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List of Acronyms

BMP	Best Management Practices
CDBG	Community Development Block Grant
CFR	Code of Federal Regulations
COSS	City of Sandy Springs
CMOM	Capacity Management Operations and Maintenance
DWR	Department of Water Resources
EIA	Effective Impervious Area
FC	Fecal Coliform
GA DNR	Georgia Department of Natural Resources
GA EPD	Georgia Environmental Protection Division
HUC	Hydrologic Unit Codes
MIP	Monitoring and Implementation Plan
MNGWPD	Metropolitan North Georgia Water Planning District
MP	Maintenance Points
MS4	Municipal Separated Storm Sewer System
NP	Non-Point Source
NPDES	National Pollution Discharge Elimination System
SOP	Standard Operating Procedure
SPID	Stream Point Identification
SPLOST	Special Purpose Local Option Sales Tax
SQAP	Sampling Quality Assurance Plan
SSO	Sanitary Sewer Overflows
SWMP	Stormwater Management Plan
TMDL	Total Maximum Daily Loads
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UR	Urban Runoff
WPP	Watershed Protection Plan

Executive Summary

City of Sandy Springs (COSS) completed a stream assessment inventory of the impaired streams watershed in COSS. COSS includes 32-miles of main stem and tributaries of impaired streams that confluence with the Chattahoochee River. These impaired streams are listed on the 2016 Georgia 305(b)/303(d) Report lists of impaired streams for *fecal coliform* bacteria (**Figure EX-1**). This listing is a result of elevated levels of bacteria and sediment which may be caused by the influence of urban stormwater runoff. The stream assessment inventory includes a review of the watershed, sanitary sewer inventory, stream assessment summary, potential best management practice (BMP), and recommendations for improving water quality.

Stream Assessment

Stream assessments are conducted on Nancy Creek, Crooked Creek, Ball Mill Creek, Marsh Creek, and Long Island Creek. Stream assessments identify visual conditions of habitat, stream bank degradation, stream buffer conditions, illicit discharges, existing and potential BMP locations, maintenance issues, etc. Stream assessments were conducted in October through December of 2017. Stream assessments provide a firsthand account of the condition of the streams and the surrounding area. **Figure EX-1** shows the stream assessments conducted within COSS subwatersheds. Stream assessments indicate most of the land use in COSS consists of medium density residential properties throughout the COSS watersheds. Commercial and Institutional properties are located along Roswell Road, Georgia 400 Interstate 285 interchange and the Johnson Ferry. Several of the impaired stream segments are categorized as a channelized stream with some disturbance and channel incision. The stream bed material is mostly sand and silt, and mild to moderate erosion is observed throughout the length of this reach.

To identify the habitat conditions in the COSS watersheds, representative reach points are evaluated (**Figure EX-2**). Habitat conditions for each representative reach location are summarized in **Table EX-1**. Habitat conditions within the COSS watersheds are identified to be marginal to poor within the COSS study area.

Several potential maintenance issues were also identified during stream assessments. In general, the results indicated that stream banks have been reduced because of local scour likely resulting from historic high velocity and volume associated with stormwater runoff. The list of maintenance issues observed is presented in **Appendix A**.

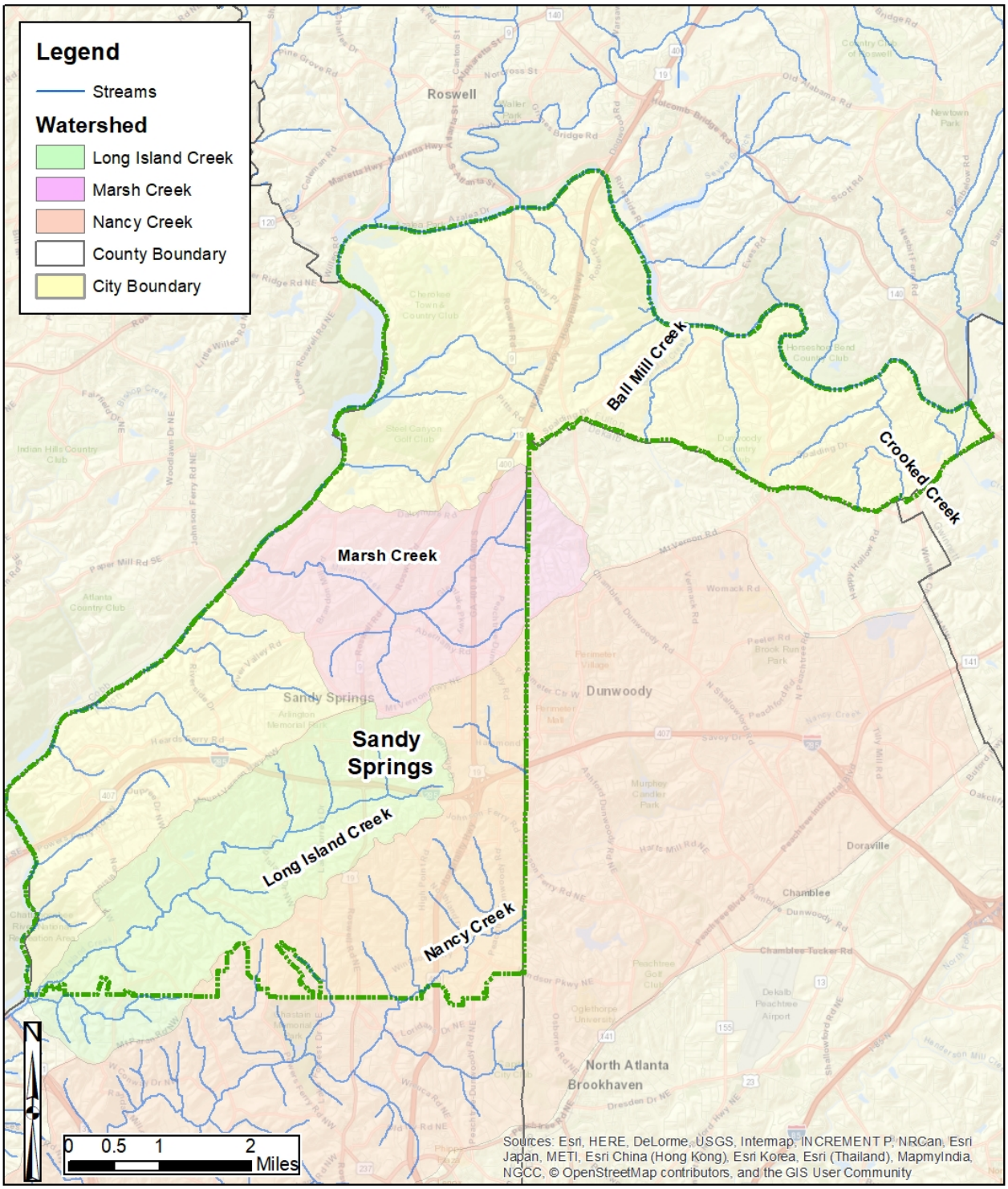
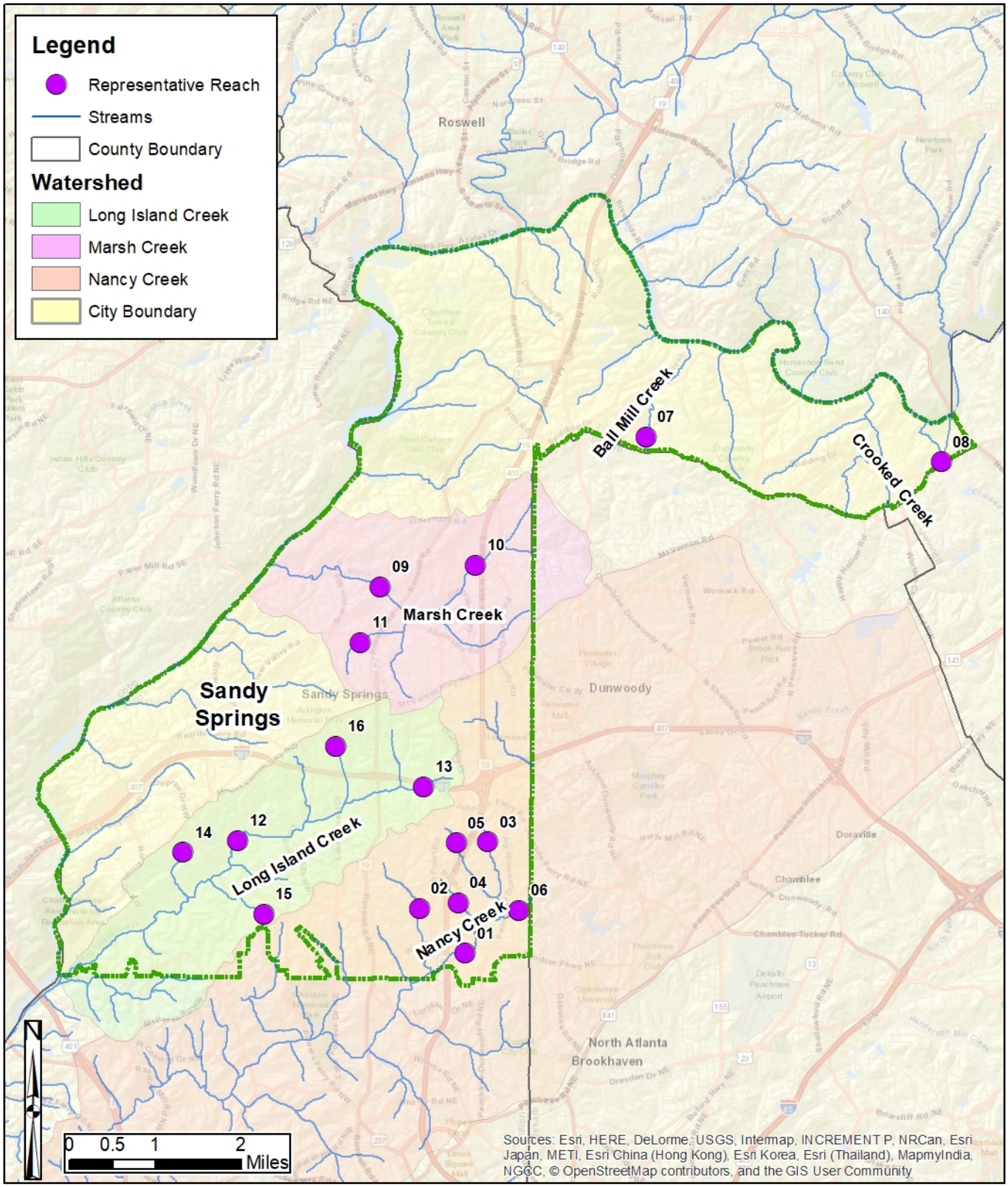


Figure EX-1 – Stream Assessments Subwatersheds



City of Sandy Springs
Stream Assessment

Figure EX-2 – COSS Watershed Representative Reach Location

Table EX-1 Sandy Springs Stream Assessment Habitat Scores

Habitat Parameters	Nancy Creek ID (1)	ID (2)	ID (3)	ID (4)	ID (5)	ID (6)	Crooked Creek ID (7)	Ball Mill Creek ID (8)
1 Epifaunal Substrate/Available Cover	7	10	11	7	9	5	15	2
2 Embeddedness	6	8	8	8	6	8	12	2
3 Velocity /Depth Regime	11	9	7	5	11	11	11	12
4 Sediment Deposition	6	7	13	5	12	5	14	2
5 Channel Flow Status	5	6	6	6	5	6	8	4
6 Channel Alteration	6	4	5	8	7	6	7	9
7 Frequency of Riffles	4	4	4	5	6	4	3	4
8 Bank Stability Left Bank	2	5	4	4	3	1	5	0
8 Bank Stability Right Bank	2	4	3	3	3	1	5	0
9 Vegetative Protection Left Bank	3	1	2	1	3	2	1	2
9 Vegetative Protection Right Bank	3	1	2	1	3	2	1	2
10 Riparian Vegetative Zone Width LB	1	1	2	1	3	2	1	3
10 Riparian Vegetative Zone Width RB	1	1	1	1	3	2	1	3
Total Score	57	61	68	55	74	55	84	45
Condition Categories	**Marginal - Poor**	**Marginal**	**Marginal**	**Marginal - Poor**	**Marginal**	**Marginal - Poor**	**Marginal**	**Marginal - Poor**

* Number in parenthesis represents the Representative Reach Point ID
**Optimal 200-166, Sub-Optimal 153-113, Marginal 100-60, Poor 44-0 Source: Georgia DNR 2007 Standard Operating Procedures

Table EX-1 Sandy Springs Stream Assessment Habitat Scores

Habitat Parameters	Marsh Creek			Long Island Creek				
	ID (9)	ID (10)	ID (11)	ID (12)	ID (13)	ID (14)	ID (15)	ID (16)
1 Epifaunal Substrate/Available Cover	14	12	14	12	11	14	14	14
2 Embeddedness	17	11	14	12	14	11	11	14
3 Velocity /Depth Regime	13	13	7	13	7	3	4	7
4 Sediment Deposition	11	12	14	14	14	13	14	13
5 Channel Flow Status	6	8	6	8	8	9	6	9
6 Channel Alteration	7	7	8	8	7	7	7	7
7 Frequency of Riffles	3	3	5	6	4	6	7	6
8 Bank Stability Left Bank	3	3	4	3	3	4	3	4
8 Bank Stability Right Bank	4	4	5	2	3	4	3	5
9 Vegetative Protection Left Bank	2	3	2	2	1	2	1	1
9 Vegetative Protection Right Bank	2	3	2	2	1	2	1	1
10 Riparian Vegetative Zone Width LB	2	2	3	1	1	2	5	2
10 Riparian Vegetative Zone Width RB	2	2	3	1	1	2	5	2
Total Score	86	83	87	84	75	79	81	85
Condition Categories	**Marginal**	**Marginal**	**Marginal**	**Marginal**	**Marginal**	**Marginal**	**Marginal**	**Marginal**

* Number in parenthesis represents the Representative Reach Point ID
**Optimal 200-166, Sub-Optimal 153-113, Marginal 100-60, Poor 44-0 Source: Georgia DNR 2007 Standard Operating Procedures

Sewer and Septic System Inventory

The COSS watersheds have extensive sewer service within the City limits. Leaking sewer pipes can contribute to elevated levels of bacteria in streams. Older homes within the sewer service area may not be connected to the available sewer lines. Homes on septic systems are assumed to represent only a small portion of the residential area based on the age of the housing base. Several sewer line crossings were identified during stream assessment. Aerial crossings often capture stream debris and cause potential for a pipe break. Several aerial crossings were identified downstream of debris dams. Two potential illicit discharges were observed during the stream assessment and reported to Fulton County for repair.

Best Management Practices

Several areas of COSS watersheds are identified for implementation of stormwater management measures to reduce urban runoff and improve water quality. **Table EX-2** identifies the best management practices (BMPs) recommended in the COSS watersheds. These practices include public involvement, non-structural measures, and structural measures.

The BMPs are evaluated by effectiveness, costs (preliminary planning), and ease of implementation based on previous project experiences. BMPs are prioritized as being effective for removing bacteria or directly changing the source of pollution such as the stormwater detention basins and septic tank elimination. The priority is then determined by planning cost, and ease of implementation. **Table EX-3** shows the preliminary prioritization for implementing the recommended BMPs.

Table EX-2 - Potential BMPs for Stream Assessment
COSS Stream Assessment

	Measures	Improves
Public Awareness/ Public Involvement	Public Awareness to Reduce FOGs	Bacteria
	Industrial Facilities Focused BMPs	Sediment & Runoff
	Home Owner Education Workshops	Overall WQ
	Stormwater Detention Basin Maintenance Education	Sediment & Runoff
	School Education Activities	Overall WQ
Non-structural Measures	Sanitary Sewer Overflow Management	Bacteria
	Bacteria Monitoring	Bacteria
	Bacteria Source Tracking	Bacteria
Structural Measures	Addressing Maintenance Issues	Sediment & Runoff
	Debris Removal	Sediment & Runoff
	Stream Bank Restoration	Sediment & Runoff
	Stormwater Detention Basins	Overall WQ
	Rain Gardens/Barrels – Schools	Overall WQ

Table EX-3- Potential BMP Evaluation

BMPs	Cost	Effectiveness	Ease of Implementation
Public Awareness – COSS Watersheds	Low	Medium	High
FOG Education and Outreach Activities	Low	Medium	High
Home Owner / Business Owner Workshop	Low	Low	High
School Education Activities	Low	Low	High
SSO Management Program	High	High	Low
Bacteria Monitoring	Medium	Low	Medium
Bacteria Source Tracking	Medium	Low	Medium
Addressing Maintenance Issues	Low	High	Low
Debris Removal	Low	High	Low
Stream Bank Restoration	High	Medium	Low
Stormwater Detention Basins	High	High	Medium
Rain Gardens / Barrels	Low	Low	High

The stream assessment inventory recommends continued water quality and biological monitoring to provide historic and current data for calculating pollutant loading and to determine BMP effectiveness. The overall results of the COSS stream assessment project identify the stream segments to be typical of urban streams. COSS streams are categorized as channelized streams with some disturbance and channel incision. Medium density residential properties dominate the subwatersheds in COSS. BMPs identified in this report focus on reducing pollution from urban sources including reducing sanitary sewer overflows (SSO) and providing stormwater education to residence.

Section 1 – Introduction

The City of Sandy Springs (COSS) and its tributaries are in the Upper Chattahoochee River Watershed Hydraulic Unit Code (HUC03130001). The purpose of this document is to identify the current conditions of the identified waters listed as impaired on the Federal Clean Water Act 303(d)/305(b) list of impaired streams. These five streams include portions of Nancy Creek, Crooked Creek, Ball Mill Creek, Marsh Creek and Long Island Creek located within the jurisdictional area of the City of Sandy Springs. Most of these impaired streams are listed for violation of the water quality criteria for fecal coliform bacteria and fish biota impairment. Table 1 shows the details of the 303(d) stream listings. Urban runoff is listed as the potential pollutant source or cause.

Table 1 – Listed Streams within COSS

Stream	Reach	Violation	Potential Cause	Stream Length
Nancy Creek	Headwaters to Peachtree Creek	FC, Bio F	UR	16 Miles
Long Island Creek	Headwaters to Chattahoochee River	FC, Bio F	UR	5 Miles
Ball Mill Creek	Headwaters to Chattahoochee River	FC	UR	3 Miles
Crooked Creek	Headwaters to Chattahoochee River	FC, Bio F	UR	2 Miles
Marsh Creek	Headwaters to Chattahoochee River	FC, Bio F	UR	4 Miles

FC- Fecal Coliform, Bio F – Fish Biota, UR – Urban Runoff

1.1 Background

COSS maintains the local stormwater management system and has a Municipal Separated Storm Sewer System (MS4) permit and Stormwater Management Plan to address urban runoff and manage local land planning. Fulton County maintains the local sanitary sewer system and is required to monitor stream health within the sewersheds under the National Pollution Discharge Elimination System (NPDES) permit of its wastewater treatment facilities. The following regulatory drivers provide the support for stream assessments and water quality.

1.2 Regulatory Drivers

Federal law requires Total Maximum Daily Loads (TMDLs) for streams that do not meet the designated use water quality criteria. TMDLs have been developed by the Georgia Environmental Protection Division (GaEPD) for the listed COSS stream segments that have bacteria impairment because of excess fecal coliform bacteria. The TMDL represents the maximum level of pollution to be able to meet the water quality criteria. There are several regulatory permits and documents that require water quality monitoring for bacteria pollution including the National Pollution Discharge Elimination System documents outlined in this section.

