosion.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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	

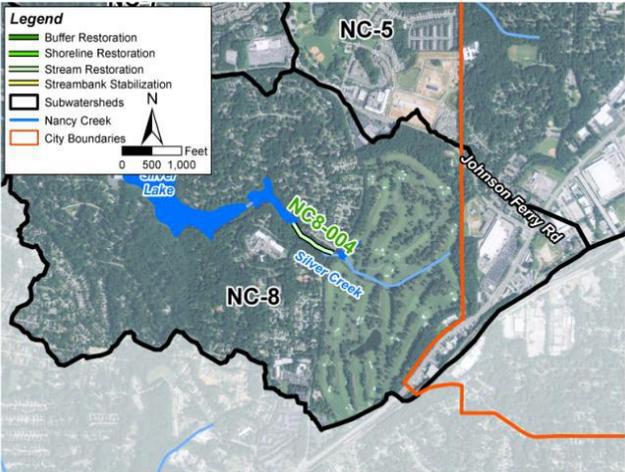
IMPLEMENTATION INFORMATION		EXAMPLE OF RECOMMENDED PROJECT
Planning Level Planning/Design/Permitting Cost (\$): 22,500		
Planning Level Capital Cost (\$): 90,000		
Planning Level Total Cost (\$): 117,000		
Annual Cost/Benefit Ratio (Planning Level Annualized Capital \$/ annual TSS removal) (\$): 10,200		
<p>Implementation Notes: Provide technical assistance to the golf course and forward opportunities for recompense projects.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 2,700		
<p>Annual Maintenance Notes: Maintain newly planted vegetation and remove any volunteer invasive species. Replace vegetation, as needed.</p>		
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: <ol style="list-style-type: none"> 1. Meet state water quality standards: Yes 2. Restore stream buffers: Yes 3. Improve streams to sub-optimal condition: No 4. Wildlife diversity and aesthetics: Yes 	
GENERAL SITE INFORMATION	SITE PHOTOS
Owner: Private Property	
Existing Conditions: Existing school with no stormwater management. Opportunity to infiltrate stormwater runoff.	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): 7.31	
Contributing Impervious Area (ac): 1.75	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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		
<p>Implementation Notes: Inform private property owner of stormwater utility fee benefits from upgrading existing stormwater controls. Integrate into school science curriculum.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 4,400		
<p>Annual Maintenance Notes: Maintain vegetation. The special soil mixture will need to be replaced approximately every 10 years.</p>		
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: <ol style="list-style-type: none"> 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: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 2,600		
<p>Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.</p>		
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	
<p>Description: Restore stream and protect utilities upstream of Little Silver Lake. Coordinate with the ongoing Ashford Dunwoody Road corridor study and any recommended projects.</p>	
<p>Watershed Goal(s) Supported:</p> <ol style="list-style-type: none"> 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	
<p>Existing Conditions: Stream habitat conditions rated "sub-marginal". Erosion and sedimentation in the segment upstream of Little Silver Lake.</p>	
WATER QUALITY MODELING DATA	
Contributing Drainage Area (ac): -	
Contributing Impervious Area (ac): -	
Primary Hydrologic Soil Group (HSG) in DA: NA	
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
<p>Planning Level Planning/Design/Permitting Cost (\$): 42,500</p>	
<p>Planning Level Capital Cost (\$): 170,000</p>	
<p>Planning Level Total Cost (\$): 221,000</p>	
<p>Annual Cost/Benefit Ratio (Planning Level Annualized Capital \$/ annual TSS removal) (\$): 17,500</p>	
<p>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.</p>	
<p>Annual Maintenance Costs (post-construction based on capital cost) (\$): 3,400</p>	
<p>Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.</p>	
PROJECT RANKING	
<p>Rank: 23</p>	<p>TSS Score: 37.5</p>
<p>Pollutant Removal Score: 5</p>	<p>TSS Score: 3 Phosphorus Score: 1 Nitrogen Score: 1</p>
<p>Cost Benefit Score: 15</p>	
<p>Ease of Implementation: 7.5</p>	<p>Total Cost Score: 5 Ownership Score: 0 Maintenance Burden Score: 2.5 Potential Permitting Requirements Score: 0</p>
<p>Additional Benefits: 10</p>	<p>Visibility to Community Score: 2.5 Wildlife Diversity Score: 5 Compatibility with other City Plans: 2.5</p>
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: <ol style="list-style-type: none"> 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: NA	
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		
<p>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.</p>		
Annual Maintenance Costs (post-construction based on capital cost) (\$): 13,100		
<p>Annual Maintenance Notes: Monitor the bank stability and any newly planted vegetation until established.</p>		
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

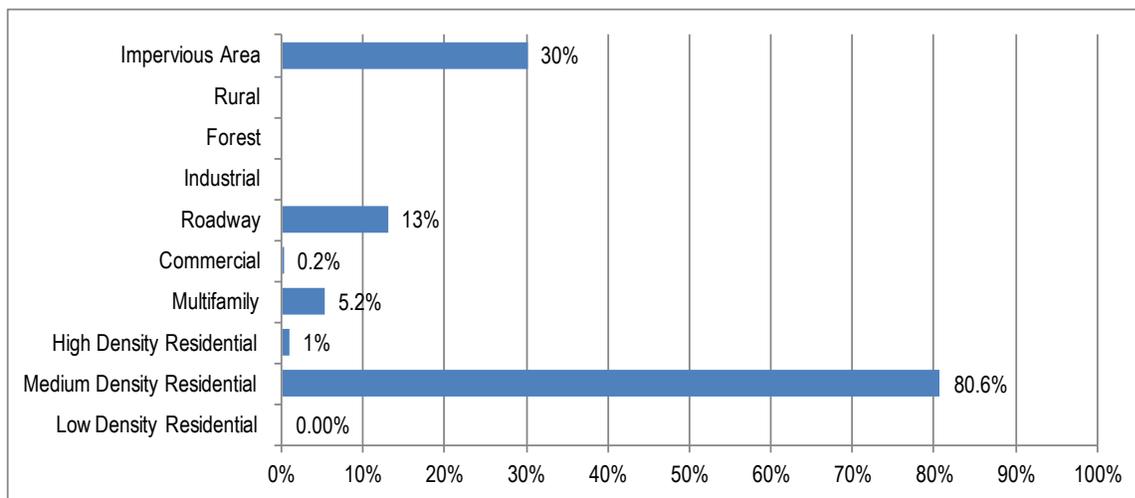
APPENDIX C: SUBWATERSHED SUMMARIES

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.

