# Review of Stormwater Discharge to the Pithlachascotee River

# City of New Port Richey River Basin Study

The City of New Port Richey

6132 Pine Hill Road
New Port Richey, FL
34668

Prepared by:

GHS, LLC

GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732

May 2016

# Table of Contents



## List of Tables

## List of Figures



## List of Appendices

The City of New Port Richey (City) has dedicated monies for restoration activities within the Pithlachascotee River (Cotee River) watershed by conducting direct restoration activities and indirect stormwater maintenance to improve the water quality entering the watershed. Past and present activities include the Orange Lake Feasibility Study, the Orange Lake Restoration Project, the Heights Stormwater Improvement, the Meadows Rehabilitation Project, and the North Park Stormwater Improvement. Several of these projects have been submitted for cooperative funding with the Southwest Florida Water Management District (SWFWMD), and the Orange Lake Restoration Project has been submitted for RESTORE Act Pot 1 funds in addition to SWFWMD Cooperative Funding.

The Cotee River is a primary attraction for the residents within the City of New Port Richey, and the City recognizes the potential impacts from stormwater and other sources to the river. As the coastal areas continuously become more developed, stormwater quantity increases while water quality of stormwater runoff decreases. In an effort to reduce this progressive impact, the City has initiated a City-wide river basin study to quantify the nutrient and pollutant load of stormwater to the river by identifying areas of high pollutant loads, origin of pollutants and types of pollutants. With the results of this study, the City will be able to evaluate future stormwater best management practices to reduce or eliminate loads in these contributing areas.

Additionally, the state government has also established various surface water standards for the Cotee River as well as for the estuary where the river meets the Gulf of Mexico. Nutrients, specifically nitrogen and phosphorus, have been identified as one of the most severe water quality problems. Water quality standards, in the form of Numeric Nutrient Criteria (NNC), have been introduced to protect specific areas. The estuary downstream of the City of New Port Richey has an established NNC of 0.65 mg/l for total nitrogen and 0.034 mg/l for total phosphorus (Ch. 62-302.532, F.A.C.).

This river basin study includes a general review of the Pithlachascotee River watershed, past rainfall and streamflow records, the City's existing stormwater system, and present land use within the City's limits. Detailed information is found in the appendices; whereas the body of the report contains summaries of pertinent information leading to the conclusions.

Surface water samples from the Cotee River and from the City's stormwater system were collected and analyzed by a National Environmental Laboratory Accreditation Council (NELAC) certified laboratory for various pollutants and nutrients. A total of ten (10) sample events were conducted in coordination with rainfall events. A total of eight (8) locations were selected for a total of eighty (80) samples. The Cotee River upstream of the City's limits was sampled during every sampling event. The stormwater system sample locations were selected based on the acreage of the drainage basin (DB), number of outfalls, and size of outfalls. These sample locations from upstream of the City's limits to downstream of the City's limits include: an upstream location, DB#126, DB#102, DB#120, DB#92, DB#87, DB#60 and a downstream sample location. The initial sampling event included the downstream location of the city limits to determine if this location would be acceptable for pollutant loading and dilution factors, but this location was replaced since the lab results proved the downstream location to remain brackish at a low tide due to its connection with the Gulf of Mexico. A second location, DB#92, was also dropped due its brackish nature after the initial sampling event. Two alternate locations, DB#95 and DB#19, were selected and sampled for the remaining nine (9) sampling events.

Samples were collected following rainfall events that caused discharge from the City's stormwater system. Sample collection began in March 2015 and ended in January 2016 to evaluate the seasonal differences in loading associated with the changing rainfall and flow patterns associated with the river. Over 2,600 laboratory analyses were conducted and included the various species of nutrients, heavy metals as well as herbicides and pesticides. The herbicides and pesticides were not tested regularly but on select events due to budgetary constraints.

Overall, the quality of the Cotee River upstream of the City of New Port Richey show little signs of impact from stormwater runoff with regular detections of nutrients (nitrogen and phosphorus) above the NNC. On average, the total nitrogen and total phosphorus was present in concentrations of 0.85 mg/l and 0.061 mg/l, respectively. Oils/greases (or HEM) was detected once out of the ten sampling events with a low concentration of 0.17 mg/l, which is below the Class III Limited Surface Water Standard (Ch. 62-302, F.A.C.) of 5.0 mg/l. Copper was detected once (0.0049 mg/l) with the concentration above the Class III Limited Surface Water Standard, which is 0.0037 mg/l. Zinc was detected twice with concentrations below the Class III Limited Surface Water Standard of 0.086 mg/L. An herbicide parameter, 2,4-D, was detected once well below Ch. 62-777, F.A.C. surface water standards. Fecal and coliform bacteria were present in high concentrations at all sampling events. On average, fecal and total coliform was too numerous to count or had counts of 676 colony forming units per 100 milliliters (cfu/100 ml) or 22,750 cfu/100 ml. Chloride, total dissolved solids (TDS), and total suspended solids (TSS) were detected regularly but for the purpose of this study are being used to confirm that brackish water was not mixing with the collected samples.

The downstream sampling location proved to be mixed with the brackish water at a low tide and was determined applicable to determine downstream pollutant loading or dilution factors (already said this). The individual basins produced water quality results that have pollutants that are directly associated with land use within that basin.

The most significant pollutant contributions from the City include copper, zinc, nitrogen, and phosphorous. DB#60 contributes the most pollutants as individual parameters, the highest concentrations of those pollutants, as well as the highest loading of each parameter per event even though it is medium sized drainage basin in comparison to the rest. These include copper, zinc, ammonia, TKN, total nitrogen, and TSS. The mixture between residential and highway commercial land uses contribute high concentrations of each parameter and a high runoff coefficient when multiplied across the entire basin produced high loading values. DB#60 includes a significant portion of drainage from US Highway 19 capturing various heavy metals from the combustion of gasoline, commercial developments along US Highway 19 capturing herbicides from the retention/detention ponds and heavy metals from the parking lots, and residential areas capturing excessive nutrients from lawn care products.

The results of this study show that it DB #87 contributes the highest load of orthophosphate and total phosphorus and produces the second largest loads for the other nutrient parameters. Although it is the largest drainage basin, these results can also be explained by the fact that samples were collected from Orange Lake instead of using bucket samplers, which catches the “first flush”. Orange Lake has a high dilution factor considering that it captures and holds large quantities of stormwater runoff over a large basin as well as receiving direct rainfall and irrigation supplies from the park directly surrounding it. Orange Lake then pulses to directly to the Cotee River as water levels exceed the elevation of the concrete weir.

DB#102 and DB#120 contribute the highest loads for individual pollutants specifically chromium and lead, respectively. Both of these drainage basins include major thorough fairs for traffic. Both basins include Grande Boulevard heading towards the downtown area from US Highway 19, and DB#120 include Gulf Drive from US Highway 19.

In review, there were no pesticides detected over the duration of the study. There were four herbicides that were detected within various drainage basins and during several rainfall events. All detections were minor in comparison to all applicable standards.

There were two heavy metals, copper and zinc, that regularly exceeded the Ch. 62-302, F.A.C. Fresh Surface Water Standard. The average concentration for copper exceeded the standard of 0.0037 mg/l in seven (7) of the eight (8) drainage basins that were sampled. Zinc exceeded the standard in two (2) of the eight (8) drainage basins.

Regulation has defined the nutrients as total nitrogen and total phosphorus, and the standard is written so that nutrient concentrations shall not impact or alter a body of water to cause an imbalance of natural populations of aquatic flora and fauna. Specific nitrogen and phosphorus forms, such as nitrate, nitrite, orthophosphate and total phosphorus do not have a set numerical values but ammonia does. Average ammonia concentrations in DB#60 and DB#87 exceed the standard of 0.2 mg/l.

A subsection of Ch. 62-302, F.A.C. includes the Numeric Nutrient Criteria (NNC), which was developed specifically for estuary environments. NNC values for total nitrogen and total phosphorus have been developed for the Cotee River downstream of the City of New Port Richey. All drainage basins that were sampled including the Cotee River upstream of the city limits exceeded the NNC for both nitrogen and phosphorus.

One of the main objectives of this study was to identify “hot spots” or areas within the city that contribute to high pollutant and nutrient loads. Overall, the city contributes high nutrient loads to the Cotee River due to high residential land uses. DB#60, DB#87, DB#120 and DB#102 are drainage basins that are in need of evaluation for best management practices (BMP’s) to incorporate treatment or filtration systems to reduce pollution discharge to the Cotee River.

# 2.0 Introduction

## 2.1 Pithlachascotee River

### 2.1.1 Location

The Pithlachascotee River (the locally nicknamed "Cotee" River) is located within the Springs Coast Watershed in west, central Florida. The Cotee River is a blackwater stream/river in Pasco County that is approximately 27 miles long originating from the Crews Lake outlet. The river flows predominantly southwestwardly, picking up flow from Gowers Corner Slough and Fivemile Creek crossing through the Starkey Wilderness Park as it meanders through Pasco County. Eventually, the river makes its way out to the Gulf of Mexico at Miller's Bayou near Port Richey, Florida. Figure 1 shows the location of the Pithlachascotee River, its headwaters, and entrance into the Gulf of Mexico at Miller's Bayou.

### 2.1.2 Watershed

The Pithlachascotee River watershed (Figure 1) is relatively small, draining approximately 200 square miles originating from the outlet of Crews Lake and meandering southwestwardly through Pasco County. Northeast of Fivay Junction, covering approximately 30 square miles, the watershed is highly permeable characterized by numerous closed depressions and sinkholes which infiltrates a large proportion of stormwater runoff to the Upper Floridan aquifer. Streamflow generated in this portion of the river does not reach the lower reaches of the river. The largest section of the watershed, covering approximately 150 square miles, between Fivay Junction and the Main Street Bridge in New Port Richey, Florida is where the majority of the stream flow is generated before mixing with waters of the Gulf of Mexico. Past the Main Street Bridge is the remaining 20 square miles of the watershed, and the Pithlachascotee River becomes brackish and is highly influenced by the tidal flux of the Gulf.

## 2.2 The City of New Port Richey

The City of New Port Richey is located along the southern central coastline of Pasco County and is considered to be a suburban city of the Tampa Bay area. Sims Park and the Hacienda Hotel are the main attractions of New Port Richey, and the Pithlachascotee River and Orange Lake are the main environmental features, which are located in the center of downtown. See Figure 2.

### 2.2.1 City Limits

The approximate city limit of the City of New Port Richey has a total area of 4.6 square miles. The red line in Figure 2 is the city limits boundary. The Pithlachascotee River and Orange Lake comprise less than 2% of the city.

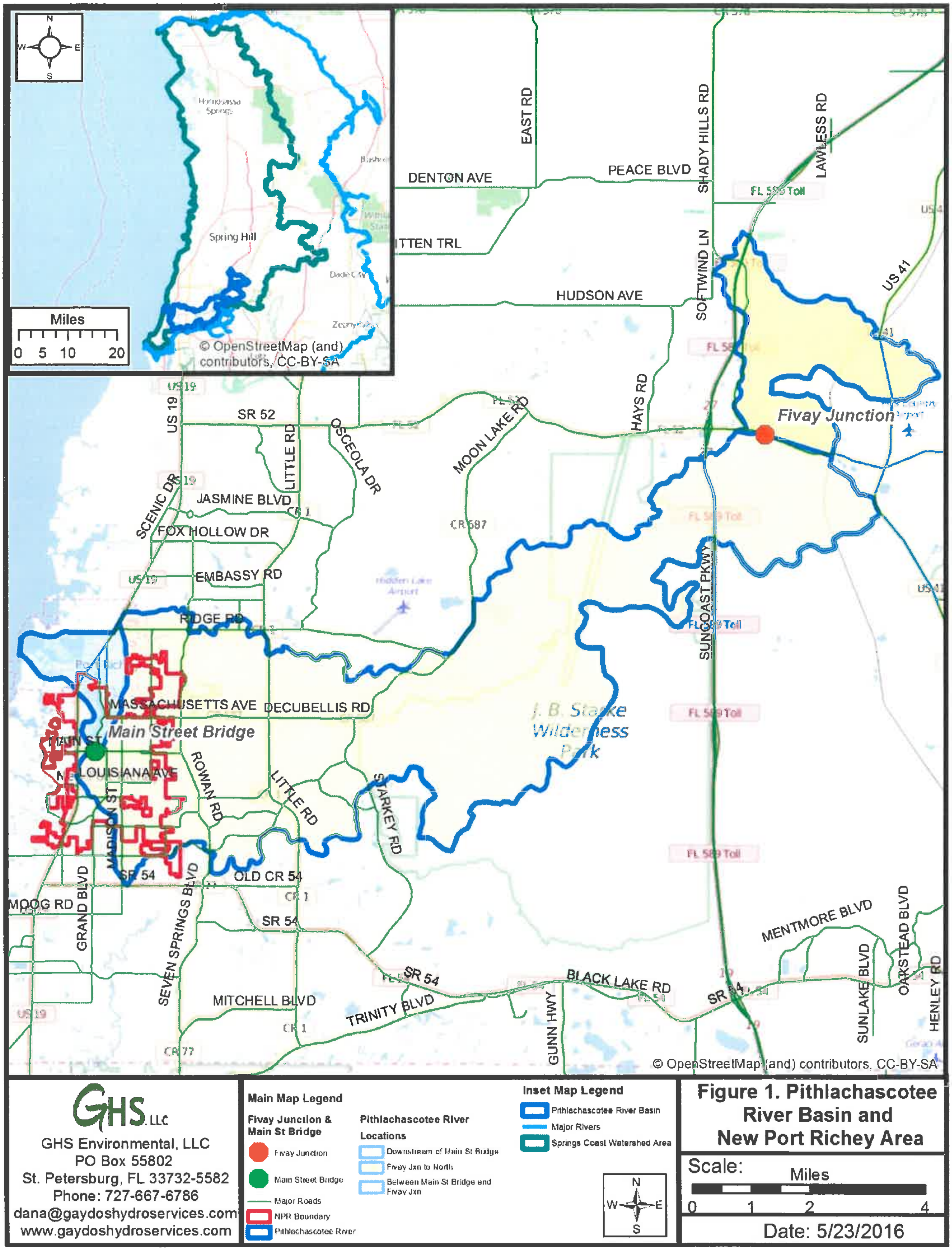
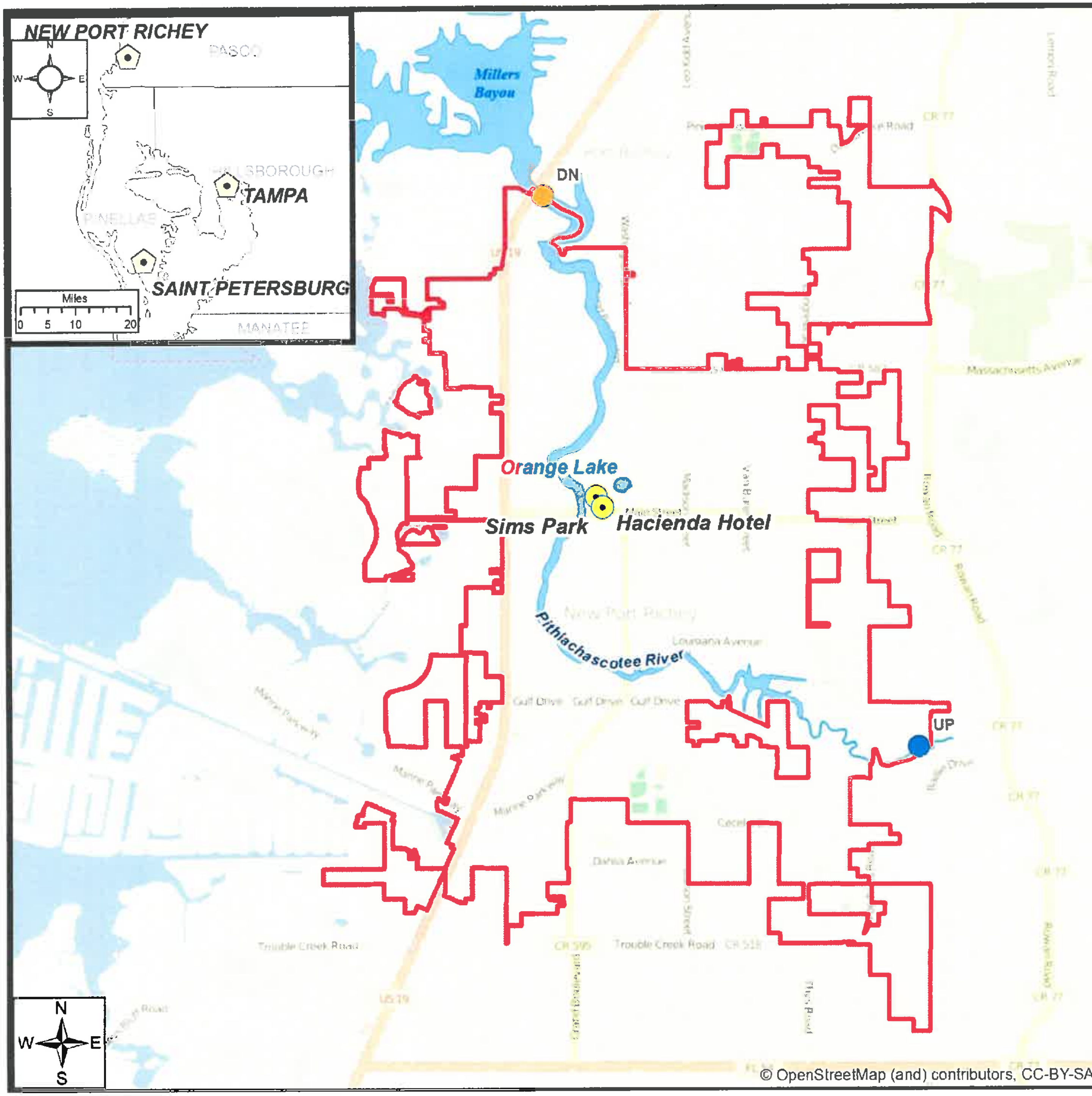



**Figure 1. Pithlachascotee River Basin and New Port Richey Area**

Scale: Miles 0 1 2 4

Date: 5/23/2016


GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com




# Figure 2. New Port Richey Area

**Legend**

**River Sample Locations**

- Sims Park & Hacienda Hotel
- NPR Boundary
- Pithlachascotee River
- Orange_Lake
- Pithlachascotee River
- County

**Inset Map Legend**

- Cities
- Counties

Scale: Feet

0 1,250 2,500 5,000

Date: 5/24/2016

GHS LLC

GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com

### 2.2.2 Drainage Basins

Due to significant growth within New Port Richey, the City began experiencing stormwater related problems, such as lake and river pollution and street flooding. To address these issues, the City of New Port Richey selected Dames & Moore to develop a Master Drainage Plan, which was completed in 1992. The 1992 Master Drainage Plan involved a quantitative analysis of flood problem areas with subsequent conceptual design. The following objectives that were concluded with this plan were utilized for this study:

1. Inventory of existing stormwater drainage facilities and other hydrological related parameters;
2. Existing stormwater drainage systems; and
3. Stormwater model calculations of runoff and pollutant loading.

