FEAB MEETING MINUTES
February 8th, 2019
3:00 p.m.
Conference Room, Public Works, 555 South Section Street, Fairhope, AL

Member Attendees: Gary Gover, Jim Horner, Jeanine Normand, Ron Allen, Tony Pritchett, Rick Frederick and Mike Shelton

City Council: None

City of Fairhope: Kim Burmeister, Planning and Zoning Department; Richard Peterson, Utilities Superintendent; Jay Whitman, Assistant Water and Sewer Superintendent; Sean Saye, Fairhope Docks Manager

Honored Guests: John Manelos

Minutes taken by: Kim Burmeister

FEAB MINUTES:

January 11, 2019 FEAB minutes were approved as amended.
January 25, 2019 FEAB Special Meeting minutes were approved as amended (Tony added a few comments).

Discussion of Items:

1. **Fairhope Docks Marina**
   Sean Saye introduced himself as the new marina manager overseeing the Fairhope Docks. He said that the marina is moving towards Clean Marina standards, but a lot of the upgrades have more to do with resiliency than environmental stewardship. However environmental upgrades have taken place over the past year, notably:
   1. Parking lot stabilization
   2.New pump out station

   More to come in the next 2 years.

   Native plant assessment is forthcoming so that the marina may be landscaped with native plants as much as possible. Addition of a full-service boat yard is just in the discussion stage. Per Kim, addition of a boat yard would require ADEM permitting. Sean said the Harbor Board is reviewing aspects of the possibility of a boat yard, and it is only in discussion at this point. Sean suggested FEAB members and citizens interested in the status of boat yard considerations attend upcoming Harbor Board meetings.

Tony suggested FEAB be kept in the loop on boat yard considerations as well as contracts for boat yard manager. He wants to make sure the boat yard contract, when written, will include strict Clean Marina guidelines.

Gary is concerned about liveaboards living at the marina contributing to the high pathogen contamination of Fly Creek. Sean said that the liveaboards at the Fairhope Docks slots mostly use the facilities at the marina, and most do not have heads hooked up. He is confident there are no liveaboards illegally releasing gray or black water (sewage) into the marina.

2. **Fly Creek – water quality**
The 2018 Fly Creek Water Quality Assessment from Mobile Baykeepers (testing for enterococcus) is attached. According to the Mobile Baykeepers report, intermittent high levels of bacteria in the lower watershed are likely resulting from sewage/septic, stormwater and/or lack of boat pumpouts.

Jay said the wet well at the Woodlands has been tested for leaks and is not leaking.

John asked if there was a septic tank inventory. RP said that the City does not have one and that the City of Fairhope's priority is to make sure the waste water treatment plant and infrastructure is maintained. Septic tanks are regulated and checked by the Baldwin County Health Dept, though Fairhope does have some oversight and enforcement if they fail. City can turn off water to dwellings, for instance, if they have septic tank failures, standing sewage, that are not being fixed or repaired.

RP mentioned that phosphorus is an indicator of human impact but does not necessarily come from septic or waste water from homes. It could come from marine sources (boats).

Jeanine said that while some older septic tanks are grandfathered in, new ones (and ones that need significant repair) can only be placed or repaired on grounds that perc.

Tony asked about the ph of our drinking water, is it acidic? RP said it's 7.8, not acidic.

John said the ADEM water quality testing for 2018 results for Fly Creek showed much higher pathogen counts than previous years. Kim thought the spike could be from the excessive rain events in 2018 (84+" for 2018).

RP said the upcoming Fly Creek Watershed Study will include a water quality analysis. Marlon Cook will be sampling all watersheds for e.coli for 10 storm events. This sampling plan is attached.

Rick said the upcoming Fly Creek Watershed Study will encompass the entire Eastern Shore from Daphne to Bailey's Creek. It may be renamed to be more accurate.

Jeanine said she has received emails and phone calls from concerned citizens wondering what the City is doing to address high fecal coliform in Mobile Bay.

Gary will get with Mike after today's meeting to discuss volunteer water sampling.

Gary asked RP how the FEAB can assist with waste water treatment improvements and infrastructure upgrades. RP said "show support for the 5 year capital spending plan". Two of the major components of the 5-year capital spending plan:

1. Transmission upgrade and
2. Purchase of (4) vessels to temporarily store waste water during high flow events. This will allow the plant to operate more efficiently. Vessels will range in capacity from 150,000 to 300,000 gallons.

John suggested FEAB and all citizens show up at the council meeting Monday Feb. 11 to show support for RP's funding request ($36K) for SCADA system upgrades.

Jay said a technical service department is also needed.

Rick said he recently received a call from a City Councilman asking about dredging of Fly Creek. Citizen or citizens along Fly Creek are reaching out to Council persons to encourage dredging as key component or proposed action of the Fly Creek Watershed Study.

3. Triangle Property

Ron said the triangle property at the entrance to Fairhope (Fly Creek watershed) is being studied for proposed bike trails.

Next meeting is Friday, March 8th, 3 p.m. at the Fairhope Public Library Boardroom.

FEAB CONTACT INFORMATION:

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Assessment of Fly Creek Water Quality

Submittal Date: May 9, 18

Submitted To: City of Fairhope

Prepared by: Casi Callaway, Executive Director and Baykeeper; Cade Kistler, Program Director; Laura Jackson, Program Coordinator; Diego Calderon-Arrieta and Ellie Mallon, AmeriCorps Patrol Members

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DEFINITIONS

- Acidic – A quality of a liquid when it has a pH value less than 7. Acidic waters can have a negative impact on aquatic species as pH levels decrease below 5.
- Conductivity – A type of measurement that indicates the capacity of water to conduct electricity. Conductivity can indicate the presence of metals, salts, or other conductive materials in the water column.
- Colony Forming Units/100mL (CFU/100mL) – Units of measurement that indicate the concentration of bacterial colonies in a 100mL-sample of water.
- Dissolved Oxygen – Oxygen that is dissolved into a body of water. Dissolved oxygen is critical for survival of aquatic species and can decrease rapidly when organic matter (lawn clippings, sewage, leaves, etc.) is added to the waterway.
- Duplicate – A quality assurance/quality control method when another sample is taken in the same area to confirm that the bacteria levels are very representative and not an estimate.
- Enterococcus – A type of bacteria that indicates contamination from sewage or fecal matter that can survive in saltwater and freshwater.
- Environmental Protection Agency (EPA) – Federal executive agency responsible for protecting environmental health and human health.
- Federal standards of Enterococcus for designated swimming waters – The safe level for swimming is determined by the EPA to be 104 colony forming units (CFU) of Enterococci 100 mL of water. At this level it is estimated that approximately 3% of healthy adult swimmers will become ill. These rates may be higher for children, pregnant women, the elderly, or those with weakened immune systems.
- Failing sewer main – A broken pipe or line in the sewage system that can release human waste into nearby water bodies.
- Failing septic system – A chamber through which domestic wastewater (sewage) flows for treatment and if failing, the system may release waste without proper treatment into nearby water bodies
- Fecal contamination – A type of contamination resulting from human or animal feces entering a waterbody.
- Fluorometer – Device that can detect the concentration of optical brighteners in a water sample.
- Optical brighteners – Chemicals used in laundry detergents that indicate sewage/septic contamination of a water body.
- Most Probable Number (MPN) Enterococcus (100CFU/100mL) – Units of measurement that indicate the most probable number of Enterococcus bacteria in a 100mL-sample.