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

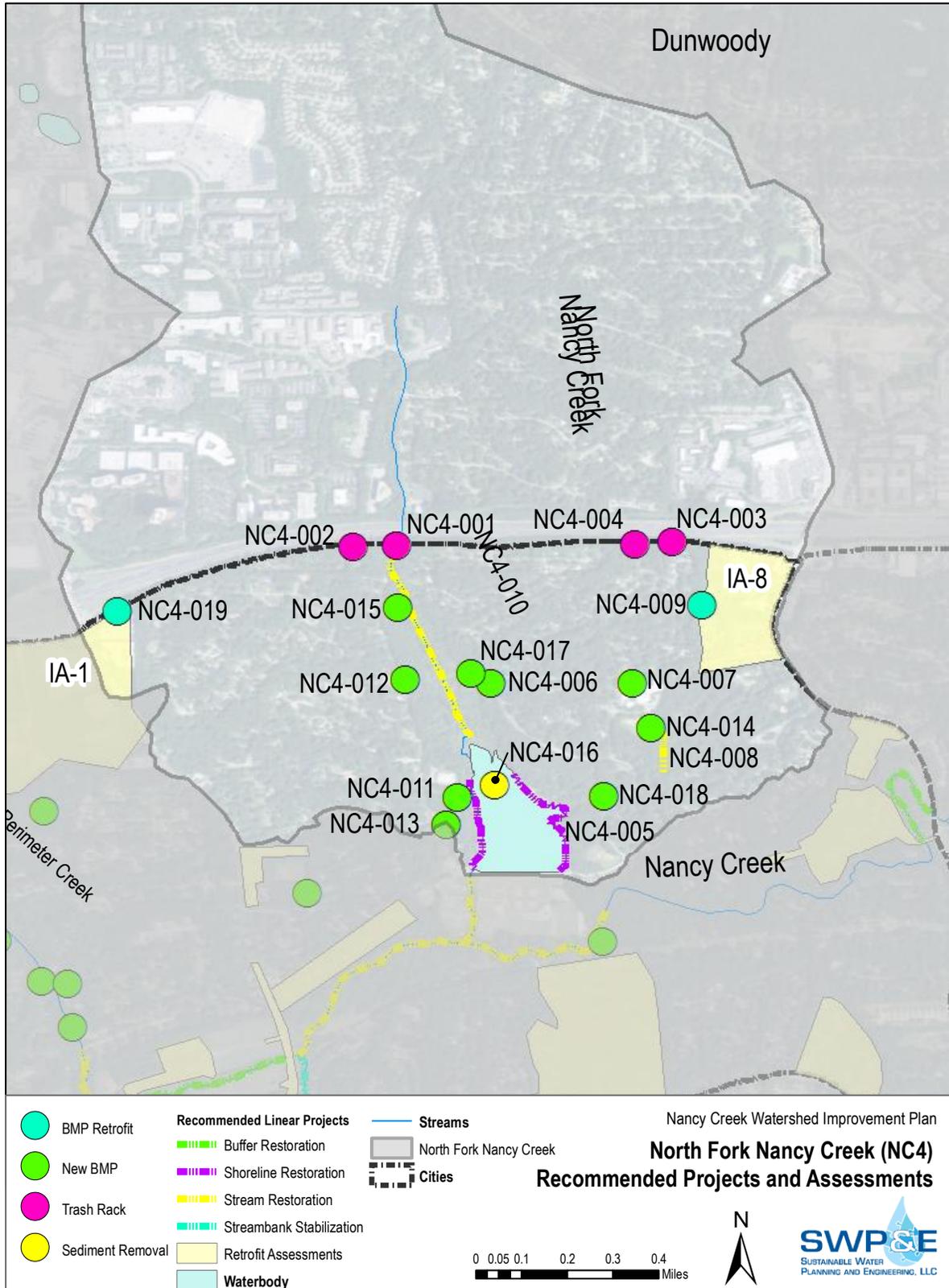


Table C-1. Recommended Watershed Improvement Projects for the North Fork Nancy Creek Subwatershed

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	
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.

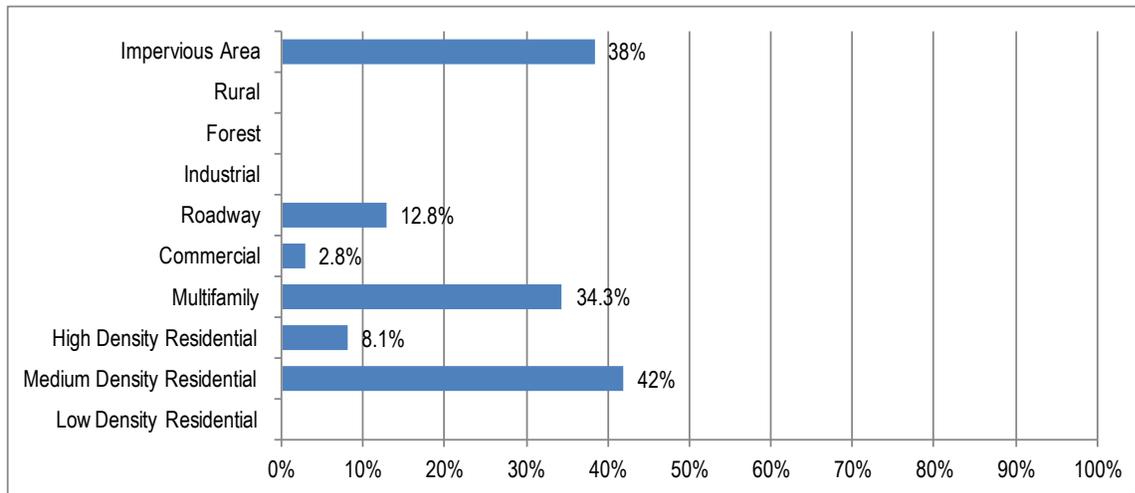
Table C-2. Retrofit Assessments Recommended for the North Fork Nancy Creek Subwatershed

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.

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

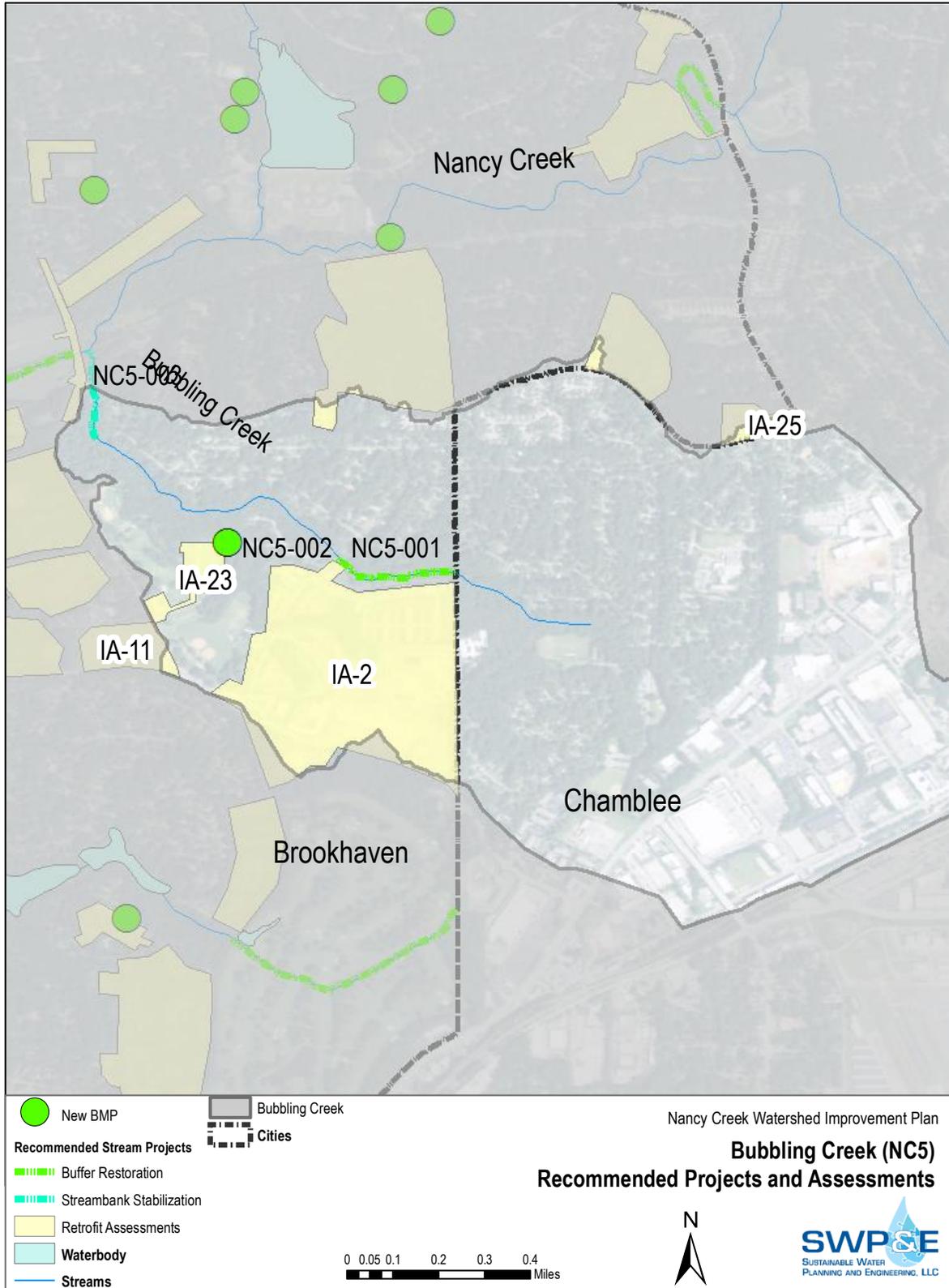


Table C-3. Recommended Watershed Improvement Projects for the Bubbling Creek Subwatershed

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.