1.2.1 National Pollution Discharge Elimination System (NPDES)

COSS is required by the MS4 permit and Stormwater Management Plan to collect water quality monitoring data on stream segments for which a TMDL has been developed. The objective of the MS4 program is to reduce non-point source pollution from municipal storm water discharges to the maximum extent possible. COSS is monitoring water quality at one location on Nancy Creek and one location on Crooked Creek for bacteria impacts of concern to comply with the MS4 permit. Fulton County is monitoring water quality at one location on Marsh Creek, one location on Long Island Creek, and one location on Ball Mill Creek.

1.2.2 NPDES Watershed Protection Plan

A thorough Watershed Protection Plan (WPP) meets the NPDES permit requirement for monitoring impaired streams in sewershed areas associated with a wastewater treatment plant. The key elements of the WPP include strategies for continued management, monitoring, and protection of the watershed. Fulton County is monitoring Marsh Creek, Long Island Creek and Ball Mill Creek as three of the 16 locations within the Fulton County sewer service area for bacteria to comply with the NPDES Permit and WPP.

1.2.3 District Watershed Management Plan Requirements

COSS is a member of the Metropolitan North Georgia Water Planning District (District). The District was created by the Georgia General Assembly in 2001 (O.C.G.A. §12-5-572) to provide a region wide approach to planning and implementing watershed management measures for the greater metropolitan Atlanta area. Water quality monitoring is required as part of the Watershed Management Plan local management measures (WATERSHED-10 Long Term Ambient Trend Monitoring).

1.2.5 Water Quality Criteria

The Federal Clean Water Act 303(d) list identifies the waterbodies that are not supporting their designated use classifications due to exceedances of water quality standards for fecal coliform bacteria. The Georgia 391-3-6 Water Use Classification and Water Quality Criteria Rule define the bacteria criteria for each designated water use as the following:

For the months of May through October, when water contact recreation activities are expected to occur, fecal coliform are not to exceed a geometric mean of 200 per 100 mL based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. Should water quality and sanitary studies show fecal coliform levels from non-human sources exceed 200/100 mL (geometric mean), occasionally then the allowable geometric mean fecal coliform shall not exceed 500 per 100 mL in free-flowing freshwater streams.

For the months of November through April, fecal coliform not to exceed a geometric mean of 1,000 per 100 mL based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 mL for any sample. The State does not encourage swimming in surface waters since many factors which are beyond the control of any State regulatory agency contribute to elevated levels of fecal coliform.

Section 2 - Watershed Characterization

COSS and its tributaries are in the Upper Chattahoochee River Watershed (HUC03130001) **(Figure 2- 1**). The purpose of this document is to identify the current conditions of the identified waters listed as impaired on the Federal Clean Water Act 303(d)/305(b) list of impaired streams. These five streams include portions of Nancy Creek, Crooked Creek, Ball Mill Creek, Marsh Creek and Long Island Creek located within the jurisdictional area of the City of Sandy Springs. Most of these impaired streams are listed for violation of the water quality criteria for fecal coliform bacteria and fish biota impairment.

2.1 Land Use

The COSS area watershed land use is categorized primarily as medium to high density residential land use. Commercial and industrial properties are located along the major corridor of Interstate 285, Georgia 400 and Roswell Road. The Atlanta Regional Commission Research & Analytics Division has developed a generalized landcover database designed for regional planning with a land use component used for forecasts and modeling. The 2010 land pro data is provided in **Figure 2-2**. **Table 2-1** summarizes the land use cover acres as a percent of the COSS watersheds.

Table 2-1 COSS Land Cover

Land Cover	Acres	% Acres
AGRICULTURE	12.84	0%
CEMETERIES	130.66	0%
COMMERCIAL	2,419.05	7%
FOREST	1,922.38	5%
GOLF_COURSES	590.61	2%
IND/COM	59.39	0%
INST_INTENSIVE	656.04	2%
LTD_ACCESS	4,483.21	12%
PARKS	137.61	0%
RES_HIGH	324.39	1%
RES_LOW	9,461.86	26%
RES_MED	11,495.10	32%
RES_MULTI	2,466.97	7%
RESERVOIRS	78.83	0%
RIVERS	1,257.32	3%
TCU	33.64	0%
TRANSITIONAL	245.80	1%
URBAN_OTHER	35.39	0%
WETLANDS	163.18	0%
Total	**35,974.25**	**100%**

The level of watershed imperviousness has long been linked to impacts on changes in hydrologic characteristics that lead to increased intensity and frequency of peak stormwater flows, which impacts stream stability, water quality, and aquatic habitat and biotic community integrity. In general, the most sensitive aquatic organisms are impacted at impervious levels greater than 10 percent. Between 11 and 25 percent most stream communities become impacted, and above 25 percent streams are generally no longer able to support viable biotic communities (Schueler, 2001). The

COSS watershed area has an effective impervious area (EIA) range of 15% to 20% percent. The effects of the Interstate 285 and Georgia 400 transporation corridors are apparent in contributing to imperviousness of the COSS watersheds.

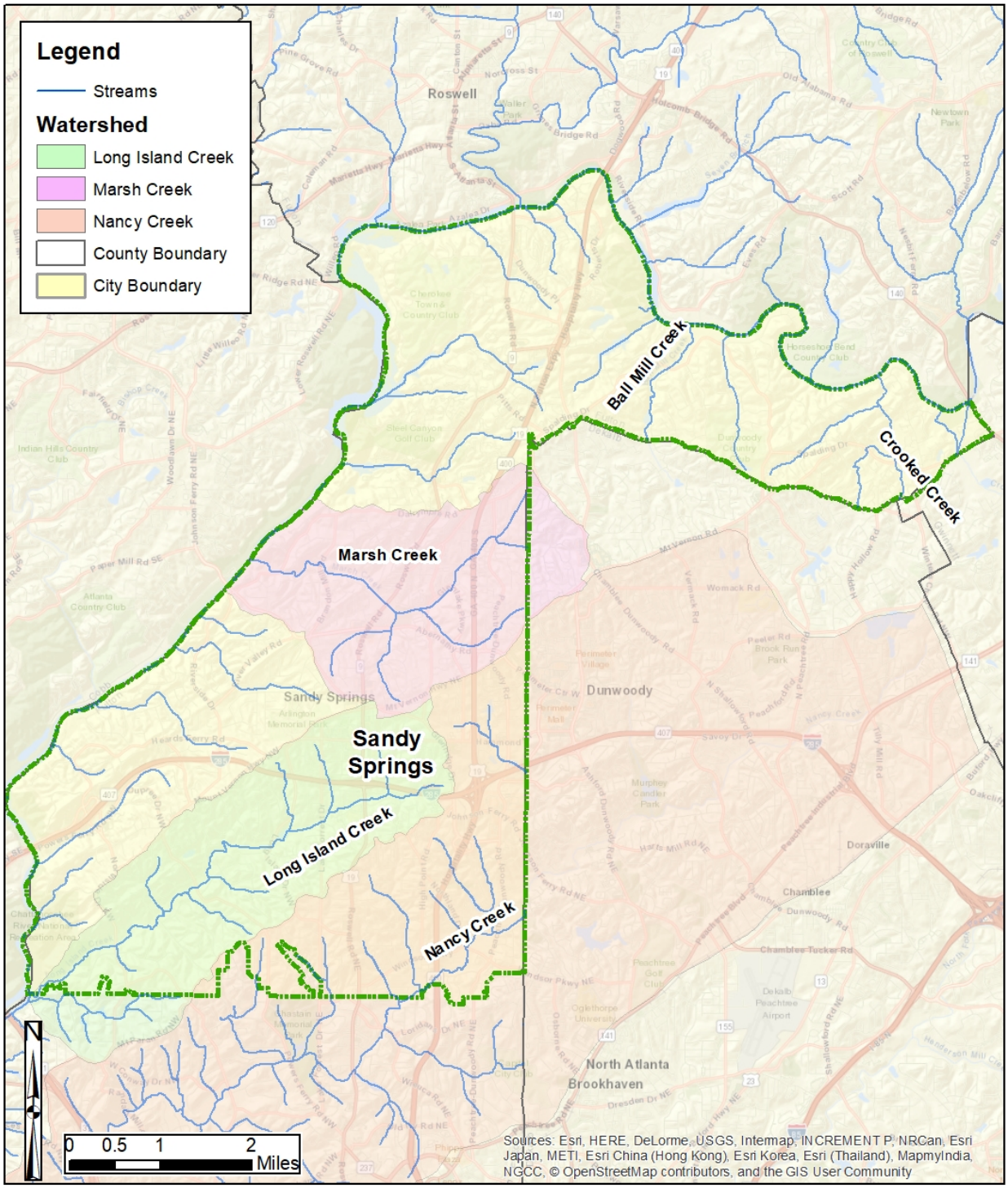
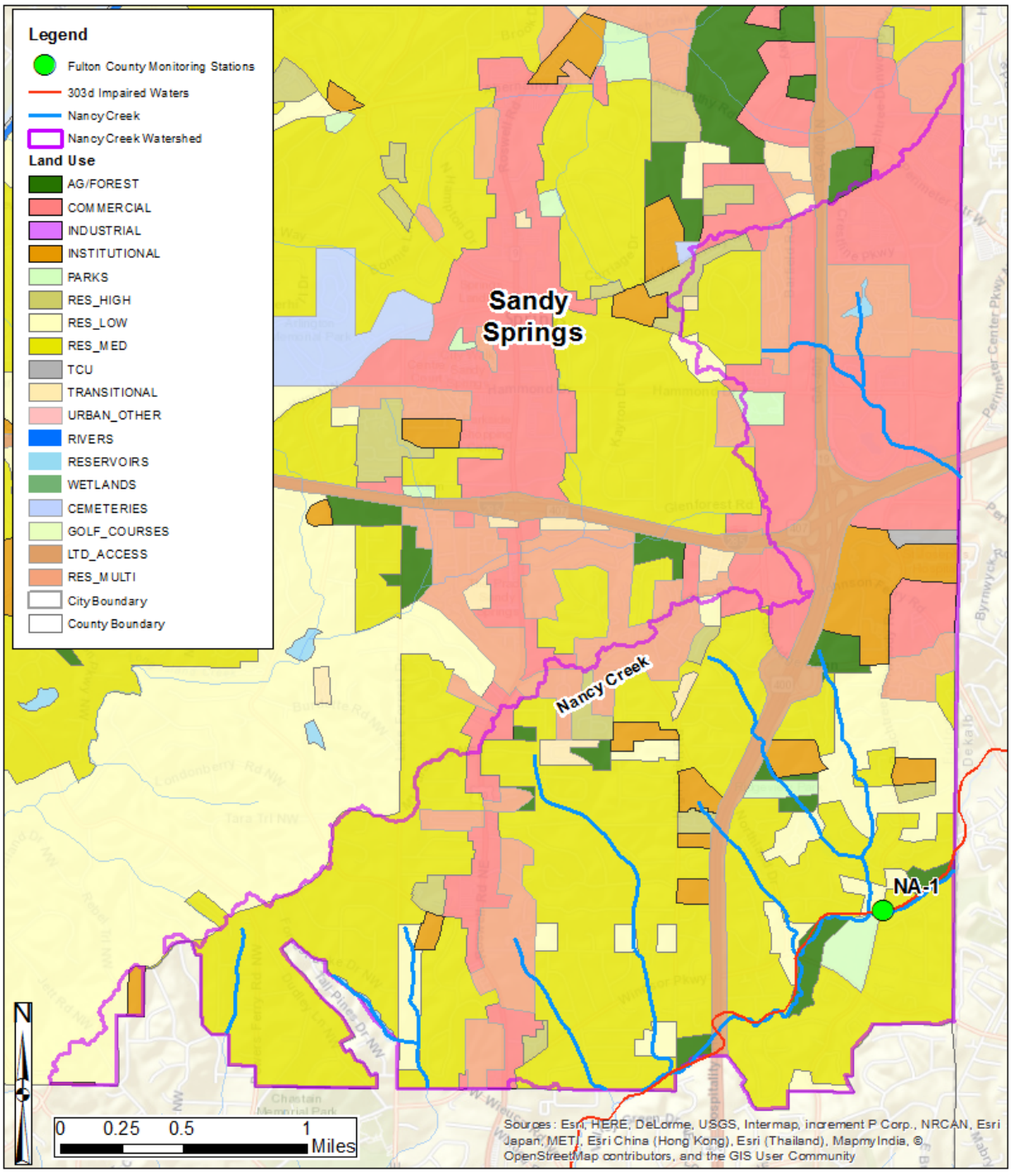


Figure 2-1 – Sandy Springs Watersheds



Nancy Creek
Existing Land Use

Figure 2-2 – COSS Watersheds Existing Land Use

2.2 Identify Causes and Sources of Pollution

COSS streams listed on the 2016 Georgia 305(b)/303(d) list of impaired streams were targeted for stream assessments. The listing of these streams is a result of elevated levels of bacteria and sediment that impairs fish habitat. The listings identify urban runoff as potential pollutions sources. Urban runoff contains high volume and high velocity of surface water entering the stream.

The Georgia Environmental Protection Division (EPD) has established a Total Maximum Daily Load (TMDL) for bacteria for each of the listed streams. The TMDL is identified by Georgia EPD. The TMDL identifies the load allocation for bacteria and the waste load allocation from stormwater management. The current load is estimated to be greater than the established TMDL and therefore reduction goals are recommended. The TMDLs prepared for the US Environmental Protection Agency (EPA) identified stormwater runoff and urban development as potential pollutant sources. COSS conducted stream assessments in Nancy Creek, Crooked Creek, Ball Mill Creek, Marsh Creek and Long Island Creek to further characterize the watersheds and identify potential pollution sources. Details of the stream assessment by sub-watershed are included in Section 3 of this report. These streams are monitored for fecal coliform as shown in **Figure 2-3**. Crooked Creek and Nancy Creek are monitored by COSS and Ball Mill Creek, Marsh Creek and Long Island Creek are monitored by Fulton County.

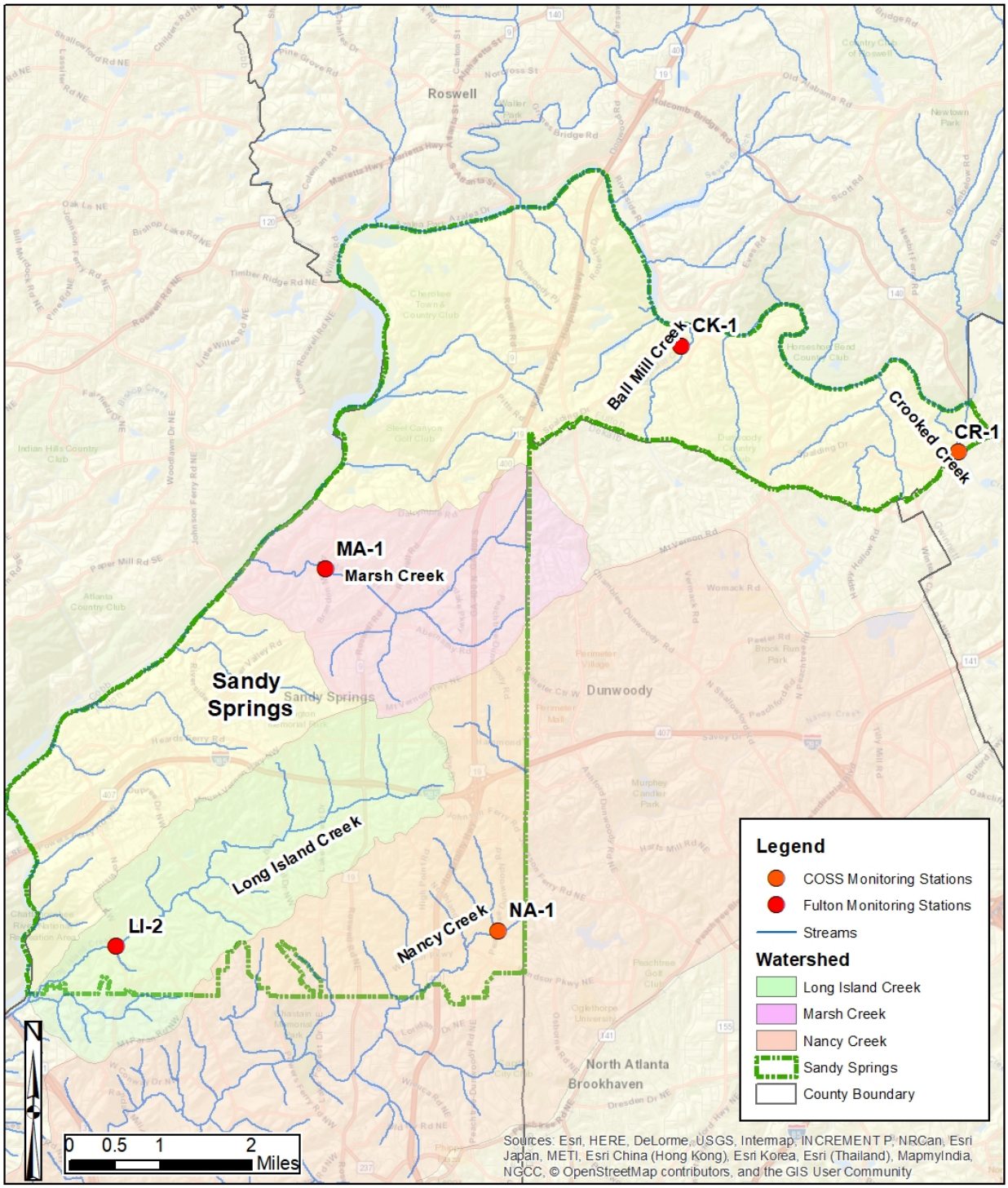


Figure 2-3 - COSS Watershed 303(d) Listed Water and Monitoring Location.

2.3 Environmental Data Review

An environmental data review is provided to identify potential sources of contamination. A search of the Georgia Department of Natural Resources (DNR) and EPA databases, including Comprehensive Environmental Response Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Information System (RCRIS/RCRA), Toxic Release Inventory (TRI), Air Facility System (AFS), Integrated Compliance Information System (ICIS), Georgia Environmental Information Management System (GEIMS) for underground storage tanks (UST) and leaking underground storage tanks (LUST) and Hazardous Waste databases[1] provide information on potential environmental pollutants. Source information consisted of Geographic Information Systems (GIS) data from both the DNR and EPA (**Figure 2-4**). This information is then cross-referenced with the EPA's Envirofacts Multisystem website which allowed for searching several environmental databases for facility information. This search is focused on CERCLA, RCRA, TRI, and hazardous waste sites located within the COSS watersheds.

Results of the evaluation identify two CERCLA list sites, one in Marsh Creek and one in Nancy Creek. Several RCRA facilities were identified within the COSS watersheds. RCRA facilities include car dealers, auto repair shops, paint stores, dry cleaners, chemical laboratories, car care companies, energy corporations, food and beverage industries etc. Seven Air Facilities (AFS) locations are identified in COSS watersheds. Seven NPDES facilities are identified in the COSS watersheds. Several facilities in COSS watersheds are identified on the ICIS database. These facilities have required environmental regulatory compliance in the past or are currently part of a compliance program. The following facilities are included on multiple databases and could be considered as watershed partners and stakeholders.