- Nephelometric Units (NTU) – Units of measurement used to indicate turbidity (cloudiness of water); a higher value indicates higher cloudiness.
- pH – Type of measurement that indicates the acidity (acid) or alkalinity (base) of a water body.
- Recreational waters – Waters in the US that are used frequently for activities like swimming or canoeing.
- Salinity – Type of measurement that measures how much salt is in the water.
- Sewage/septic waste – Human waste from broken sewer lines or septic systems that can enter water bodies directly through stormwater runoff.
- Stormwater runoff – Rainwater that carries contamination upon hitting the ground and flows into nearby water bodies.
- Turbidity – Type of measurement that measures how "cloudy" or unclear the water body is.
- Water Rangers – Web tool that allows visitors to view water quality measurements taken by Baykeeper staff at Fly Creek; app.waterrangers.ca.

EXECUTIVE SUMMARY

Purpose:

The City of Fairhope contracted Mobile Baykeeper to conduct water quality sampling in the Fly Creek Watershed to understand and identify potential sources of pollution. The impetus for the study arose when high bacteria levels were found in sampling during the summer of 2017. Mobile Baykeeper took developed a plan, chose locations, took samples, and reviewed existing data on the Fly Creek Watershed. This report describes the water quality sampling results, delivers conclusions based on those results, and provides recommendations to protect the water quality and physical integrity of Fly Creek as well as safeguard the health of citizens who love to swim, fish, and play in the creek.

Fly Creek is relatively buffered from many pollutants with much of its landscape covered with forest, wetlands, and other natural vegetation. That land cover, however, is rapidly changing as Fairhope grows, threatening the ecological integrity and health of the creek and watershed. If development takes place without proper best management practices it can create severe harm through siltation of the creek. Aging infrastructure, sewer lines and septic tanks pose a threat to water quality and the safety of swimmers and others recreating in the creek.

Fly Creek and forested areas nearby are important habitats for aquatic and terrestrial species. The creek contributes to the water quality of Mobile Bay and, as noted in the 2013 Fly Creek Watershed Restoration Plan prepared for the City of Fairhope by Thompson Engineering, the creek is an important supplier of clean, fresh water and organic materials to Mobile Bay. Fly Creek is used extensively for recreation and is an essential part of Fairhope's charm – it enhances the quality of life for residents of the City and visitors to the area.

Mobile Baykeeper sampled 12 sites over 24 weeks for enterococcus, optical brighteners, dissolved oxygen, pH, conductivity, and turbidity and ambient characteristics. Sampling took place from the most upstream stretches of the watershed where waterways were intermittent and had very low flow to the mouth of Fly Creek at Mobile Bay. Sites were chosen to help identify where high bacteria levels were originating. Sampling was performed from land at smaller sites and via kayak at downstream sites.

Findings:

While most of the parameters sampled during this study revealed generally good water quality, bacteria levels in the creek remain a concern. Fly Creek's water quality was often safe for swimming, however, at times bacteria levels were elevated -- exceeded the Alabama Department of Environmental Management's (ADEM) water quality standards and, most importantly, precluded using the creek for swimming. Results obtained during the study found Enterococcus (a type of bacteria that indicates contamination from sewage or fecal matter) concentrations in Fly Creek above the level allowable (level at which the EPA estimates ~3% of swimmers will become ill) for swimming a total of 37 times out of the 162 samples (28%) taken in the 12 weeks of sampling. The most upstream site in Fly Creek (FCHO) was an outlier, consistently returning excessive levels of bacteria; if removed from the calculation, only 19% of the samples were above the standard for swimming. In many of these remaining cases, however, bacteria levels only slightly exceeded the *safe* level. Concentrations of bacteria greater than the EPA threshold were found at least once at 10 of the 12 sampled sites. In many of these cases, optical brighteners, an indicator that there is sewage or septic waste in the water, were also found. Turbidity was consistently low as no major development projects were taking place in close proximity to the creek during the study period. Evidence exists that development projects in the watershed have previously had significant negative impacts on the creek and resulted in excessively high levels of turbidity in Fly Creek.

Conclusions:

Mobile Baykeeper sees three overall findings in the Fly Creek Watershed:

1) Intermittent high levels of bacteria in lower watershed likely resulting from sewage and septic systems, stormwater, lack of boat pump-outs;
2) High bacteria levels in upper Fly Creek likely resulting from livestock and septic systems; and
3) A diminished impact of high bacteria levels downstream from the upper watershed sites due to ponds and small volume of water.

The highest bacteria levels were found in the uppermost reaches of Fly Creek where agriculture – especially livestock – play a major role as well as the great potential for leaking septic tanks. The sources of high levels of bacteria found at the sites in the lower reaches of Fly Creek were more difficult to pinpoint, but it is likely that contributions are mainly from human wastewater. Finding high levels of bacteria and the presence of moderate to high levels of optical brighteners lead to this conclusion for both the upper and lower reaches of the creek. The lack of a vessel pump-out station at the marina during the period of this study may have also played a role in high bacteria levels found in the lower reaches of Fly Creek.

It is also clear that the ponds downstream of County Rd. Thirteen have a positive effect by reducing the concentrations of bacteria from the upper reaches of the watershed, keeping them out of the areas frequently used for recreation.

Overall, the water quality in Fly Creek is generally good but key changes are needed to protect the creek long-term. Our findings show that the growth and additional development pressures are having a small impact now that could grow if left unchecked. Occasional high bacteria levels indicate issues, most likely with aging septic systems and sewage lines in the watershed. With the frequency Fairhope citizens swim and kayak in the creek, it is critical to implement the key recommendations below to protect public health, water quality in Fly Creek, and the watershed's value to Mobile Bay and the quality of life of Fairhope residents.

Recommendations:

Fly Creek is a beloved waterway running through the City of Fairhope and out into Mobile Bay. It is a major reason people are flocking to the community and encouraging Fairhope to be the fastest growing city in Alabama. In order to maintain that reason for growth, Fairhope must undertake all necessary steps to protect this unique and special place.

To address high bacteria levels, four main tasks must be undertaken:

1) Conduct further investigation into Creek Dr/Sunset Point Sewer Main and Lift Station;
2) Undertake a Septic Tank Inventory and, using the results, establish maintenance and improvement requirements;
3) Immediately install a Pump-Out Station and establish strict usage requirements at the Fly Creek Marina; and
4) Implement Best Management Practices for livestock and pets to keep animals and their waste out of the creek.

To address other, long-term threats to the Creek, the following three tasks are needed:

1) Develop a Comprehensive Land Use Plan for the Watershed that incorporates protection of wooded, wet, and open space needed to allow water purification along the creek's banks;
2) Encourage and support the creation of a Fly Creek Watershed Management Plan; and
3) Create a Long-Term Monitoring Plan to consistently test water quality challenges for the most used waterway in Fairhope.