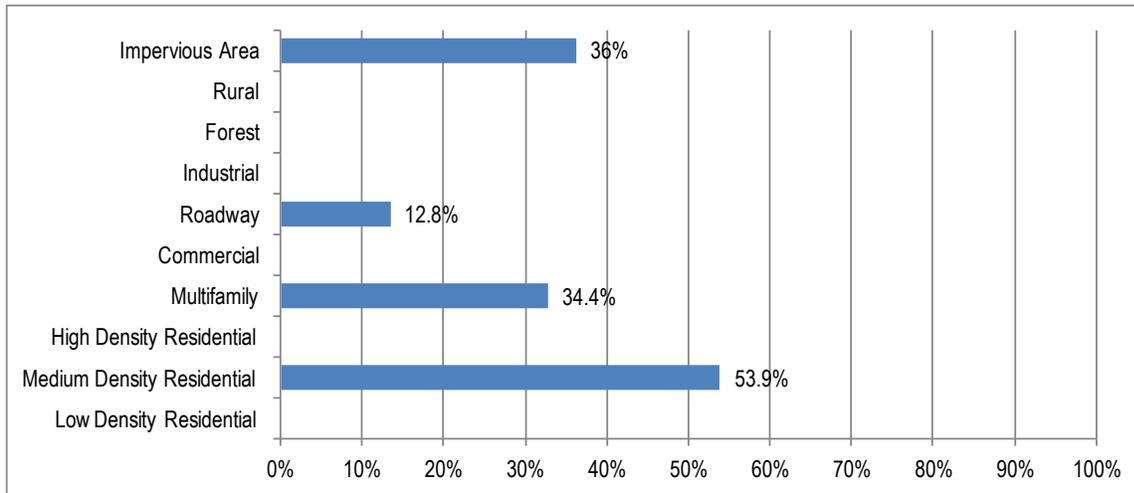
Table C-4. Retrofit Assessments Recommended for the Bubbling Creek Subwatershed

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.

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

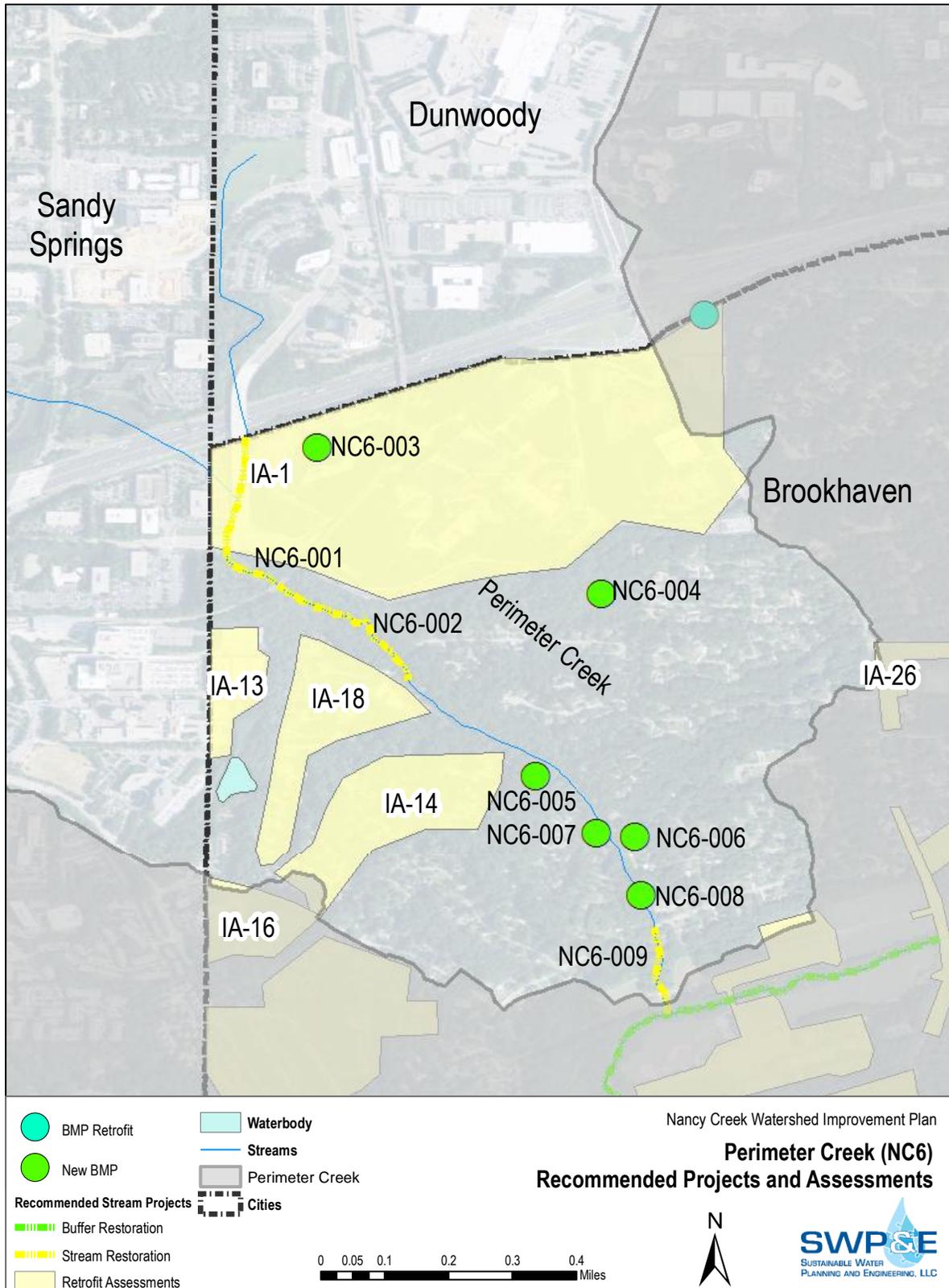


Table C-5. Recommended Watershed Improvement Projects for Perimeter Creek Subwatershed

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.

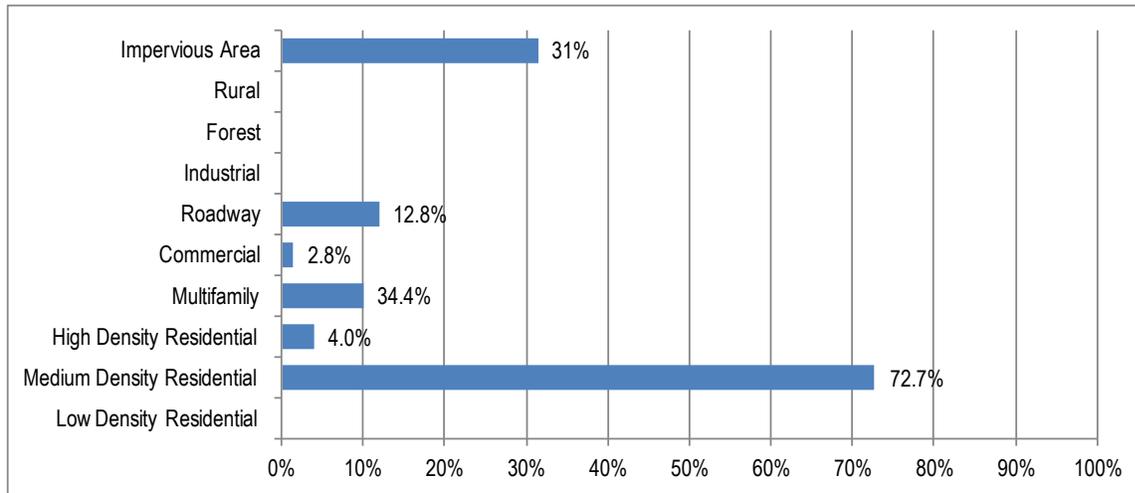
Table C-6. Retrofit Assessments Recommended for the Perimeter Creek Subwatershed

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.