The 1992 Master Drainage Plan identified fifty-two (52) stormwater systems with two hundred and twelve (212) subbasins. At that time, eighteen (18) systems had stormwater treatment, primarily closed retention ponds, or were closed systems, leaving thirty-four (34) systems contributing untreated loads to the Cotee River. Water quality findings from the 1992 Master Drainage Plan supports the findings from this study and identified the same pollutant and nutrient parameters, specifically nitrogen and zinc. The 1992 Master Drainage Plan identified lead as a primary concern; however, leaded gasoline was still in use at that time. With the enforcement of removing lead from gasoline, lead is no longer a major pollution concern in regards to stormwater runoff.

This study primarily assess the pollution loading generated within specific drainage basins as delineated by the 1992 Master Drainage Plan along with updated land uses. Table 1 lists the drainage basin, identifies the outfall to the Cotee River, total acreage of each basin, and provides a location description of the approximate drainage area by of that basin. Figure 3 identifies the drainage basins selected for evaluation in this study.

### 2.2.3 Zoning and Land Use

The zoning and land use (LU) maps were created from a 2004 zoning and LU GIS shapefile provided by the city of New Port Richey. The 2004 Zoning shapefile was clipped to the individual sampled drainage basin boundaries, and the area was calculated in both acreage and percent (%) coverage of total area. There are eleven (11) types of land use within the sampled drainage basins. The 2004 zoning GIS file does not include coverage for the areas covered by roads and right of way (ROW). This means that when using this file to calculate areas, the numbers or percent of area would not perfectly match the total area within the drainage basin GIS file. For example, the polygon shape that covers drainage basin 19 is 8.59 acres, whereas the 2004 zoning shape clipped to drainage basin 19 covers 7.36 acres due to the road and ROW not having representation within the shape. This discrepancy is discussed in further detail in Appendix A. Table 2 summarizes which land use types were sampled and the abbreviation used in the graphics.

Table 1. Drainage Basin and Outfall Summary.

| Drainage Basin | Acreage | Outfall Name | Outfall Size | Area |
|---|---|---|---|---|
| Upstream | NA | NA | NA | Before City Limits |
| 126 | 34.0 | OF32 | 30" | Drains southeast City along Gulf Dr/Maple St, north of River |
| 102 | 37.0 | OF76 | 30" | Drains south central City along Grande Blvd/Louisiana Ave, north of River |
| 120 | 46.8 | MOF3 | 42" | Drains southwest side City along Gulf Dr/Crafts St, south of River |
| 95 | 40.3 | MOF5* | 36" | Drains west mid City along Illinois Ave/Lafayette St, east of River |
| 92 | 71.3 | OF13* | 30" | Drains east mid City along Missouri Ave/Grande Blvd, east of River |
| 87 | 122.5 | MOF8 | 42" | Orange Lake outfall include Main St, east of River |
| 60 | 38.5 | OF83 | 24" | Drains west City north of Main St, includes Hwy 19 runoff, west of River |
| 19 | 8.59 | OF25⁺ | 24" | Furthest north drainage basin with large diameter outfall |
| Downstream⁺ | NA | NA | NA | Upstream of US 19 bridge within NPR city limits |
| East Gate Estates | | Lake | | East Gate Estates |

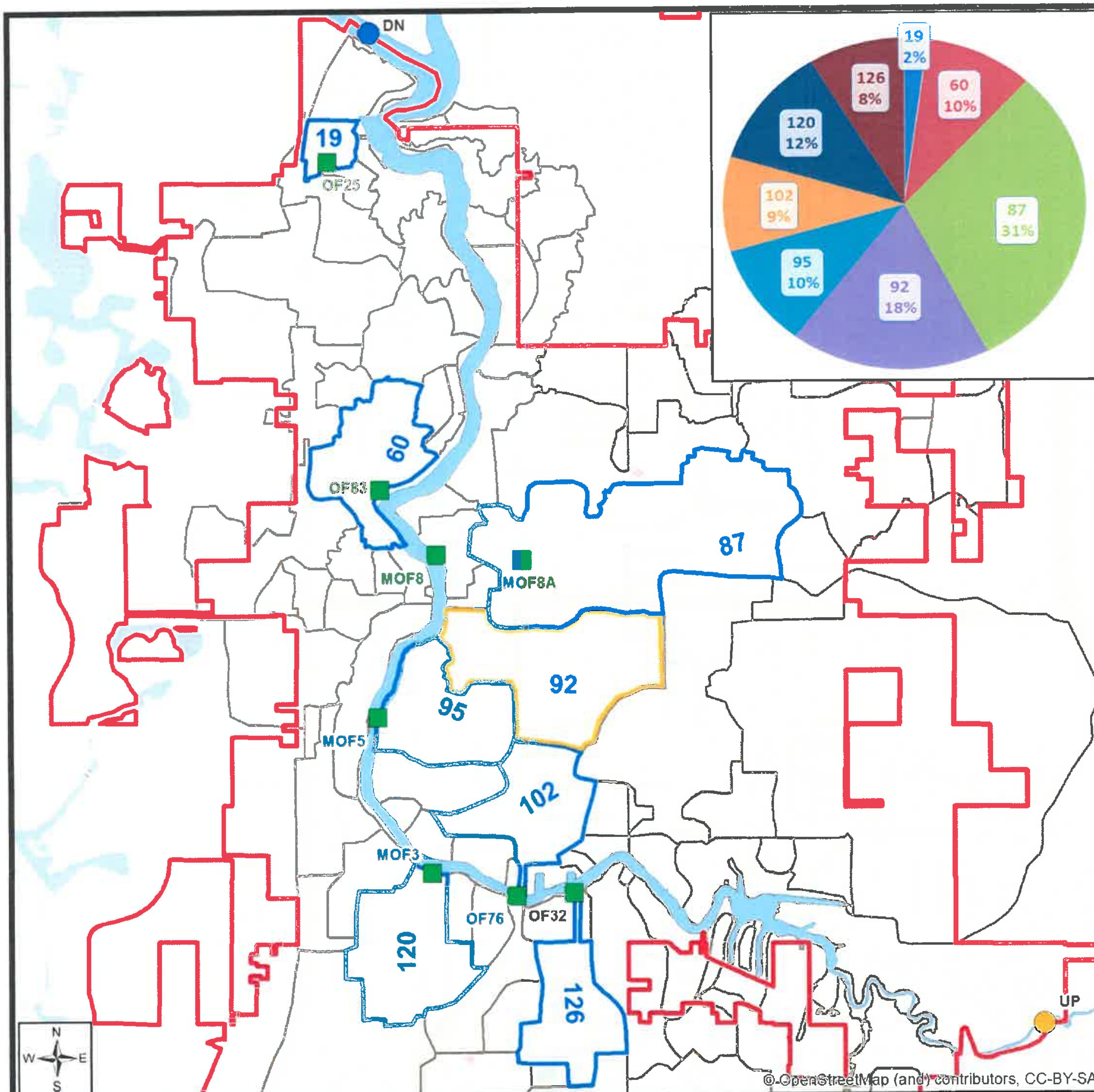
* Due to its location in close proximity to MOF8, which drains Main St and Orange Lake, MOF5 was chosen as an alternate sampling location.

⁺ OF25 was chosen as an alternate sampling location for the downstream location.

Table 2. Zoning and Land Use Types.

| Abbreviation | Description |
|---|---|
| DOWNTWN | Downtown |
| GEN COM | General Commercial |
| HIGH DEN | High Density Residential - 30 units/acre |
| HWY COM | Highway Commercial |
| LMD | Low Medium Density Residential - 10 units/acre |
| LOW DEN | Low Density Residential - 5 units/acre |
| MDR=14 | Medium Density Residential - 14 units/acre |
| MDR=20 | Medium Density Residential - 20 units/acre |
| PUB SEMI/P | Public/Semi Public |
| REC O/S | Recreation/Open Space |
| RES. OFFIC | Residential/ Office |

# Figure 3. Sampled Drainage Basins




## Legend

**River Sample Locations**

- DN
- UP
- NPR Boundary
- Outfall Locations

**Basins**

- Regularly Sampled Basins
- Basin Sampled Once
- Pithlachascotee River
- Basins Not Sampled

| Drainage Basin | Acreage | Outfall Name | Outfall Size (in) |
|---|---|---|---|
| 126 | 34.04 | OF32 | 30" |
| 102 | 37.03 | OF76 | 30" |
| 120 | 46.81 | MOF3 | 42" |
| 95 | 40.34 | MOF5 | 36" |
| 92 | 71.34 | OF13 | 30" |
| 87 | 122.46 | N/A | N/A |
| 60 | 38.54 | OF83 | 24" |
| 19 | 8.59 | OF86 | 24" |

Scale: Feet
0 750 1,500 3,000

Date: 5/24/2016

GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com

The City of New Port Richey is the largest city in Pasco County and has experienced tremendous growth in the last 50 years. Table 3 summarizes the zoning and land use categories by total acreage per drainage basin and by percent area covered per drainage basin based on the 2004 Zoning GIS files provided by the City of New Port Richey. Figure 4 shows the land use zoning within the sampled drainage basins. Maps zoomed in to each individual basin is provided in Appendix A. Almost half (47%) of the area within the sampled drainage basins (DB) is comprised by "Low Medium Density Residential - 10 units/acre" zoning/LU code. The ""Downtown" zoning/LU code comprises approximately 20% of the sampled drainage basins (DB).

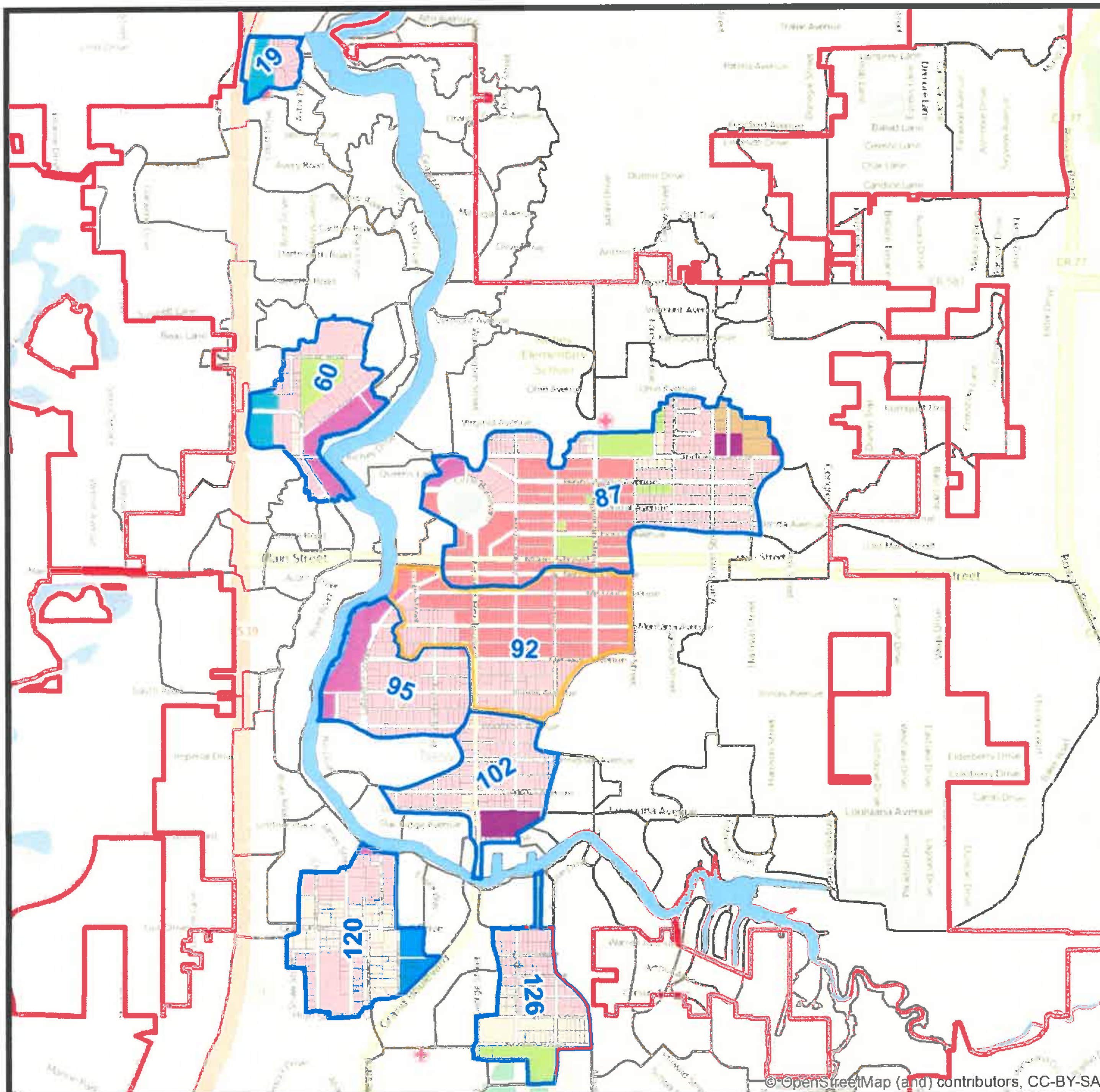
The largest type of zoning/LU within any individual drainage basin (DB) is "Downtown" with 33.04 acres (ac) in DB#92 and in DB #87 with 31.59 ac. The next highest zoning/LU category present in the sampled drainage basins was "Low Medium Density Residential - 10 units/acre" at 29.36 ac in DB#87 and 22.07 ac in DB#95. Land use types, specifically Downtown and Highway Commercial, are considered to have the heaviest vehicular traffic. DB#19 is comprised of almost 50% of Highway Commercial.

Figure 5 shows the progression between low medium density residential and residential/office land use categories in the upstream basins to low medium residential and downtown land use categories in the center of the city to low medium density residential and highway commercial land categories as the river flows towards US Highway 19.

The most diverse zoning/LU is spread throughout DB#87, which is covered by seven (7) different types of zoning/LU and is also the largest in area of the drainage basins, covering approximately 79.7 acres. The second most diverse zoning/LU is spread throughout DB#102, which is the one of the smallest areas that was sampled containing 38.5 total acres.

Table 3. Statistics for Zoning/Land Use (Total Acres and % Area Covered).

| | | Drainage Basin (Total Acres/% Area Covered) | | | | | | | | | Total Acres |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NPR FLU DESC | | 126 | 102 | 120 | 95 | 91 | 92 | 87 | 60 | 19 | |
| DOWNTWN | Acres | | | | 0.2 | 3.7 | 33.0 | 31.6 | | | 68.6 |
| | % | | | | 0.7% | 18.6% | 64.6% | 39.6% | | | |
| GEN COM | Acres | | | 3.9 | | | | | | | 3.9 |
| | % | | | 10.1% | | | | | | | |
| HIGH DEN | Acres | | 3.9 | | | | | 1.9 | | | 5.8 |
| | % | | 14.8% | | | | | 2.4% | | | |
| HWY COM | Acres | | | | | 1.6 | | | 3.7 | 3.5 | 8.9 |
| | % | | | | | 8.0% | | | 10.9% | 48.1% | |
| LMD | Acres | 13.1 | 20.3 | 17.6 | 22.1 | | 17.7 | 29.4 | 16.9 | 3.8 | 140.9 |
| | % | 47.0% | 77.8% | 45.8% | 71.8% | | 34.6% | 36.8% | 49.3% | 51.9% | |
| LOW DEN | Acres | | 0.0 | 0.6 | 8.4 | 14.8 | 0.4 | 2.0 | 8.0 | | 34.3 |
| | % | | 0.1% | 1.4% | 27.5% | 73.4% | 0.9% | 2.6% | 23.3% | | |
| MDR=14 | Acres | | 0.1 | | | | | | | | 0.1 |
| | % | | 0.4% | | | | | | | | |
| MDR=20 | Acres | | 0.6 | | | | | | | | 0.6 |
| | % | | 2.5% | | | | | | | | |
| PUB SEMI/P | Acres | 6.2 | | | | | | 7.9 | 4.7 | | 18.8 |
| | % | 22.2% | | | | | | 9.9% | 13.7% | | |
| REC O/S | Acres | | | | | | | 5.0 | | | 5.0 |
| | % | | | | | | | 6.3% | | | |
| RES. OFFIC | Acres | 8.6 | 1.2 | 16.4 | | | | 2.0 | 1.0 | | 29.1 |
| | % | 30.7% | 4.5% | 42.7% | | | | 2.5% | 2.8% | | |
| Total Acres | | 27.9 | 26.2 | 38.5 | 30.7 | 20.1 | 51.1 | 79.7 | 34.3 | 7.4 | 315.9 |