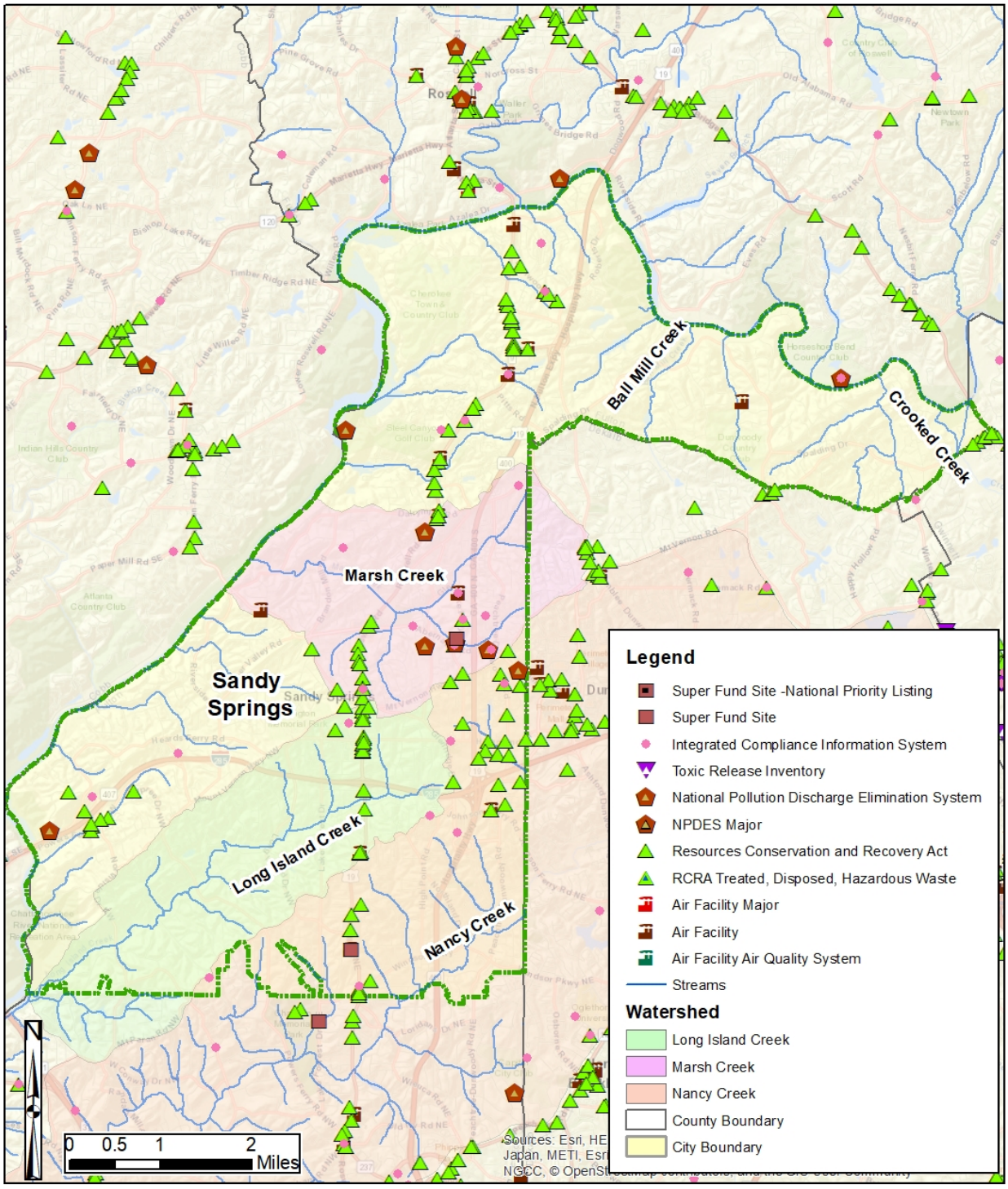


Figure 2-4 - COSS Area EPA listed Facilities

2.4 Sewer Line Inventory

Leaking sewer pipes can contribute to elevated levels of bacteria in streams. A review of the Fulton County sewer system using GIS mapping tools is conducted to locate sewer crossings within the COSS watersheds. **Figure 2-5** shows the sewer manholes located within the COSS watersheds. Fulton County provides sanitary sewer manhole locations within the COSS jurisdictional area. Most of the COSS watersheds consist of residential homes, commercial businesses and institutional schools that are connected to sanitary sewer. The Fulton County implements several programs to manage the sanitary sewer system and reduce the number of Sanitary Sewer Overflows (SSOs). Fulton County sanitary sewer programs include the CMOM program, Emergency Sanitary Sewer Evaluation Study (ESSES), Interim Collection System Master Plan, Sanitary Sewer Modeling, and Flow Monitoring.

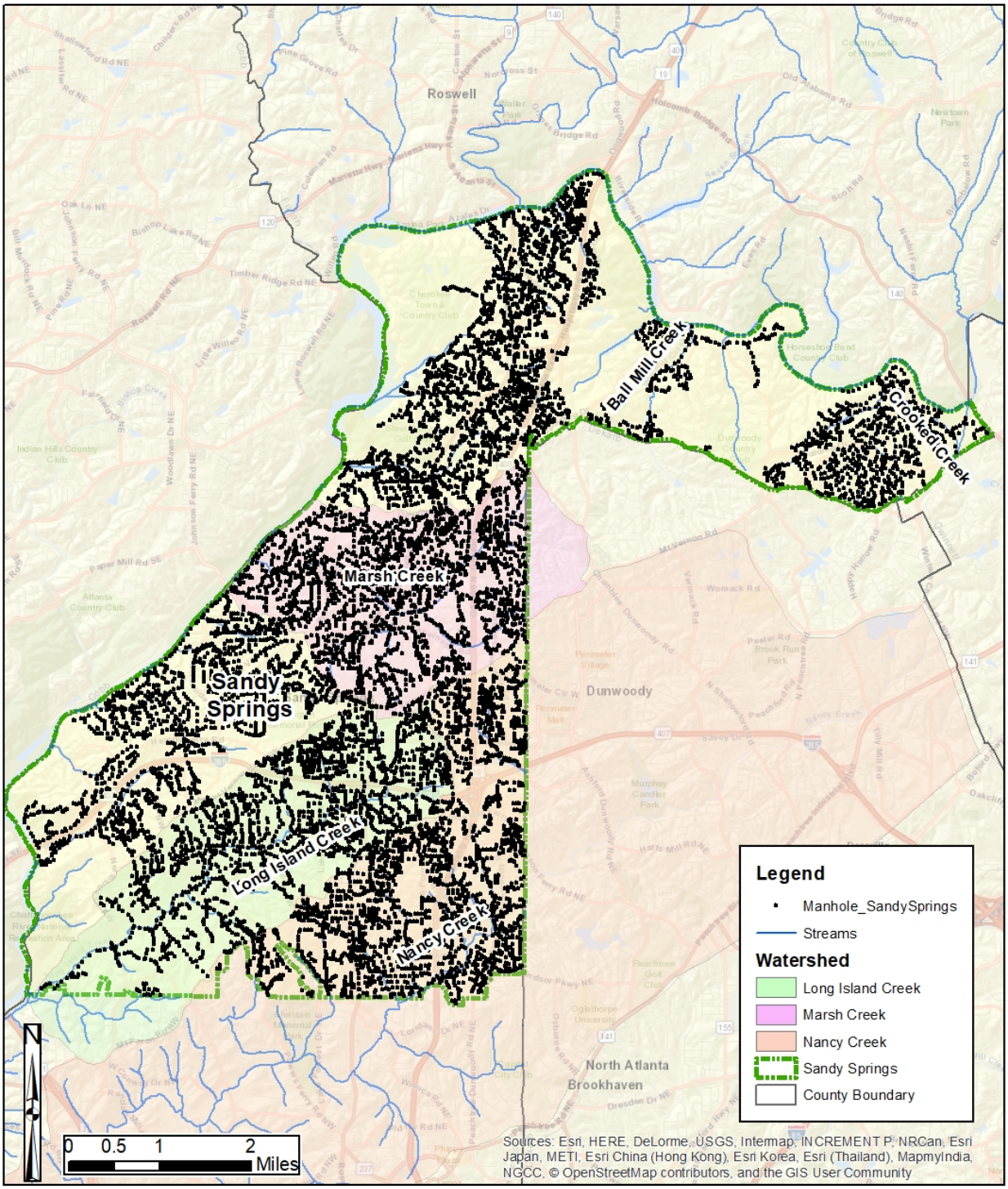


Figure 2-5 – COSS Area Sewered Areas Maintained by Fulton County

Section 3 – Stream Assessment

Stream assessments were conducted within COSS subwatersheds of Nancy Creek, Crooked Creek, Ball Mill Creek, Marsh Creek and Long Island Creek. Stream assessments allow for identification of areas for watershed improvement including stream bank erosion, stormwater runoff erosion, reduced buffer/clearing, potential point source pollution, nearby sewer/septic issues, heavy algae growth, livestock, vehicle crossings, debris, siltation, habitat reduction, sediment aggradation and surrounding land use as well as sites for potential projects and updated maintenance.

3.1 Stream Assessment Methodology

Stream inventory points are collected approximately every 500 feet and included evaluation of water quality from potential pollution sources (broken or leaking sewer lines, poor agricultural practices, illicit discharges, illicit dumping, confined animal areas, and suspect odors). Field staff gather information on each subwatershed to summarize stream conditions and maintenance issues.

Representative reach points are inventoried in each subwatershed which included cross-section measurements and physical characteristics of the stream which are used for habitat assessments. Sites are chosen such that each distinct subwatershed had at least one comprehensive habitat score for approximately each square mile of subwatershed area.

Cross sectional measurements included bankfull width and depth, floodplain width and depth, bank-top depth and width, bank slope in degrees, dominant and sub-dominant stream bed material and bank type. These measurements can be used to compute the entrenchment ratio and width-depth ratio, which are used in the Rosgen Stream Classification System. Habitat status can be assessed based on the Georgia Department of Natural Resources methodology using the collected surveyed condition of the stream and aquatic condition. This information is associated with each representative reach point and included in the GIS database CD for this study.

Maintenance points are inventoried in each subwatershed and are noted based on the conditions of assets including stormwater pipes, outfalls, sewer pipes, manholes and other issues. Most of these identified points are outfall locations or private water withdrawal locations that may require no action from the City or County. Maintenance Points (MP) are identified in the text as (MP #).

At each stream inventory point, four photographs are taken including, facing upstream and downstream of the channel, and left and right sides of the bank to represent the morphology of the stream. The pictures are provided in the GIS database CD and correspond with each stream inventory point. Stream inventory points are identified in the text as (Stream Point #). In some cases, the photos referenced within tables are those taken from the nearest stream point drop location and not at the exact location of the project type/conditions observed. Project types/conditions in these cases are along the last 500 feet (approximately) since the last drop point.

Results of the stream walks are provided in this report and accompanying CD. Each stream reach is surveyed and coded according to the methods provided. Field teams also identified pollutants (if present and detected), stream morphology, and overall bank conditions.

Point/Non-Point Inventory

Point Source Inventory. The summarization of potential point source pollutants follows the nomenclature used below:

- Septic Tank (ST). A septic discharge directly into or adjacent to the stream - gray water and strong fecal odor.
- Sewer Line or SSO (SL). A sewer line has ruptured or a man-hole is overflowing.
- Chemical Discharge (PC). Any chemical discharge into the stream. This would include permitted discharges such as WWTPs.
- Unknown Illicit Discharge (ID). Other discharges that cannot be readily identified in the field and do not fall in the above categories.

Non-Point Sources. During the stream walk evaluation, non-point sources are identified for their potential to cause water quality degradation. Non-point sources are documented using the following terms:

- Livestock (LS). Livestock have access to the stream or where runoff from active pastures directly enters the stream.
- Kennels/Domestic Animals (KD). Kennels or domestic animals near the stream
- Chemical Discharge (NC). Other chemical discharges that can be detected by smell or site, but point source is not readily present
- Urban Runoff (UR). Evidence of large overland flow events in the channel margin originating from upslope regions
- Agricultural Runoff (AR). Evidence of overland flow or ditch draining active agricultural fields for crops.

Channel Morphology

R2T gathered information from reaches where channel morphology has been altered due to direct or indirect anthropogenic causes.

Hydrologic Alterations. The following hydrologic alterations are identified during the COSS Stream Assessment:

- Channel incised (CI). The channel has cut-down into the stream bed and/or the stream is actively head-cutting.
- Channel widened (CW). The channel has widened out or is in the process of widening, which is characterized by large point bars, fallen trees, and/or bank erosion.
- Channel incised and widened (IW). The channel has incised and widened.
- Channel aggraded (CA). The channel bed has built-up near the top of the channel, and is characterized by deep sand deposits.
- Drainage ditch (DD). A lateral drainage swale draining into the stream channel that is causing scour and/or erosion into the channel or at the confluence with the channel.

Man-made Alterations: In addition to the evaluation of hydrologic alterations, the following are inventoried:

- Channelized reach (CR). Straightened/dredged sections of the channel and/or areas where the channel has been relocated.
- Piped reach (PR). Sections of the stream that have been piped over long distances.
- Rip-rap channel (RC). Areas where the channel or bank is lined with rip-rap, excluding sewer line crossings.

- Floodplain built-up (FB). Areas where the floodplain has been built up leaving the channel confined to a narrow valley.
- Concrete channel (CC). Reaches where the channel is now a concrete trapezoid, including concrete channels and concrete culverts under road crossing locations.

Stream Bank Evaluations

Stream banks were evaluated to identify bank erosion where channel morphology is altered due to direct or indirect anthropogenic causes. The following is documented during stream evaluations:

- Bank erosion percentage approximately every 500-ft. stream length (mild, moderate and high)
- Bank slope approximately every 500-ft. stream length
- Bank erosion length approximately every 500-ft. stream length
- Average bank height over length to nearest 0.5 ft.

In addition, the following buffer encroachment types are assessed and recorded:

- AG – Active pastures or croplands within the stream buffer;
- AU – Cleared/maintained utilities parallel to the stream and within the stream buffer;
- EU – Cleared/maintained utilities perpendicular to the stream;
- CG – Recently cleared and grubbed for development;
- IM – Impervious cover such as roads, sidewalks, buildings, or other structures;
- LA – Landscaping such as small planted shrubs and landscaping plants and/or mulched beds;
- LN – Grassed lawns; and
- OF – Pastures or old residential areas that are re-vegetating but not considered a forested riparian buffer.

Stream Geomorphology

The geomorphology of the channel is determined, and six stages are used for the stage classification of the channel:

- Stage One – Sinuous, pre-modified condition
- Stage Two – Channelized, initial disturbance
- Stage Three – Degradation, incision
- Stage Four – Degradation, incision and widening
- Stage Five – Aggradation or increase in land elevation due to the deposition of sediment and widening
- Stage Six – Quasi-equilibrium, new flood plain established

Structural Best Management Practices

Information is gathered by field investigations (when observed) on the following structural BMPs as noted.

- Dry Pond (DP). Detention basins intended to provide for the temporary storage of storm water runoff to reduce downstream flooding impacts.
- Wet Pond (WP). Detention basins that have a permanent pool of water.
- Constructed Wetlands (SW). These are shallow marsh systems designed to hold and treat stormwater. Large amounts of land are needed.

- Weir Structure (WS). A concrete, brick, or other hard structure that has been placed in the stream that allows base flows to pass through, but detains water in the channel during storm events.
- Off-channel Detention (OC): Forested areas that have space in the floodplain can be used for off channel storage.

Additional Stream Characteristics

Miscellaneous stream characteristics are noted during stream evaluations including:

- Reference reach (RR). A reach of stream where the channel morphology appears stable and what would be expected as typically characteristic of the subwatershed.
- Riparian preservation (RP). Areas of undeveloped land where the riparian buffer would be beneficial to protect.
- Debris dam (DD). A debris dam that completely blocks the channel to cause significant bank erosion and/or upstream sedimentation.
- Beaver dam (BD). Beaver dams are completely blocking the channel altering the hydrology and morphology of the channel.
- In-channel wetland (WI). A non-constructed wetland that is located within the channel, often resulting in a braided stream channel.
- Off-channel wetland (OW). A non-constructed wetland that is located adjacent to the stream channel. These are “backswamp” areas that appear to remain inundated most of the year.
- Water withdrawal (WW). Intake pipes and pumps are observed in the stream; these are most often where homeowners are withdrawing water from the creek for irrigation purposes.
- Backwater extent (BW). The upstream limit of the backwater/sedimentation zone due to downstream impoundments. This point marks a break in slope between a free-flowing channel and the backwater zone.
- Unusual/comment (UC). A problem or point of interest that does not fall in any of the defined categories. The field crews take detailed field notes when it is utilized.
- Invasive species (US). Dense stands of privet, kudzu, bamboo, or English ivy along the riparian corridor and/or Stream banks.

Maintenance Evaluations
Maintenance points are collected to provide a list of maintenance issues in the subwatersheds. These maintenance points are identified as (MP #) in the text. Appendix A includes an indexed list of all potential maintenance issues identified during the stream walk.

Conveyance System.
The evaluations included identifying issues with conveyance structures including:
- Type (Conv_Type). Closed conduit, ditch, stream, swale, or other.
- Shape (Conv_Shp). Round, boxed, rectangular, arched, elliptical, or other.
- Material (Conv_Mat). Reinforced concrete pipe, Bitum. Coated pipe, HDPE, CMP, PVC.
- Aluminized steel, ductile iron, aluminum, cast iron, clay, tile, truss, brick, or other.
- Issue (Conv_Cause). Structure damage, ditch erosion, blockage, or scour around the conveyance.

Ponds. Issues with ponds are documented using the following:
- Type (Pond_Type). Detention, underground, retention, water quality, reservoir, lake or wetland.
- Material (Pond_Mat). Earthen or hard material.
- Size (Pond_Sz). Less than an acre, 1 to 3 acres, 3 to 5 acres, 5 to 10 acres, or greater than 10 acres.
- Issue (Pond_Cause). Pond inlet, outlet control structure, spillway, stream outlet stability, litter, clogging, vegetation, sedimentation, slope erosion, or bank integrity.