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

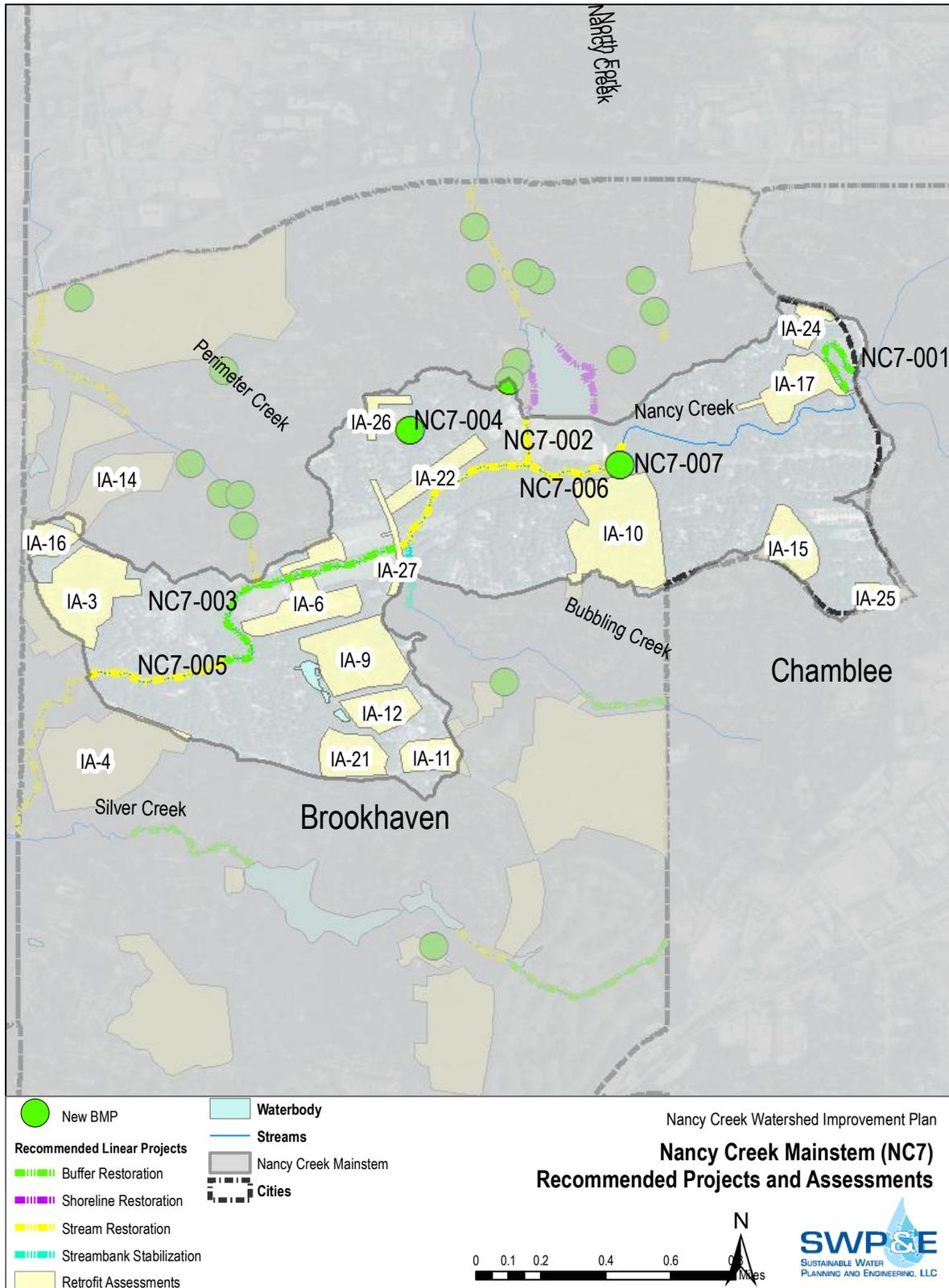


Table C-7. Recommended Watershed Improvement Projects for the Nancy Creek Mainstem Subwatershed

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

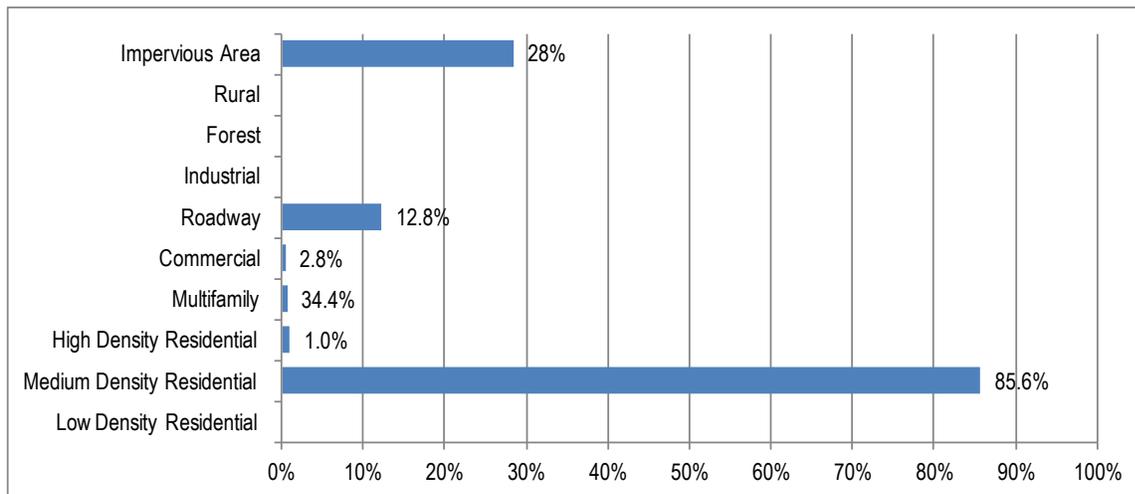
Number	Total Area (acres)	Impervious Area (acres)	% Impervious Area	Unmanaged Impervious Area to Treat (acres)	Description
IA-3	39.1	14.5	37.2%	14.5	High density residential area located between S Johnson Ferry Road and Old Johnson Ferry Road.
IA-6	23.3	11.4	49.1%	11.4	Marist campus. Coordinate with 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.