BACKGROUND

Fairhope, the fastest growing city in Alabama[1], is defined by its natural resources – especially its waterways. Fly Creek is particularly important to the community for a multitude of reasons. Fly Creek provides vital habitat for many aquatic and terrestrial species, affects water quality in Mobile Bay, and is profoundly enjoyed by citizens of Fairhope for recreation. Its headwaters are crucial to supporting agriculture in Fairhope and Baldwin County and the lower reaches of the creek are enjoyed for swimming, boating, fishing, canoeing, and kayaking. The health and functions of the creek are crucial to the quality of life in Fairhope.

The creek is also subject to intense development pressures and has been beset by rapid change as more area across the watershed is developed and the percentage of impervious (paved/hard) surfaces increase. Mobile Baykeeper's study evaluated Fly Creek's water quality and provides a snapshot of the conditions. To protect and maintain Fly Creek's water quality, the City and its residents must make thoughtful and firm decisions regarding conservation, planning, and restoration.

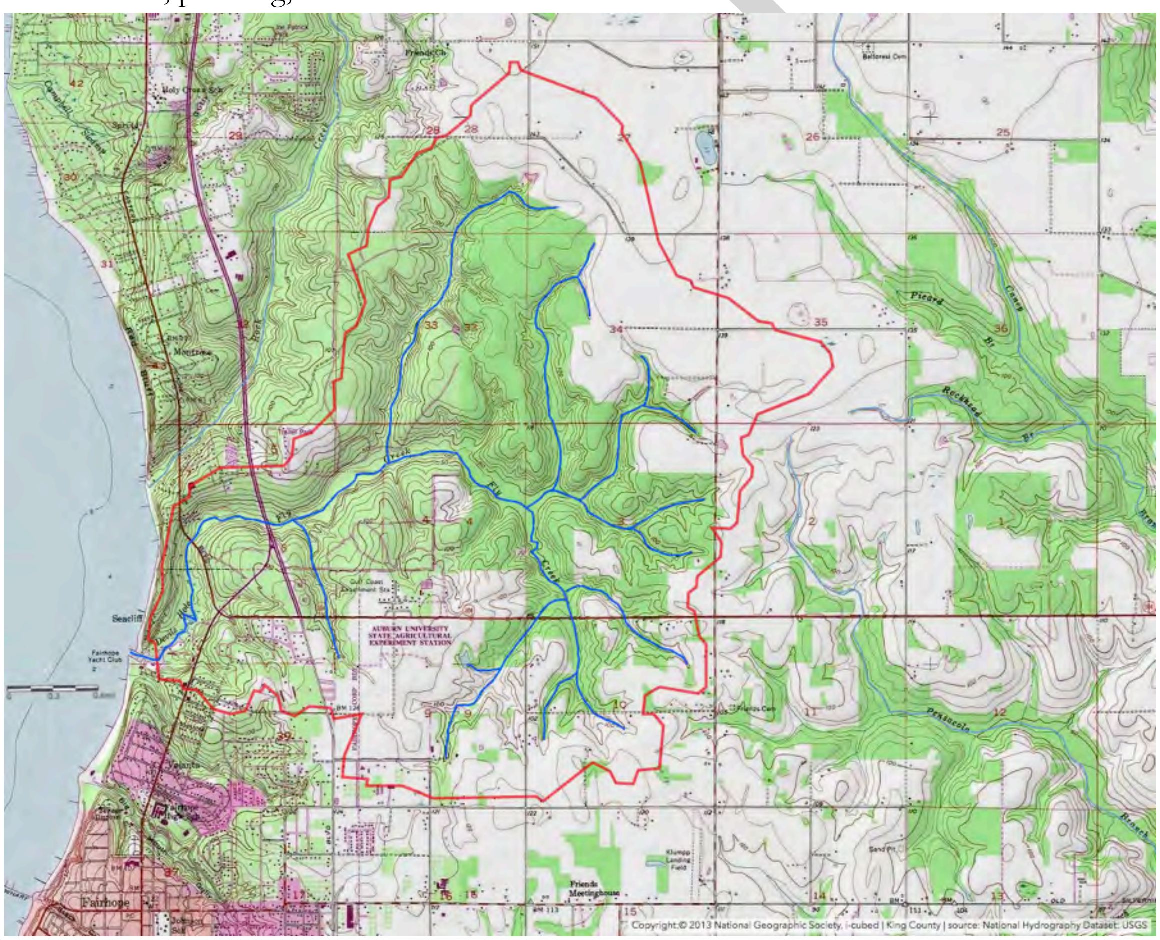

Figure 1. Topographic Map of Fly Creek Watershed.

Watershed Characteristics

Fly Creek is a perennial stream that drains much of Fairhope, portions of Baldwin County and a small area in Daphne. The Fly Creek Watershed is slightly more than 5,000 acres and the main stem of the creek is approximately 5.3 miles long.[2] Swimming and boating take place frequently downstream of the Scenic 98 Bridge and a marina is located at the mouth of the creek. According to the National Land Cover database from 2006, the majority of the watershed is forest (30%) and cropland (24%), with pasture (18%) and wetlands/water (13%) making up much of the rest of the watershed. As the population of Fairhope increases, developed area (14% in 2006) is increasing rapidly.[3]

Water Quality

ADEM's "Water Use Classification" categorizes Fly Creek as "Swimming" and "Fish and Wildlife". These classifications mean that protective standards for Fly Creek should allow for people to swim safely, and the water quality is suitable for fishing and the survival of wildlife. Water Quality Standards set for "Swimming" waters identify the acceptable ranges of water quality parameters. A table of standards applicable to Fly Creek is below (*Table 1*).

ADEM Standards for Swimming Waters	
Temperature	Max = 90 F
pH	6.0 – 8.5
Dissolved Oxygen	DO >5.0 ppm
Enterococci	Geometric Mean <35 CFU/100 mL Single Test Value <104 CFU/100mL
Turbidity	Not to exceed 50 NTU greater than background

Table 1 – Applicable ADEM Water Quality Standards for Fly Creek

Fly Creek has demonstrated generally good water quality in past studies. This is generally attributed to its low levels of development and high levels of buffering from forests, wetlands, and other natural landscapes. Results from the 2004 study by ADEM[4] are shown in the table below.

ADEM 2004 Fly Creek Study Results	Average	Max	Min
Water Temperature (°C)	19.5°	28.8°	12.4°
Conductivity (µs/cm)	1,473	48,880	33
Salinity (PPT)		38	0
Dissolved Oxygen (ppm)	9.02	11.7	6.6
pH (S.U.)	5.9	6.98	5.04
Turbidity (NTU)	8.7	51.4	1.9
Fecal Coliform (CFU/100mL)	393	>3000	32
Nitrate/Nitrite (ppm)	0.942	1.76	0.106

Table 2 - Abbreviated Summary of Results from 2004 ADEM Water Quality Study in Fly Creek.

Infrastructure

According to ADPH data, in the Fly Creek Watershed there are at least 109 septic systems (Figure 3). For many of these systems there is no information on when they were installed, last repaired or pumped out, and if they were engineered.