# Figure 4 . Zoning and Land Use with New Port Richey

**Legend**

- NPR Boundary

**Sampled Basins**

**Basin_No**

- Regularly Sampled Basins
- Basin Sampled Once
- Pithlachascotee River

**LandUse**

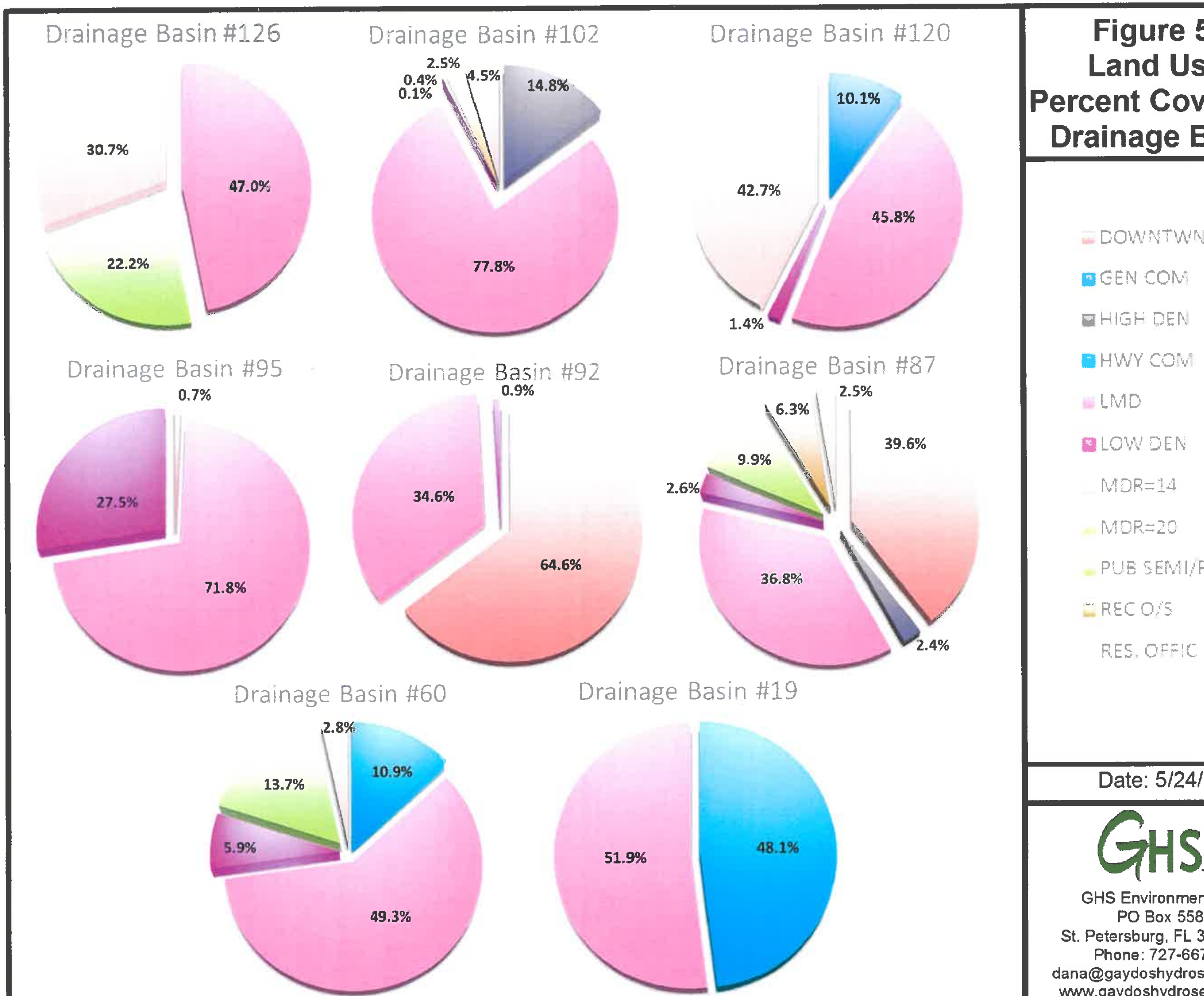
- Downtown
- General Commercial
- High Density Residential - 30 units/acre
- Highway Commercial
- Low Medium Density - 10 to 30 units/acre
- Low Density - 5 units/acre
- Medium Density Residential - 14 units/acre
- Medium Density Residential - 20 units/acre
- Public/Semi Public
- Recreation/Open Space
- Residential/Office
- Basins Not Sampled

N W E S

Scale:
Feet
0 470 940 1,880 2,820

Date: 5/24/2016

GHS LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com




# Figure 5. Land Use Percent Cover per Drainage Basin

Date: 5/24/2016


GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com

# 3.0 Methodology

An adaptive water quality sampling program was developed for this project due to the numerous variables within the Cotee River watershed. This program was designed to quantify nutrient and pollutant loads from the watershed, delineate “hot spots” within the river system and identify areas or regions of specific sources. The water quality sampling program established loading from direct runoff from the stormwater system. One area of concern is downstream of East Gate Estates, which is one of the last remaining communities along the river still on septic systems. The water quality sampling program was designed to identify such areas of concerns and to determine if pollutant loads can be linked directly to a land use source.

## 3.1 Sample Collection

Typical sampling of rivers and streams occurs when there is flow. Since the Cotee River is predominantly influenced by the tides, sampling directly from the drainage outfall had to occur during low tide to ensure the collection of stormwater discharge and not a mixture of stormwater with river water, which could be of a brackish nature during high tide event. An initial investigation of the stormwater outfalls showed that the majority of the outfalls remain submerged during low tide. Because the focus of this sampling program was to determine areas of high pollutant discharge to the Cotee River, samples were collected upstream of the discharge point to the river and within the stormwater system infrastructure. The first three (3) samples were collected during a low tide event and within the stormwater system. Diligent effort was expended to capture the first flush of the rain event at a low tide and with a safe working environment. To eliminate the safety concerns of sampling during a rain storm, a bucket sampler was designed and constructed to capture and hold the first flush of the rain event. Two bucket samplers were placed in each of drainage basins to be sampled except for drainage basin that includes Orange Lake. Samples were collected from directly from the end of the stormwater pipes on the east side of Orange Lake. The captured material was combined and considered as a composite sample to represent the parameter concentrations of that basin. Samples were collected using this bucket sampler method for the remaining seven (7) events. Further information regarding the bucket sampler is included in Appendix B.

### 3.1.1 Sample Locations

The City of New Port Richey provided the locations and drainage basins for each of the outfalls discharging to the Cotee River. Additionally, large diameter outfalls (diameter of 24 inches and greater) were reviewed for sample selection. New Port Richey has a total of twenty-five (25) large diameter outfalls discharging to the Pithlachascotee River. Of those, ten (10) large diameter outfalls with the highest acreage within the drainage basin were selected to be sampled for this project. Table 4 summarizes the selected drainage basins by outfall size and acreage. Drainage basins that were sampled for this study include DB#126, DB#102, DB#120, DB#95, DB#87, DB#60 and DB#19 along with one upstream location and one downstream location. Figure 3 identifies the sampled drainage basins and outfall locations.

Table 4. Drainage Basin Summary.

| Drainage Basin | Acreage | Outfall Name | Outfall Size (in) |
|---|---|---|---|
| 126 | 34.04 | OF32 | 30" |
| 102 | 37.03 | OF76 | 30" |
| 120 | 46.81 | MOF3 | 42" |
| 95 | 40.34 | MOF5 | 36" |
| 92 | 71.34 | OF13 | 30" |
| 87 | 122.46 | MOF8 | 42" |
| 60 | 38.54 | OF83 | 24" |
| 19 | 8.59 | OF86 | 24" |

DB#92 (Outfall OF13) was sampled initially then replaced with DB#95 (Outfall MOF5) since it lies adjacent to DB#87 (Outfall MOF8), which is larger in total acreage, contains Orange Lake, and has the largest covered area within downtown. The selection of DB#95 allowed for better spatial coverage between the various drainage basins east and west of the river as well as north and south within the city limits.

A downstream location was initially sampled, and laboratory results confirmed the brackish nature of the river water even at a low tide. Since nutrient and pollutant inputs are the focus of the project, DB#19 replaced the downstream location since it contains the last outfall upstream of the river's terminus from the city limits. It was also selected since it is the only drainage basin with the highest percent coverage (48%) of the "Highway Commercial" zoning/LU code, although the total acreage of DB#19 is only 8.59 acres.

### 3.1.2 Sampling Frequency

Eight (8) sampling locations were sampled a total of ten (10) for a total of eighty (80) samples. All samples were collected following a rain event that caused discharge from the City's stormwater system into the Cotee River. The wet season in central Florida is considered mid-May through mid-October (5 months) with the dry season being the end of October through April (7 months). There were five (5) sampling events in both the wet and dry season. Table 5 lists the dates each of the drainage basins were sampled.

## 3.2 Sample Parameters

Samples were collected and analyzed for concentrations of major inorganic constituents and physical characteristics, nutrients, trace elements, suspended sediment, selected organic compounds, and bacteriological and biological constituents. All samples were analyzed by a certified National Environmental Laboratory Accreditation Conference (NELAC) laboratory.

Table 5. Summary of Sampling Events.

| Basin | UP | 126 | 102 | 120 | 95 | 92* | 87 | 60 | 19 | DN* |
|---|---|---|---|---|---|---|---|---|---|---|
| Date Sampled | 3/23/15 | 3/23/15 | 3/23/15 | 3/23/15 | | 3/23/15 | 3/23/15 | 3/23/15 | | 3/23/15 |
| | 5/26/15 | 5/26/15 | 5/26/15 | 5/26/15 | 5/26/15 | | 5/26/15 | 5/26/15 | 5/26/15 | |
| | 7/17/15 | 7/17/15 | 7/17/15 | 7/17/15 | 7/17/15 | | 7/17/15 | 7/17/15 | 7/17/15 | |
| | 9/14/15 | 9/14/15 | 9/14/15 | 9/14/15 | 9/14/15 | | 9/14/15 | 9/14/15 | 9/14/15 | |
| | 9/28/15 | 9/28/15 | 9/28/15 | 9/28/15 | 9/28/15 | | 9/28/15 | 9/28/15 | 9/28/15 | |
| | 10/5/15 | 10/5/15 | 10/5/15 | 10/5/15 | 10/5/15 | | 10/5/15 | 10/5/15 | 10/5/15 | |
| | 10/28/15 | 10/28/15 | 10/28/15 | 10/28/15 | 10/28/15 | | 10/28/15 | 10/28/15 | 10/28/15 | |
| | 11/10/15 | 11/10/15 | 11/10/15 | 11/10/15 | 11/10/15 | | 11/10/15 | 11/10/15 | 11/10/15 | |
| | 1/11/16 | 1/11/16 | 1/11/16 | 1/11/16 | 1/11/16 | | 1/11/16 | 1/11/16 | 1/11/16 | |
| | 1/22/16 | 1/22/16 | 1/22/16 | 1/22/16 | 1/22/16 | | 1/22/16 | 1/22/16 | 1/22/16 | |
| Total # Samples per Drainage Basin | 10 | 10 | 10 | 10 | 9 | 1 | 10 | 10 | 9 | 1 |
| Total # of Samples | 80 | | | | | | | | | |

* Sampled one time.

## 3.2.1 Field Parameters

At all sampling locations, in situ field measurements of water temperature, pH, specific conductance, dissolved oxygen, and turbidity was collected using a YSI Pro Plus Multi-Parameter Water Quality Meter and a LaMotte 2020we turbidity meter. Table 6 lists all field parameters collected. All field equipment was calibrated according to the manufacturer's specifications prior to deployment in the field. For the first three sampling events, measurements were recorded by placing the unit directly into a clean container filled with stormwater from the nearest manhole of the outfall structure immediately prior to discharge to the river in the selected drainage basin. For the last seven (7) events, measurements were recorded by placing the unit directly into the sample bucket. Please note that ambient atmospheric conditions may have affected several of the physical parameters, specifically temperature.

Table 6. Field Parameter List.

| **Field Parameters** | | |
|---|---|---|
| Temperature (°C) | Specific Conductance (µS/cm) | Dissolved Oxygen (mg/l and %) |
| pH (St. Units) | Total Dissolved Solids (mg/l) | Turbidity (NTU) |

Additional data was observed, measured and recorded at the upstream sample location regarding stream conditions. These included the following flow (if visible) whether upstream or downstream based on the tide, tide and water level elevation, vegetation coverage and visual observation of debris or obstructions. This information can be found summarized in Appendix C.

### 3.2.2 Laboratory Parameters

The scope of this project is to determine areas within New Port Richey contribute pollutants to the Pithlachascotee River. The various parameters are summarized below in Table 7. All nutrients, heavy metals and bacteriological parameters were sampled during each sampling event at each location for a total of 80 samples. Due to the expense of the pesticide/herbicide scans, these parameters were only be sampled for a total of four sample events, specifically in the months of March 2015, July 2015, November 2015 and January 2015.

A composite grab sample (comprised of several sub-sample vessels) was collected at each monitoring location for laboratory analysis. The collected samples are preserved in the field and taken to the laboratory for measured of the following parameters.

Table 7. Laboratory Parameter Summary.

| Pesticides | Herbicides | Metals |
|---|---|---|
| 4,4'-DDD | 2,4,5-T | Arsenic |
| 4,4'-DDE | 2,4-D | Cadmium |
| 4,4'-DDT | 2,4-DB | Chromium |
| Aldrin | Dalapon | Copper |
| alpha-BHC | Dicamba | Lead |
| beta-BHC | Dichlorprop | Nickel |
| Chlordane (technical) | Dinoseb | Zinc |
| delta-BHC | MCPA | |
| Dieldrin | Mecoprop | **Oil & Grease** |
| Endosulfan I | Pentachlorophenol | HEM |
| Endosulfan II | Silvex (2,4,5-TP) | |
| Endosulfan sulfate | | **Nutrients** |
| Endrin | **Ionic Measurements** | Ammonia as N |
| Endrin aldehyde | Chloride | Nitrogen, Kjeldahl |
| Endrin ketone | Total Dissolved Solids | Nitrate as N |
| gamma-BHC (Lindane) | Total Suspended Solids | Nitrate Nitrite as N |
| Heptachlor | | Nitrite as N |
| Heptachlor epoxide | **Microbiology** | Total Nitrogen |
| Methoxychlor | Coliform, Total | Dissolved Orthophosphate |
| Toxaphene | Coliform, Fecal | Total Phosphorus |

The methods used in the collection, handling and storage of all samples were conducted in accordance with FDEP/USEPA/NELAP approved procedures (FS 2100). All samples were held on ice and delivered to a National Environmental Laboratory Accreditation Conference (NELAC) laboratory. Analysis of all surface water samples was conducted by TestAmerica, Inc. (NELAC Certification #E83079).

GHS, LLC

## 3.3 Rainfall Data Collection and Analysis

A rain gage is located at every lift station within the city limits. Each rain gage is a self-emptying tipping bucket with a measurement increment of 1 centimeter (cm). There are approximately 70 rain gages providing rainfall coverage across the entire city; however, there were twenty-eight (28) stations that had recorded rain data on the dates sampled and fifteen (15) stations on average. Figure 6 shows the locations of the rain gages and the sampled drainage basins used in this analysis. The data provided by the City for last two dates, January 11, 2016 and January 22, 2016, did not contain enough data points to interpolate without supplementing from other sources, in this case the NOAA website. The rain was reported in centimeters (cm) and converted to inches (in), then plotted in their geographic locations as points (Figure 6). The manner of rain and sample collection was by event. There was one sample date that was combined for a storm that encompassed two sequential dates: November 9 and 10, 2015. Rain data per rain gage per date is included in Appendix D along with contour maps for each rain event.

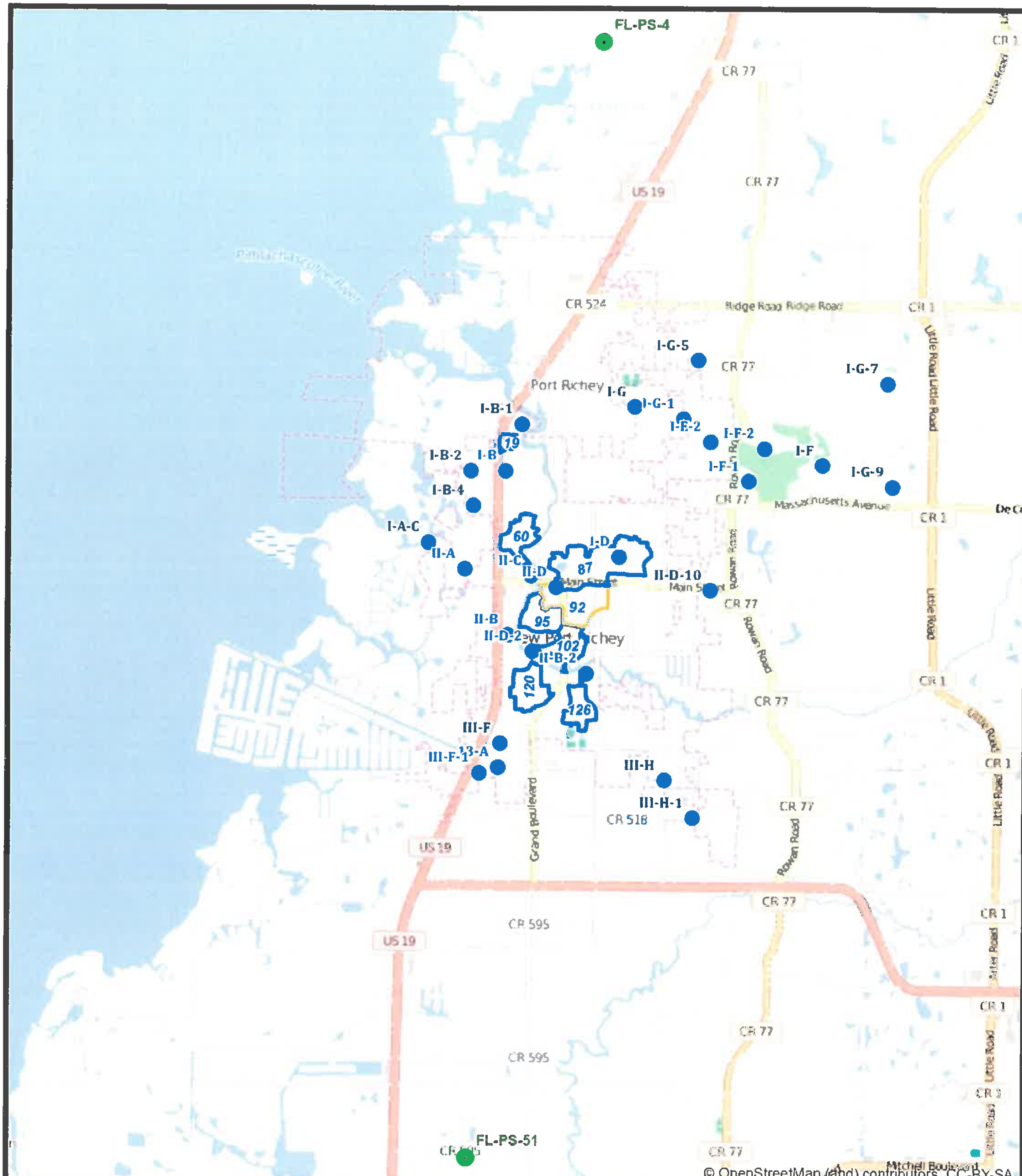
Each data point was interpolated using ArcGIS, 3-D Analyst Extension. The method of interpolation used was Inverse Distance Weighting (IDW), which assumes that the variable being mapped decreases in influence with distance from its sampled location, therefore it applies weighting based on the proximity of the sample locations to each raster cell of the overall sample area, generating a surface (continuous) raster output. The raster surfaces were generated for each date of sampling, then clipped to the 10 drainage basins for those dates. Once this was done, statistics could be gathered on the average rain over each basin for each date.