Figure C-10. Silver Creek Subwatershed (NC8) Recommended Projects and Assessments

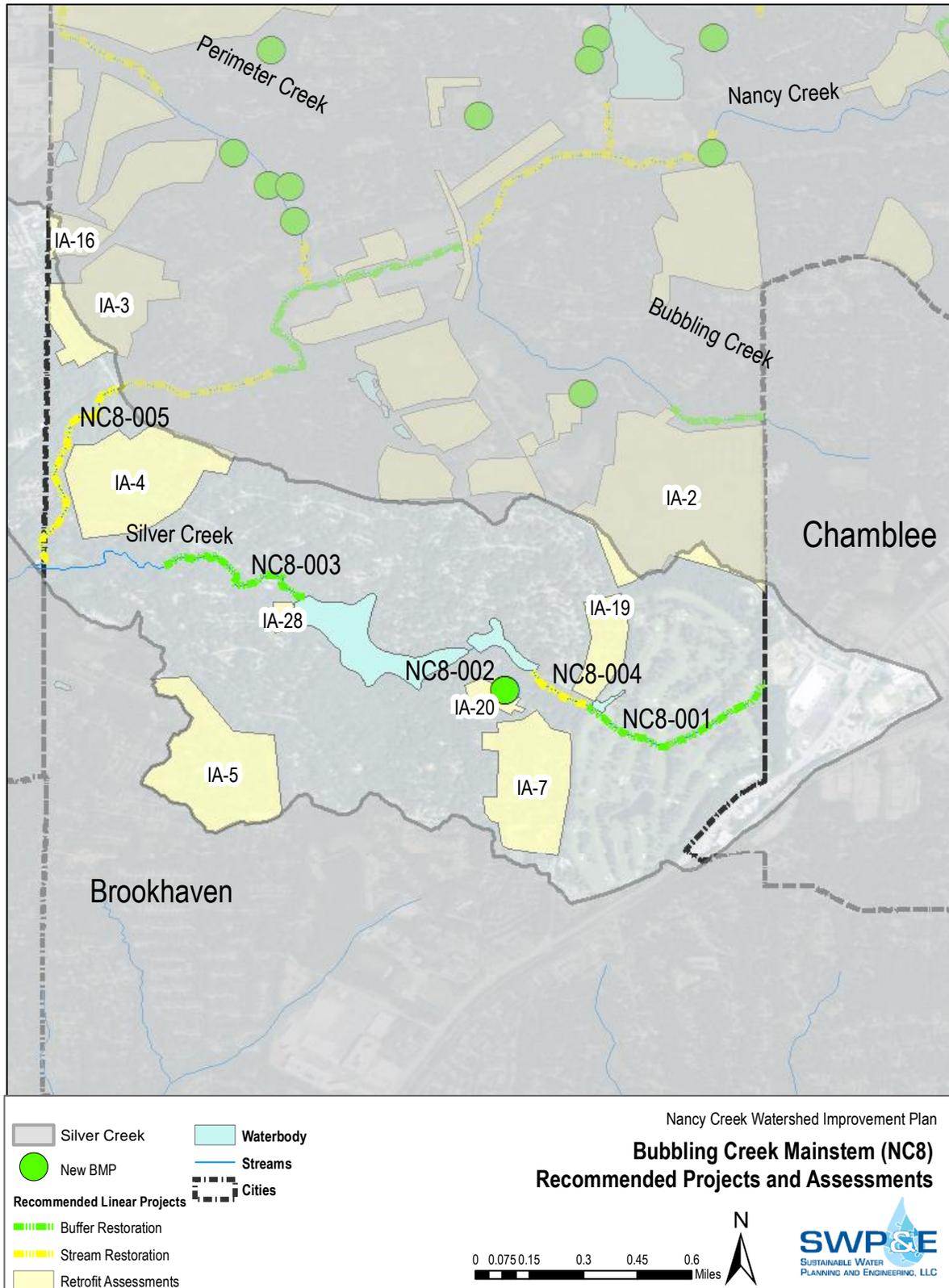


Table C-9. Watershed Improvement Projects Identified in the Silver Creek Subwatershed

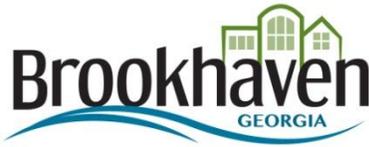
Number	Project Type	Owner	Description	Goals Supported				Rank
				1	2	3	4	
NC8-001	Buffer Restoration	Private Property	Improve vegetated buffer along Silver Creek with golf course appropriate vegetation to help protect against stream bank erosion.	Y	Y	Y	Y	42
NC8-002	New BMP	Private Property	Opportunities 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

	Performing Maintenance in an Established Riparian Buffer	SOP #	1
		Revision #	0
		Implementation Date	August 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 wretched 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 wretched 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

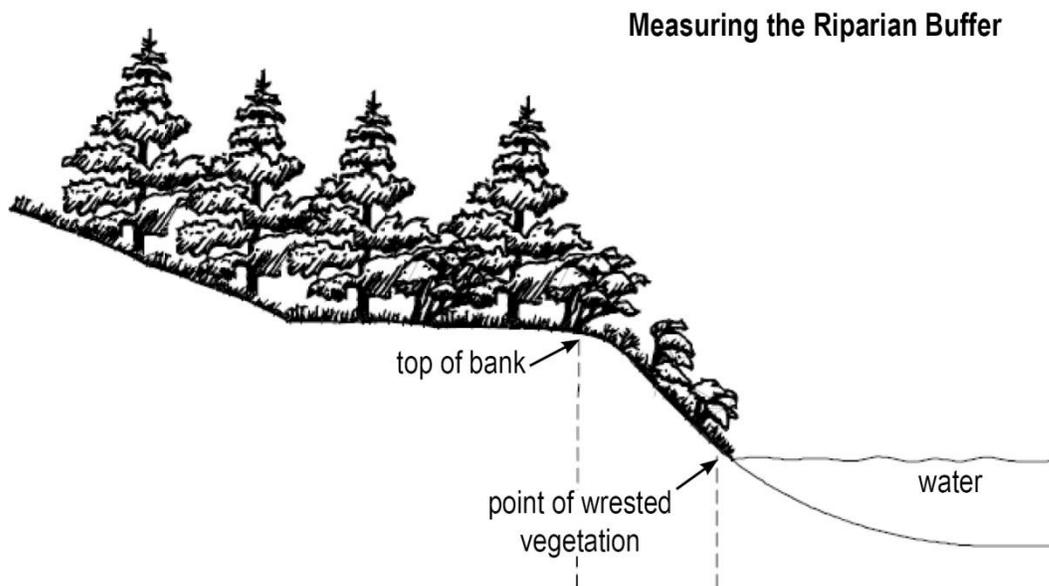
The maintenance activities outlined in this SOP include delineating the riparian buffer area, tree pruning, tree removal, thinning of the tree canopy, removal of invasive vegetation, and mowing and general yard maintenance.

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

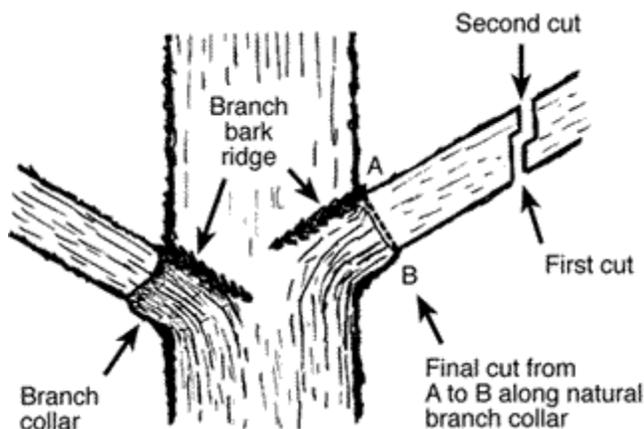
Riparian buffers are intended to be natural areas and pruning is generally not necessary. However, as most city-owned riparian buffers are associated with parks and pedestrian trails; some limited pruning may be needed to provide for visitor safety. Examples of pruning for the safety of park visitors 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.

	Removing Invasive Species from the Riparian Buffer and Replanting	SOP #	2
		Revision #	0
		Implementation Date	August 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 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 wretched 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 wretched 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 1 plants at the time of this SOP, listed by type, include:

Tree

- Tree-of-heaven
- Mimosa
- Chinaberry
- Princesstree
- Chinese tallowtree

Shrub

- Autumn olive
- Chinese privet***
- Multiflora rose

Herbaceous

- Japanese climbing fern

- Marsh dayflower
- Japanese stiltgrass

Vine

- English ivy***
- Japanese honeysuckle
- Kudzu***
- Chinese wisteria

Aquatics

- 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 areas 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, the 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
<p>Hand Pull Application: small vines, herbaceous plants, seedlings < 1 inch in diameter</p> <p>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.</p>	
<p>Uprooting Application: vines, shrubs, saplings <3 inches in diameter</p> <p>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</p>	

Technique	Example
<p>when the ground is damp.</p> <p>Suffocation (aka Cardboard and Mulch) Application: herbaceous plants</p> <p>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.</p>	
<p>Air Stripping Application: climbing vines</p> <p>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.</p>	
<p>Repetitive Cutting Application: trees, shrubs, saplings > 2 inches in diameter, large vines</p> <p>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.</p>	

Chemical Removal of Invasive Species:

Technique	Example
<p>Foliar Chemical Applications Applications: herbaceous plants, shrubs</p> <p>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.</p>	
<p>Cut Stem or Cut and Paint Applications:</p> <p>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.</p>	
<p>Girdle or “Hack and Squirt” Applications:</p> <p>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.</p>	

Biological Control of Invasive Species:

Technique	Example
<p>Animal Grazing Application: herbaceous plants, seedlings, saplings, small vines, shrubs</p> <p>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</p>	

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

Georgia Exotic Pest Plant Council (GA EPPC) website.