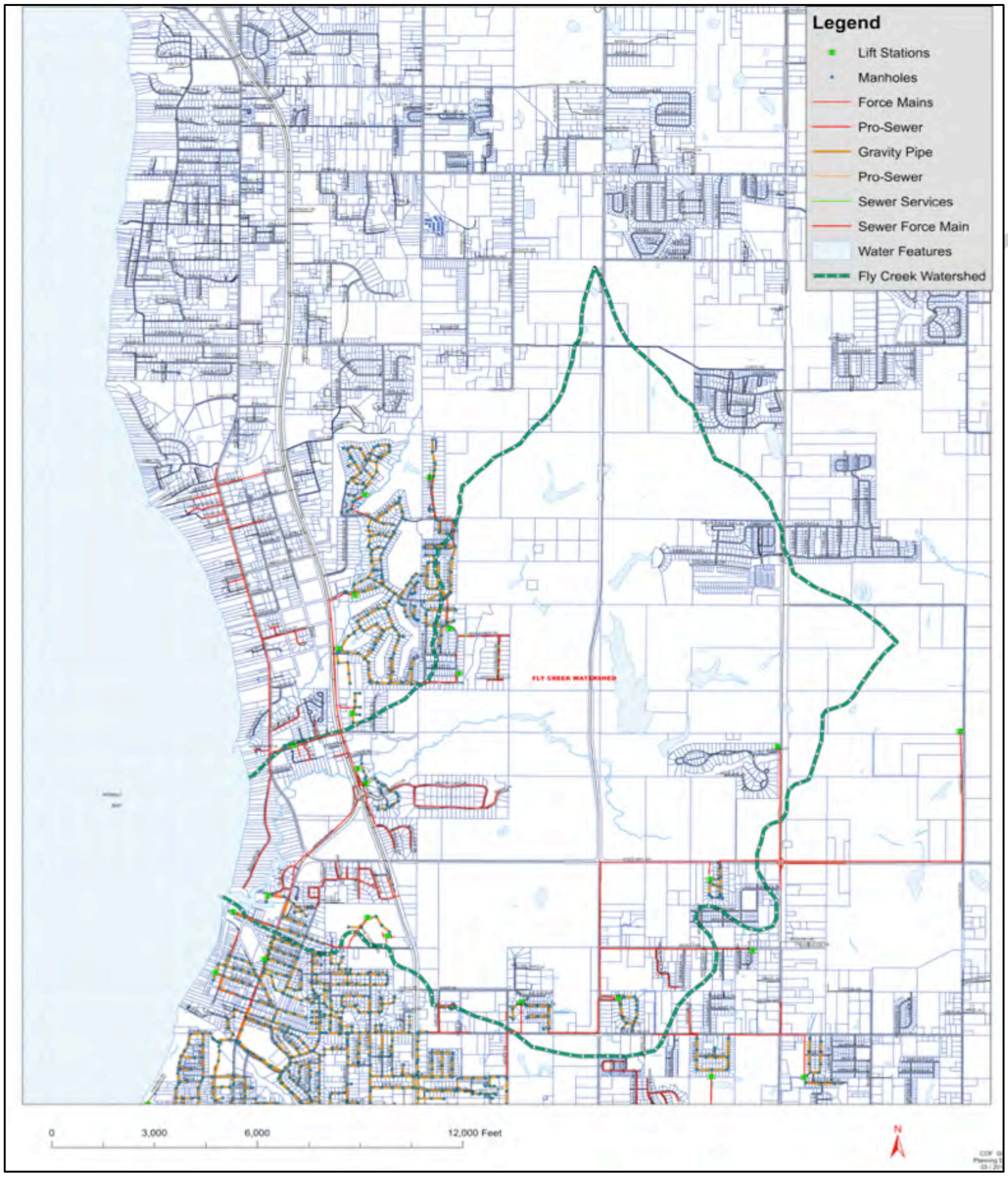

Figure 2 – Map showing City of Fairhope sewer infrastructure. Baldwin County Sewer Service also has a marginal amount of sewage infrastructure in the northern most portion of the watershed off of Highway 181 in the Dunmore and Old Field subdivisions.

A large percentage of the watershed has sewage service available from Fairhope (*Figure 2)* or Baldwin County Sewer Service (BCSS). Goodwyn Mills and Cawood were tasked with conducting a basic characterization and assessing the City of Fairhope's sewage system capacity. Their study, completed in August 2017, noted that treatment at the plant was effective, but there were serious issues with the pipes tasked with carrying the sewage to the plant. The study states that of the approximately 175 miles of sewage pipe in the City's system, approximately 60 miles is uninspected unlined clay pipe. Going on to say, "It is highly probable that this pipe is allowing ground and stormwater to enter the system, as well as allowing sewage to escape the collection system without…treatment."[5]

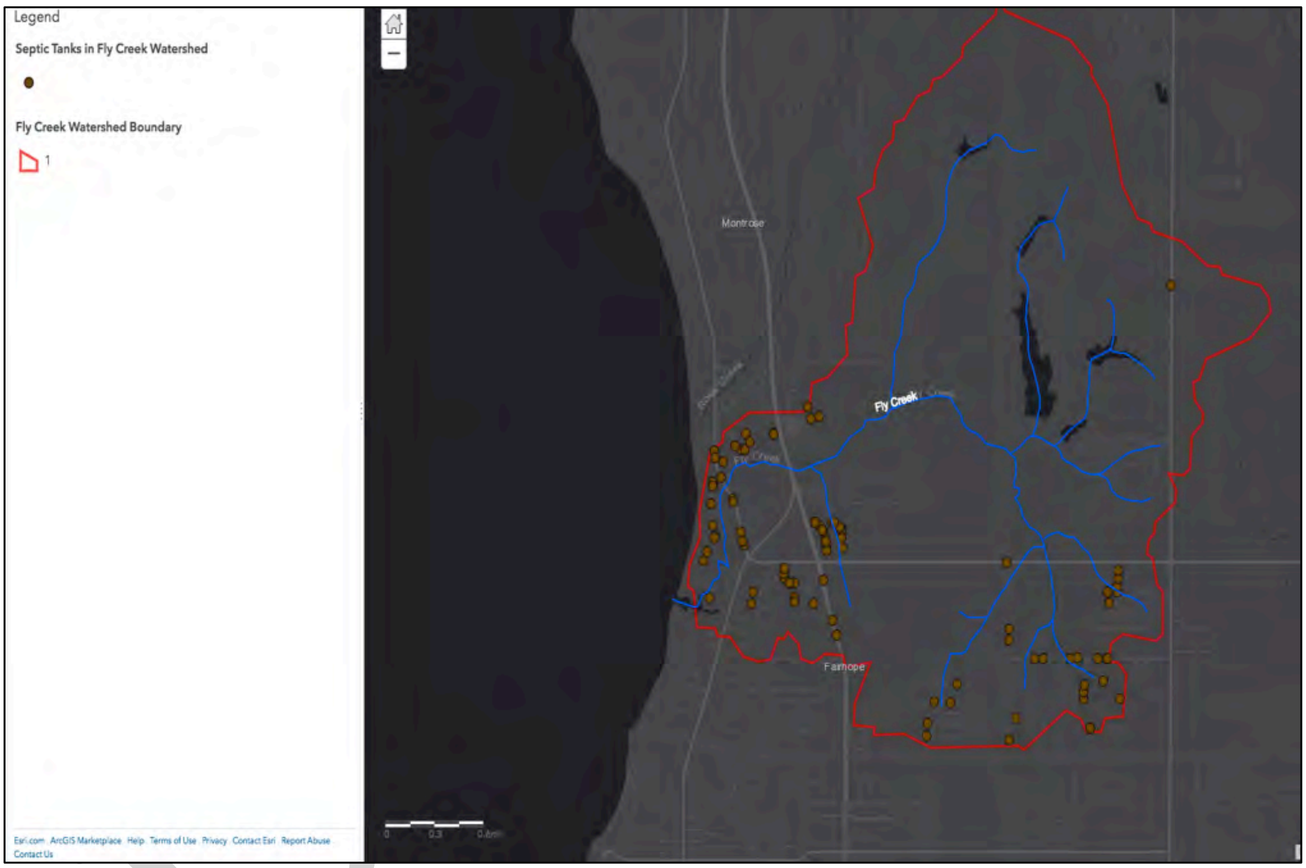

Figure 3 – Map showing 109 septic systems in the Fly Creek Watershed. Data from ADPH.