## 3.4 Stormwater Runoff Calculations

The purpose of this study is to present methodology that can be used to estimate nutrient loads discharged from the stormwater system within the boundaries of New Port Richey to the Cotee River.

There are several major assumptions used in our estimations.

1. All data provided by the City of New Port Richey is reasonable accurate.
2. The acreage provided by the City of New Port Richey for each outfall was representative of the total acreage for the entire drainage basin it services.
3. The runoff coefficients from the 1992 drainage basin report by Dames and Moore is a valid representation of current conditions.
4. The 2004 GIS zoning and land use files are a valid representation of current conditions.
5. Where data was missing, GHS used the next closest and available data set, specifically for rainfall for the last two sample dates.
6. The collected sample is a valid representative of the entire drainage basin it was collected in both in area and time.





GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com


**Legend**

- Rain Gages
- NOAA Rain Gages
- Regularly Sampled Basins
- Basin Sampled Once

N
W E
S

**Figure 6.**
**Rain Gage Locations**

Scale: Miles
0 0.25 0.5 1

Date: 5/24/2016

Typical river systems include tributary stream flow from the watershed into the river contributing flow and other associated inputs. Within the City of New Port Richey, the tributary system has become the City's municipal Separate Storm Sewer System (MS4) inputs instead of tributary streams and can be considered similar for nutrient loading correlation. Nutrient loading is a continuous process that is a product of streamflow and nutrient concentration over time. A general equation for nutrient loading is defined as:

$$L_E = C_E \times Q_E \qquad \text{Eq. 1}$$

Where $L_E$ = load (mass transported) per event, $C_E$ = nutrient concentration (mass/volume) per event, and $Q_E$ = Flow (volume) per event.

Flow ($Q_E$) through the stormwater system can be quantified by calculating the total rainfall captured within the drainage basin and estimating the runoff coefficient to account for evaporation and infiltration:

$$Q_E = A \times R_E \times D_C \qquad \text{Eq. 2}$$

Where $Q_E$ = Flow (volume) in million gallons (mgal) per event, A = Area (total acres), $R_E$ = Rainfall per event, and $D_C$ = Drainage Coefficient ($D_C < 1$).

The 1992 Master Drainage Plan identified and determined sub-basins within the designated drainage basins of New Port Richey based on land use. For this study, a composite runoff coefficient was determined for each of the seven sampled drainage basins. The composite coefficient was selected by determination of the size of the sub-basins versus the total area of the sampled drainage basin. The following table lists the runoff coefficient for each sampled drainage basin.

Table 8. Runoff Coefficients for Drainage Calculations.

| Drainage Basins | Acreage | Drainage Coefficient ($D_C$) |
|---|---|---|
| UP | | |
| 126 | 34.0 | 80 |
| 120 | 46.8 | 79 |
| 102 | 37.0 | 78 |
| 95 | 40.3 | 77 |
| 92* | 71.3 | 79 |
| 87 | 122.5 | 80 |
| 60 | 38.5 | 90 |
| 19 | 8.6 | 91 |
| DN* | | |

* Sampled once.

The two drainage basins, DB #60 and DB #19, which contain the Highway Commercial land use have the highest runoff coefficients. As other land use types become predominate, such as residential, public areas and residential areas, the runoff coefficient goes down.

In order to create loading amounts for each variable that was determined to be most important with each drainage basin, the analytical results for each sampled parameter was then multiplied by the volumetric calculation to quantify the pounds per event.

$$L_E = C_E \times Q_E \times 8.34 \text{ Lbs/gal} \qquad \text{Eq. 3}$$

Where $L_E$ = load (mass transported) or pounds (Lbs) per event, $C_E$ = nutrient concentration (mass/volume) per event, and $Q_E$ = Flow (mgal) per event, and the conversion factor = 8.34 pounds (Lbs) per gallons (gal). The concentration, CE, must be expressed in parts per million (ppm) or milligrams per liter (mg/l). Using these specific units, the parts per million (ppm) converts easily to pounds per million pounds (Lbs/MLbs). The Flow, $Q_E$, must be expressed as millions of gallons. Using the units of million gallons for flow with the pounds per million pounds (Lbs/MLbs) and the conversion factor between gallons to pounds converts easily to pounds (Lbs).

$$\frac{\text{Lbs}}{\text{MLbs}} \times \frac{\text{Mgal}}{\text{event}} \times \frac{\text{Lbs}}{\text{gal}} = \frac{\text{Lbs}}{\text{event}}$$

# 4.0 Results

Due to the large dataset, the following sections review the averages of the various parameters found within the sampled drainage basins and the loading potential based on average rainfall between the sampling events. Parameters that exceeded any specific environmental standard is discussed individually. All other parameters and all datasets can be found in the appendices.

## 4.1 Rainfall (in) per Event

Rainfall data was collected from an average of 15 rain gages from within the city limits. Each individual data point was geographically referenced and contours could be made to calculate the total rainfall within each drainage basin. Statistics were generated over each drainage basin for each sampling date. The average rainfall range for each drainage basin is listed in Table 9.

Table 9. Rainfall (in) per Drainage Basin.

| Rainfall per Basin (in) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin (Acreage) | 126 (34.04) | 102 (37.03) | 120 (46.81) | 95 (40.34) | 92* (71.34) | 87 (122.46) | 60 (38.54) | 19 (8.59) | Average (in) |
| 3/23/2015 | 0.84 | 0.94 | 0.95 | 1.06 | 1.12 | 1.33 | 1.04 | 0.96 | 1.07 |
| 5/26/2015 | 3.62 | 3.14 | 3.43 | 3.04 | | 2.94 | 2.84 | 3.12 | 3.08 |
| 7/17/2015 | 0.38 | 0.4 | 0.42 | 0.47 | | 0.25 | 0.51 | 0.57 | 0.41 |
| 9/14/2015 | 0.44 | 0.39 | 0.43 | 0.38 | | 0.41 | 0.3 | 0.28 | 0.38 |
| 9/28/2015 | 0.08 | 0.08 | 0.08 | 0.08 | | 0.04 | 0.06 | 0.06 | 0.07 |
| 10/5/2015 | 1.2 | 1.37 | 1.24 | 1.38 | | 1.73 | 1.09 | 0.34 | 1.36 |
| 10/28/2015 | 1.18 | 1.12 | 0.96 | 0.97 | | 1.74 | 1.18 | 0.73 | 1.19 |
| 11/10/15+ | 0.50 | 0.62 | 0.78 | 0.8 | | 0.52 | 0.95 | 0.79 | 0.73 |
| 1/11/2016 | 0.28 | 0.62 | 0.59 | 0.88 | | 0.78 | 1.13 | 1.07 | 0.80 |
| 1/22/2016 | 0.08 | 0.08 | 0.08 | 0.08 | | 0.08 | 0.08 | 0.08 | 0.08 |
| Average Rainfall per Event (in) | | | | | | | | | 0.92 |

* Sampled once.

+ Includes rainfall for the entire rain event from 11/9/15 through 11/10/15.

The largest rain event that occurred during the monitoring period was May 26, 2016 with an average of 3.08 inches over the city. The lightest rain event occurred on September 28, 2016 with an average of 0.07 inches over the city. The average rainfall over the monitoring period was 0.92 inches per event.

### 4.1.1 Rainfall Volume (Mgal/event)

Table 10 lists the rainfall volumes in million gallons per event (Mgal/event) for each drainage basin. The largest rainfall volume received during the monitoring period was May 26, 2016 with a total of 9.8 million gallons within the largest drainage basin, DB#87. Over the duration of the May 26, 2015 rainfall event, the city received 4.0 Mgal/event on average. The smallest rainfall volume received was on September 28, 2016 with a total of 0.019 Mgal/event within the smallest drainage basin, DB#19, and a total of 0.10 Mgal/event over the entire sample area. The average rainfall volume over the sampling area was 1.2 Mgal/event.

Table 10. Rainfall Volume per Basin (Mgal/event).

| Rainfall Volume per Basin (Mgal/event) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin (Acreage) | 126 (34.04) | 102 (37.03) | 120 (46.81) | 95 (40.34) | 92* (71.34) | 87 (122.46) | 60 (38.54) | 19 (8.59) | Average (in) |
| 3/23/2015 | 0.78 | 0.95 | 1.21 | 1.16 | 2.2 | 4.4 | 1.1 | 0.22 | 1.5 |
| 5/26/2015 | 3.3 | 3.2 | 4.4 | 3.3 | | 9.8 | 3.0 | 0.73 | 4.0 |
| 7/17/2015 | 0.35 | 0.40 | 0.53 | 0.51 | | 0.83 | 0.53 | 0.13 | 0.47 |
| 9/14/2015 | 0.41 | 0.39 | 0.55 | 0.42 | | 1.4 | 0.31 | 0.065 | 0.50 |
| 9/28/2015 | 0.074 | 0.080 | 0.10 | 0.088 | | 0.13 | 0.063 | 0.014 | 0.08 |
| 10/5/2015 | 1.1 | 1.38 | 1.6 | 1.5 | | 5.8 | 1.1 | 0.079 | 1.8 |
| 10/28/2015 | 1.1 | 1.13 | 1.2 | 1.1 | | 5.8 | 1.2 | 0.17 | 1.7 |
| 11/10/15+ | 0.46 | 0.62 | 0.99 | 0.88 | | 1.7 | 0.99 | 0.18 | 0.84 |
| 1/11/2016 | 0.26 | 0.62 | 0.75 | 0.96 | | 2.6 | 1.2 | 0.25 | 0.95 |
| 1/22/2016 | 0.074 | 0.080 | 0.10 | 0.088 | | 0.27 | 0.084 | 0.019 | 0.10 |
| Average Rainfall Volume per Event (ac-ft) | | | | | | | | | 1.2 |

* Sampled once.
\+ Includes rainfall for the entire rain event from 11/9/15 through **11/10/15**.

### 4.1.2 Stormwater Runoff Volume (Mgal/event)

Table 11 lists the stormwater runoff volume estimates for each drainage basin per rain event based on a composite runoff coefficient from the 1992 Master Drainage Plan. The largest stormwater runoff volume was seen on May 26, 2015 with an average of 3.2 Mgal/event averaged over the sample area. The smallest stormwater runoff volume was 0.064 Mgal/event averaged over the sample area.

Table 11. Stormwater Runoff Volumes per Basin (Mgal/event).

| Stormwater Runoff Volume per Basin (Mgal/event) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin (Acreage) | 126 (34.04) | 102 (37.03) | 120 (46.81) | 95 (40.34) | 92* (71.34) | 87 (122.46) | 60 (38.54) | 19 (8.59) | Average (in) |
| 3/23/2015 | 0.62 | 0.74 | 0.95 | 0.89 | 1.7 | 3.5 | 0.98 | 0.20 | 1.21 |
| 5/26/2015 | 2.7 | 2.5 | 3.4 | 2.6 | | 7.8 | 2.7 | 0.7 | 3.2 |
| 7/17/2015 | 0.28 | 0.31 | 0.42 | 0.40 | | 0.67 | 0.48 | 0.12 | 0.38 |
| 9/14/2015 | 0.33 | 0.31 | 0.43 | 0.32 | | 1.1 | 0.28 | 0.059 | 0.40 |
| 9/28/2015 | 0.059 | 0.063 | 0.080 | 0.067 | | 0.11 | 0.057 | 0.013 | 0.064 |
| 10/5/2015 | 0.89 | 1.1 | 1.2 | 1.2 | | 4.6 | 1.0 | 0.072 | 1.44 |
| 10/28/2015 | 0.87 | 0.88 | 0.96 | 0.82 | | 4.6 | 1.1 | 0.15 | 1.35 |
| 11/10/15+ | 0.37 | 0.49 | 0.78 | 0.67 | | 1.4 | 0.89 | 0.17 | 0.68 |
| 1/11/2016 | 0.21 | 0.49 | 0.59 | 0.74 | | 2.1 | 1.1 | 0.23 | 0.77 |
| 1/22/2016 | 0.059 | 0.063 | 0.080 | 0.067 | | 0.21 | 0.075 | 0.017 | 0.082 |
| Average per Basin | 0.64 | 0.69 | 0.90 | 0.77 | 1.7 | 2.6 | 0.86 | 0.17 | |
| Average Stormwater Runoff Volume per Event (ac-ft) | | | | | | | | | 1.0 |

* Sampled once.

+ Includes rainfall for the entire rain event from 11/9/15 through 11/10/15.

## 4.2 Average Sample Parameter Concentrations

A total of 80 samples were collected for this study following a range of rainfall events. Over 2,600 analyses were conducted of various parameters of nutrients, pollutants including herbicides, pesticides and heavy metals, and other biological and ionic constituents. Out of the 2,600 analyses that were conducted, there was approximately 1,100 parameters detected. All parameters that were detected during the monitoring period are included in the body of this report. All data is listed in summary tables by drainage basin in Appendix E. Laboratory Reports are included in Appendix F.

### 4.2.1 Undetected Parameters

Many herbicides and pesticides breakdown into non-toxic compounds when mixed with water so it can be expected to see the majority of these parameters to be reported as undetected. Table 12 lists the parameters that were sampled for and not detected. None of the pesticides were detected, and seven (7) out of eleven herbicides were not detected. There were two heavy metals, arsenic and cadmium, that were also not detected during the monitoring period. Man-made sources of arsenic include mining operations, burning of fossil fuels, timber treatment, agricultural operations as well as glass and pharmaceutical manufacturing. Man-made sources of cadmium include plastic stabilizers, pigments, solder, and nickel-cadmium batteries. None of those industries are present in within the city limits of New Port Richey.

Table 12. Undetected Sample Parameters.

| **Pesticides** | | **Herbicides** |
|---|---|---|
| 4,4'-DDD | Endosulfan II | 2,4-DB |
| 4,4'-DDE | Endosulfan sulfate | Dalapon |
| 4,4'-DDT | Endrin | Dichlorprop |
| Aldrin | Endrin aldehyde | Dinoseb |
| alpha-BHC | Endrin ketone | MCPA |
| beta-BHC | gamma-BHC (Lindane) | Mecoprop |
| Chlordane (technical) | Heptachlor | Silvex (2,4,5-TP) |
| delta-BHC | Heptachlor epoxide | **Metals** |
| Dieldrin | Methoxychlor | Arsenic |
| Endosulfan I | Toxaphene | Cadmium |

### 4.2.2 Herbicides

There were four (4) herbicides that were detected and include 2,4,5-T, 2,4-D, dicamba and pentachlorophenol. Each of these parameters were detected in specific drainage basins on specific sampling dates and were not consistently present. Table 13 lists the detections per drainage basin per date. Several of the detections were below the laboratory's practical quantitation limit but above the method detection limit so the parameter was detected; however, the concentration cannot be verified since it is so low. Herbicides were detected within several drainage basins, specifically in DB#126, DB#102, DB#120, and DB#60 on various rainfall events. Average concentrations of the herbicides are listed in Table 14. All individual detections and average herbicide concentrations are well below the Ch. 62-777, F.A.C. Class III Surface Water Standard. The drainage basins with detections of various herbicides correlates well with the major land use category being residential. It is common in residential areas to have heavy fertilizer and herbicide applications.

### 4.2.3 Heavy Metals

Heavy metals in stormwater are of particular concern due to their toxicity and conservative nature. There are numerous sources of heavy metals in stormwater and include impervious surfaces, such as highways, road surfaces and rooftops. Heavy metals are found dissolved in the stormwater or are bound to particles. The different phases effects the occurrence, transport, fate and biological effects in aquatic systems. Most heavy metals pollutants in stormwater are bound to particulates and tend to settle out of the water column, accumulating in sediments. This study focused on the dissolved concentrations of heavy metals in the stormwater runoff, which can have the most impact on the Cotee River, the downstream estuary and, ultimately, the Gulf of Mexico.

Several heavy metals were detected regularly in the stormwater runoff in the various drainage basins. Table 15 lists the average concentrations from each of the sampled

GHS, LLC

## Table 13. Individual Detections of Herbicides.

| Sample Date | | | | | | 7/17/2015 | 3/23/2015 | 11/5/2015 | 1/22/2016 | 1/22/2016 | 11/5/2015 | 1/22/2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | Reporting Units | NNC Cotee Estuary | 62-302 Fresh Surface Water | 62-777 Fresh Surface Water | 62-777 Marine Water | UP | 126 | 102 | 102 | 120 | 60 | 60 |
| 2,4,5-T | ug/l | | | 140 | 140 | U | U | U | U | U | 0.31 | U |
| 2,4-D | ug/l | | | 80 | 80 | 0.14 | U | 0.88 | 0.052 (I) | U | U | 0.58 |
| Dicamba | ug/l | | | 200 | 200 | U | U | U | U | U | U | 0.14 (I) |
| Pentachlorophenol | ug/l | | 8.2 | | | U | 0.061 | U | U | 0.19 (I) | U | U |

U - Undetected.
(I) - The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.

## Table 14. Average Herbicide Concentrations.

| Drainage Basin | Reporting Units | NNC Cotee Estuary | 62-302 Fresh Surface Water | 62-777 Fresh Surface Water | 62-777 Marine Water | UP | 126 | 102 | 120 | 95 | 92* | 87 | 60 | 19 | DS* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2,4,5-T | ug/l | | | 140 | 140 | U | U | U | U | U | U | U | 0.078 | U | U |
| 2,4-D | ug/l | | | 80 | 80 | 0.035 | U | 0.23 | U | U | U | U | 0.14 | U | U |
| Dicamba | ug/l | | | 200 | 200 | U | U | U | U | U | U | U | 0.035 | U | U |
| Pentachlorophenol | ug/l | | 8.2 | | | U | 0.015 | U | 0.048 | U | U | U | U | U | U |

U - Undetected.
* - Location sampled once.