Invasive Plants of Georgia's Forests: Identification and Control. Georgia Forestry Commission, University of Georgia, USDA Forest Service. March 2006. <http://bugwoodcloud.org/mura/gist/assets/File/pubs/gfcnew.pdf>

Cobb County Stream Buffer Restoration Guidelines. Cobb County Soil and Water Conservation District. March 2006.

Riparian Buffers Modification and Mitigation Guidance Manual. Virginia Department of Conservation and Recreation, Chesapeake Bay Local Assistance. 2006.

US Fish and Wildlife Services. Prescribed Grazing in Practice website.
<http://www.fws.gov/invasives/staffTrainingModule/methods/grazing/practice.html>

Online Athens News Article. <http://onlineathens.com/breaking-news/2013-04-09/goats-tackle-invasive-plants-choking-uga-stream-side>

Weed Control Methods Handbook, The Nature Conservancy, Tu et al.
(<http://www.invasive.org/gist/products/handbook/07.herbicideguidelines.pdf>)

Guidelines for Disposal of Terrestrial Invasive Plants. The Connecticut Department of Energy and Environmental Protection and the University of Connecticut. 2014. http://cipwg.uconn.edu/wp-content/uploads/sites/244/2014/01/InvasivePlantDisposal_2014-01-23.pdf

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
<p>Tree of Heaven (<i>Ailanthus altissima</i>)</p> 	<p>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.</p> <p>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.</p> <p>Flower Yellow flowers bloom in early summer. Each tree may produce several hundred flowers.</p> <p>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.</p>	<p>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.</p> <p>For larger trees and stands, a combination of mechanical and chemical controls will be needed.</p>
<p>Mimosa (<i>Albizia julibrissin</i>)</p> 	<p>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.</p> <p>Foliage The delicate-looking leaves are found in odd numbered groupings (bi-pinnately compound). The leaves turn yellow in the fall.</p> <p>Flower Fragrant pink flowers bloom in early summer.</p> <p>Fruit Mimosa's flat seed pod fruit develop in late summer.</p>	<p>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.</p>
<p>Chinaberry (<i>Melia azedarach</i>)</p> 	<p>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.</p> <p>Foliage The leaves are alternate in odd numbered groupings (bi-pinnately compound) and about 1 to 2 feet in length.</p>	<p>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.</p>

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	<p>Flower Flowers are showy, lavender and occur in the spring.</p> <p>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.</p>	
<p>Princesstree (<i>Paulownia tomentosa</i>)</p> 	<p>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 (<i>catalpa speciosa</i>), a native tree. Princesstree bark is grey-brown and rough. Princesstree is an aggressive tree and invades disturbed natural areas. Seeds can be dispersed by the wind up to 2 miles away.</p> <p>Foliage Large heart-shaped leaves that have a fuzzy/ hairy surface on both sides. The leaves are arranged opposite along the stem.</p> <p>Flower In the spring, there are large, fragrant light pink flowers in upright clusters.</p> <p>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.</p>	<p>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.</p>
<p>Chinese Tallowtree (<i>Triadica sebifera</i>)</p> 	<p>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.</p> <p>Foliage Leaves are alternate, heart-shaped, 2-3 inches long with a long, pointed tip.</p> <p>Flower Flowering occurs from April to June. The flowers are yellowish and occur on 8 inch long, dangling spikes.</p>	<p>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.</p>

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	<p>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.</p>	
Shrub		
<p>Autumn Olive (<i>Elaeagnus umbellata</i>)</p> 	<p>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.</p> <p>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.</p> <p>Flowers Small, yellowish tubular flowers bloom form in abundant clusters of 5 to 10 flowers near the stem. Blooms from February to June.</p> <p>Fruit Fruits are round, red, juicy drupes which have very small silvery scales. Each drupe contains one seed. Fruit ripens from August to November.</p>	<p>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.</p>
<p>Chinese privet (<i>Ligustrum sinense</i>)</p> 	<p>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.</p> <p>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.</p> <p>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.</p>	<p>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.</p>

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	<p>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.</p>	
<p>Multiflora rose (<i>multiflora rose</i>)</p> 	<p>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.</p> <p>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.</p> <p>Flowers Small, 5-petaled flowers that are white to pink in color present in abundant clusters in the spring.</p> <p>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.</p>	<p>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.</p>
Herbaceous		
<p>Japanese climbing fern (<i>Lygodium japonicum</i>)</p> 	<p>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.</p> <p>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.</p> <p>Flower This plant does not produce flowers.</p>	<p>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.</p>

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	<p>Fruit Fertile fronds bear sporangia that produce tiny, wind-dispersed spores. Plants are also spread by rhizomes.</p>	
<p>Marsh dayflower (<i>Murdannia keisak</i>)</p> 	<p>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.</p> <p>Foliage Leaves are alternate, lance-shaped, and up to 3 inches long.</p> <p>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.</p> <p>Fruit The fruit is a capsule that contains several small seeds.</p>	
<p>Japanese stiltgrass (<i>Microstegium vimineum</i>)</p> 	<p>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.</p> <p>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.</p> <p>Flowers Flowering begins in September, when delicate flower stalks develop in the axils of the leaves or at the top of the stems.</p> <p>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.</p>	<p>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.</p>
Vine		

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
<p>English ivy (<i>Hedera helix</i>)</p> 	<p>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.</p> <p>Foliage Leaves are alternate, dark green, waxy, somewhat leathery; extremely variable leaf forms, from unlobed to 3-5 lobed; typically green with whitish veins.</p> <p>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.</p> <p>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.</p>	<p>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.</p>
<p>Japanese honeysuckle (<i>Lonicera japonica</i>)</p> 	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>	<p>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.</p>

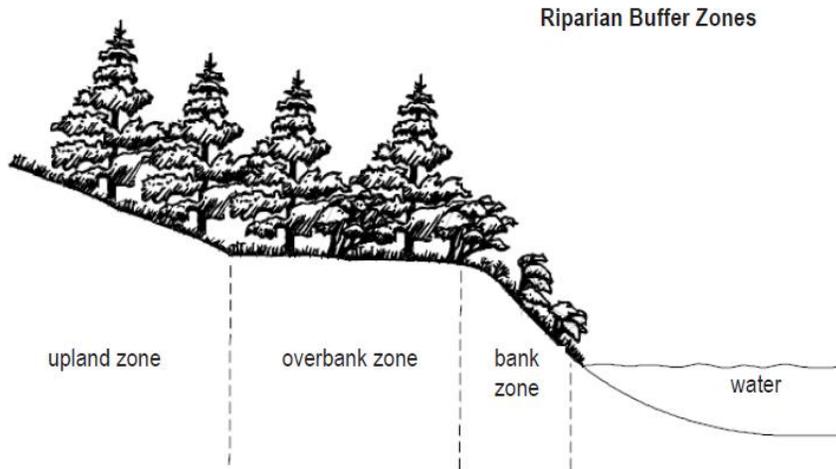
Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
<p>Kudzu (<i>Pueraria montana var. lobata</i>)</p> 	<p>General Information Kudzu is a climbing, deciduous vine capable of reaching lengths of over 100 feet in a single season. Its fleshy tap roots can reach 7 inches wide and grow 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.</p> <p>Foliage Leaves are alternate, compound (with three, usually lobed, leaflets), hairy underneath and up to 5.4 inches long.</p> <p>Flowers Flowering occurs in midsummer, when 0.5 inch long, purple, fragrant flowers hang, in clusters, in the axils of the leaves.</p> <p>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.</p>	<p>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.</p> <p>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.</p>
<p>Chinese wisteria (<i>Wisteria sinensis</i>)</p> 	<p>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.</p> <p>Foliage Alternate, pinnately compound (7-13 leaflets) leaves are tapered at the tip with wavy edges. Leaflets are approximately 3 inches long.</p> <p>Flowers Lavender, purple or white flowers are fragrant, very showy and abundant and occur in long, dangling clusters in the spring.</p> <p>Fruit Seeds are contained in flattened, hairy, 6 in. (15.2 cm) long, bean-like pods. Invasions often occur around previous plantings.</p>	<p>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.</p> <p>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.</p>
Aquatics		
<p>Alligatorweed (<i>Alternanthera</i>)</p>	<p>General Information Alligatorweed is an emergent or rooted floating plant that invades aquatic</p>	<p>Herbicides must be used to eliminate alligator weed and sometimes is done in combination with water level</p>