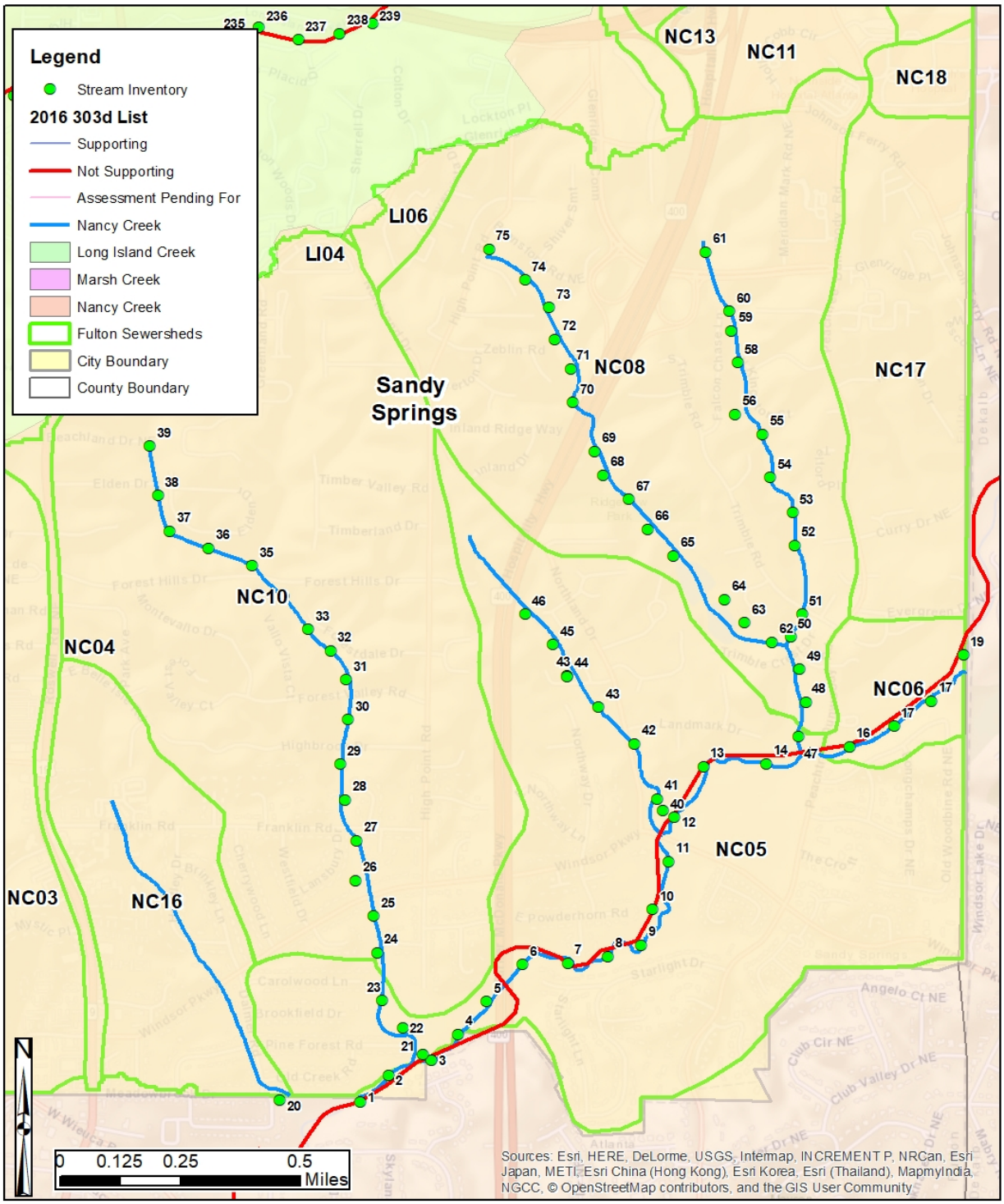
Structures. Issues with structures are documented according to the following:
- Type (Struct_Type). Catch basin, junction box, headwall, intersection, drop inlet, flume, control structure, standpipe, plain pipe end, trench drain, bridge, manhole, spillway, and other.
- Shape (SW_Shape). Left side, right side, 4x4 MH LID, flared end section, spillway, winged grated inlet, raised inlet, orifice, v-notched, broad crested, or other.
- Issue (Struct_Cause). Damage, separation, sediment/vegetation/debris blockage, scour, undermined, missing, or outlet stability.

3.2 Stream Assessment Results

Stream Assessments included the survey of the subwatersheds located in COSS jurisdictional area including the sewer area subwatersheds. The subwatershed environmental summaries are described below in detail. Maintenance points are inventoried in each subwatershed and are identified in the text as (MP #) and listed in **Appendix A**. Stream inventory points are identified in the text as (SPID #). **Figure 3-1** identifies all the stream assessment points collected during stream walks conducted during the fall of 2017. **Figure 3-2** identifies all the Nancy Creek representative reach points collected during the stream assessment. **Figure 3-3** and **Figure 3-4** identifies all the potential maintenance points and potential maintenance types collected during stream the stream inventory of Nancy Creek.

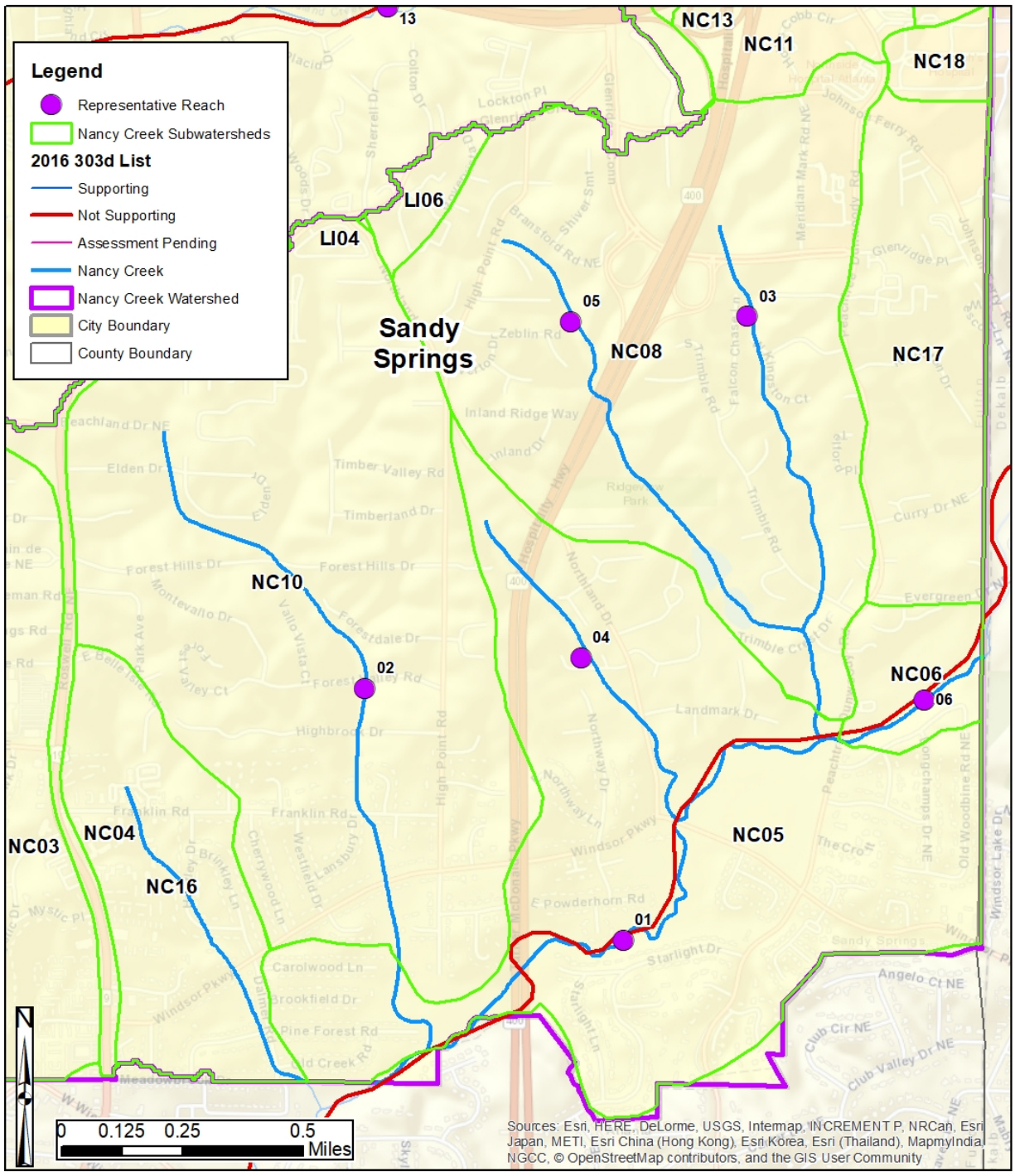
Nancy Creek

The overall Nancy Creek watershed area is categorized mostly as medium density residential properties to the north and south of the main stem. Nancy Creek headwaters are in DeKalb County to the east. Nancy Creek flows south and west into the City of Atlanta near Wieuca Road.



City of Sandy Springs
Stream Assessment

Figure 3-1 Nancy Creek Inventory Points



Nancy Creek
Representative Reach Locations

Figure 3-2 Nancy Creek Representative Reach Points

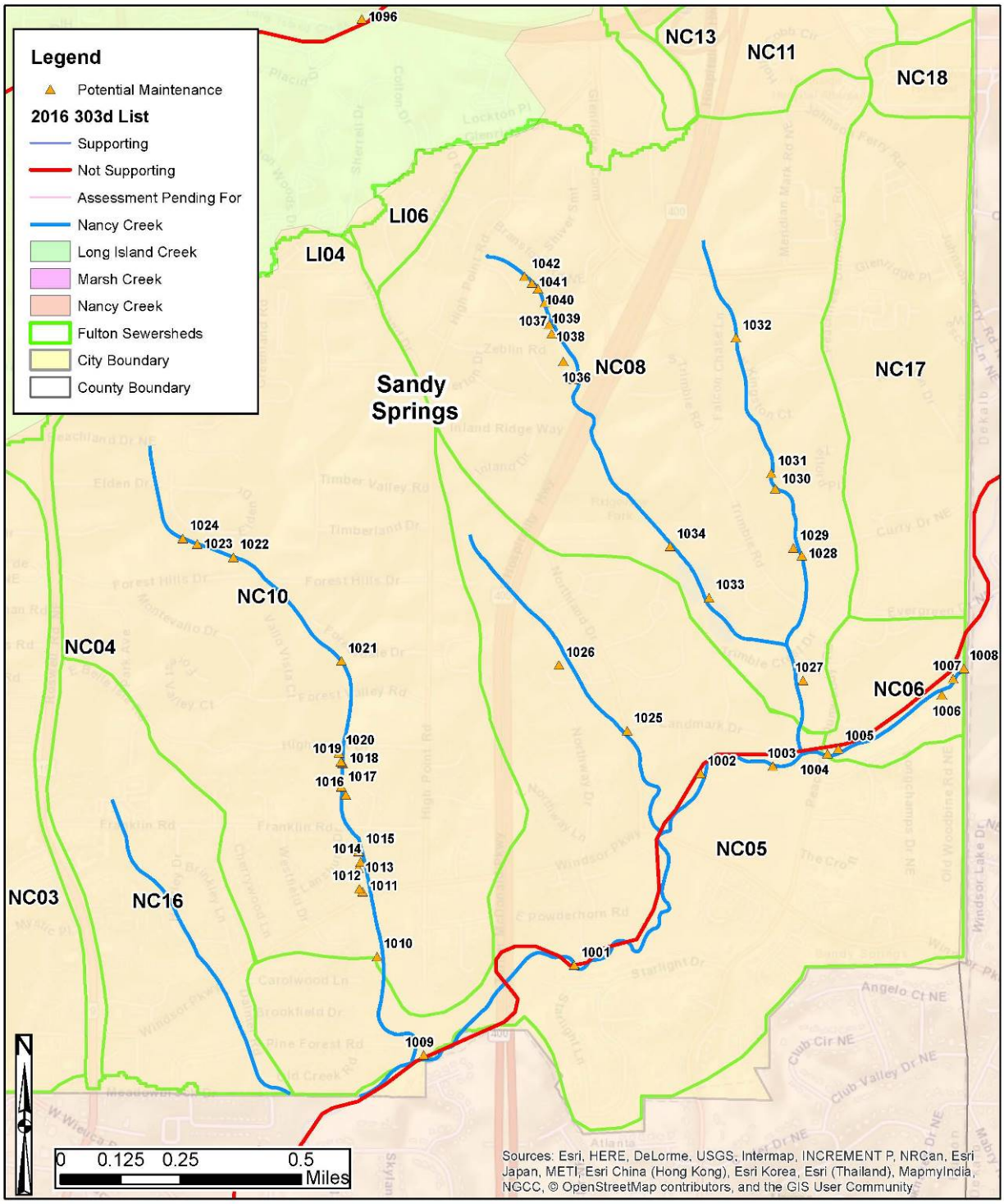


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Figure 3-3 Nancy Creek Potential Maintenance Points

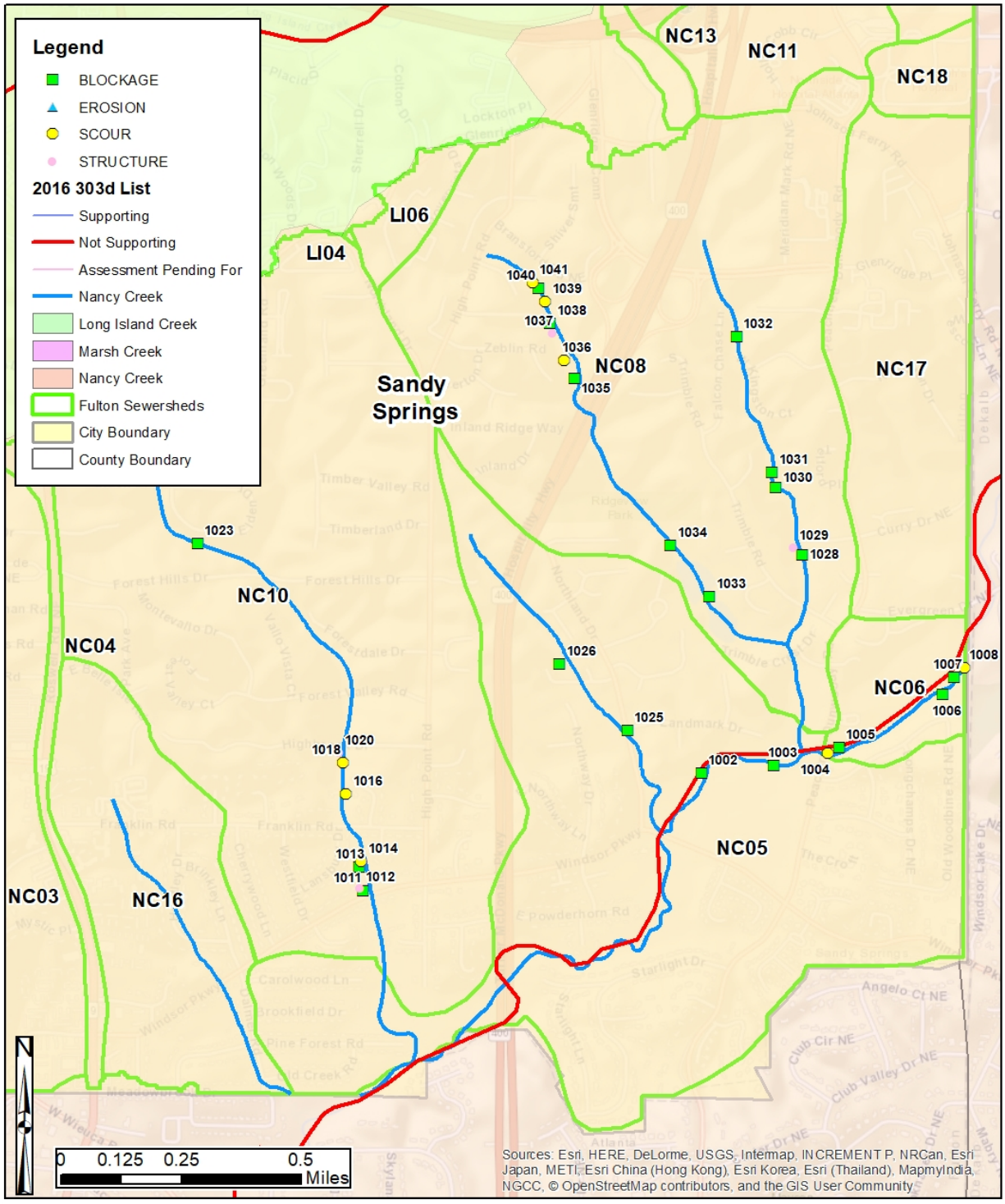

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Figure 3-4 Nancy Creek Potential Maintenance Type Points

Nancy Creek - Subwatershed NC05,

Subwatershed NC05 represents the most downstream portion of main stem of Nancy Creek within COSS jurisdiction. One unnamed tributary to the north joins with Nancy Creek near Windsor Parkway. Georgia 400 crosses Nancy Creek between Wieuca Road and Windsor Parkway. The remaining subwatershed area is considered medium density residential. The main stem of Nancy Creek from north of Wieuca Road to Peachtree Dunwoody Road is categorized as an aggraded (Stage Five) stream with channel incision and widening for most of the stream (**Figure 3-5**). The stream bed material is mostly silt and sand. Mild to moderate erosion is observed throughout the length of this reach. Mixed hard wood trees including water oaks, maple, poplar, and pine trees dominate the buffer zone in the Nancy Creek watershed. Significant amounts of Chinese privet, river cane, and briar are found growing near or on the stream bank. Debris dams were identified in multiple locations within the subwatershed reducing stream assessment access and collecting vegetation and trash debris (Maintenance Point (MP#1002, MP#1003). Debris dams can contribute to sewer line breaks in aerial sewer crossings. Stream inventory points collected in subwatershed NC05 ranged from SPID#1-SPID#15.

Figure 3-5 Main Stem Nancy Creek in Subwatershed NC05 at MP#1003.

Nancy Creek - Subwatershed NC06,

Subwatershed NC06 represents the small portion of Nancy Creek between Peachtree Dunwoody Road and the city limits. The subwatershed area is characterized as medium density residential properties. The main stem of Nancy Creek from Peachtree Dunwoody Road and the city limits Road is categorized as an aggraded (Stage Five) stream with channel incision and widening for most of the stream (**Figure 3-6**). Localized scour was identified in two sections (MP#1004 and MP#1008). A sewer crossing at MP#1008 shows corrosion and sag. The stream bed material is mostly sand. Moderate erosion is observed throughout the length of this reach. Stream buffers in this area included mixed hard wood trees including water oaks, maple, poplar, and residential lawns. Several fallen trees were identified in this subwatershed. Stream inventory points collected in subwatershed NC06 ranged from SPID#16- SPID#19.

Figure 3-4 Main Stem Nancy Creek in Subwatershed NC06 (MP#1008)

Nancy Creek - Subwatershed NC10,

Subwatershed NC10 represents the tributary to Nancy Creek within COSS from the confluence with Nancy Creek north to Glenridge Drive between Roswell Road to the west and Georgia 400 to the east. The subwatershed area is characterized as medium density residential to high density residential near Roswell Road. The tributary in this subwatershed is categorized as a Stage Five stream with degradation, channel incision, and widening for most of this stream segment. The stream bed material is mostly sand and silt. Mild erosion is observed throughout the length of this reach. Debris dams (MP#1011) impact stream flows in this area (**Figure 3-6**). The stream assessment identified yard debris and waste in the stream near SPID#27 Stream inventory points collected in subwatershed NC10 ranged from SPID#21- SPID#31.

Figure 3-6 Debris Dam along the tributary in Subwatershed NC10 (MP#1011)

Nancy Creek - Subwatershed NC08,

Subwatershed NC08 represents a tributary of Nancy Creek between Georgia 400 to the west and Peachtree Dunwoody Road to the east. The subwatershed area is characterized by medium density residential properties, high density residential properties and hospital properties near Glenridge Connector and Johnson Ferry Road. Two tributaries branch from the main tributary within this subwatershed, a small tributary to the east that begins near Trimble Crest Drive and a larger tributary in the northwest of the watershed with its headwaters near the Georgia 400 and Interstate 285 interchange. These tributaries are categorized as an aggraded (Stage four) stream with channel incision and widening for most of the stream segment. The stream bed material is mostly silt and sand. Debris dams were identified in multiple locations throughout the subwatershed reducing stream assessment access and collecting vegetation and trash debris ((MP#1030-MP#1035, MP#1038, MP#1040) (**Figure 3-7**). Debris dams can contribute to sewer line breaks in aerial sewer crossings (MP#1035). Stream inventory points collected in subwatershed NC10 ranged from SPID#47- SPID#75.