Impacts of Development on Fly Creek

Over the past decade, Fairhope has experienced substantial population growth and development. This growth is changing the watershed from a majority of woodlands, pastures, and cropland into homes, parking lots, and businesses. That paved or covered area is known as impervious because rainwater (stormwater) doesn't have time to seep into the ground, but storm water picks up everything—chemicals, sediment, etc.—on the pavement, parking lots, roofs, etc. and rushes into the nearest waterway. ADEM's 2004 study showed just 5.4% of the watershed was composed of impervious surface with a Fairhope population of 12,480. As of July 1, 2016 the U.S. Census Bureau estimates Fairhope's population as 19,421[7], a 55.6% increase since 2004. It is highly likely the amount of impervious and developed area has increased in a similar fashion. As Fairhope continues to be one of the fastest growing cities in Alabama, more forested and agricultural lands will be developed. This development often results in clearing large areas and leaving the ground unprotected. With steep slopes and moderately erodible soils, construction in the watershed poses a real threat of stream siltation or mud rushing into the creek. Effects of this type of siltation can already be seen in the stretch of Fly Creek between U.S. 98 and Scenic Highway 98 (Image 1). A 2011 report by Wayne Ishphording[6] describes sediments originating from construction of the Regency Shopping Center approximately 5 feet in depth extending 2 miles downstream of U.S. 98. This becomes clearer when comparing methods of access from the 2004 ADEM water quality study to those from Mobile Baykeeper's study. In the 2004 ADEM study, ADEM describes sampling from a boat as far as 1,200 feet upstream of Scenic Highway 98.[7]

Image 1 – A segment of Fly Creek near site FCCS is heavily impacted with sediment.

During the course of Mobile Baykeeper's study, the first site sampled upstream of Scenic Highway 98 was approximately 200 feet upstream of the highway and the creek was too shallow to access via a very shallow draft kayak (less than 1 foot) at that point.

There are a number of permitted discharges in the Fly Creek Watershed. All but one of these discharges is from construction projects. The one permitted site not related to construction is the marina at the mouth of the creek.

Figure 4 – Permitted point source discharges in the Fly Creek Watershed.

SCOPE AND METHODS OF STUDY

The primary goal of this study was to identify the source(s) of elevated bacteria levels in Fly Creek. Secondarily, we attempted to identify any other water quality concerns impairing the creek. A total of 12 sites (*Figure 5*) were strategically chosen to eliminate and/or expose problem areas and identify if the sources of bacteria and other identified issues were primarily from sewage/septic, stormwater, agriculture, or naturally occurring. Sites spanned the entirety of the creek with the most downstream sampling site located at the mouth of Fly Creek and the site furthest upstream at Highway 181.

At each site, Mobile Baykeeper staff tested for and quantified Enterococcus spp. using Enterolert, an EPA approved test procedure for detection of enterococci. Staff also tested for optical brighteners using a Turner Designs AquaFluor Fluorometer. Additional analytes collected included pH, turbidity, dissolved oxygen, conductivity, and total dissolved solids. Conductivity, pH, and total dissolved solids were measured with a Hanna Instruments HI98130. Turbidity was measured with a Hach 2100Q turbidimeter. Dissolved oxygen was measured with Alabama Water Watch LaMotte kit and methods (Modified Winkler titration).

Physical conditions including time, date, air and water temperature, climatic conditions, and tidal conditions were also recorded. A table of this data is provided in Appendix A. All data collected has been posted to and can be accessed on the Water Rangers water quality data app.

Figure 5. Map of Fly Creek sampling sites with their associated site codes.

RESULTS AND DISCUSSION

Overall

The overall water quality in the creek for dissolved oxygen, pH, conductivity, and turbidity generally met minimum standards set by the State for the Swimming classification.

ADEM Standards for Swimming Waters	
Temperature	Max = 90 F
pH	6.0 – 8.5
Dissolved Oxygen	DO >5.0 ppm
Enterococci	Geometric Mean <35 CFU/100 mL Single Test Value <104 CFU/100mL
Turbidity	Not to exceed 50 NTU greater than background

Dissolved oxygen values were rarely less than 6.0. pH values were regularly lower than 6; although, the water quality standard for pH is between six and nine, pH values slightly lower than six are not especially uncommon or problematic in streams with high levels of tannic acid that come from pine and other evergreen trees. Furthermore, low pH values are consistent with previous studies in the creek (ADEM, 2004) and the physical characteristics of the creek. Turbidity was almost unilaterally low. Bacteria levels on the other hand were concerning. In the headwaters of the watershed (FCHO), high bacteria (average – 10,796 CFU/100mL, max – 48,393CFU/100mL), likely resulting from livestock in close proximity to the creek and septic systems, were prevalent and produced the highest bacteria concentrations of the study. Luckily the volume of these headwater streams was so low that these bacteria levels were not detected at the sites immediately downstream (FCCT average – 20 CFU/100mL, max – 82 CFU/100mL). In the lower part of the watershed, intermittent high bacteria levels were found at sites FCMO (average – 76 CFU/100mL, max – 126 CFU/100mL), FCSP (average – 118CFU/100mL, max – 518 CFU/100mL), and FCDH (average – 310 CFU/100mL, max – 2,628 CFU/100mL). Because of the prevalence of swimming in this area, these bacteria levels are more alarming than the high values in the intermittent agricultural streams located in the upper portion of the watershed.

Bacteria

Enterococcus is a type of bacteria commonly used as an indicator of fecal contamination in recreational waters. It is commonly found in close association with other pathogens (viruses, bacteria, and other microbes) that cause illnesses in humans. The EPA's water quality threshold for enterococcus in recreational swimming waters is 104 colony forming units (CFU)/100mL. Enterococcus was detected above this level at 10 sites, with FCHO and FCDH with the highest concentrations and frequency of high bacteria readings (*Figure 6*). At site FCHO, 14 of 16 samples were greater than 104 CFU/100mL and 10 of those samples were greater than 501 CFU/100mL (max >48,392 CFU/100mL; Average: 5425.4 CFU/100mL).