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
<p><i>philoxeroides</i></p> 	<p>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.</p> <p>Foliage Opposite, elliptical leaves are thick but non-succulent and are up to 4 inches long.</p> <p>Flowers Flowering occurs during the summer with white, clover-like heads in the axils of the leaves.</p> <p>Fruit Fruits are very small, and single-seeded.</p>	<p>management. Any herbicide application in a riparian buffer should carefully consider any negative impacts to local waterbodies.</p>
<p>Common water hyacinth (<i>Eichhornia crassipes</i>)</p> 	<p>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.</p> <p>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.</p> <p>Flowers The very showy blue-purple flowers are born on upright spikes. Each flower has six petals with the uppermost having a yellow patch.</p> <p>Fruit This plant reproduces chiefly by vegetative means.</p>	<p>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.</p> <p>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.</p>
<p>Hydrilla (<i>Hydrilla verticillata</i>)</p>	<p>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.</p> <p>Foliage Leaves are whorled in bunches of 3-8, but most often with whorls of 5. The</p>	<p>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.</p> <p>Seasonal drawdowns can also be effective in controlling hydrilla , especially when the drawdown occurs in the fall when tubers are developing.</p>

Name/ Photo	Description	Removal Techniques within 50 foot Riparian Buffer
	<p>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.</p> <p>Flowers Only the female flowers of this dioecious plant have been found in the United States, which means no viable seed are produced.</p> <p>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.</p>	<p>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.</p>

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	<i>Acer rubrum</i>	✓	✓	✓	Good
River Birch	<i>Betula nigra</i>	✓	✓	✓	Good
Shagbark Hickory	<i>Carya ovate</i>		✓	✓	Good
Sugarberry	<i>Celtis laevigata</i>	✓	✓	✓	Good
Persimmon	<i>Diospyros virginiana</i>		✓	✓	Good
American Beech	<i>Fagus grandiflora</i>		✓	✓	Good
White Ash	<i>Fraxinus Americana</i>		✓	✓	Good
Green Ash	<i>Fraxinus pennsylvanica</i>	✓	✓	✓	Good
Sweetgum	<i>Liquidambar styraciflua</i>	✓	✓	✓	Good
Tulip Poplar	<i>Liriodendron tulipifera</i>		✓	✓	Good
Southern Magnolia	<i>Magnolia grandiflora</i>		✓	✓	Good
Black Gum	<i>Nyssa sylvatica</i>		✓	✓	Good
Loblolly Pine	<i>Pinus taeda</i>		✓	✓	Good
Virginia Pine	<i>Pinus virginiana</i>			✓	Good
Sycamore	<i>Platanus occidentalis</i>	✓	✓	✓	Good
White Oak	<i>Quercus alba</i>		✓	✓	Good
Southern Red Oak	<i>Q. falcate</i>		✓	✓	Good
Overcup Oak	<i>Q. lyrata</i>	✓	✓	✓	Good
Swamp Chestnut Oak	<i>Q. michauxii</i>	✓	✓	✓	Good
Red Oak	<i>Q. rubra</i>		✓	✓	Good
Shumard Oak	<i>Q. shumardii</i>	✓	✓	✓	Good
Water Oak	<i>Q. nigra</i>	✓	✓	✓	Good
Willow Oak	<i>Q. phellos</i>	✓	✓	✓	Good
Black Willow	<i>Salix nigra</i>	✓	✓		Good
Bald Cypress	<i>Taxodium distichum</i>		✓		Good

Small Trees (25%)

Common Name	Scientific Name	Bank Zone	Overbank Zone	Upland Zone	Hardiness
Florida Maple	<i>Acer barbatum</i>		✓	✓	Good
Red Buckeye	<i>Aesculus pavia</i>		✓	✓	Good
Serviceberry	<i>Amelanchier canadensis</i>		✓	✓	Fair
Ironwood	<i>Carpinus caroliniana</i>	✓	✓	✓	Good
Redbud	<i>Cercis Canadensis</i>		✓	✓	Good
Dogwood	<i>Cornus florida</i>		✓	✓	Good
Hawthorn	<i>Crataegus phaenopyrum</i> , <i>Crataegus spp.</i>		✓	✓	Good
Carolina Silverbell	<i>Halesia Carolina</i>		✓	✓	Fair
American Holly	<i>Ilex opaca</i>		✓	✓	Good
Sweetbay	<i>Magnolia virginiana</i>	✓	✓	✓	Good
Southern Crabapple	<i>Malus angustiflora</i>			✓	Good
Hophornbeam	<i>Ostrya virginiana</i>		✓	✓	Good
Sourwood	<i>Oxydendrum arboretum</i>			✓	Good

Shrubs (20%)

Common Name	Scientific Name	Bank Zone	Overbank Zone	Upland Zone	Hardiness
Buckeye	<i>Aesculus sylvatica</i>		✓	✓	Good
Tag Alder	<i>Alnus serrulata</i>	✓	✓		Good
Red Chokeberry	<i>Aronia arbutifolia</i>	✓	✓	✓	Fair
Pawpaw	<i>Asimina triloba</i>		✓	✓	Fair
Sweetshrub	<i>Calycanthus floridus</i>		✓	✓	Good
American Beautyberry	<i>Callicarpa americana</i>		✓	✓	Good
Buttonbush	<i>Cephalanthus occidentalis</i>	✓	✓		Good
Sweet Pepperbush	<i>Clethra alnifolia</i>	✓	✓	✓	Good
Silky Dogwood	<i>Cornus amonum</i>	✓	✓		Good
American Strawberry Bush	<i>Euonymous americanus</i>		✓	✓	Good
Witchhazel	<i>Hamamelis virginiana</i>		✓	✓	Good
Inkberry	<i>Ilex glabra</i>		✓		Fair
Oak-leaf Hydrangea	<i>Hydrangea quercifolia</i>		✓	✓	Good
Florida Anise	<i>Illicium floridanum</i>		✓	✓	Good
Small Anise	<i>I. parviflorum</i>		✓	✓	Good
Possumhaw	<i>Ilex deciduas</i>	✓	✓		Good
Winterberry	<i>I. verticillata</i>	✓	✓		Good
Itea, Virginia Sweetspire	<i>Itea virginica</i>	✓	✓		Good
Mountain Laurel	<i>Kalmia latifolia</i>		✓		Poor
Spice Bush	<i>Lindera benzoin</i>		✓		Good
Dog Hobble	<i>Leucothoe spp.</i>	✓	✓		Poor
Wax Myrtle	<i>Myrica cerifera</i>		✓	✓	Good
American Devilwood	<i>Osmanthus americanus</i>		✓	✓	Fair
Chickasaw and Hog Plum	<i>Prunus angustifolia</i> , <i>P. umbellata</i>		✓	✓	Good
Wild Plum	<i>P. americana</i>		✓	✓	Good
Piedmont Azalea, other natives (not Jap. Evergreen azaleas)	<i>Rhododendron canescens</i> , <i>R. periclymenoides</i> , <i>R. flammeum</i> , <i>R.</i>		✓	✓	Fair