Figure 3-7 Fallen tree along tributary to Nancy Creek in Subwatershed NC08 (MP#1035)

Crooked Creek and Ball Mill Creek

The small portion of Crooked Creek watershed within the COSS jurisdiction is the tailwater section of the Creek near the confluence with the Chattahoochee River near Spalding Drive. The land use in this area is medium density and high density residential and some commercial near Holcomb Bridge Road. The headwaters of Crooked Creek begin in Gwinnett County and flow north west into COSS. Ball Mill Creek originates within DeKalb County in the City of Dunwoody. The stream flows north into COSS to the confluence with the Chattahoochee River north of Spalding Drive. The predominate land use within the COSS portion of the watershed is low density residential. **Figure 3-8** identifies all the stream assessment points collected during stream walks conducted during the fall of 2017. **Figure 3-9** identifies the Crooked Creek and Ball Mill Creek representative reach points collected during the stream assessment. **Figure 3-10** and **Figure 3-11** identifies all the potential maintenance points and potential maintenance types collected during stream the stream inventory of Crooked Creek and Ball Mill Creek.

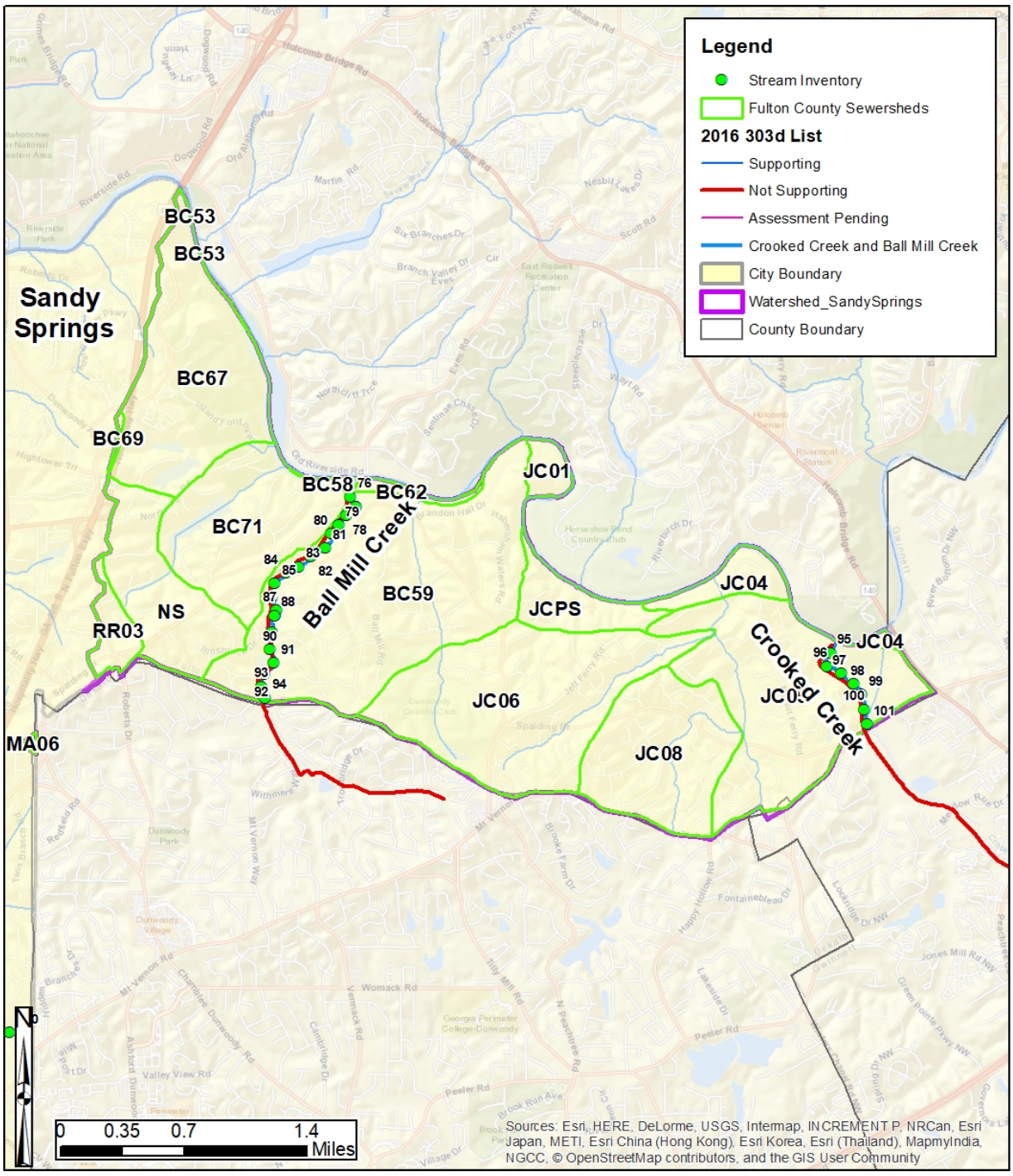
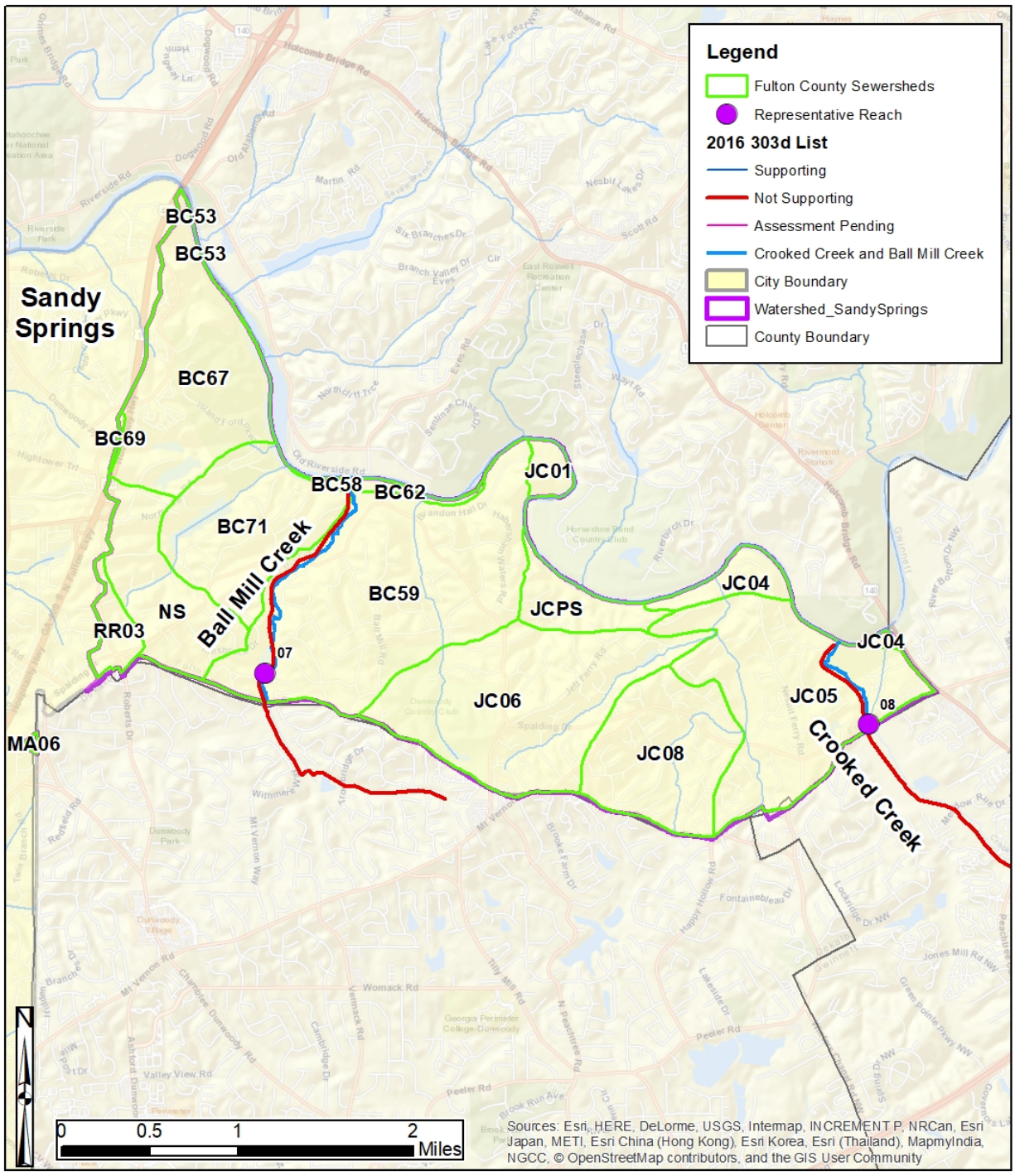


Figure 3-8 Crooked Creek and Ball Mill Creek Inventory Points



City of Sandy Springs
Stream Assessment

Figure 3-9 Crooked Creek and Ball Mill Creek Representative Reach Points

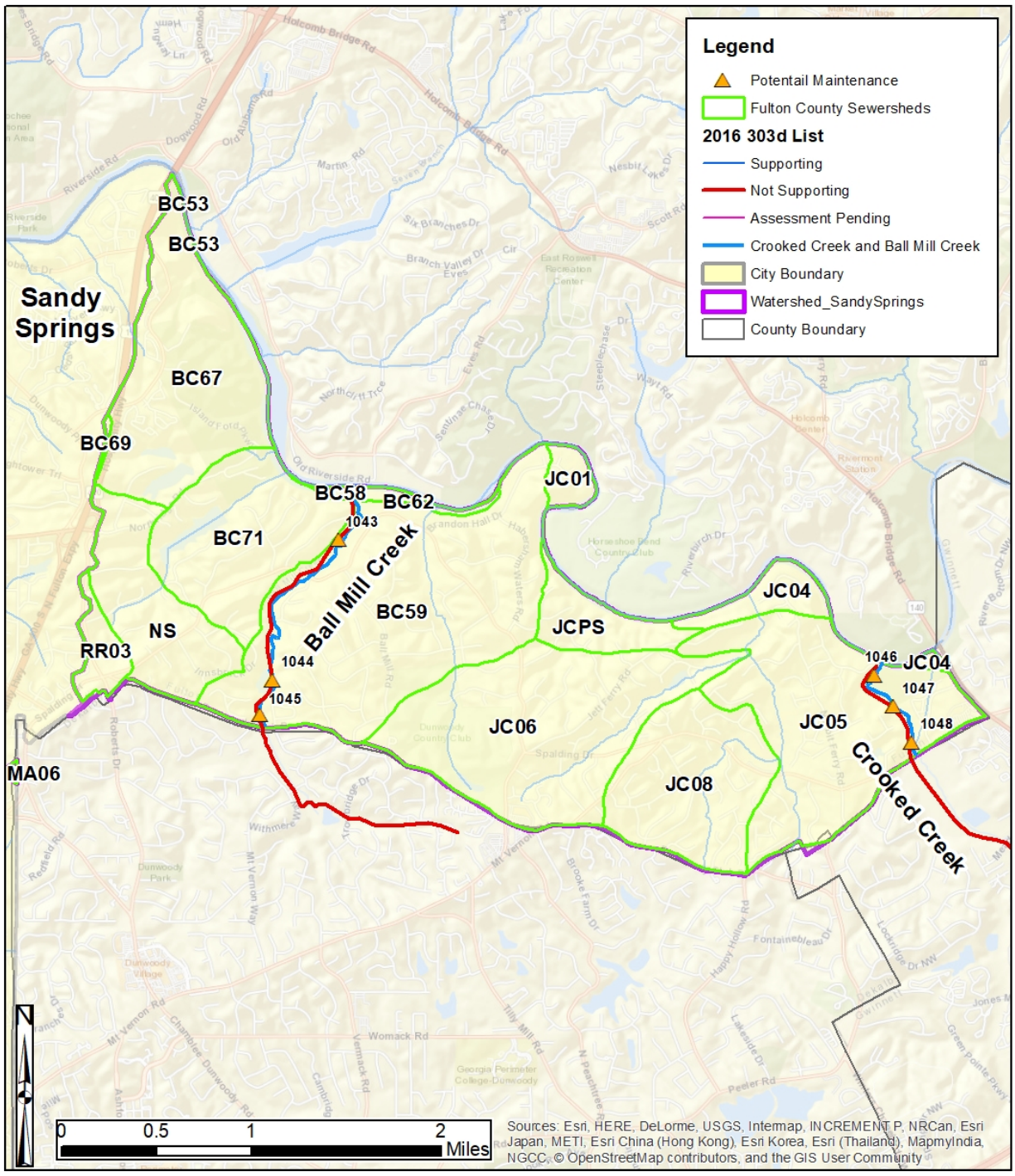


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Figure 3-10 Crooked Creek and Ball Mill Creek Potential Maintenance Points

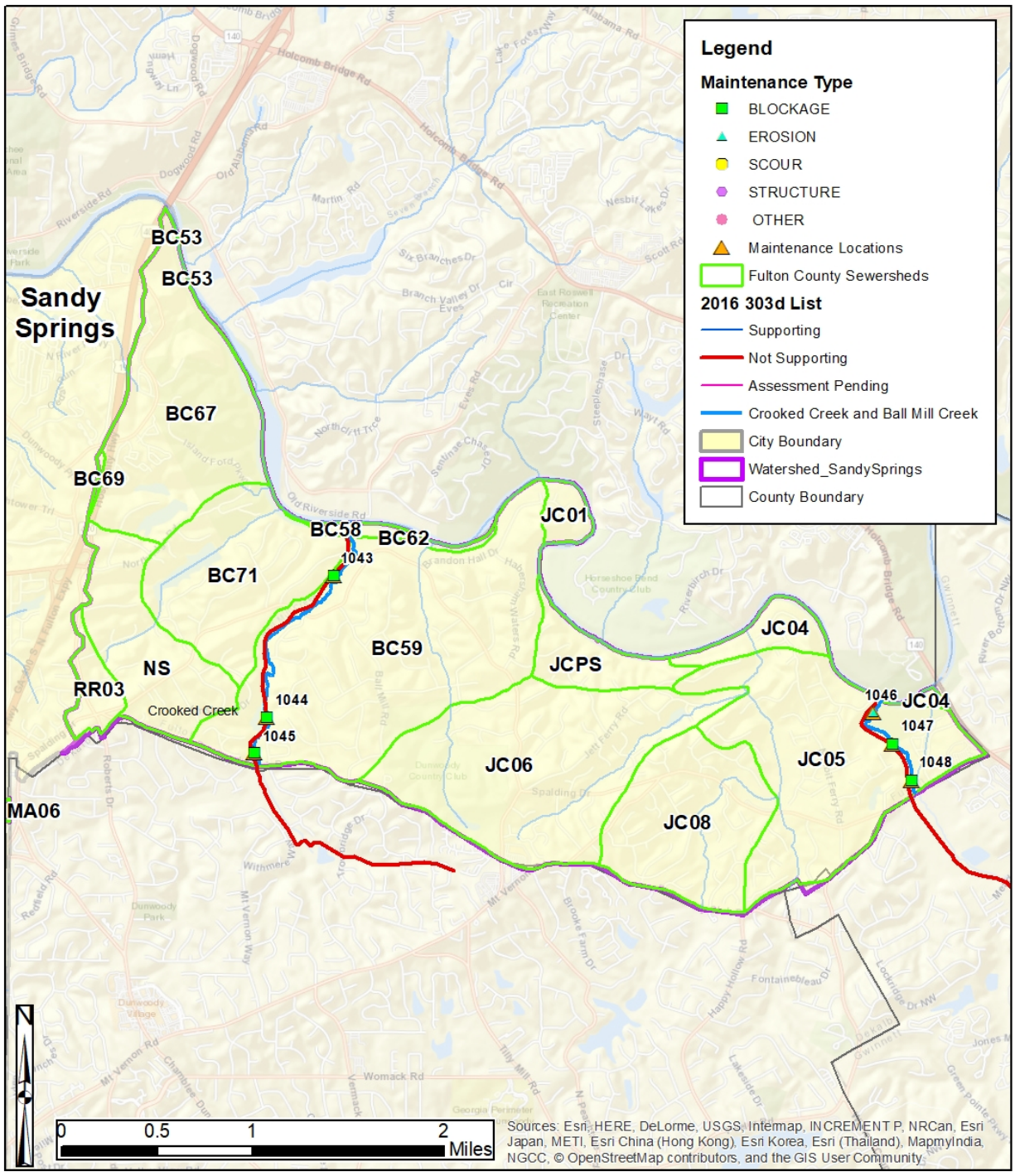

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Figure 3-11 Crooked Creek and Ball Mill Creek Potential Maintenance Type Points

Crooked Creek - Subwatershed JC05,
Subwatershed JC05 represents the tailwaters of Crooked Creek before the confluence with the Chattahoochee River in COSS. The subwatershed area is characterized by medium density residential properties. Crooked Creek from the City Limits to the confluence with the Chattahoochee River is categorized as an aggraded (Stage five) stream with channel incision and widening for most of the stream segment. The stream bed material is mostly silt and sand. Debris dams were identified in multiple locations throughout the subwatershed reducing stream assessment access and collecting vegetation and trash debris (MP#1046-MP#1047) (**Figure 3-12**). Stream inventory points collected in subwatershed JC05 ranged from SPID#95- SPID#101.

Figure 3-12 Crooked Creek Subwatershed JC05 (MP#1046)

Ball Mill Creek - Subwatershed BC59,

Subwatershed BC59 represents the tailwaters of Ball Mill Creek before the confluence with the Chattahoochee River in COSS. The subwatershed area is characterized by low density residential properties. Ball Mill Creek from the City Limits to the confluence with the Chattahoochee River is categorized as an aggraded (Stage four) stream with channel incision and widening for most of the stream segment. The stream bed material is mostly silt and sand. Debris dams were identified in multiple locations throughout the subwatershed reducing stream assessment access and collecting vegetation and trash debris (MP#1043-MP#1045) (**Figure 3-13**). Debris dams can contribute to sewer line breaks in aerial sewer crossings (MP#1044). Stream inventory points collected in subwatershed JC05 ranged from SPID#76- SPID#94.

Figure 3-13 Ball Mill Creek Subwatershed BC59 (MP#1044)

Marsh Creek

The Marsh Creek watershed is in the central portion of COSS jurisdiction. The headwaters of Marsh Creek originate in the City of Dunwoody in DeKalb County and flow west towards the confluence with the Chattahoochee River near Riverside Drive north of Johnson Ferry Road. The land use in this area is medium density with high density residential and commercial land use near Roswell Road and U.S. Route 19/Georgia 400. **Figure 3-14** identifies all the stream assessment points collected during stream walks conducted during the fall of 2017. **Figure 3-15** identifies all the Marsh Creek representative reach points collected during the stream assessment. **Figure 3-3** and **Figure 3-4** identifies all the potential maintenance points and potential maintenance types collected during stream the stream inventory of Marsh Creek.