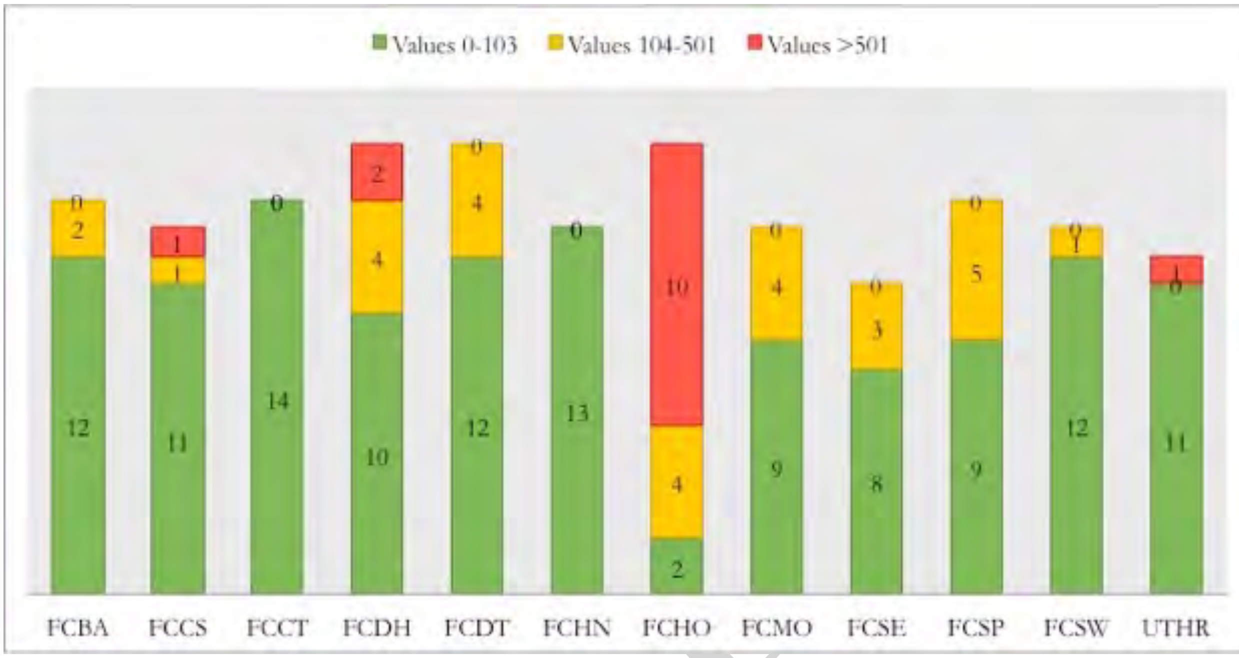

Figure 6. Enterococcus samples categorized by occurrence for containing results 0-103 CFU/100mL (green/safe), 104-501 (yellow/above federal standards), and >501 CFU/100mL (red/above federal standards for "infrequent" swimming waters).

Optical Brighteners

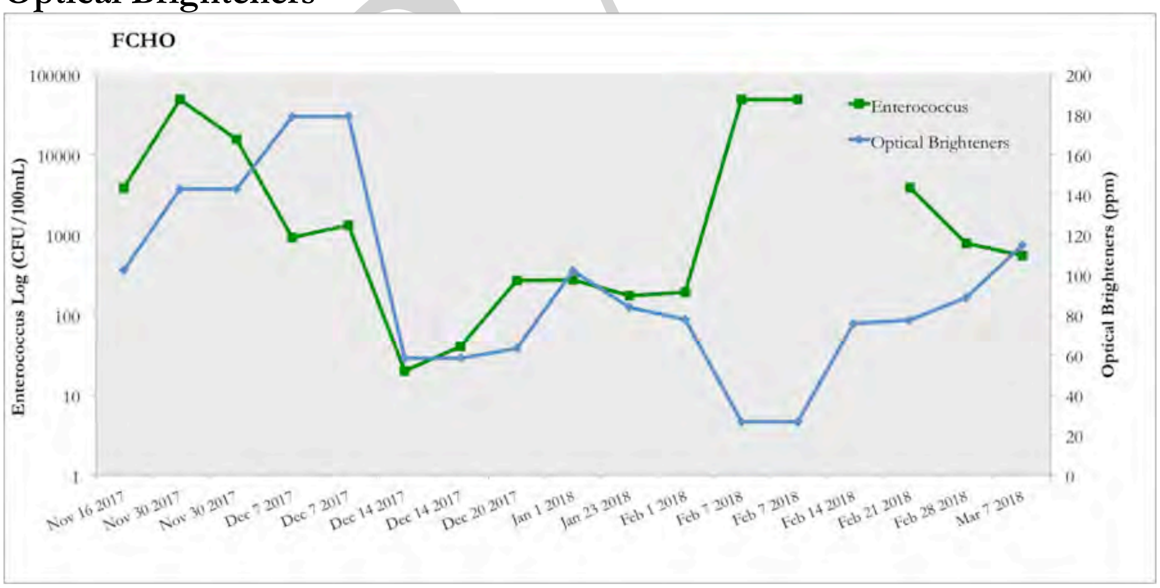

Figure 7. Time series of optical brightener measurements received from all sampling locations to date.

Optical brighteners are primarily added to laundry soaps, detergents and commonly found in laundry wastewater. Because of this, optical brighteners are ideal indicators of leaking sewer lines, and/or failing septic tanks.

Optical brighteners were found in high concentrations (Max – 178.7; Average 97.8) at the FCHO site. The presence of bacteria and optical brighteners indicates human wastewater contamination. Because there is no record of municipal/private sewage infrastructure (lines, lift stations, etc.) upstream of FCHO, it appears the upstream septic tanks are contributing to the high bacteria levels.

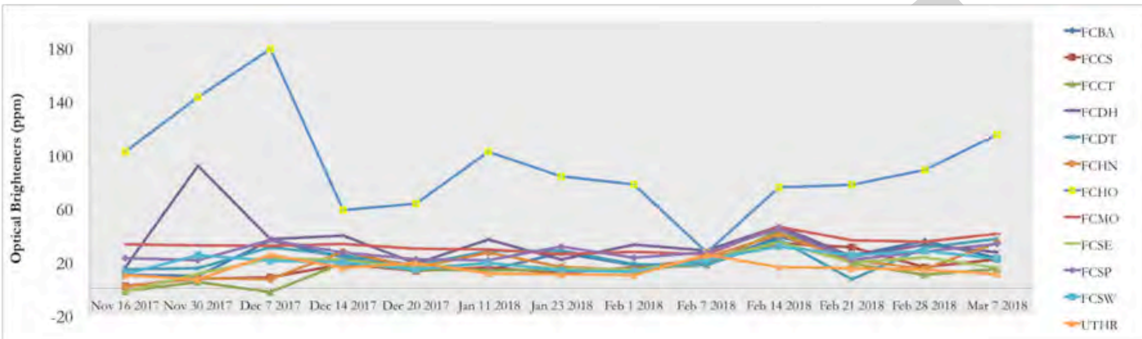

Figure 8. Time series plot of optical brighteners and enterococcus readings from site FCHO. *Redundant dates indicate sample was a duplicate for quality control.

pH

pH was relatively stable throughout the sampling period except for December 20, 2017 and February 28, 2018 when several sites experienced more acidic conditions with measurements below 6.0 pH (*Figure 9*). pH levels just less than 6 are not overly concerning and are often caused by influences such as slightly acidic rainfall, needle droppings from pine and cedar trees, and other natural factors. The pH result February 21, 2018 at the FCDT sampling site featured a pH level (12.8) that was determined to be an outlier using the IQR rule. Additionally, at that site, upstream, and downstream on that date, typical results were found for all other parameters and no visual evidence of an illicit discharge was noted. It is believed that this value was most likely due to equipment error and therefore the value is not included in the overall study results.