## Table 15. Average Heavy Metal Concentrations.

| Drainage Basin | Reporting Units | NNC Cotee Estuary | 62-302 Fresh Surface Water | 62-777 Fresh Surface Water | 62-777 Marine Water | UP | 126 | 102 | 120 | 95 | 92* | 87 | 60 | 19 | DS* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chromium | mg/l | | 0.011 | 0.011 | 0.05 | U | 0.0014 | 0.0014 | 0.0031 | 0.0014 | 0.0022 | U | 0.0051 | 0.00092 | U |
| **Copper** | mg/l | | 0.0037 | | | 0.00049 | **0.0077** | **0.0076** | **0.0073** | **0.0054** | **0.014** | 0.0007 | **0.013** | **0.0062** | **0.0043** |
| Lead | mg/l | | 0.0085 | | | U | 0.0019 | 0.0028 | 0.0035 | 0.0027 | 0.0058 | 0.00028 | 0.0022 | 0.0020 | U |
| Nickel | mg/l | | 0.0083 | | | U | 0.0010 | 0.00064 | 0.00057 | 0.00071 | 0.0054 | U | 0.0010 | 0.00080 | U |
| **Zinc** | mg/l | | 0.086 | | | 0.0025 | 0.080 | 0.054 | 0.065 | 0.047 | **0.48** | 0.0083 | **1.46** | 0.064 | U |

**BOLD** - Concentrations is above acceptable standard.
U - Undetected.
* - Location sampled once.

drainage basins. The heavy metals analyzed for in this study include arsenic, cadmium, chromium, copper, lead, nickel and zinc. Arsenic and cadmium were not detected during the study and are not included in this section.

Two heavy metals, copper and zinc, have average concentrations that exceed the Ch. 62-302 Fresh Surface Water Standard. Copper was found in all drainage basins sampled including the upstream location (UP). The upstream location (UP) had the lowest average copper concentration, which is expected. All but one drainage basin, DB#87, as well as the downstream location (DN) had average copper concentrations in excess of the Ch. 62-302 Fresh Surface Water Standard. It is presumed that DB #87 experienced dilution affects due the samples being collected from Orange Lake and not from a bucket sampler or the storm water system. The highest copper concentration reported was in DB#92, but this drainage basin was sampled only once then replaced with an alternative location for spatial diversity within the study. The highest average copper concentration was found in DB #60.

Zinc was detected in all the drainage basins at varying averages. The upstream location (UP) had the lowest average zinc concentration, which is expected. DB#87 showed low zinc averages and is considered to be due to dilution affects due the samples being collected from Orange Lake. The highest average copper concentration was found in DB#60. The second highest zinc concentration reported was in DB#92, but this drainage basin was sampled only once. Average concentrations in these two drainage basins, DB#60 and DB#92, were in excess of the Ch. 62-302 Fresh Surface Water Standard. Although only sampled once, the downstream location (DN) did not have a detection of zinc, which is presumed to be due to active tidal flushing as seen by the more brackish water as confirmed by the chloride concentration.

On average, chromium, lead and nickel were not in excess of the Ch. 62-302 Fresh Surface Water Standard. These parameters were undetected in both the upstream (UP) and downstream (DN) locations. Similar trends were seen in the various drainage basins with DB#87 having the lowest average concentrations, and either DB#60 or DB#92 having the highest average heavy metal concentrations.

#### 4.2.4 Nutrients

Nutrients include various chemical components but primarily refer to nitrogen and phosphorus species. Nutrients are essential for plants and animals, but excessive amounts, or eutrophication, may lead to severe environmental impacts to aquatic habitats. Sources of nitrogen and phosphorus include wastewater treatment plants or septic tanks, runoff from fertilized lawns and agricultural areas, and industrial discharges. There are multiple forms of nitrogen, which include ammonia, nitrates and nitrites, that are commonly measured in water bodies. Total nitrogen is the sum of total kjeldahl nitrogen, TKN, (ammonia, organic and reduced nitrogen) and nitrate-nitrite. There are two (2) common forms or phosphorus, which are commonly measure in water bodies, and include orthophosphate and total phosphorus. Total phosphorus is sum of reactive, condensed and organic phosphorous.

Table 16 lists the average nutrient concentrations among the various drainage basins. There are several standards for nutrients which include Ch. 62-302 Fresh Surface Water and the Numeric Nutrient Criteria (NNC), which is applicable to the estuary downstream of the City of New Port Richey. It is crucial for stormwater water and river water coming from the City of New Port Richey, which is upstream of the estuary, to meet the NNC.

Ammonia was not detected in the upstream (UP) or downstream (DN) locations. Although only sampled once, the downstream (DN) location did not have a detection of ammonia, which is presumed to be due to active tidal flushing as seen by the more brackish water as confirmed by the chloride concentration. All drainage basins except DB #126 had detections of ammonia. Two drainage basins, DB#87 and DB#60, had average ammonia concentration in excess of the Ch. 62-302 Fresh Surface Water Standard of 0.2 mg/l.

Total kjeldahl nitrogen (TKN) and total nitrogen (TN) had similar reported concentrations due to the slight differences between the two parameters. Due to this similarity, total nitrogen (TN) is discussed. Total nitrogen (TN) was detected in all sample locations including upstream (UP) and downstream (DN) of the City of New Port Richey. The upstream location (UP) had the lowest average concentration of total nitrogen that did not exceed the NNC. All drainage basins had total nitrogen concentrations in excess of the NNC with DB#60 having the highest average concentration (DB#60 = 11.29 mg/l) overall.

On average, the other nitrogen species, nitrate, nitrate-nitrite, and nitrite, were not in excess of the NNC at any of the sampling locations. These parameters were undetected in downstream location (DN). Similar trends were seen where the upstream location (UP) had the lowest average concentrations, and DB#60 having the highest average concentrations of the individual nitrogen species.

Orthophosphate was detected in the upstream (UP) or downstream (DN) locations and all of the drainage basins above the NNC for phosphorus (NNC = 0.034 mg/l). The highest average concentration of orthophosphate was seen in DB#102 with the lowest average concentration seen in the upstream (UP) and downstream (DN) locations. Although only sampled once, the downstream (DN) location is presumed to be diluted by active tidal flushing as seen by the more brackish water as confirmed by the chloride concentration.

Total phosphorus was detected and exceeded the NNC for phosphorus in all drainage basins including upstream (UP) location. The highest average concentration of total phosphorus was seen in DB#60 along with the other nutrient parameters. The downstream (DN) location did not have total phosphorus in the one sampling event and is presumed to be diluted by active tidal flushing.

### 4.2.5 Ionic, Physical and Biological Contaminants

The ionic measurements include chloride and total dissolved solids (TDS). Total suspended solids (TSS). Chloride and TDS were analyzed to ensure stormwater, not brackish water, was collected during sampling since many outfall locations remained submerged at low tide. TSS is important in analyzing for the transportation of fine sand, silts, clays and organic matter that tend to contain more biologically bioavailable pollutants. Bacteriological contaminants, such as fecal and total coliform, are critical parameters to measure for recreational activities in aquatic environments. Table 17 lists the average concentrations of the ionic and biological contaminants.

Average chloride and TDS concentrations indicated that all samples collected from the stormwater system were fresh in nature. The one downstream sample (DN) confirmed the presence of brackish water even at low tide, and the data collected from that location could not be used to quantify dilution factors moving downstream the Cotee River.

Total suspended solids (TSS) represents the solids that are flushed from roadways, paved areas, eroded land areas, and organic debris into the stormwater system. The reason for concern for TSS is due to its ability to settle or be filtered from the stormwater. Chemical constituents that are of pollution concern can adsorb onto the sediment particles. High concentrations of suspended solids can cause many problems for stream health and aquatic life. The upstream (UP) and downstream (DN) locations had the lowest average TSS concentrations. The drainage basins varied in average TSS concentrations with the highest being in DB#102.

The upstream (UP) and downstream (DN) locations had the lowest average fecal and total coliform concentrations. The drainage basins varied in coliform concentrations with the highest being in DB#92. The majority of the coliform concentrations were above the Ch. 62-302 Fresh Surface Water Standard of 800 cfu/100ml. Due to the sampling methodology using bucket samplers, the majority of the sampling events were conducted the following day. Because of this delay, the hold times for biological samples were exceeded allowing bacteriological communities to develop in large concentrations. These parameters are not analyzed in detail due to this issue.

## Table 16. Average Nutrient Concentrations.

| Drainage Basin | Reporting Units | NNC Cotee Estuary | 62-302 Fresh Surface Water | 62-777 Fresh Surface Water | 62-777 Marine Water | UP | 126 | 102 | 120 | 95 | 92* | 87 | 60 | 19 | DS* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ammonia as N** | mg/l | | 0.2 | | | U | U | 0.036 | 0.02 | 0.037 | 0.12 | **0.23** | **0.24** | 0.013 | U |
| Total Kjeldahl Nitrogen | mg/l | | | | | 0.77 | 1.77 | 1.69 | 1.52 | 1.64 | 1.9 | 1.15 | 11.00 | 1.40 | 0.51 |
| Nitrate as N | mg/l | | | | | 0.058 | 0.19 | 0.14 | 0.20 | 0.095 | U | 0.16 | 0.20 | 0.53 | U |
| Nitrate Nitrite as N | mg/l | | | | | 0.074 | 0.17 | 0.13 | 0.18 | 0.092 | U | 0.18 | 0.21 | 0.49 | U |
| Nitrite as N | mg/l | | | | | 0.00082 | 0.0027 | 0.0023 | 0.0051 | 0.0034 | U | 0.018 | 0.042 | 0.0035 | U |
| **Total Nitrogen** | mg/l | 0.65 | | | | **0.85** | **1.63** | **1.86** | **1.79** | **1.76** | 0.12 | **1.32** | **11.29** | **1.88** | 0.51 |
| **Dissolved Orthophosphate** | mg/l | 0.034 | | | | **0.051** | **0.28** | **0.32** | **0.29** | **0.25** | **0.16** | **0.23** | **0.16** | **0.25** | 0.013 |
| **Total Phosphorus** | mg/l | 0.034 | | | | **0.061** | **0.36** | **0.56** | **0.37** | **0.38** | **0.35** | **0.26** | **0.63** | **0.49** | U |

**BOLD** - Concentrations is above acceptable standard.
U - Undetected.
* - Location sampled once.

## Table 17. Average Concentrations for Ionic, Physical and Biological Contaminants.

| Drainage Basin | Reporting Units | NNC Cotee Estuary | 62-302 Fresh Surface Water | 62-777 Fresh Surface Water | 62-777 Marine Water | UP | 126 | 102 | 120 | 95 | 92* | 87 | 60 | 19 | DS* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chloride | mg/l | | | | | 59 | 4.4 | 4.1 | 5.8 | 3.5 | 3.4 | 75 | 21 | 13 | 9,000 |
| Total Dissolved Solids | mg/l | | | | | 215 | 36 | 72 | 66 | 72 | 76 | 197 | 165 | 94 | 16,000 |
| Total Suspended Solids | mg/l | | | | | 2.0 | 83 | 90 | 52 | 73 | 48 | 5.6 | 77 | 52 | 7.3 |
| **Fecal Coliform** | cfu/100ml | | 800 | | | 676 | **629,163** | **629,363** | **629,775** | **626,975** | TNTC | **716,443** | **702,080** | **502,375** | 500 |
| **Total Coliform** | cfu/100ml | | 800 | | | **22,750** | **877,125** | **876,250** | **891,333** | TNTC | TNTC | **760,625** | **912,000** | **762,750** | **1,900** |

**BOLD** - Concentrations is above acceptable standard.
U - Undetected.
* - Location sampled once.

## 4.3 Parameter Loading Estimates

In order to create loading amounts for each variable, the parameter concentration was multiplied by the volumetric calculation to quantify the pounds per event. Nutrient loading is a continuous process that is a product of streamflow and nutrient concentration over time. Parameters that exceed any of the standards per Florida Administrative Code, (F.A.C.) or was consistently detected in the laboratory analysis is reviewed in the section. These parameters include specific nutrient constituents, specifically ammonia, total kjeldahl nitrogen (TKN), total nitrogen, orthophosphate, and total phosphorus. For the heavy metals, chromium, copper, lead and zinc are reviewed along with total suspended solids (TSS). Table 18 lists the average load per parameter per drainage basin. Appendix G includes geographic maps with the various loading concentrations per rainfall event.

Table 18. Average Loading Estimates per Parameter per Basin (lbs/event).

| Average Loading per Basin (lbs/event) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Basin (Acreage) | 126 (34.04) | 102 (37.03) | 120 (46.81) | 95 (40.34) | 87 (122.46) | 60 (38.54) | 19 (8.59) |
| Chromium | 0.032 | 0.079 | **0.095** | 0.039 | U | 0.063 | 0.0042 |
| Copper | 0.13 | 0.16 | **0.22** | 0.11 | 0.048 | **0.29** | 0.030 |
| Lead | 0.029 | **0.073** | 0.058 | 0.056 | 0.0086 | 0.060 | 0.0084 |
| Zinc | 1.04 | 0.82 | 1.88 | 1.39 | 1.30 | **37.0** | 0.23 |
| Ammonia | U | 5.7 | 0.3 | 2.0 | 20.7 | **61.1** | 0.26 |
| Total Kjeldahl Nitrogen (TKN) | 23.5 | 29.1 | 31.8 | 32.7 | 92.0 | **274** | 6.40 |
| Total Nitrogen | 23.9 | 33.2 | 36.8 | 37.7 | 99.4 | **282** | 9.51 |
| Orthophosphate | 3.19 | 3.92 | 5.53 | 4.16 | **18.0** | 3.19 | 1.29 |
| Total Phosphorus | 4.62 | 7.48 | 7.47 | 6.68 | **19.1** | 15.58 | 2.58 |
| Total Suspended Solids (TSS) | 528 | 714 | 1,452 | 671 | 467 | **1,944** | 255 |

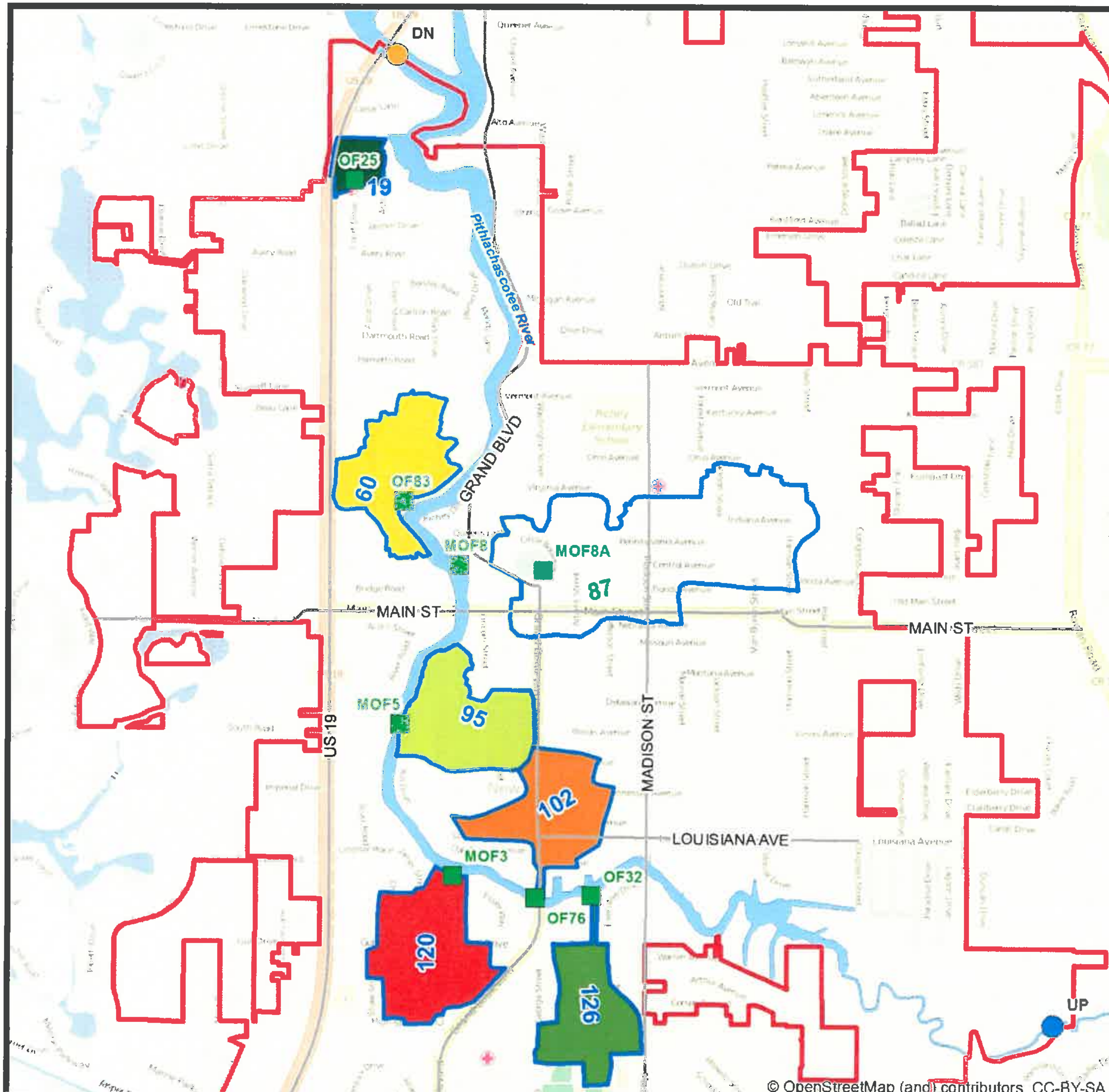
**BOLD** - Maximum loading average.

DB#60 contributes the majority of the pollutants (6 out of 10) over all the drainage basins that were sampled. It is the 4th largest drainage basin that was assessed; however, it is dominated by low to medium residential land use with a mixture of public/semi-public, which contributes to the loading of nutrients, and highway commercial land uses along US Highway 19, which contributes to the loading of heavy metals.