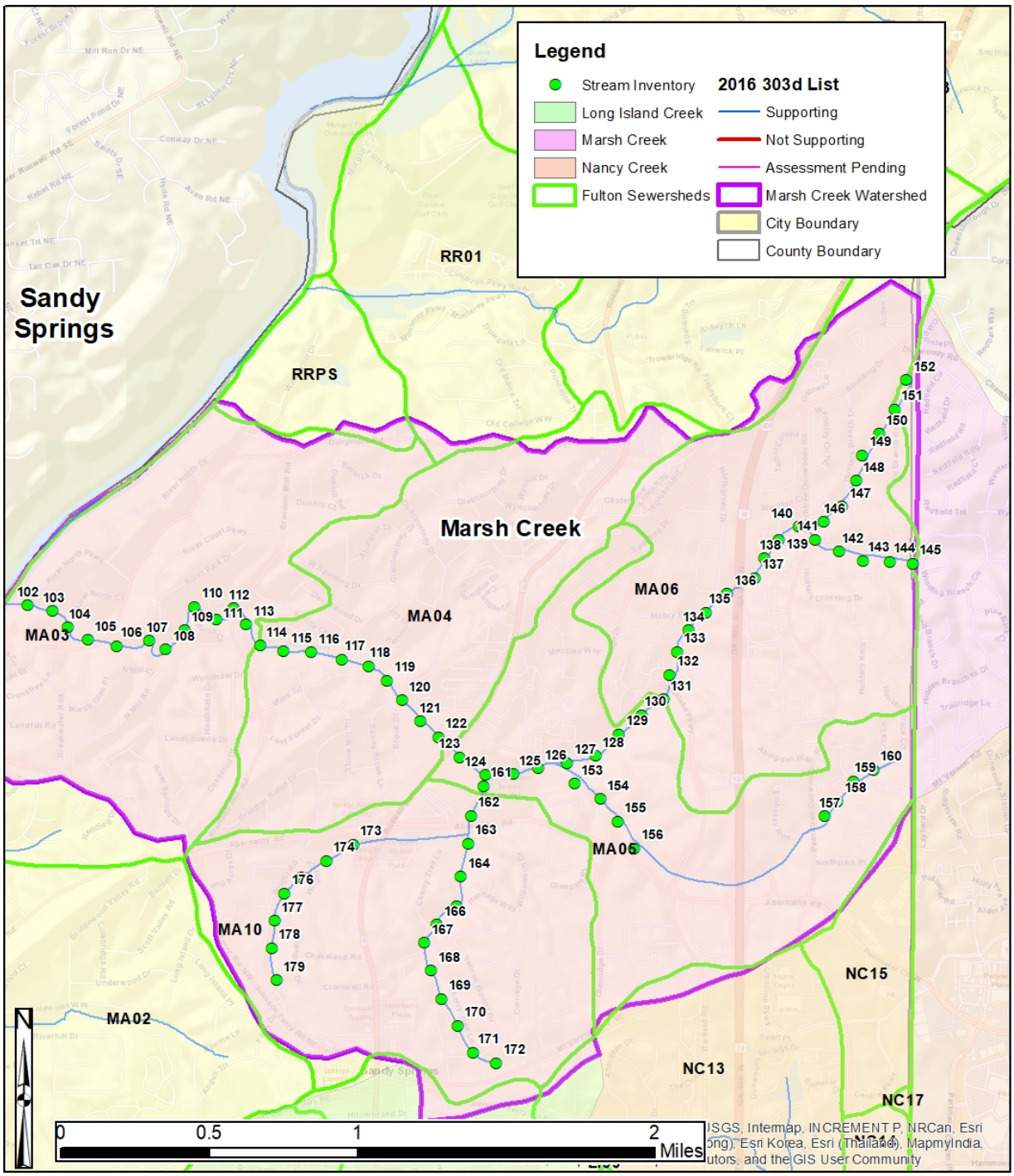

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Figure 3-14 Marsh Creek Inventory Points

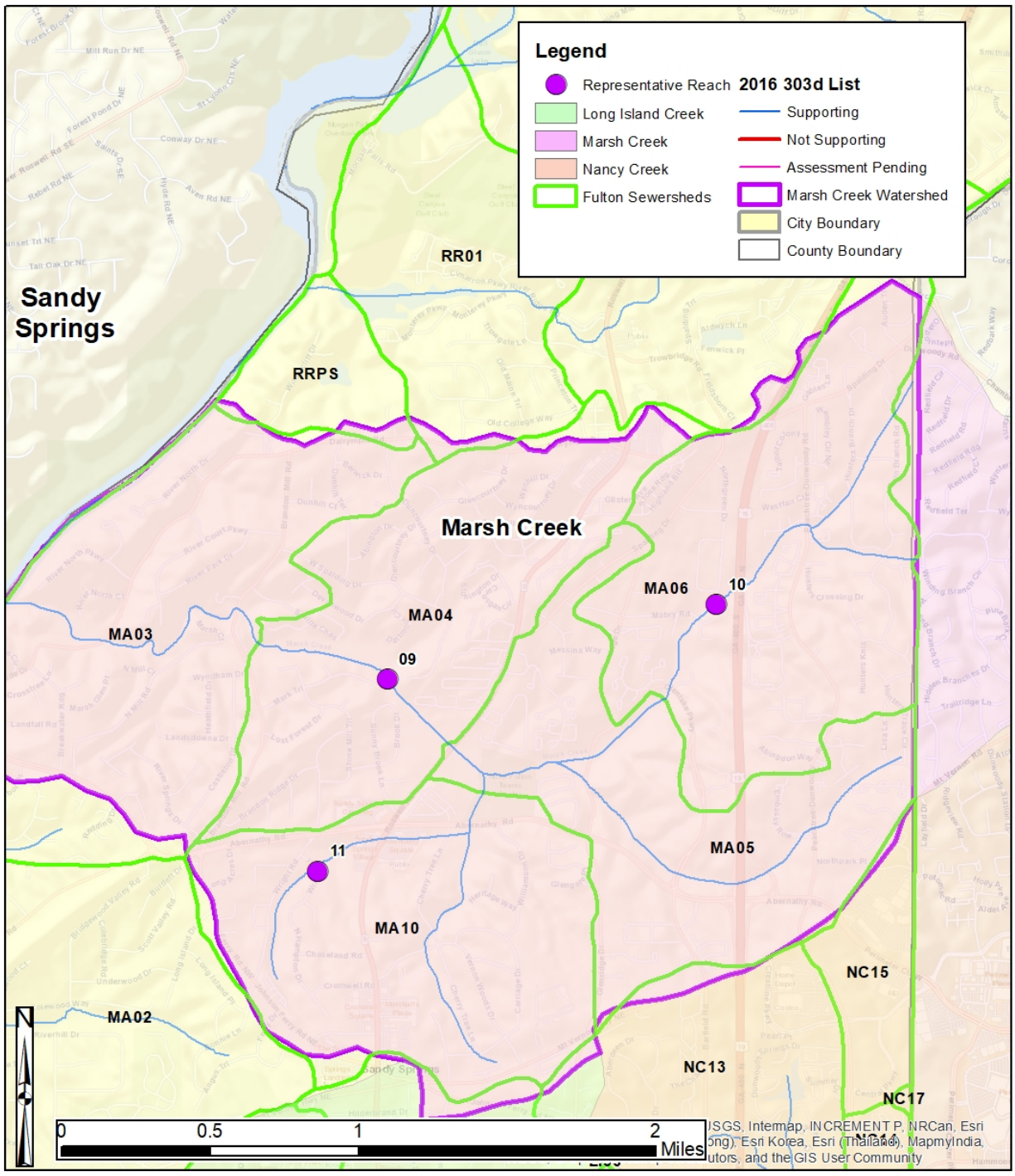
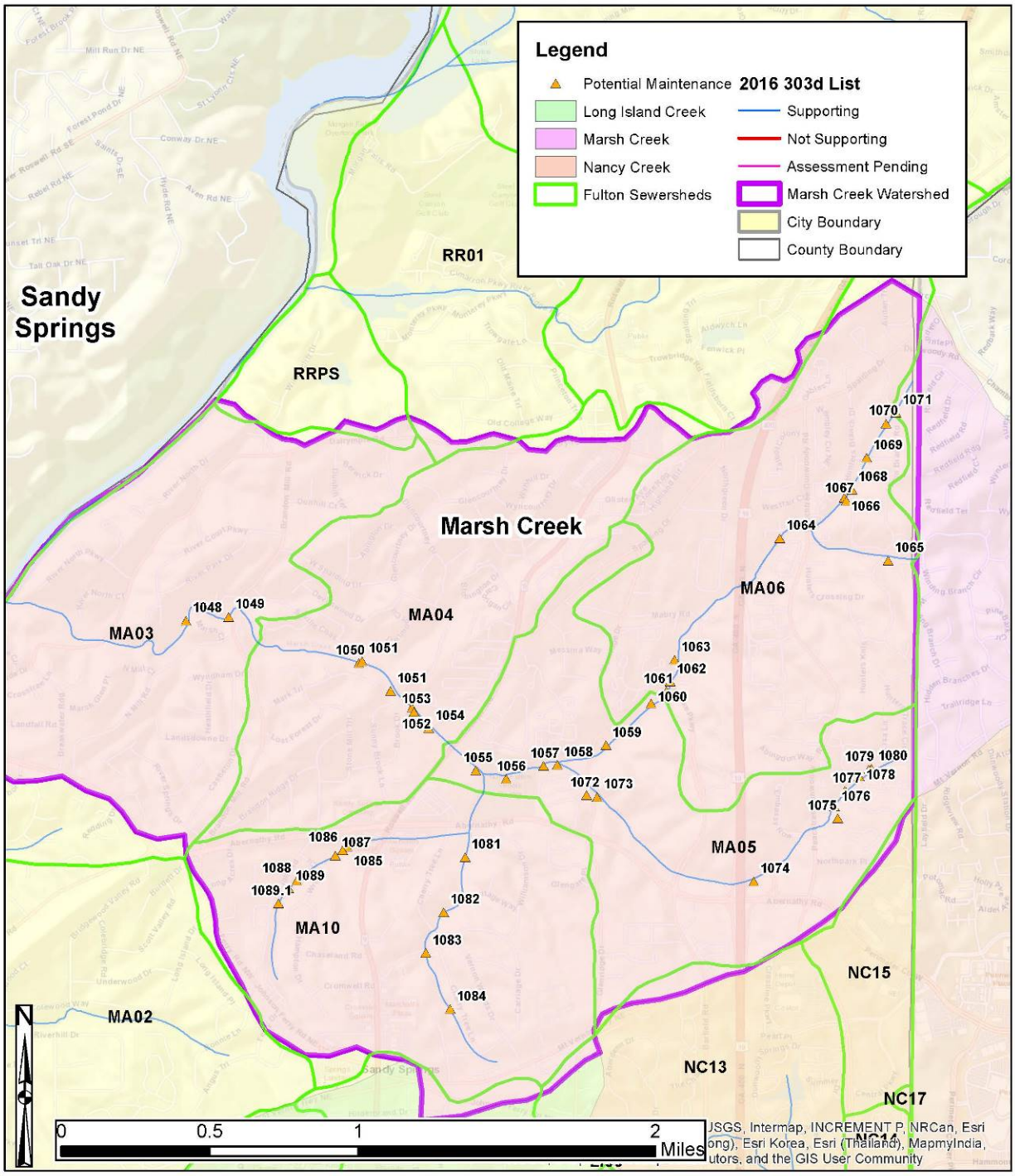


Figure 3-15 Marsh Creek Representative Reach Points



City of Sandy Springs
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Figure 3-16 Marsh Creek Potential Maintenance Points

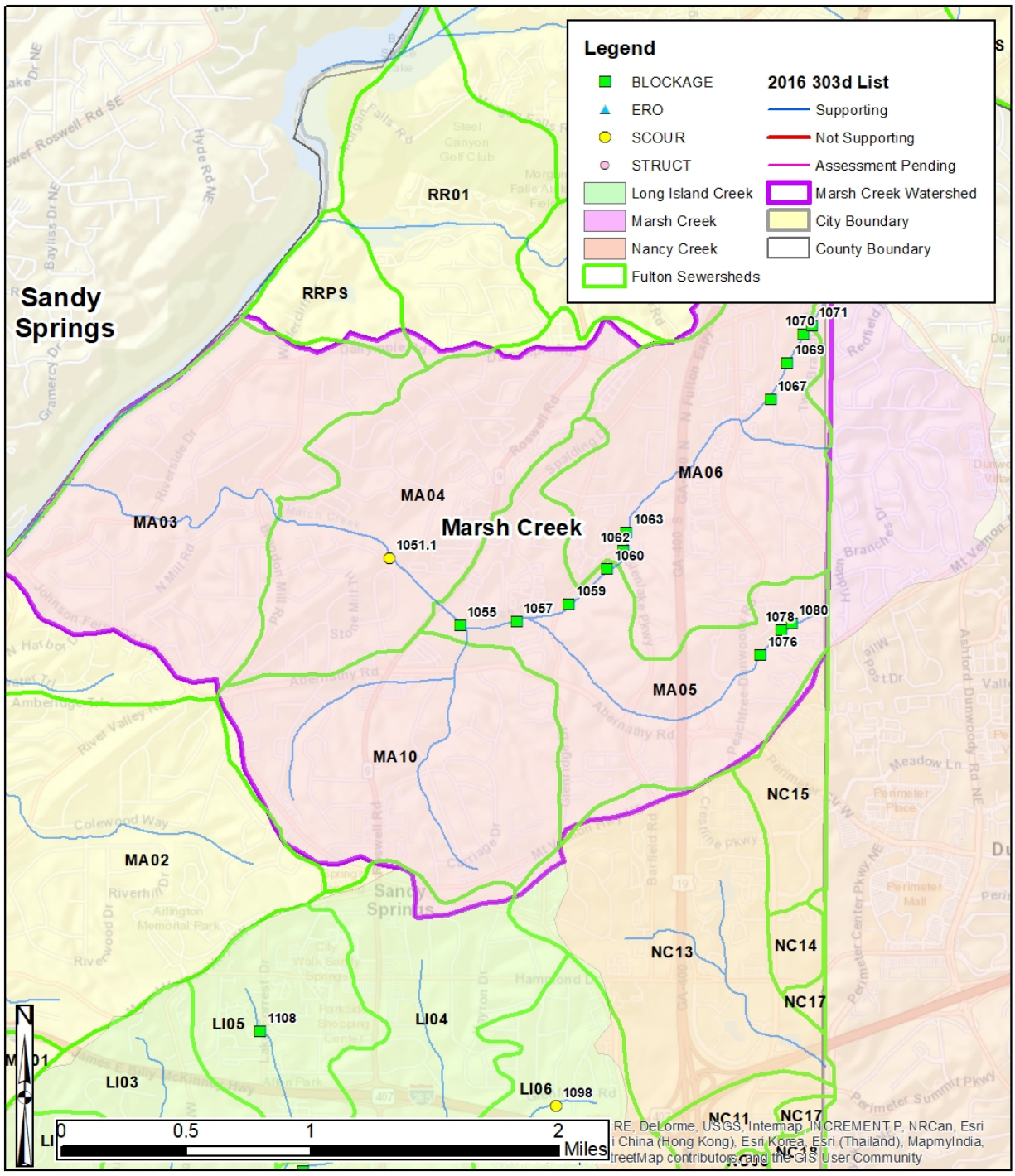

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Figure 3-17 Marsh Creek Potential Maintenance Type Points

Marsh Creek - Subwatershed MC03,
Subwatershed MC03 represents the downstream portion of the main stem of Marsh Creek within COSS. The subwatershed area is characterized by low density residential properties near Riverside Drive and Brandon Mill Road. The downstream portion of Marsh Creek from the Chattahoochee River to Riverside Drive is categorized as an aggraded (Stage five) stream with channel incision and widening for the majority of the stream segment. The stream bed material is mostly silt and sand. From Riverside Drive to Brandon Mill Road the stream segment is categorized as (Stage 2) stream with initial disturbance. The stream substrate in this area is cobble and boulders that are impacted less by high stream velocities. An exposed sewer crossing was in this section (MP#1049) (**Figure 3-18**). Stream inventory points collected in subwatershed MC03 ranged from SPID#102- SPID#113.

Figure 3-18 Sewer Crossing in Subwatershed MC03 (MP#1049)

Marsh Creek - Subwatershed MC04,

Subwatershed MC04 represents the main stem of Marsh Creek from Brandon Mill Road to Roswell Road/ State Route 9 within COSS. The subwatershed area is characterized by low density residential properties with high density residential properties near Roswell Road. This portion of Marsh Creek is categorized as an aggraded (Stage four and Stage five) stream with channel incision and widening for most of the stream segment. The stream bed material is mostly sand and silt. Fallen trees were observed near the sewer line (MP#1050) (**Figure 3-19)**. Stream inventory points collected in subwatershed MC04 ranged from SPID#114- SPID#122.

Figure 3-19 Sewer Crossing in Subwatershed MC04 (MP#1050)

Marsh Creek - Subwatershed MC05,
Subwatershed MC05 represents the main stem of Marsh Creek from Roswell Road/ State Route 9 to Glenridge Parkway NE within COSS. The subwatershed area is characterized by commercial properties. This portion of Marsh Creek is categorized as an aggraded (Stage five) stream with channel incision and widening for most of the stream segment. The stream bed material is mostly pebbles and sand. Fallen trees were observed near a storm water outfall (MP#1058) (**Figure 3-20)**. Stream inventory points collected in subwatershed MC05 ranged from SPID#123- SPID#129 and SPID#153-SPID#160 on the south tributary.

Figure 3-20 Stormwater Outfall in Subwatershed MC05 (MP#1058)

Marsh Creek - Subwatershed MC06,

Subwatershed MC06 represents the main stem of Marsh Creek from Glenridge Parkway NE to the City limits within COSS. This watershed also includes a small tributary north of the main stem near Peachtree Dunwoody Road. The subwatershed area is characterized by commercial properties. This portion of Marsh Creek is categorized as an aggraded (Stage four and Stage five) stream with channel incision and widening for most of the stream segment. A Fallen headwall is located near a double box culvert located at Glenridge Parkway NE (MP#1061) (**Figure 3-21)**. Stream inventory points collected in subwatershed MC06 ranged from SPID#130- SPID#152.

Figure 3-21 Glenridge Parkway Culvert and broken headwall in Subwatershed MC06 (MP#1061)

Long Island Creek

The Long Island Creek watershed within the COSS jurisdiction includes the headwaters of Long Island Creek near the Interstate 285 / Georgia 400 Interchange to the confluence with the Chattahoochee River just north of Interstate 75. The land use in this area is low density residential with commercial and high density residential along Roswell Road. The stream flows from northeast to southwest within COSS. **Figure 3-22** identifies all the stream assessment points collected during stream walks conducted during the fall of 2017. **Figure 3-23** identifies all the Long Island Creek representative reach points collected during the stream assessment. **Figure 3-24** and **Figure 3-25** identifies all the potential maintenance points and potential maintenance types collected during stream the stream inventory of Long Island Creek.