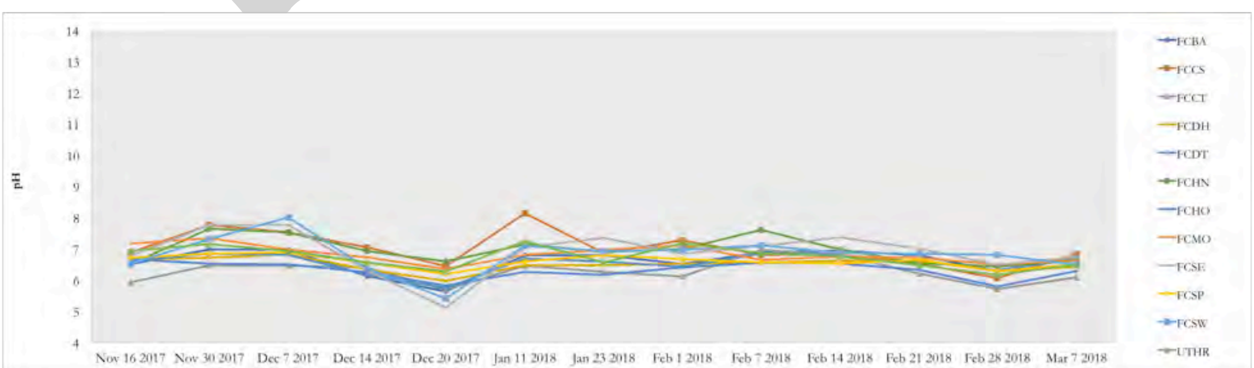

Figure 9. Time series of pH measurements received from all sampling locations to date.

Dissolved Oxygen

Dissolved oxygen, an important water quality parameter, is required for aquatic life to survive. Typically, levels of dissolved oxygen need to be above 5 ppm for a stream to maintain survival of fish and other aquatic species. Dissolved oxygen was not detected at critically low levels but was found at levels below 6 ppm at four different sites throughout the sampling period. These sites were predominantly in the upper part of the watershed. The levels of dissolved oxygen found in this study (Average – 6.98 ppm, Min – 4 ppm) were substantially less than those found in the 2004 ADEM study (Average -9.02, Min – 6.6). FCCT (Average -5.85 ppm, Min – 4 ppm), FCHO (Average – 6.57, Min – 4.8), FCMO (Average – 7.47, Min – 5.4), and UTHR (Average – 6.23, Min - 5), contained the lowest dissolved oxygen readings (*Figure 10*). Low levels of dissolved oxygen can result when organic matter from sewer overflows, yard wastes, or from other sources is introduced to the creek. Bacteria consume this organic matter. A component of that consumption is oxygen. The addition of organic matter to the creek creates a high demand on oxygen, which removes much of the oxygen from the creek and threatens many aquatic species. This change over the last decade can indicate a long-term negative trend associated with aging sewage or septic tank infrastructure, increased population and/or increased impervious surfaces.

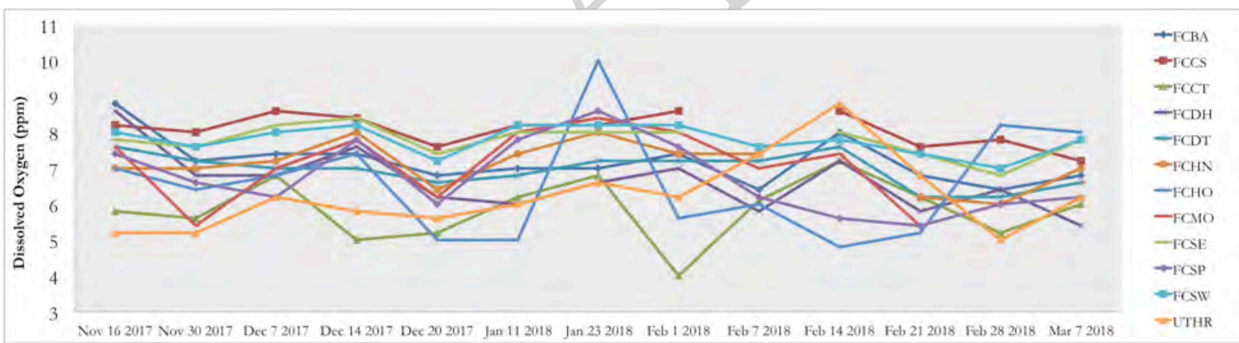

Figure 10. Times series of dissolved oxygen measurements received from all sampling locations to date.

Turbidity

Turbidity was consistently low in this study (average – 8.6 NTU). The highest value (Max – 71.2 NTU) was found in the most upstream site (FCHO) where agricultural encroachment has caused severe stream bank erosion. There was little to no development or land disturbance in the watershed during the data gathering portion of the study. Despite the low averages, turbidity is still considered an important parameter in Fly Creek due to the overwhelming evidence of a substantial influx of sediment from past construction in the watershed. Significant care will need to be taken with new development in the watershed and specifically on land adjacent to or near the creek. The steep slopes, intense rainfall characteristic of Fairhope's climate, and moderately erodible soils make conditions ripe for mud filling in the creek when new construction occurs in the watershed.

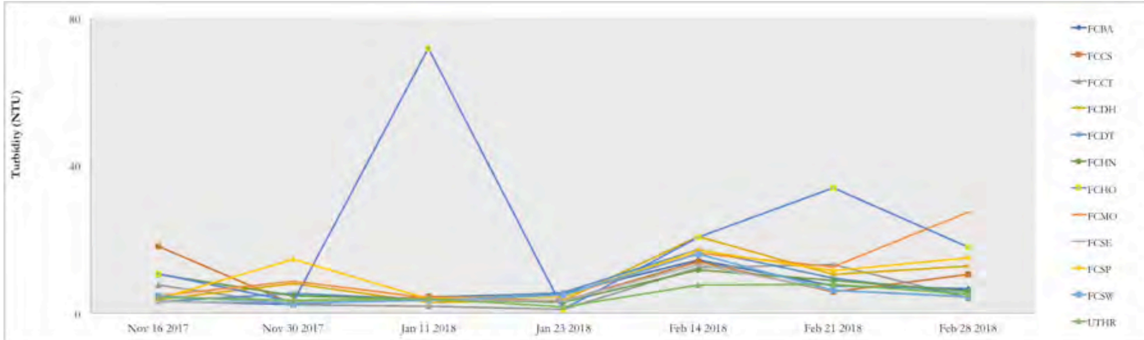

Figure 11 – Time series of turbidity measurements from all sampling locations.