DB#87 is the largest drainage basin in total acres and contains the majority of the area in and around downtown and nearby low density residential area. DB#87 contributes the highest loads of orthophosphate and total phosphorus.

DB #120 produces the highest load of chromium on average per rainfall event. This drainage basin consists mainly of low to medium residential and residential/office land uses. DB#102 produces the highest load of lead on average per rainfall event. This drainage basin consists mainly of low to medium residential land use.

Figures 7 through 16 show the average loading estimates for each by each individual parameter.




# Figure 7 . Average Loading Estimates for Chromium

**Legend**

- Outfall Sample Locations
- DN
- UP
- NPR_MajorRoads
- NPR Boundary
- Regularly Sampled Basins

**AVG LBS/EVENT_Cr**

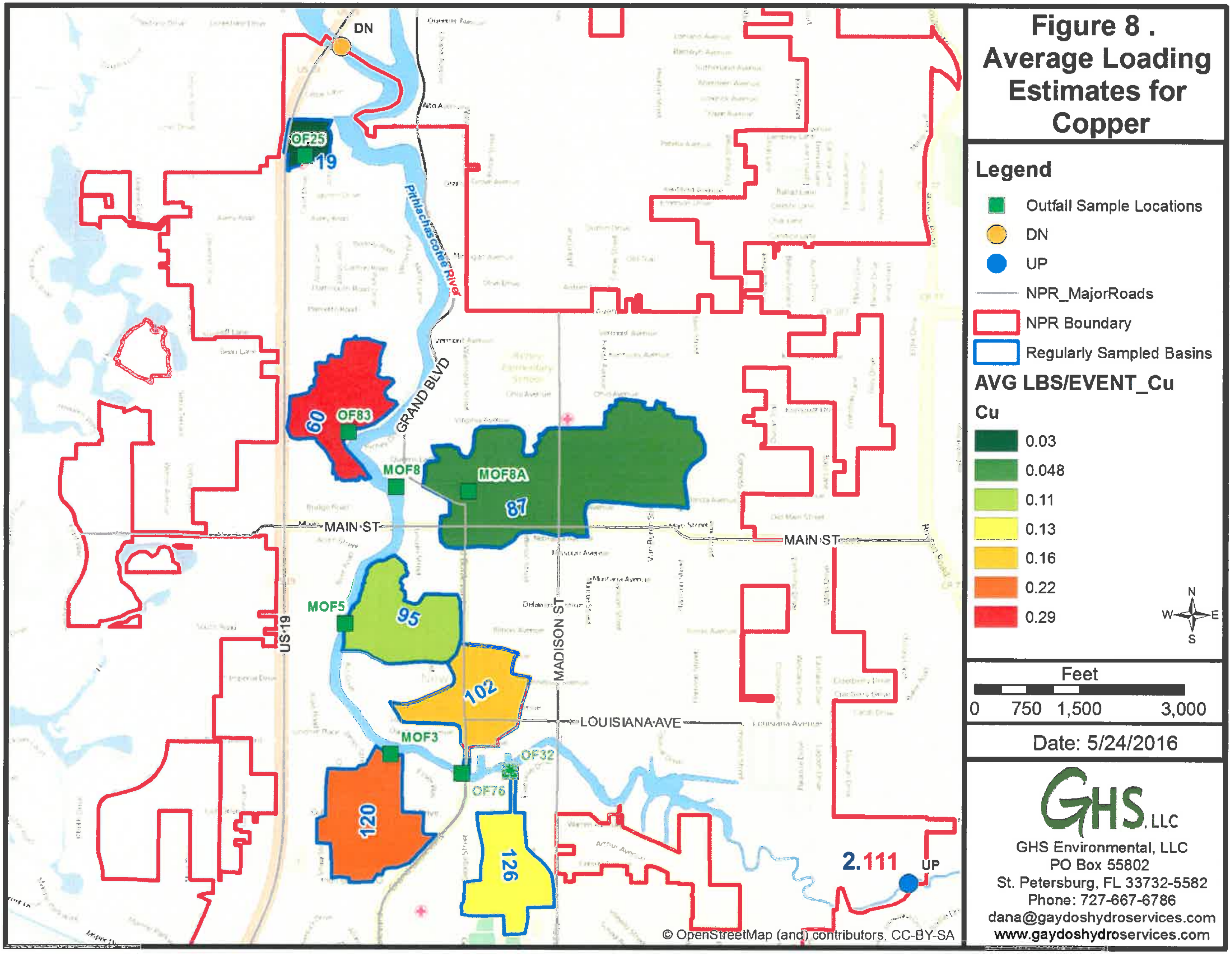
- 0.0042
- 0.032
- 0.039
- 0.063
- 0.079
- 0.095

N W E S

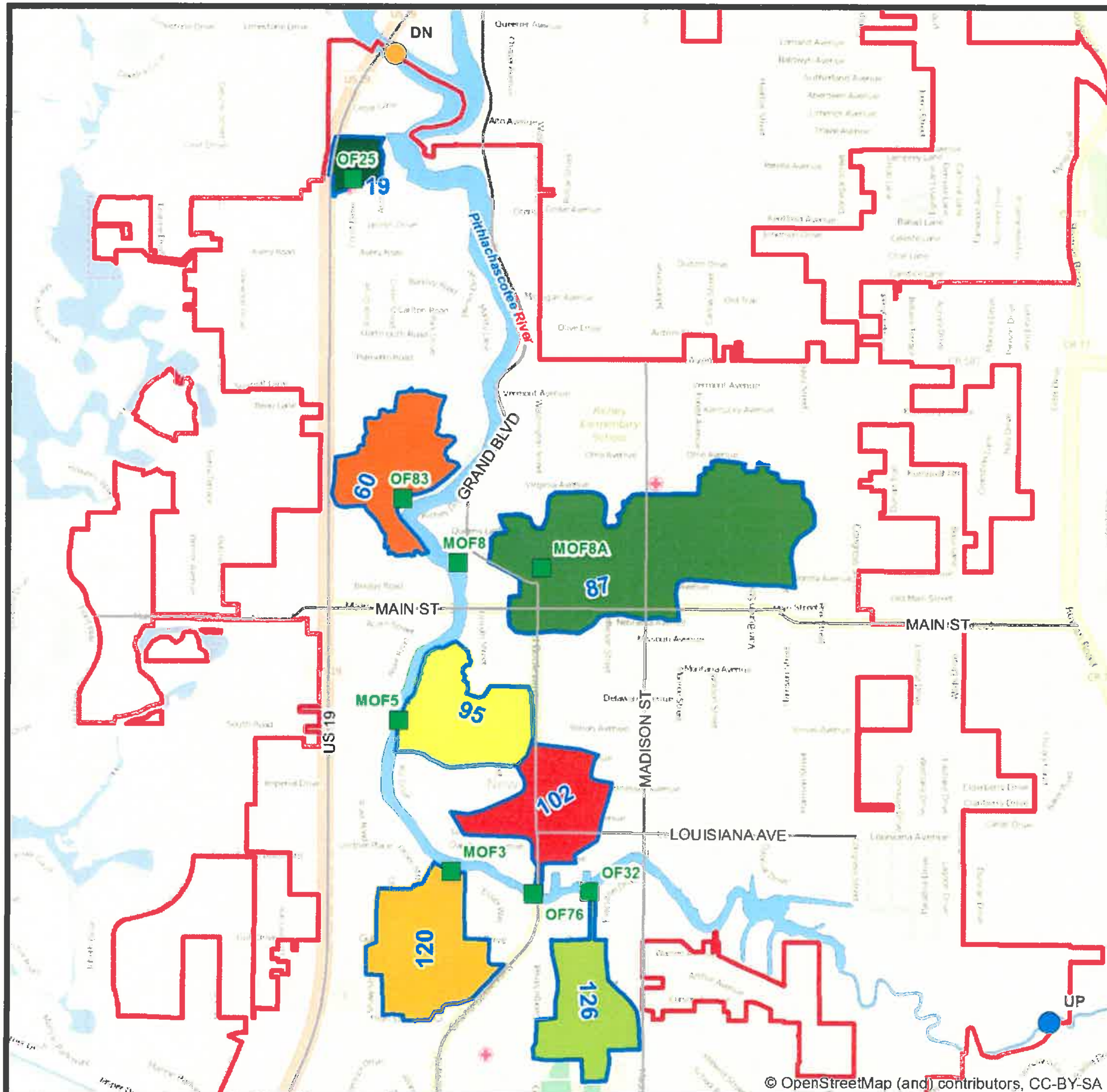
Feet
0 750 1,500 3,000

Date: 5/24/2016

GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com



DN
OF25
19
Pithlachascotee River
GRAND BLVD
60
OF83
MOF8
MOF8A
87
MAIN ST
MOF5
95
US 19
MADISON ST
102
LOUISIANA AVE
MOF3
OF32
OF76
120
126
2.111
UP
© OpenStreetMap (and) contributors, CC-BY-SA
Figure 8 . Average Loading Estimates for Copper
Legend
Outfall Sample Locations
DN
UP
NPR_MajorRoads
NPR Boundary
Regularly Sampled Basins
AVG LBS/EVENT_Cu
Cu
0.03
0.048
0.11
0.13
0.16
0.22
0.29
N
W
E
S
Feet
0 750 1,500 3,000
Date: 5/24/2016
GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com

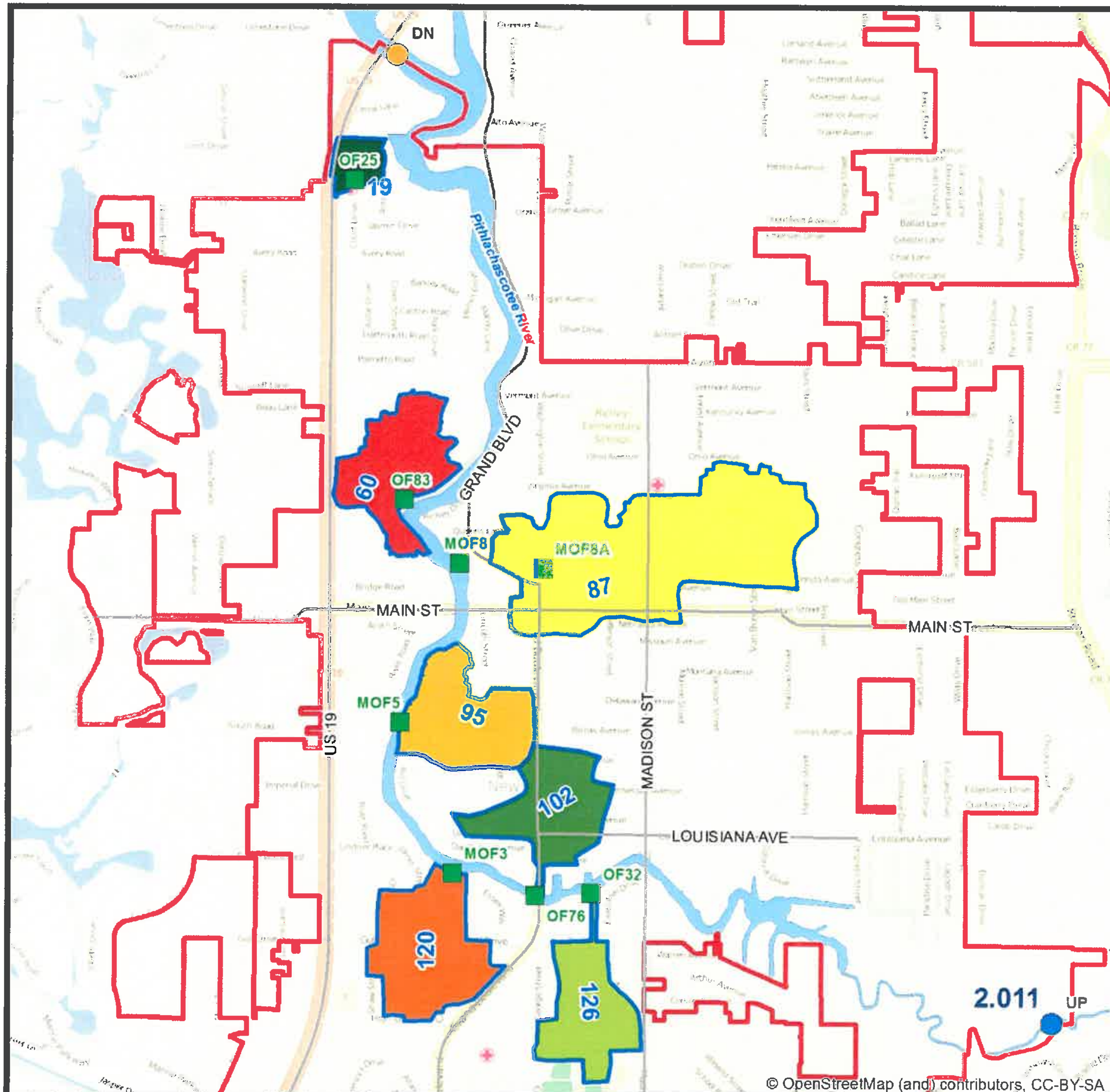



# Figure 9. Average Loading Estimates for Lead

Date: 5/24/2016

GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com

# Figure 10. Average Loading Estimates for Zinc




## Legend

- Outfall Sample Locations
- DN
- UP
- NPR_MajorRoads
- NPR Boundary
- Regularly Sampled Basins

**AVG LBS/EVENT_Zn**

**Zinc**

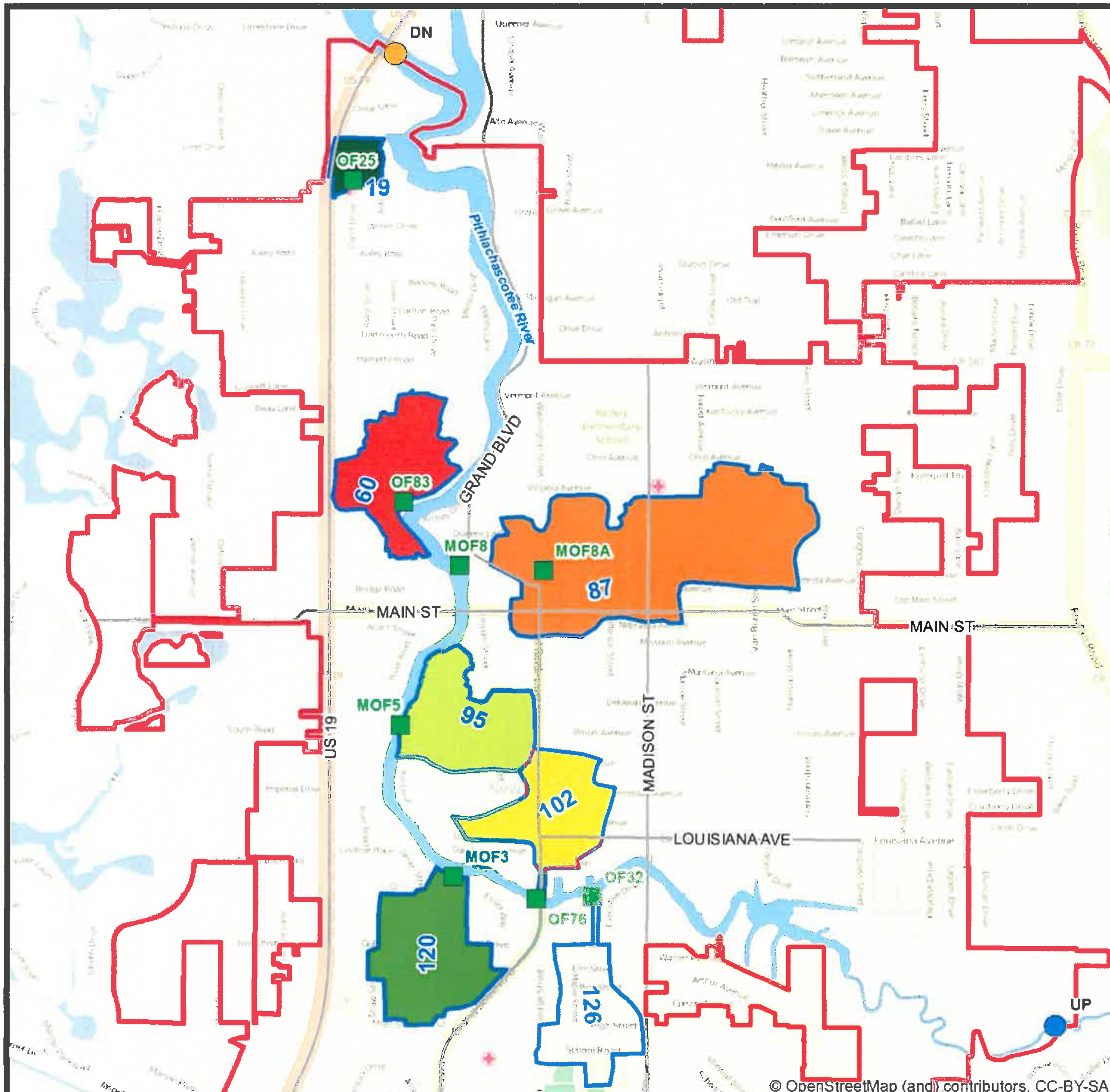
- 0.23
- 0.82
- 1.04
- 1.3
- 1.39
- 1.88
- 37

N W E S

Feet
0 750 1,500 3,000

Date: 5/24/2016

GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com




# Figure 11. Average Loading Estimates for Ammonia

**Legend**

- Outfall Sample Locations
- DN
- UP
- NPR Boundary
- NPR_MajorRoads
- Regularly Sampled Basins