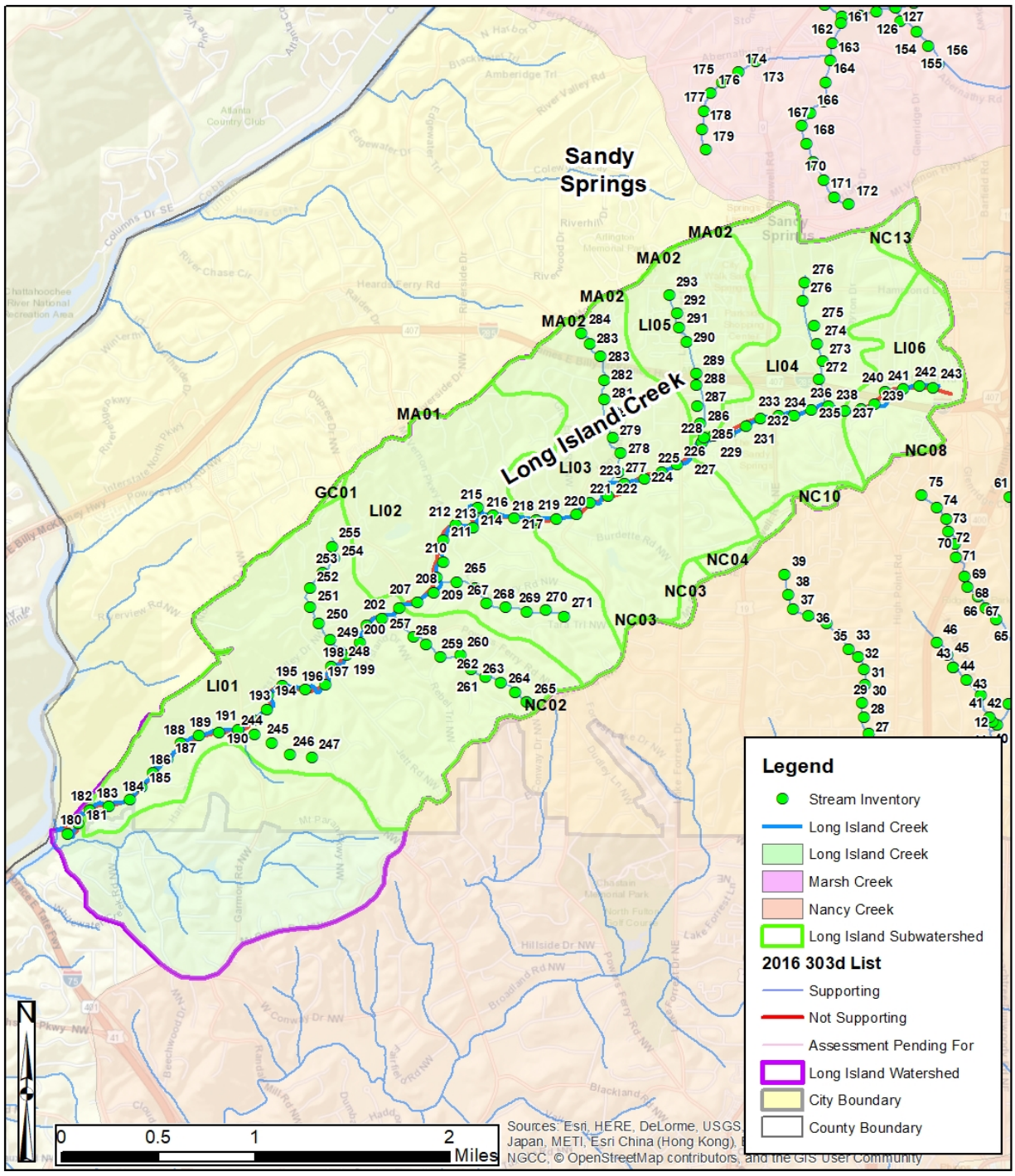

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Figure 3-22 Long Island Creek Inventory Points

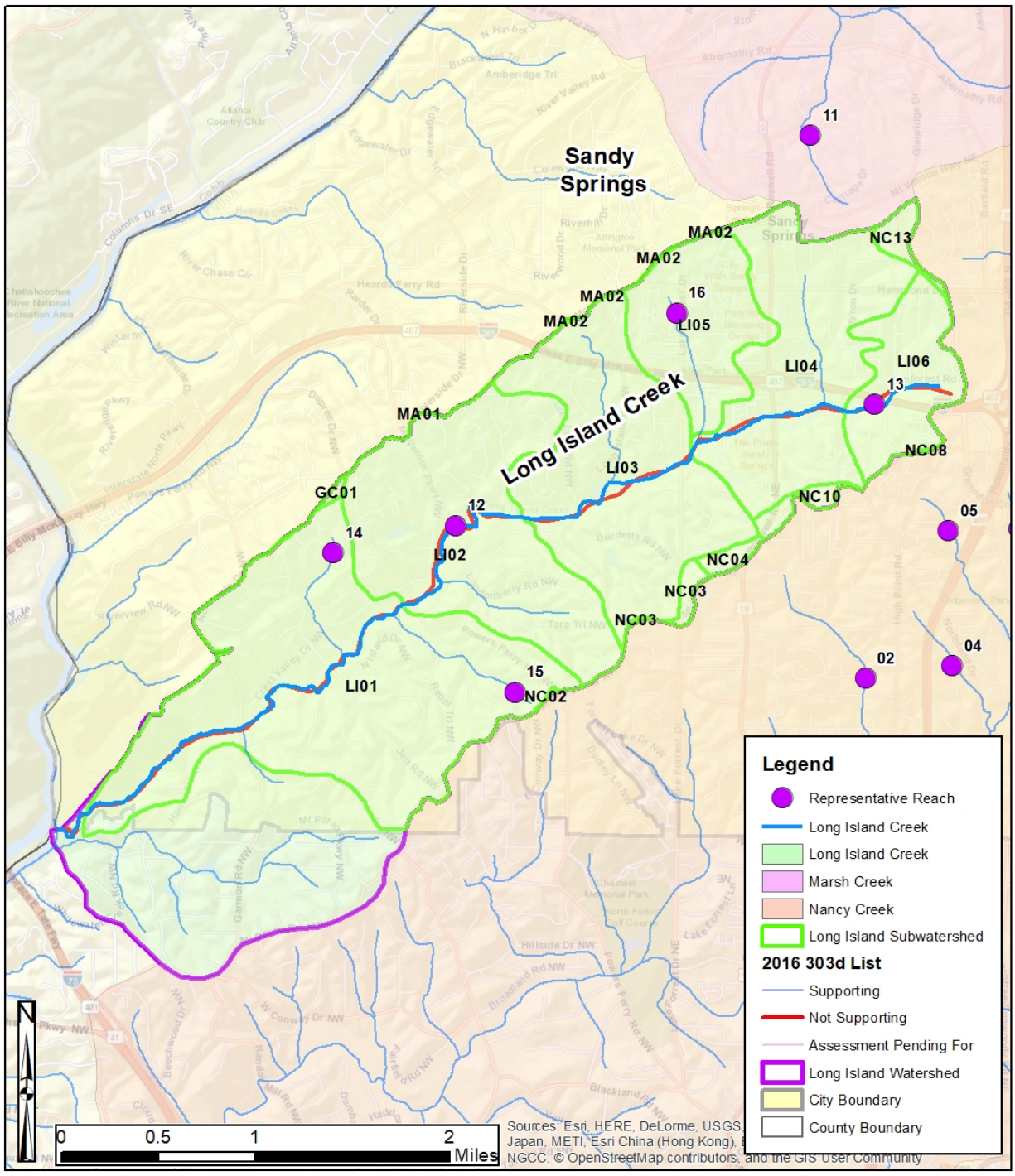

Figure 3-23 Long Island Creek Representative Reach Points

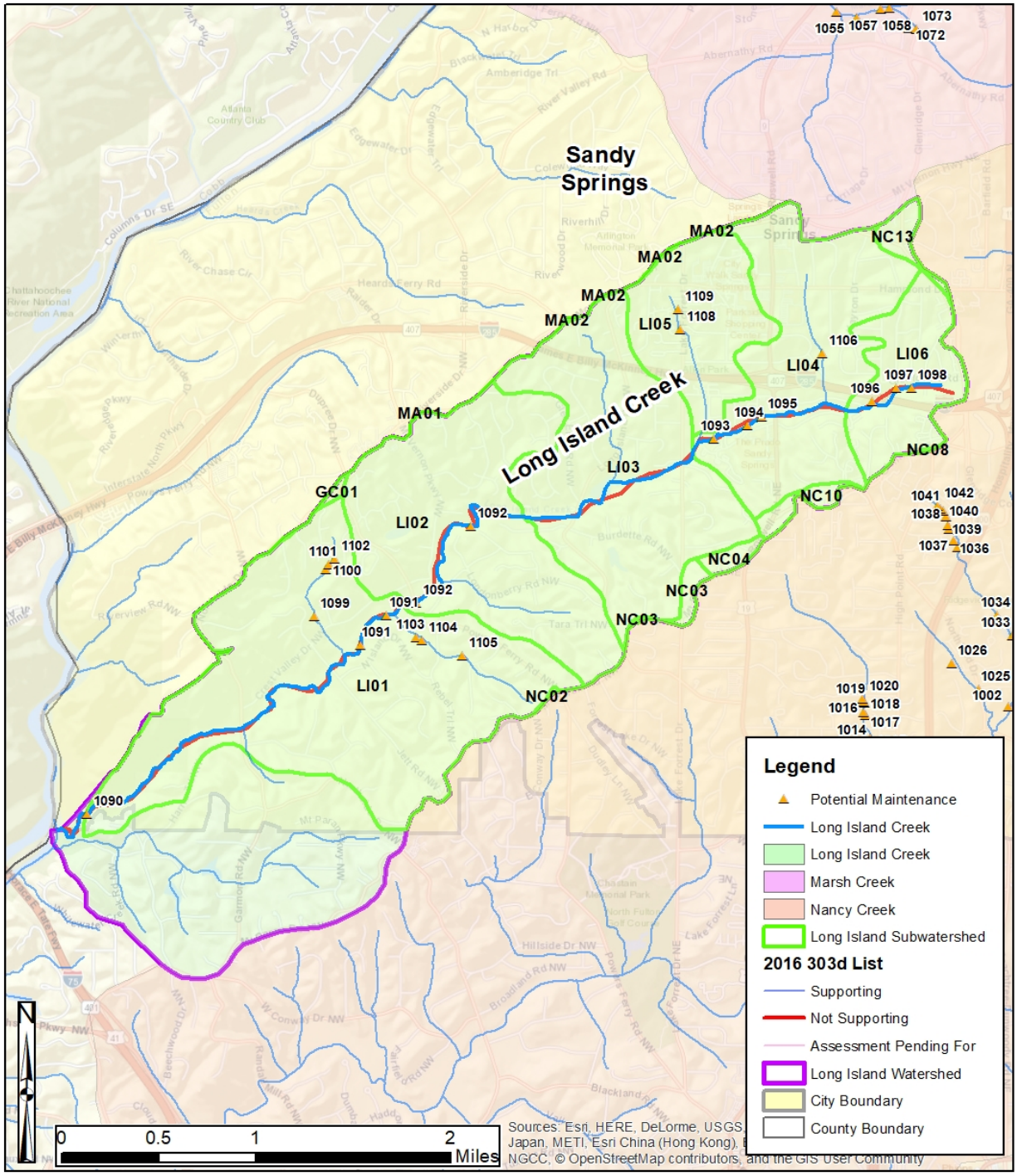

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Figure 3-24 Long Island Creek Potential Maintenance Points

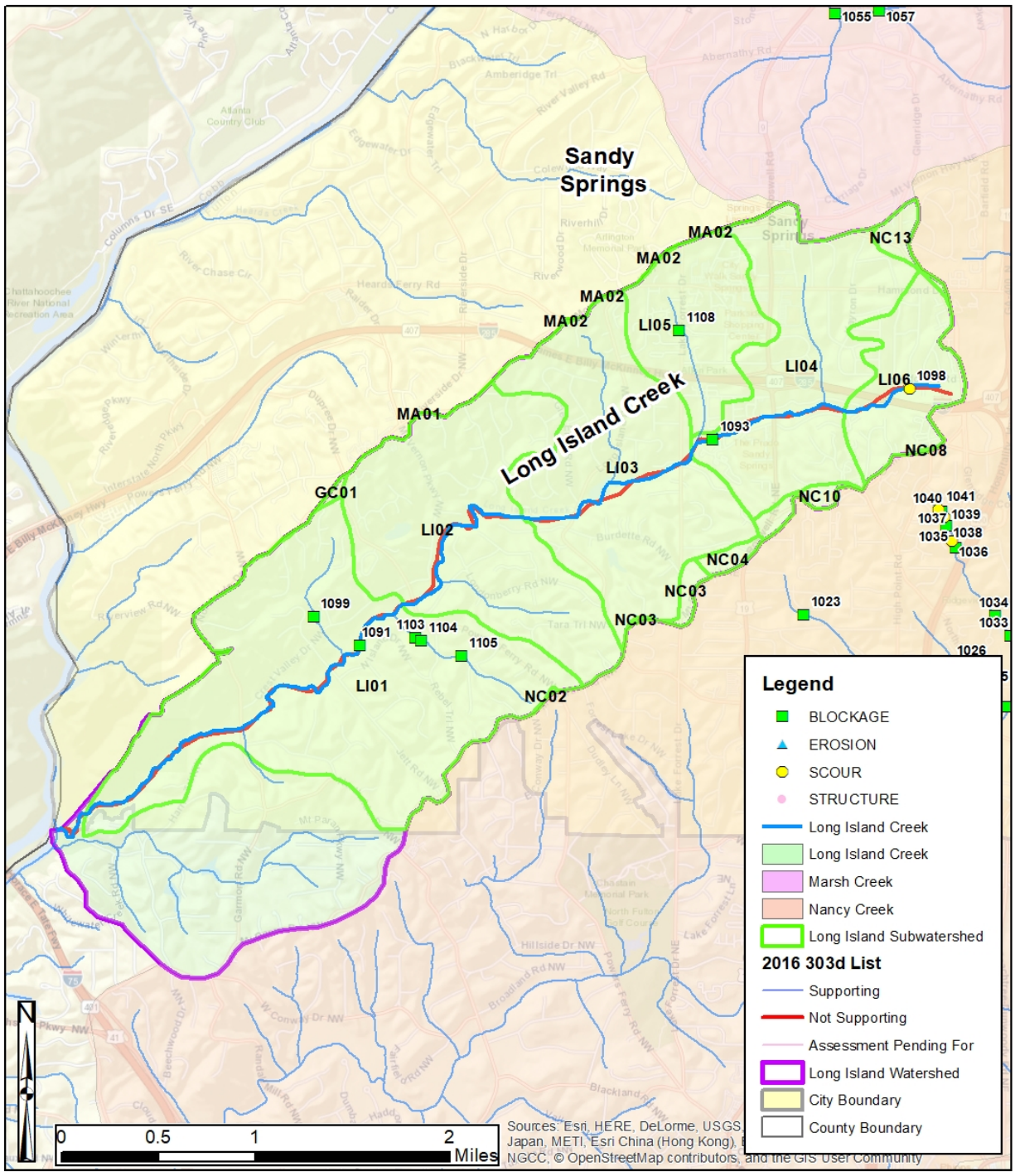

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Figure 3-25 Long Island Creek Potential Maintenance Type Points

Long Island Creek - Subwatershed LI01

Subwatershed LI01 represents the most downstream section of Long Island Creek from the confluence with the Chattahoochee River northeast to near Powers Ferry Road. This subwatershed also includes three tributaries, two branching along the south banks of the main stem and one branching on the north bank of the main stem near Powers Ferry Road. The subwatershed area is characterized by low density residential. This portion of Long Island Creek is categorized as an aggraded (Stage four and Stage five) stream with channel incision and widening for most of the stream segment. The streambed substrate consists of gravel and sand. A debris dam was located within the stream segment (MP#1092) (**Figure 3-26**). Stream inventory points collected in subwatershed LI01 ranged from SPID#180- SPID#202. Stream inventory points collected along the tributaries in subwatershed LI01 ranged from SPID#244- SPID#265.

Figure 3-26 Debris Dam in Subwatershed LI01 (MP#1091)

Long Island Creek - Subwatershed LI02,

Subwatershed LI02 the downstream section of Long Island Creek from Powers Ferry Road to Long Island Drive. This subwatershed also includes one tributary three tributaries, two branching along the south banks of the main stem and one branching on the north bank of the main stem near Powers Ferry Road. The subwatershed area is characterized by low density residential. This portion of Long Island Creek is categorized as an aggraded (Stage four and Stage five) stream with channel incision and widening for most of the stream segment. The bridge footing downstream of Long Island Drive is damaged along with the associated pipe support footings (MP#1092) (**Figure 3-27)**. Stream inventory points collected in subwatershed LI02 ranged from SPID#203- SPID#218. Stream inventory points collected along the tributaries in subwatershed LI02 ranged from SPID#266- SPID#271

Figure 3-27 Structural damage to bridge footings in Subwatershed LI02 (MP#1092)

Long Island Creek - Subwatershed LI03,
Subwatershed LI03 represents the mid-section of Long Island Creek from Long Island Drive to Lake Forest Drive. The subwatershed area is characterized by low density residential. This portion of Long Island Creek is categorized as an aggraded (Stage four) stream with channel incision and widening for most of the stream segment. The streambank substrate consists of cobble, pebbles and sand (SPID#223) (**Figure 3-28)**. Stream inventory points collected in subwatershed LI03 ranged from SPID#219- SPID#227.

Figure 3-28 Long Island Creek Subwatershed LI03 (SPID#223)

Long Island Creek - Subwatershed LI04,
Subwatershed LI04 represents the section of Long Island Creek from Lake Forest Drive to Kayron Drive. The subwatershed area is characterized by low density residential with commercial and high density residential properties near Roswell Road. Most of this portion of Long Island Creek is categorized as an aggraded (Stage four) stream with channel incision and widening for most of the stream segment. The streambank substrate consists of cobble, pebbles and sand (MP#1093) (**Figure 3-29)**. Stream inventory points collected in subwatershed LI04 ranged from SPID#228-SPID#236.

Figure 3-29 Debris Dam on Sewer Crossing in Subwatershed LI04 (MP#1093)

Long Island Creek - Subwatershed LI05,
Subwatershed LI05 represents the tributary to Long Island Creek from the confluence with Long Island Creek north under Interstate 285 to near Hammond Drive. The subwatershed area is characterized by commercial and high density residential properties near Roswell Road and Lake Forest Drive. Most of this portion of tributary to Long Island Creek is categorized as an aggraded (Stage four) stream with channel incision and widening for the majority of the stream segment. The streambank substrate consists of cobble, pebbles and sand (SPID#291) (**Figure 3-30)**. Stream inventory points collected in subwatershed LI05 ranged from SPID#277- SPID#292.

Figure 3-30 Tributary to Long Island Creek in Subwatershed LI05 (SPID#291)

Long Island Creek - Subwatershed LI06,
Subwatershed LI06 represents the headwaters of Long Island Creek to Kayron Drive. The subwatershed area is characterized by commercial properties and high density residential properties. Most of this portion of Long Island Creek is categorized as an aggraded (Stage four) stream with channel incision and widening for the majority of the stream segment. A portion of the stream is piped under Interstate 285. The streambank substrate consists of cobble, pebbles and sand. A large concrete pipe and debris were located within the stream (MP#1098) (**Figure 3-31)**. Stream inventory points collected in subwatershed LI06 ranged from SPID#237- SPID#243.

Figure 3-31 Concrete Pipe Debris in Subwatershed LI06 (MP#1098)

Stream Walk Habitat Summary

Habitat conditions are observed and logged for the COSS watersheds. These characteristics included (but are not limited to) variables such as stream bank slope and sediment composition, erosion, bankfull heights, and riparian vegetative presence. Summaries of these variables and the corresponding habitat scoring evaluations are outlined in this section.

The COSS watershed stream banks are also observed to be mostly steep/vertical (60-90°) and are composed of mostly cohesive sand and silts. Once again, though these soils are resistant to erosion, several stretches of mild to moderate erosion are observed within the COSS watershed. Bankfull height ranged between 3 to 5 feet within the COSS watershed. This discharge is morphologically significant because it identifies the location where the active channel stops, and the floodplain begins. It represents the breakpoint between the processes of channel formation and floodplain formation. As channels experience incision and widening, lower stream velocities and fallen vegetation can cause debris dams to form. Debris dams can also form because of sediment deposition from recent flooding events. The instability of the stream banks during these storm events, as well as during channel widening, can augment the occurrence of fallen natural debris.