Common Name	Scientific Name	Bank Zone	Overbank Zone	Upland Zone	Hardiness
	<i>calendulaceum, R. viscosum, etc.</i>				
Dwarf Rhododendron	<i>Rhododendron minus</i>		✓		Fair
Smooth or Winged Sumac	<i>Rhus glabra, R. copallinum</i>			✓	Good
Elderberry	<i>Sambucus Canadensis</i>	✓	✓		Good
Maple-leaf Viburnum	<i>Viburnum acerifolium</i>		✓	✓	Fair
Swamphaw Viburnum	<i>Viburnum nudum, V. cassinoides</i>	✓	✓		Good

Forbs, Ground Covers, Perennials (15%)

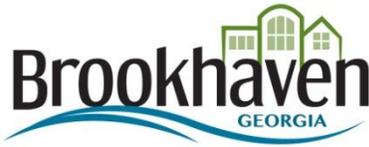
Common Name	Scientific Name	Bank Zone	Overbank Zone	Upland Zone	Hardiness
Sensitive fern	<i>Onoclea sensibilis</i>		✓		Fair
Cinnamon fern	<i>Osmunda cinnamomea</i>		✓		Fair
Royal fern	<i>Osmunda regalis</i>		✓		Fair
Christmas fern	<i>Polystichum acrostichoides</i>		✓		Fair
Virginia Chain fern	<i>Woodwardia virginica</i>		✓		Fair
Butterflyweed	<i>Asclepias tuberosa</i>		✓	✓	Fair
New England Aster	<i>Aster novae-angliae</i>		✓	✓	Fair
Turtlehead	<i>Chelone lyonii</i>		✓	✓	Fair
Lanceleaved Coreopsis	<i>Coreopsis lanceolata</i>		✓	✓	Fair
Bleeding heart	<i>Dicentra eximia</i>		✓	✓	Fair
Hardy ageratum	<i>Eupatorium coelestinum</i>		✓	✓	Fair
Joe-Pye Weed	<i>Eupatorium fistulosum</i>		✓	✓	Fair
Wild Geranium	<i>Geranium maculatum</i>		✓	✓	Fair
Narrow-leaved sunflower	<i>Helianthus angustifolius</i>		✓		Fair
Hibiscus (NOT shrub althea)	<i>Hibiscus coccineus, H. moscheutos</i>		✓		Fair
Gayfeather	<i>Liatris spicata, L. aspera</i>		✓	✓	Fair
Cardinal flower	<i>Lobelia cardinalis</i>		✓		Fair
Great Lobelia	<i>Lobelia siphilitica</i>		✓		Fair
Partridgeberry	<i>Mitchella repens</i>		✓		Fair
Evening Primrose	<i>Oenothera speciosa, O. fruticosa</i>		✓		Fair
False Dragonhead, Obedient Plant	<i>Physostegia virginiana</i>		✓	✓	Fair
Salomon's Seal	<i>Polygonatum biflorum</i>		✓		Fair
Goldstrum Black-Eyed Susan	<i>Rudbeckia fulgida "Goldsturm"</i>		✓	✓	Good
Black-Eyed Susan	<i>Rudbeckia hirta</i>		✓	✓	Good
False Solomon's Seal	<i>Smilacina racemosa</i>		✓	✓	Fair
Goldenrod	<i>Solidago spp.</i>		✓	✓	Fair
Stoke's Aster	<i>Stokesia laevis</i>		✓	✓	Fair
Foamflower	<i>Tiarella cordifolia</i>		✓		Poor
Spiderwort	<i>Tradescantia virginiana</i>		✓	✓	Fair
Ironweed	<i>Vernonia noveboracensis</i>		✓	✓	Good
Yellow-root	<i>Xanthorhiza simplicissima</i>	✓	✓		Good

Suggested Grass Species and Seeding Rates

Common Name	Scientific Name	Type	Seeding Rate (lbs/acre)
Big Bluestem	<i>Andropogon gerardii</i>	Warm	25
Side-Oats Grama	<i>Bouteloua curtipendula</i>	Warm	20
Wild Rye	<i>Elymus virginicus</i> , <i>E. canadensis</i>	Cool	20
Switchgrass	<i>Panicum virgatum</i>	Warm	10
Little Bluestem	<i>Schizachyrium scoparium</i>	Warm	14.5
Indian Grass	<i>Sorghastrum nutans</i>	Warm	22
Eastern Gamagrass	<i>Tripsacum dactyloides</i>	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.

	Caring for Newly Established Riparian Buffers	SOP #	3
		Revision #	0
		Implementation Date	August 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 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 wooded 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 wooded 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 they 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.

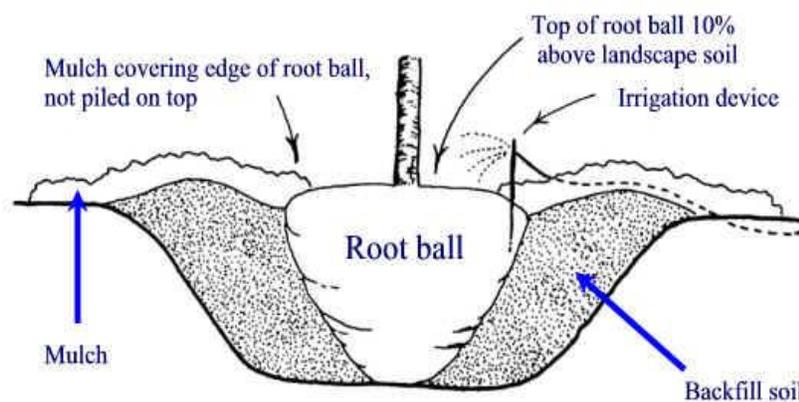
For slopes 3:1 or greater: erosion control blankets can be used that are specified for the steepness of the slope. Plantings should consist of plugs, live stakes and/or hydroseed. Always follow manufacturer's recommendations when using any erosion or sediment control products.

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 composted 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

Riparian Buffers Modification and Mitigation Guidance Manual. Virginia Department of Conservation and Recreation, Chesapeake Bay Local Assistance. 2006.

Stream Buffer Maintenance Handbook: For newly established buffers. Virginia Department of Conservation and Recreation, Chesapeake Bay Local Assistance. 2011.

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

https://epd.georgia.gov/sites/epd.georgia.gov/files/related_files/site_page/Guidelines_Streambank_Restoration_GSWCC_Revised_2000.pdf

Planting Riparian Buffers in the Connecticut River Watershed. No. 8. River Banks & Buffers. Connecticut River Joint Commissions, 1998.

Tree and Shrub Planting with Live Stakes. United States Department of Agriculture, Natural Resources Conservation Service. Conservation Practice Job Sheet, NH-612

Urban Soil Compaction. United States Department of Agriculture. Natural Resources Conservation Service. Soil Quality Institute. Soil Quality – Urban Technical Note No. 2. March, 2000.

Live Staking. Pennsylvania State Cooperative Extension, College of Agricultural Sciences. 2016.

Tu, M., Hurd, C. and J.M. Randall. 2001. Weed Control Methods Handbook, The Nature Conservancy, <http://tncweeds.ucdavis.edu>, version April 2001.

Transplanting Woody Plants.

<http://www.caes.uga.edu/extension/cobb/anr/Documents/transplantingwoodyplants.pdf>

Resident Canada Geese Management Options.

http://www.clemson.edu/extension/hgic/water/resources_stormwater/resident_canada_geese_management_options.html

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.