**Ammonia**

- 0.26
- 0.3
- 2
- 5.7
- 20.7
- 61.1
- Pithlachascotee River

N W E S

Feet
0 750 1,500 3,000

Date: 5/24/2016

GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com

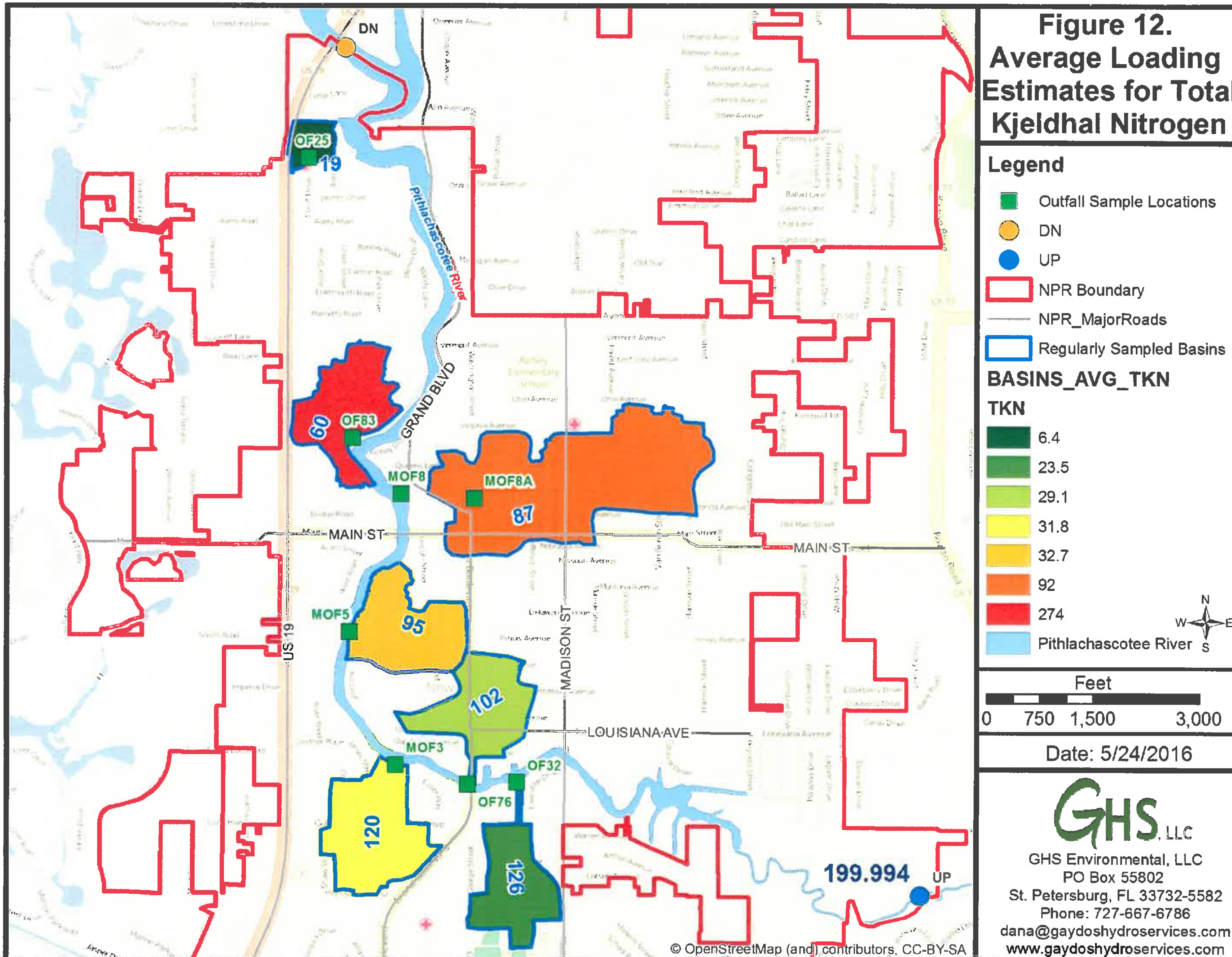
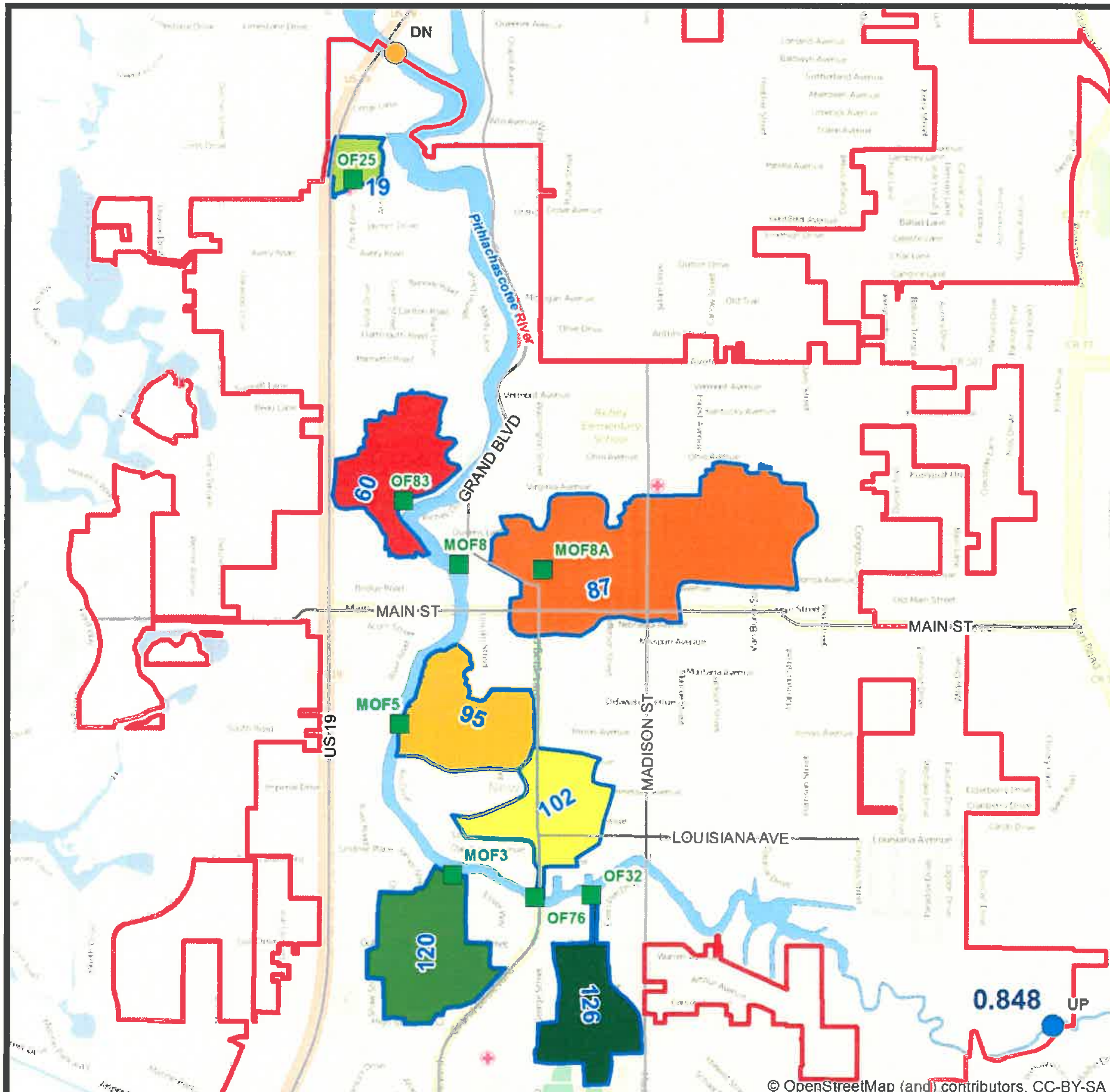


Figure 12.
Average Loading Estimates for Total Kjeldhal Nitrogen
Legend
Outfall Sample Locations
DN
UP
NPR Boundary
NPR_MajorRoads
Regularly Sampled Basins
BASINS_AVG_TKN
TKN
6.4
23.5
29.1
31.8
32.7
92
274
Pithlachascotee River
N
W
E
S
Feet
0
750
1,500
3,000
Date: 5/24/2016
GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com
DN
OF25
19
Pithlachascotee River
GRAND BLVD
60
OF83
MOF8
MOF8A
87
MAIN ST
MAIN ST
US 19
MOF5
95
MADISON ST
102
LOUISIANA AVE
MOF3
OF32
OF76
120
126
199.994
UP
© OpenStreetMap (and) contributors, CC-BY-SA




# Figure 13. Average Loading Estimates for Total Nitrogen

**Legend**

- Outfall Sample Locations
- DN
- UP
- NPR Boundary
- NPR_MajorRoads
- Regularly Sampled Basins

**Tot_N**

- 0.032
- 0.095
- 9.51
- 33.2
- 37.7
- 99.4
- 282
- Pithlachascotee River

N W E S

Feet
0 750 1,500 3,000

Date: 5/24/2016

GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com

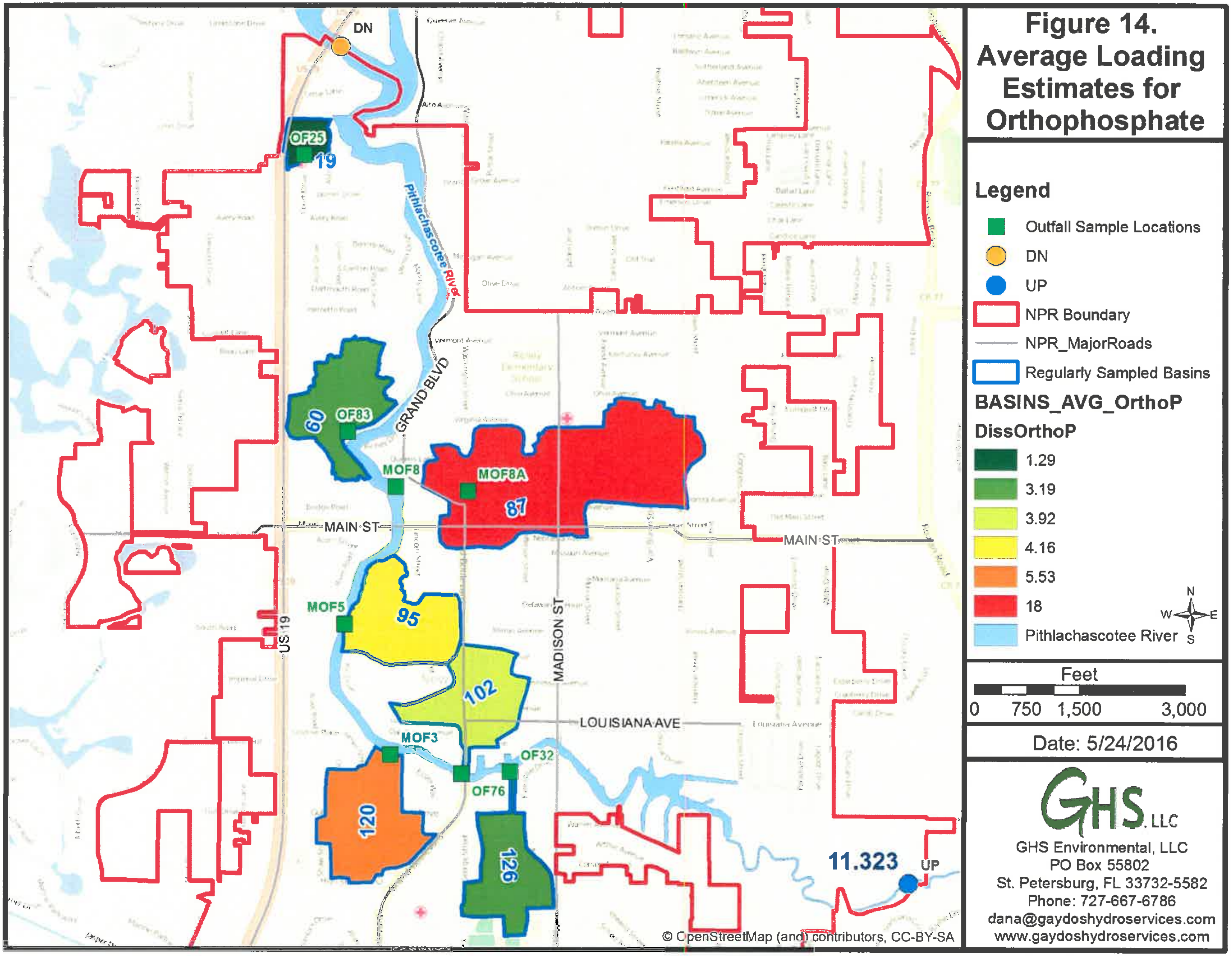
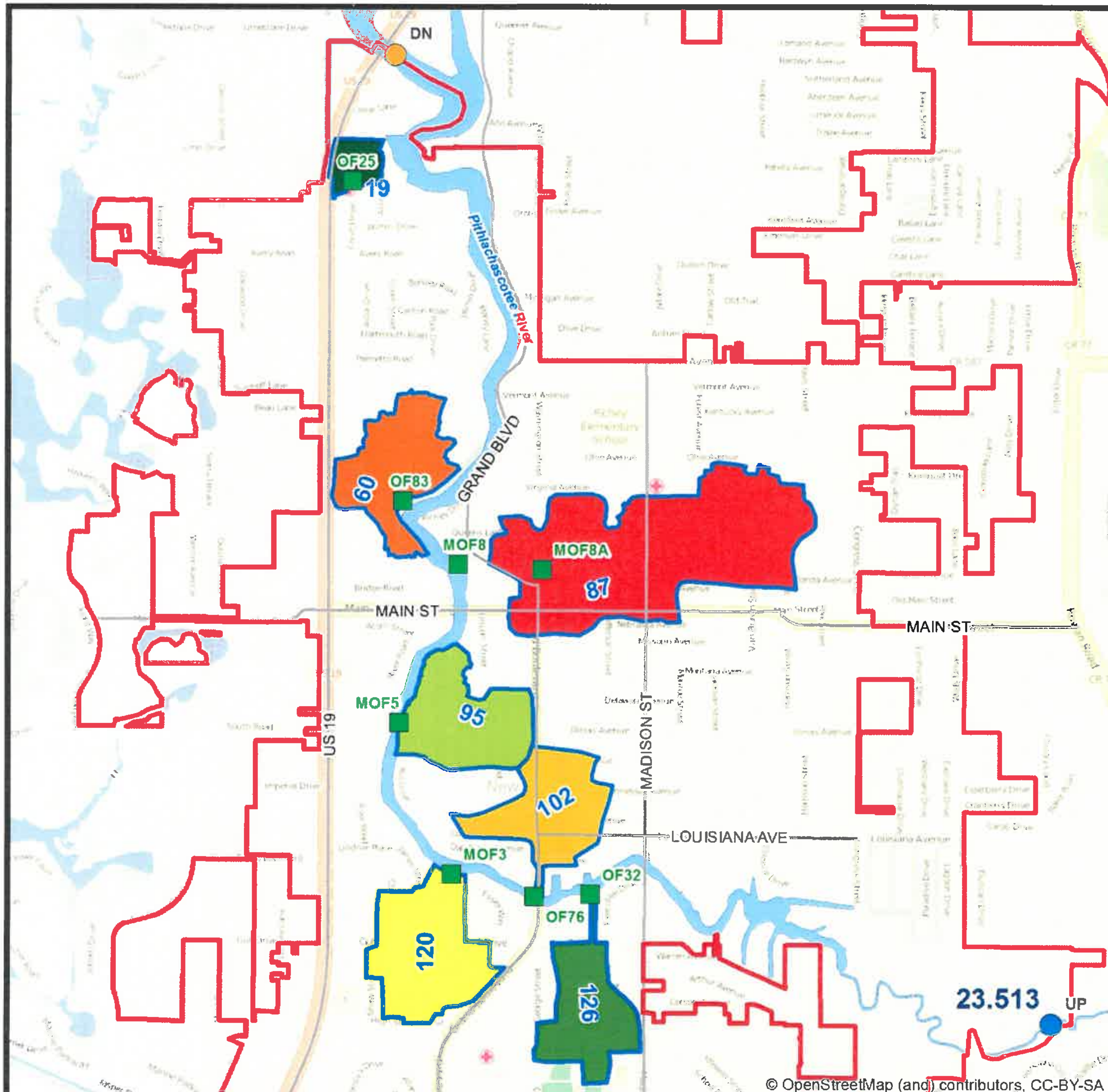


Figure 14.
Average Loading Estimates for Orthophosphate
Legend
Outfall Sample Locations
DN
UP
NPR Boundary
NPR_MajorRoads
Regularly Sampled Basins
BASINS_AVG_OrthoP
DissOrthoP
1.29
3.19
3.92
4.16
5.53
18
Pithlachascotee River
N
W
E
S
Feet
0
750
1,500
3,000
Date: 5/24/2016
GHS LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com
DN
UP
OF25
19
OF83
60
MOF8
MOF8A
87
MAIN ST
MOF5
95
102
MOF3
120
OF32
OF76
126
11.323
GRAND BLVD
Pithlachascotee River
US 19
MADISON ST
LOUISIANA AVE
© OpenStreetMap (and) contributors, CC-BY-SA




# Figure 15. Average Loading Estimates for Total Phosphorus

**Legend**

- Outfall Sample Locations
- DN
- UP
- NPR Boundary
- NPR_MajorRoads
- Regularly Sampled Basins