Additional variables can also provide insight to the overall health of a riparian ecosystem within a watershed. These variables include evaluation of physical stream conditions and assessment of riparian vegetation. One of the many functions of riparian vegetation is the stabilization of stream banks and the moderation of lateral channel migration. Vegetation binds the soil, increasing the soil's resistance to erosion, and decreasing the rate and volume of overland runoff (i.e. stormwater). This in turn limits sediment entering the stream from upland sources. Riparian vegetation is vitally important in maintaining channel form and function, as increases in the rate and volume of stream flow and sediment loading can lead to substantial channel impacts, which in turn may affect aquatic habitat.

Visually based habitat assessments are made at representative reach locations within each of the assessed watersheds. These assessments showed habitats ranging from marginal to sub-optimal conditions throughout the COSS watershed. The habitat scores and condition ratings are shown in **Table 3-1**. The corresponding reach locations are identified earlier in this section in **Figure 3-1**.

Maintenance

Several private structures, public structures, and potential maintenance issues are identified during the stream walk process. Appendix A includes a list of all identified potential maintenance issues observed. **Figure 3-2** present the location of each maintenance issue in GIS. Most issues identified such as private road crossings or private structures may not require action on the part of the County but are listed in the table for information purposes. Other issues such as debris dams or damaged stormwater structures may need to be addressed by the County.

Table 3-1 COSS Stream Assessment Habitat Scores

Habitat Parameters	Nancy Creek ID (1)	Nancy Creek ID (2)	Nancy Creek ID (3)	Nancy Creek ID (4)	Nancy Creek ID (5)	Nancy Creek ID (6)	Crooked Creek ID (7)	Ball Mill Creek ID (8)
1 Epifaunal Substrate/Available Cover	7	10	11	7	9	5	15	2
2 Embeddedness	6	8	8	8	6	8	12	2
3 Velocity /Depth Regime	11	9	7	5	11	11	11	12
4 Sediment Deposition	6	7	13	5	12	5	14	2
5 Channel Flow Status	5	6	6	6	5	6	8	4
6 Channel Alteration	6	4	5	8	7	6	7	9
7 Frequency of Riffles	4	4	4	5	6	4	3	4
8 Bank Stability Left Bank	2	5	4	4	3	1	5	0
8 Bank Stability Right Bank	2	4	3	3	3	1	5	0
9 Vegetative Protection Left Bank	3	1	2	1	3	2	1	2
9 Vegetative Protection Right Bank	3	1	2	1	3	2	1	2
10 Riparian Vegetative Zone Width LB	1	1	2	1	3	2	1	3
10 Riparian Vegetative Zone Width RB	1	1	1	1	3	2	1	3
Total Score	57	61	68	55	74	55	84	45
Condition Categories	**Marginal - Poor**	**Marginal**	**Marginal**	**Marginal - Poor**	**Marginal**	**Marginal - Poor**	**Marginal**	**Marginal - Poor**

Number in parenthesis represents the Representative Reach Point ID

**Optimal 200-166, Sub-Optimal 153-113, Marginal 100-60, Poor 44-0 Source: Georgia DNR 2007 Standard Operating Procedures

Table 3-1 COSS Stream Assessment Habitat Scores

	Marsh Creek			Long Island Creek				
Habitat Parameters	**ID (9)**	**ID (10)**	**ID (11)**	**ID (12)**	**ID (13)**	**ID (14)**	**ID (15)**	**ID (16)**
1 Epifaunal Substrate/Available Cover	14	12	14	12	11	14	14	14
2 Embeddedness	17	11	14	12	14	11	11	14
3 Velocity /Depth Regime	13	13	7	13	7	3	4	7
4 Sediment Deposition	11	12	14	14	14	13	14	13
5 Channel Flow Status	6	8	6	8	8	9	6	9
6 Channel Alteration	7	7	8	8	7	7	7	7
7 Frequency of Riffles	3	3	5	6	4	6	7	6
8 Bank Stability Left Bank	3	3	4	3	3	4	3	4
8 Bank Stability Right Bank	4	4	5	2	3	4	3	5
9 Vegetative Protection Left Bank	2	3	2	2	1	2	1	1
9 Vegetative Protection Right Bank	2	3	2	2	1	2	1	1
10 Riparian Vegetative Zone Width LB	2	2	3	1	1	2	5	2
10 Riparian Vegetative Zone Width RB	2	2	3	1	1	2	5	2
Total Score	86	83	87	84	75	79	81	85
Condition Categories	**Marginal**	**Marginal**	**Marginal**	**Marginal**	**Marginal**	**Marginal**	**Marginal**	**Marginal**

* Number in parenthesis represents the Representative Reach Point ID
**Optimal 200-166, Sub-Optimal 153-113, Marginal 100-60, Poor 44-0 Source: Georgia DNR 2007 Standard Operating Procedures

Section 4 – Management Measures

The review of the watershed characteristics culminates in the finalization of goals and the identification of watershed management solutions. This section establishes suggested written watershed planning goals as developed in the watershed protection plan. To achieve the watershed management goals management measures and targeted critical areas for improvement are identified.

4.1 Management Measures and Targeted Critical Area

BMPs can be implemented to meet the identified programmatic goals. The focus of the BMPs identified in this section will be on improved water quality and the protection of public health and safety. The results of the COSS stream assessments identified in Section 3 of this report show degraded streambanks and stream bed siltation and sedimentation. The BMPs will address sedimentation, stormwater runoff, and improve general water quality in the COSS watersheds. A comprehensive approach to BMPs selection is provided. These BMPs range from public awareness and public involvement to structural measures. Most of the structural BMPs are on private property which creates significant implementation challenges. These BMPs primarily address reducing urban runoff volumes and velocities identified as a potential source of water quality issues. **Table 4-1** shows the list of BMPs recommended for the COSS watersheds. All the aerial sewer crossings identified during stream assessments had current structural integrity and no active SSO were identified. One private lateral SSO was identified and one previous spill was also identified and reported. Several aerial sewer crossings are downstream of large debris dams that could result in SSO.

Table 4-1 - Suggested BMPs for COSS
Sandy Springs Stream Assessment

	Measures	Improves
Public Awareness/ Public Involvement	Public Awareness to Reduce FOGs	Bacteria
	Industrial Facilities Focused BMPs	Sediment & Runoff
	Home Owner Education Workshops	Overall WQ
	Stormwater Detention Basin Maintenance Education	Sediment & Runoff
	School Education Activities	Overall WQ
Non-structural Measures	Sanitary Sewer Overflow Management	Bacteria
	Bacteria Monitoring	Bacteria
	Bacteria Source Tracking	Bacteria
Structural Measures	Addressing Maintenance Issues	Sediment & Runoff
	Stream Bank Restoration	Sediment & Runoff
	Rain Gardens/Barrels – Schools	Overall WQ

4.3 Public Awareness and Public Involvement

Public awareness and public involvement are important components to managing stormwater runoff and improving water quality. COSS could continue to highlight stormwater management measures the public can do to decrease stormwater pollution.

Public Awareness COSS could highlight the impaired streams in an electronic newsletter or social media post. The information could be available on the City's stormwater and watershed education website or included with the water and sewer bill as a billing insert. The public awareness media post would include photos of COSS streams along with protection measures citizens can implement to reduce pollution into the streams such as, picking up trash and pet waste, yard leaves, replacing grass stream banks with natural stream bank cover, and installing rain barrels and rain gardens to reduce stormwater runoff. Other topics could include reducing fats, oils, and grease (FOGs) to help prevent sanitary sewer overflows (SSOs).

Public Awareness to Reduce FOGs – Fulton County Sewer Use Ordinance limits FOG disposal from commercial facilities (Chapter 82 Article IV). However, research related to metro-Atlanta municipalities indicates FOG to be a leading cause of sewer overflows. Fulton County could develop a web campaign and distribute brochures to reduce fats, oils, and grease from residents that could lead to SSOs. The brochures could be designed to inform homeowners of the consequences of grease build up in sanitary sewer lines. Brochures could be designed for both English and Spanish readers. Fulton County could develop grease disposal kits to distribute to homeowners as an alternate disposal for grease. To address FOG from multi-family residents, Fulton County can present at community events or neighborhood planning meetings. The following resources could be used to assist in providing educational materials for the public:

- Georgia Department of Natural Resources Sustainability Division (FOG Posters)
- California Fats, Oils and Grease Workgroup – FOG Outreach
- Georgia F.O.G. Alliance

Home Owners / Business Owners Education Workshops – COSS could partner with home owners and business owners within the COSS watersheds to reduce stormwater runoff and pollution prevention. Workshop topics to be covered include:

- Stream bank landscapes and encouraging the growth of natural stream bank cover.
- Pollution prevention near the stream; reducing yard waste, debris and pet waste.
- Septic tank maintenance and care. Opportunities to connect to sewer if available.
- Rain barrels and rain garden demonstrations and DIY manuals.

School Education Activities – COSS may partner with local schools within the City watersheds to reduce stormwater runoff from buildings and parking areas. COSS could distribute lesson plans about stormwater runoff and could encourage class projects including painting rain barrels or building rain gardens. Some possible activities may include:

- EPA Articles and Activities for Middle School Students
- EPA Brochure - Build Your Own Rain Barrel
- Clean Water Campaign – Teachers Resources
- Clean Water Campaign – Rain Garden DIY Guide
- Fulton County Science Fair for students

4.4 Non-Structural Measures

Sanitary Sewer Overflow Management

SSOs are a threat to water quality and require identification, evaluation, and resolution. The Fulton County Department of Watershed Management may have an existing SSO Management Plan. However, if one does not exist a SSO Management Plan could be developed to include the minimum elements:

Historical SSO Event Data Review and Trend Analysis: Collect data and investigate the overflow events from past spills by gathering and reporting information related to the overflow including, location, spill start and end time, volume, point of entry to stream or the MS4, stream inspection for signs of fish kills after the spill, flow if available and other ambient conditions of the overflow and impacted stream. The investigation also includes collection of rainfall data, flow monitoring from County database, size and type of sewer and analysis of potential causes based on land use. The spill events are evaluated against spill

cause, census data, land use data, rainfall levels, sewer inventory, etc. to identify viable reduction alternatives.

Research and Development of SSO Reduction Alternatives: Develop a list of SSO reduction alternatives, such as preventive maintenance, correction items, ordinances, residential collection of FOG, etc. that the County can develop and implement to reduce the number of SSOs. Case studies of similar systems are performed to aid in development of reduction alternatives.

Development of Final SSO Reduction Plan: Develop a final list of reduction measures and associated CIP to allow the County in planning and implementing the recommended improvements.

Sewer Capacity Management

SSOs and failed sanitary sewers could be addressed by a combination of a capacity management operations and maintenance program (CMOM), flow monitoring and inspecting sanitary sewers where they cross stream or rivers. The CMOM program includes the following elements: proactive system maintenance, capital improvements, public education, collection system modeling, industrial monitoring, commercial pretreatment, safety training, flow monitoring and emergency response plan. The CMOM program is currently ongoing and will continue during the duration of the MS4 permit.

Bacteria Monitoring – COSS has implemented a watershed monitoring program that includes a sampling location on Nancy Creek and Crooked Creek for the evaluation of *fecal coliform* and E. coli bacteria and sediment. The monitoring program identifies areas of potential pollutant sources within streams and determines the influence of stormwater on bacteria levels. COSS currently monitors these streams according to the COSS Monitoring and Implementation Plan (MIP 2016) and the Standard and Methodologies for Surface Water Monitoring (MNGWPD 2007).

Grab sampling water quality monitoring provides COSS with the data needed to evaluate its streams and the current impact of storm water on water quality. The monitoring is conducted according to the City's approved Monitoring and Implementation Plan (MIP). Four (4) geometric means are collected, two (2) in (May-October) and two (2) in (November – April) for bacteria evaluation.

Bacteria Source Tracking – Bacteria Source Tracking (BST) is a new methodology to determine the source of fecal pathogen contamination in environmental samples. BST techniques appear to provide the best method to determine the origins of fecal contamination in water bodies. BST uses DNA sampling of the *E. Coli* bacteria found in the water sample and compares the samples to a DNA library to identify if the *E. Coli* source is human, dog, geese, deer or another wildlife source. Once the source of bacteria is identified specific target BMPs can be used to reduce the amount of fecal contamination in the water body.

BST sampling is suggested for COSS watersheds. The goal of the BST sampling is to identify if the bacteria contamination is human source or animal source. One sample and one duplicate could be collected from each stream and sent to an accredited laboratory.

The laboratory will detect and quantify the fecal *bacteroidetes* human gene biomarker for human fecal contamination. This is determined by quantitative polymerase chain reaction (qPCR) DNA analytical technology. The laboratory results will indicate the Total Fecal *Bacteroidetes* Quantified, and the Human Fecal *Bacteroidetes* Quantified. This will allow

the COSS to determine the percentage of *fecal coliform* bacteria that can be attributed to human activity.

If the laboratory tests revel negative results for human fecal bacteria it can be assumed that the contamination source is from animals either wild or domestic such as dogs. Further testing can be performed to identify the source. Based on the results of the BST COSS can develop the appropriate Best Management Practices identified in the stream assessment reports to address the source of contamination.

4.5 Structural Measures

COSS is currently listed on the 2016 Georgia 305(b)/303(d) Report lists of impaired streams for *fecal coliform* bacteria. This listing is a result of elevated levels of bacteria which may be caused by the influence of urban stormwater runoff. Structural measures are recommended to restore the habitat and riparian buffer of the COSS streams. The following structural measures are suggested within the COSS watersheds.

Maintenance
Maintenance points are inventoried in each subwatershed and include issues related to physical characteristics of stormwater pipes, outfalls, potential sewer pipe issues, manhole issues and other issues. Most of these identified points are private outfall locations or private water withdrawal locations that may require no action from the County. These locations are identified in **Figures 3-4, 3-11, 3-17 and 3-25** and detailed in Appendix A.

Debris Removal – Several locations within the COSS watersheds are identified for debris removal. These areas include stream crossings that have collected debris on the upstream side of the pipe, culverts that are filled with substrate and could be cleared, areas of excessive trash from urban runoff, and fallen trees resulting from stream bank erosion. Debris removal is recommended to improve water quality and habitat.

Stream Bank Restoration – Stream banks have been reduced because of local scour. Local scour areas are a result of historic high velocity and volume associated with stormwater runoff. The silt/sand stream banks have eroded along some reaches, undercutting vegetation along the stream. However, in general, the stream bank buffers are intact and overbank runoff and upper bank failure do not contribute to the stream bank degradation in most areas. The following information describes the stream bank restoration actions that may be considered.

Bank Stabilization/Bioengineering – Several locations within the COSS watersheds were identified for bank stabilization. Increasing the natural plantings along the stream bank such as shrub dogwoods, alders, willows and shrubs such as silky dogwood or evergreen ground covers such as Hall's honeysuckle may be sufficient to restoring stream banks in these areas. It may be necessary to pursue more aggressive measures such as installing branch packing, brush mattress, live crib wall, live fascine with erosion control fabric, or Joint plantings. These measures are described in detail in the Guidelines for Stream Bank Restoration by the Georgia Soil and Water Conservation Commission. Most of the stream banks are on private property.

Stormwater Detention Basins
Stormwater detention ponds are among the most cost-effective and widely used stormwater practices. These private ponds could be cleaned and maintained to provide proper water quality detention. An evaluation of existing stormwater detention ponds and the

development of regional detention for areas of the watersheds may be considered. Since most detention ponds are private, COSS may develop a stormwater detention pond public information document to increase awareness about the responsibility of maintaining these privately owned structures.

BMP Demonstration Projects – COSS could consider developing rain gardens, rain cisterns, and rain barrels at the government buildings as demonstration projects for facilities to implement on their own property. Rain gardens and rain barrels are simple BMPs that can be duplicated by homeowners while providing stormwater detention to decrease the volume and velocity of stormwater runoff.

Rain Gardens – Rain gardens can be constructed at lower elevations to naturally collect stormwater. A rain garden captures the first flush of pollutants from these areas and provides volume storage of stormwater prior to stream discharge (**Figure 4-1**). Reducing volume and velocity by providing a pervious area for water to be stored reduces the volume and velocity of stormwater contributing to stream bank erosion. Rain gardens would be used as demonstration projects to inform citizens and business owners on how to install them and how they decrease stormwater runoff and reduce water pollution. The Stormwater BMP database (2001) indicated that sand filters or rain gardens are effective in removing 36% to 83% of the bacteria in urban runoff first flush.

Figure 4-1 Example Rain Garden

Rain Barrels – Rain barrels can be installed at COSS public buildings and at interested participants' homes or businesses by the property owners. These barrels can be connected to small irrigation soaker hoses to release water into the ground slowly over a period (**Figure 4-2**). This would reduce the first flush from building roofs that contain leaves and other organic debris and could reduce the volume and velocity of water returned to COSS watersheds. Using the surrounding pervious surface to absorb the rain water over a period could reduce urban runoff but will provide the stream with sustained base flow through groundwater recharge. Rain barrels can be used as demonstration projects to encourage home owners to engage in private installation to reduce flooding and provide irrigation water during droughts. Although values for pollution reduction are not available for rain barrels, the volume and velocity reduction of runoff contributes to improved water quality.

Figure 4-2 Example Rain Barrel. Source: EPA Fact Sheet

Section 5 – Summary

COSS has completed a stream assessment inventory of the COSS watersheds. Nancy Creek, Crooked Creek, Ball Mill Creek, Marsh Creek and Long Island Creek are currently listed on the 2016 Georgia 305(b)/303(d) List of impaired streams for *fecal coliform* bacteria. In compliance with several water quality regulations the COSS has completed a stream assessment evaluation.

Stream Assessments
Stream assessments of COSS watersheds identified typical stream segments to be categorized as an aggraded (Stage 5) stream, with channel incision and channel widening for most of the stream main stems. The dominant stream bed material is sand, and the stream banks are mostly silty-clay. The stream banks had mild to moderate historic and active erosion. Fluvial scour and mass wasting is also observed on the stream banks. Several debris dams, caused by fallen trees, are identified along streams during the stream assessments.

Representative reach points are inventoried in each subwatershed. These are developed by analyzing cross-sectional measurements and physical characteristics of the stream which are in turn used for habitat assessments. Sites are chosen such that each distinct subwatershed had at least one comprehensive habitat score for each approximate square mile of subwatershed area. Habitat status can be assessed based on the Georgia Department of Natural Resources methodology using the collected surveyed condition of the stream and aquatic condition. The habitat status within COSS watersheds ranged from poor to marginal.

Maintenance
Mmaintenance points are inventoried in each subwatershed and included issues related to the physical characteristics of stormwater pipes, outfalls, potential sewer pipe issues, manhole issues and other issues that may need to be addressed. Most of these identified points are private outfall locations that may require no action from COSS or the County.

Best Management Practices
Several BMPs are suggested within this report to provide education and reduce sedimentation by structural and non-structural measures. These BMPs are summarized based on effectiveness, planning cost, and ease of implementation. The recommended BMPs include stormwater detention basins, several small stormwater retention and infiltration structures installed near community clubhouses, septic tank elimination, stream bank restoration, and public education.

Section 6 – References

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