**Total_P**

- 2.58
- 4.62
- 6.68
- 7.47
- 7.48
- 15.58
- 19.1
- Pithlachascotee River

N W E S

Feet

0 750 1,500 3,000

Date: 5/24/2016

GHS LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com

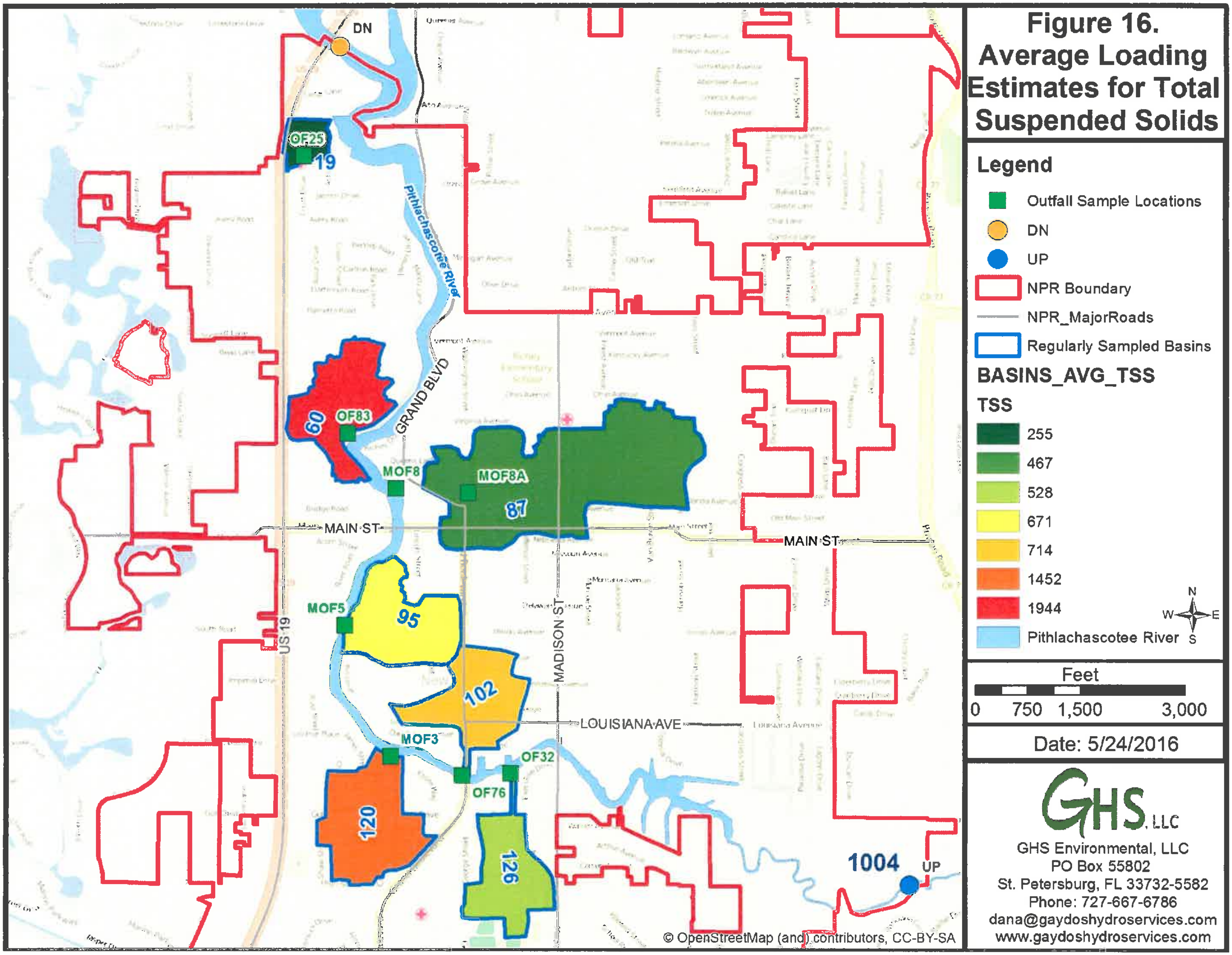


Figure 16.
Average Loading Estimates for Total Suspended Solids
Legend
Outfall Sample Locations
DN
UP
NPR Boundary
NPR_MajorRoads
Regularly Sampled Basins
BASINS_AVG_TSS
TSS
255
467
528
671
714
1452
1944
Pithlachascotee River
N
W
E
S
Feet
0
750
1,500
3,000
Date: 5/24/2016
GHS, LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com
DN
OF25
19
Pithlachascotee River
GRAND BLVD
60
OF83
MOF8
MOF8A
87
MAIN ST
MAIN ST
MOF5
95
US 19
102
MADISON ST
LOUISIANA AVE
MOF3
OF32
OF76
120
126
1004
UP
© OpenStreetMap (and) contributors, CC-BY-SA

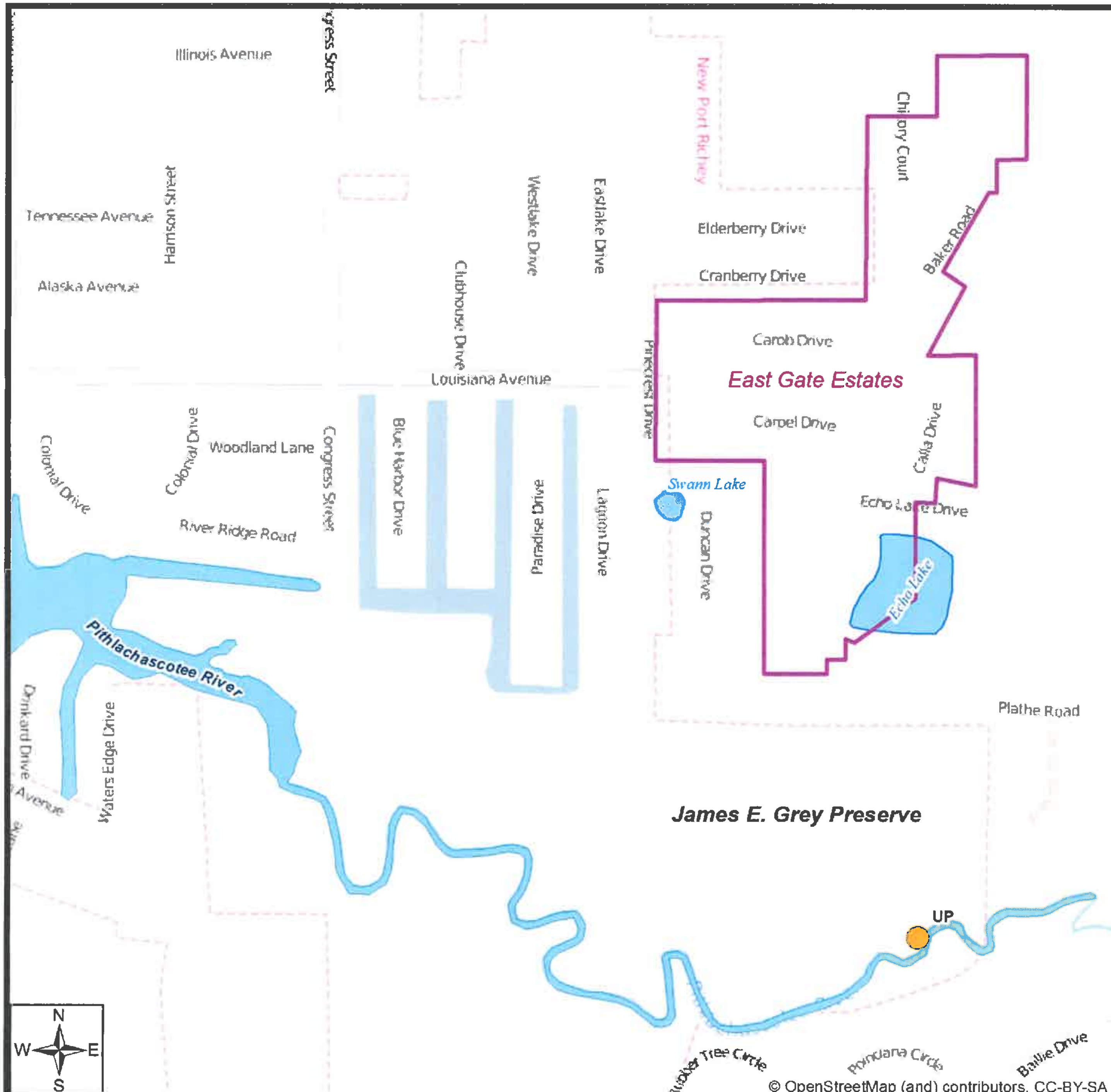
## 4.4 East Gate Estates

East Gate Estates is a residential community that lies outside of New Port Richey's city limits. This community is not incorporated into the City's sewage system, and it is assumed that the majority of the homes have aging septic systems. It is located north of Grey's Preserve and has several discharge locations to the Cotee River. Figure 17 shows the location of these features. There are several small stormwater features, either natural low elevation features that were converted to stormwater retention ponds or man-made stormwater retention ponds within the community. With historical evidence that septic systems are major nutrient contributors to eutrophic aquatic environments, a minimal evaluation was conducted to see if stormwater discharges could be influenced by this community due to again septic systems.

Several methods were utilized to assess connectivity of these small stormwater ponds to the Cotee River. An initial study was conducted by installing pressure transducers in Echo Lake and in a small pond, identified as Swann Lake, to measure and record fluxes in water level within the ponds in association with the tidal fluxes seen in the Cotee River at Grey's Preserve. The water level record at Grey's Preserve shows a tidal influence; however, the water level record for the two ponds only showed responses to rainfall and a small lunar tide, which is insignificant. Water level data is provided in Appendix H.

Since septic systems allow for conservative elements, or substances that do not break down easily over time, into the environment through seepage into the surficial aquifer and surface water, a conservative compound, specifically caffeine, was sampled and tested for in the stormwater ponds within East Gate Estates that were closest to the Cotee River. Both Echo Lake and Swann Lake have low detections of caffeine (84 ng/l and 150 ng/l, respectively) present showing that there are connections from the aging septic systems to the surface water within the local area and eventually into the stormwater system that connects to the Cotee River. Laboratory results from the caffeine testing is included in Appendix H.

# Figure 17. East Gate Estates Location Map




**Legend**

- East Gate Estates
- Swann Lake & Echo Lake

**River Sample Location**

- DN
- UP
- Pithlachascotee River

Scale: Feet 0 250 500 1,000

Date: 5/24/2016

GHS LLC
GHS Environmental, LLC
PO Box 55802
St. Petersburg, FL 33732-5582
Phone: 727-667-6786
dana@gaydoshydroservices.com
www.gaydoshydroservices.com

# 5.0 Discussion

The purpose of this study was to identify which areas of the stormwater system within New Port Richey are the largest nutrient and pollutant contributors to the Cotee River and to calculate the loading pulses associated with rainfall. With this assessment, the City will be fully armed to continue in their objective to restore the Cotee River.

Usually the stormwater that initially runs off an area will be more polluted than the stormwater that runs off later, after the rainfall has 'cleansed' the catchment. The stormwater containing this high initial pollutant load is called the 'first flush'. To examine the initial first flush, a bucket sampler was designed and used to collect the sample. This study makes the assumption that the sample collected in the bucket sampler represents the total concentration over the total rainfall event. One drainage basin, DB#87, had its sample collected from Orange Lake and not from bucket samplers. This was to also evaluate the overall health of Orange Lake over time.

## 5.1 Pollutant Loading per Drainage Basin

Based upon the data collected for this study, DB#60 contributes the most pollutants as individual parameters, the highest concentrations of those pollutants, as well as the highest loading of each parameter per event even though it is medium sized drainage basin in comparison to the rest. These include copper, zinc, ammonia, TKN, total nitrogen, and TSS. Although not included in the loading estimates due to individual detections, DB#60 had the highest number of detections of various herbicides. The mixture between residential and highway commercial land uses contribute high concentrations of each parameter and a high runoff coefficient when multiplied across the entire basin produced high loading values. DB#60 includes a significant portion of drainage from US Highway 19 capturing various heavy metals from the combustion of gasoline, commercial developments along US Highway 19 capturing herbicides from the retention/detention ponds and heavy metals from the parking lots, and residential areas capturing excessive nutrients from lawn care products.

DB #87 has the largest drainage area of 122.5 total acres. The results of this study show that it contributes the highest load of orthophosphate and total phosphorus and produces the second largest loads for the other nutrient parameters. These results can also be explained by the fact that samples were collected from Orange Lake instead of using bucket samplers, which catches the “first flush”. Orange Lake has a high dilution factor considering that it captures and holds large quantities of stormwater runoff over a large basin as well as receiving direct rainfall and irrigation supplies from the park directly surrounding it. Orange Lake then pulses to directly to the Cotee River as water levels exceed the elevation of the concrete weir.

DB#102 and DB#120 contribute the highest loads for individual pollutants specifically chromium and lead, respectively. Both of these drainage basins include major thorough fairs for traffic. Both basins include Grande Boulevard heading towards the downtown area from US Highway 19, and DB#120 include Gulf Dr from US Highway 19.

## 5.2 Pollutant Source Review

General trends found in this study mimic basic conclusions regarding stormwater and pollution sources. Overall, the drainage basins vary among pollutants and concentration, but all basins contribute to the overall load to the Cotee River. Basins with a higher coverage of residential land uses tended to have higher nutrient pollutants, and basins with a higher coverage of commercial and highway land uses tended to have higher heavy metal pollutants.

### 5.2.1 Sources of Heavy Metals Related to Land Use

Stormwater runoff from impervious surfaces, such as streets and parking lots, contain different sources of sediments like rusting metal flakes from vehicles, particles from vehicle exhaust, bits of tires and brake linings and chunks of pavement. Traffic patterns were not reviewed as part of this study, but there is a direct correlation between zinc, cadmium, chromium and lead with the traffic. Main thorough fares within New Port Richey include US Highway 19 (DB#60 and DB#19), Main Street (DB#87), and Gulf Boulevard (DB #102 and DB#120). These basin showed higher loading potentials of heavy metals and correlate well with highway commercial land uses.

Sources of chromium outside of gasoline deposition include electro-plating, paints and preservatives. There are several small manufacturing type, warehouse business located south of Gulf Drive and east of Grand Boulevard in DB#120 that could potentially contribute as a source of chromium. However, traffic patterns and vehicle density is presumed to be the largest contributor of chromium for these areas.

Copper has numerous sources including algaecides in retention and detention ponds, runoff from streets and parking lots, and rooftop runoff. DB#60 contributes the highest loading potential for copper and zinc. This basin is a mixture between residential and highway commercial land uses. It is reported that copper and zinc tend to be higher in commercial and industrial areas than residential areas due to rooftop runoff draining directly onto pavement then captured by the storm sewers; whereas downspouts in residential areas tend to discharge onto lawns.

Lead levels have decreased tremendously since the shift to unleaded gasoline. Lead was not detected in concentrations that exceeded the surface water standards in any of the basins, but the highest overall loading potentials are seen in DB #102. The locations of the bucket samplers within this basin were in the residential neighborhoods to the west of Gulf Drive. It is possible that a source for lead within these neighborhoods could be from the deteriorating of lead based paint since these homes were built during the 1950's and 1960's, wood preserved to prevent rotting or galvanized metal roofs.

### 5.2.2 Sources of Nutrients Related to Land Use

Stormwater runoff in both urban and rural areas is loaded with nutrient such as nitrogen and phosphorus. Nitrogen includes various forms such as ammonia, nitrate, and nitrite. There are several combinations of these species, which includes total kjeldahl nitrogen (TKN) and total nitrogen. TKN includes ammonia, which is an inorganic form, organic forms of nitrogen and reduced nitrogen. Total nitrogen includes TKN as well as nitrate and nitrite. There are many sources of nitrogen. Sources that are found in the City of New Port Richey include pet and animal waste, runoff from fertilized landscaping, atmospheric deposition, and in some areas, failed septic systems. All drainage basins assessed in this study ranged between 34% and 74% low to medium residential land uses in addition to the percent coverage of the other residential land uses. With high residential land use coverage, the high nitrogen loading potentials seen within this study is expected.

Phosphorus is the nutrient of greatest concern because it promotes weed and algae growth in lakes, streams and rivers. Phosphorus species attach to soil particles so areas with high sediment loads tend to have high phosphorus loads. Although DB#87 has a relatively low total suspended solids (TSS) loading potential, sediment loads is known to be high in Orange Lake. A recent sediment coring project was conducted as part of the RESTORE Act funding to dredge Orange Lake. Over the decades, Orange Lake has accumulated significant sediment from direct stormwater runoff, which is seen by the high phosphorus loads reported by this study. Other sources of phosphorus include fertilizer and the breakdown of vegetative debris like grass clippings. Both of these sources are present around Orange Lake. Orthophosphate is found in vehicle exhaust, and DB#87 is considered a high traffic area as Orange Lake is one of the primary attraction of the City of New Port Richey.

## 5.3 Regulatory Issues

The Clean Water Act provides a basis for state water quality standards programs in which states are responsible for reviewing, establishing and revising water quality standards. There are several administrative regulations that have been established and include Chapter 62-302, F.A.C. including the Numeric Nutrient Criteria (NNC) and Chapter 62-777, F.A.C. These regulations were established to protect the environment as well as human health. For surface waters of the state, the standards are established at levels or concentrations that will not alter or cause an imbalance in the natural populations of aquatic flora and fauna. For this study, both fresh water and marine water standards were considered since the Cotee River is tidally influenced throughout the City of New Port Richey.

In review, there were no pesticides detected over the duration of the study. There were four herbicides that were detected within various drainage basins and during several rainfall events. All detections were minor in comparison to all applicable standards.

There were two heavy metals, copper and zinc, that regularly exceeded the Ch. 62-302, F.A.C. Fresh Surface Water Standard. The average concentration for copper exceeded the standard of 0.0037 mg/l in seven (7) of the eight (8) drainage basins that were sampled. Zinc exceeded the standard in two (2) of the eight (8) drainage basins.

Regulation has defined the nutrients as total nitrogen and total phosphorus, and the standard is written so that nutrient concentrations shall not impact or alter a body of water to cause an imbalance of natural populations of aquatic flora and fauna. Specific nitrogen and phosphorus forms, such as nitrate, nitrite, orthophosphate and total phosphorus do not have a set numerical values but ammonia does. Average ammonia concentrations in DB#60 and DB#87 exceed the standard of 0.2 mg/l.

A subsection of Ch. 62-302, F.A.C. includes the Numeric Nutrient Criteria (NNC), which was developed specifically for estuary environments. NNC values for total nitrogen and total phosphorus have been developed for the Cotee River downstream of the City of New Port Richey. All drainage basins that were sampled including the Cotee River upstream of the city limits exceeded the NNC for both nitrogen and phosphorus.

### 5.4 BMP Development Table

One of the main objectives of this study was to identify "hot spots" or areas within the city that contribute to high pollutant and nutrient loads. Overall, the city contributes high nutrient loads to the Cotee River due to high residential land uses. Table 18 identifies which drainage basins to be further evaluated for Best Management Practices (BMP's) to treat stormwater before discharging to the Cotee River.

Table 18. BMP Development Table.

| Priority List | Acreage | % Residential Land Uses | % Highway / Commercial Land Uses |
|---|---|---|---|
| 60 | 38.5 | 72.6% | 27.4% |
| 87 | 122.5 | 39.4% | 60.6% |
| 120 | 46.8 | 47.3% | 52.7% |
| 102 | 37.0 | 80.8% | 19.2% |
| 19 | 8.6 | 51.9% | 48.1% |
| 95 | 40.3 | 99.3% | 0.7% |
| 92 | 71.3 | 35.4% | 64.6% |
| 126 | 34.0 | 47.0% | 53.0% |