Stormwater Pollution, Aging Infrastructure, and High Bacteria Levels

Stormwater runoff and issues with septic and sewer system are associated with heavy rains. Rainwater running across the ground can carry chemicals, oils and gas from automobiles, and pet and wildlife waste to waterways. Infrastructure issues become apparent during heavy rains as leaky sewer lines are overwhelmed with rain water and groundwater filling the sewer lines (infiltration and inflow). Older septic systems or those in areas with shallow water tables are not able to treat wastewater as groundwater levels rise and submerge the septic tanks. While the largest rains that took place during this study were on the order of 0.25 inches, they often resulted in high bacteria concentrations. In fact, 18 out of 37 (49%) findings of bacteria levels above the EPA threshold occurred after rainstorms greater than 0.2".

Site Summaries

Site Summary: FCHO

Image 2 – FCHO – Fly Creek at Highway One Eighty One Representative Photo

Site Description: FCHO – Fly Creek at Highway One Eighty One, is the site furthest upstream in this study. Sampling took place where Fly Creek flows under Highway 181. At the site the creek measures approximately 2.5 feet across and is ~6-12 inches deep. The immediate surrounding area consists of cattle fields and farmland with a number of development projects taking place in the nearby vicinity. The creek has a very small volume and is nearly dry at times at this location. Immediately downstream of this site the creek flows through two man-made ponds.

Results:

pH – The pH level on average was 6.3 with a minimum pH of 5.78 noted on 2/28/18.

Turbidity – Turbidity measurements were relatively high at FCHO, in-stream erosion seemed to cause a high reading of 71.8 NTU on 1/11/18 after a large rainstorm. The average for all measurements was 22.69 NTU.

Dissolved Oxygen – Dissolved oxygen at the site has been lower than 6.0 ppm for five sample, low DO values are likely the result of high levels of

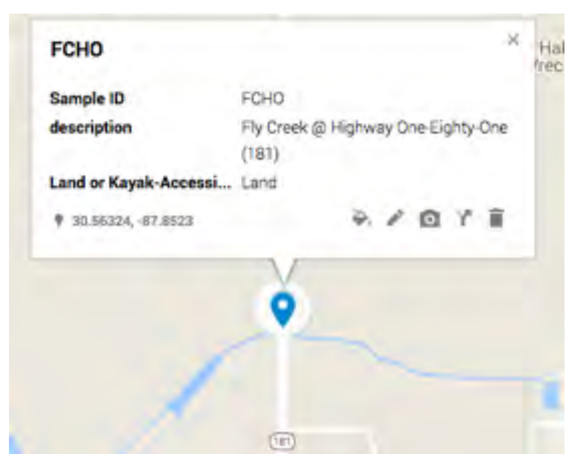

Figure 12. FCHO sampling site

organic matter at the site causing high demand on oxygen in the creek. Dissolved oxygen at the site averaged 6.57.

Optical Brighteners – Optical brighteners were consistently elevated at this site, with most samples featuring a high reading (>50 ppm) and almost 50% of the readings above 100 ppm. The average value for optical brighteners at the site was 91.59 ppm.

Bacteria – Likewise, enterococcus recorded for this site was also significantly higher than all other sites. Eleven samples indicated an enterococcus value above 104 CFU/100mL and seven of those samples were above 501 CFU/100mL (above the federal standards for swimming waters). The average value for enterococcus at the site was 10,796 CFU/100mL.

Legend	Note - All data contained herein is preliminary.									
	* indicates duplicate samples for bacteria only			PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
								4.0-9.9		
					50-99			10.0-49.9		104-501
				<6.0	>100			>50.0	<6.0	>501
Date Sampled	**Time Sampled**	**Site ID**	**Water Temp (°C)**	**pH**	**Optical Brighteners (ppm)**	**Conductivity (mS/cm)**	**Total Dissolved Solids (ppt)**	**Turbidity (NTU)**	**Dissolved Oxygen (ppm)**	**MPN Enterococcus CFU/100mL**
11/16/17	14:45	FCHO	19.7	6.65	102.1	0.16	0.08	10.6	7	3784
11/30/17	13:29	FCHO	20	6.51	142.6	0.17	0.08	3.13	6.4	48392
11/30/17	*	*	*	*	*	*	*	*	*	15402
12/7/17	11:48	FCHO	10.2	6.49	176.7	0.17	0.09	N/A	6.8	918
12/7/17	*	*	*	*	*	*	*	*	*	1300
12/14/17	11:24	FCHO	12.4	6.23	58.42	0.39	0.19	N/A	7.4	20
12/14/17	*	*	*	*	*	*	*	*	*	40
12/20/17	11:01	FCHO	21	5.81	63.17	0.33	0.17	N/A	5	268
1/11/18	11:39	FCHO	18.7	6.25	102	0.22	0.11	71.8	5	270
1/23/18	12:02	FCHO	15.9	6.15	83.56	0.2	0.1	0.98	10	172
2/1/18	12:38	FCHO	16.5	6.4	77.48	0.14	0.06	N/A	5.6	192
2/7/18	10:59	FCHO	19.5	6.54	26.69	0.7	0.3	N/A	6	>48392
2/7/18	*	*	*	*	*	*	*	*	*	>48392
2/14/18	10:26	FCHO	18.2	6.52	75.54	0.09	0.05	20.6	4.8	N/A
2/21/18	11:34	FCHO	22.7	6.32	77.29	0.13	0.06	33.8	5.2	3870
2/28/18	11:52	FCHO	25.1	5.78	88.43	0.18	0.01	17.9	8.2	778
3/7/18	10:19	FCHO	16.8	6.27	114.7	0.27	0.14	N/A	8	549.3

Table 3. FCHO sampling site water quality data

Site Summary: FCCT

Image 3 – FCCT – Fly Creek County Road Thirteen Representative Photo

Site Description: FCCT – Fly Creek at County Road Thirteen (CR 13) is a site on the main stem of Fly Creek at the CR 13 bridge. Sampling took place where the creek passes under the bridge. At this site the creek was approximately 25 feet wide and more than 5 feet deep. The immediate surrounding area consisted of forested land and farmland owned by Auburn University. The upstream area has a small amount of development going on however most of the waterbodies upstream of this site have ponds between where the development is located and FCCT.

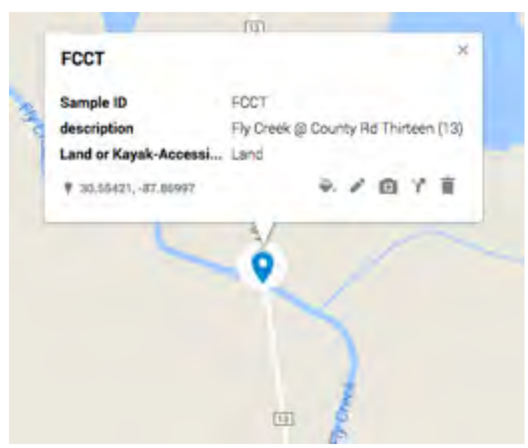

Figure 13. FCCT sampling site

Results:

pH – There were three slightly lower pH levels recorded: 5.92 on 11/16/17, 5.67 on 12/20/17, and 5.7 on 2/28/18. This is not a concern as noted in the discussions section. The average pH value for this site was 6.26.

Turbidity – Turbidity measurements were low, ranging from 0.98-13.1 NTU. This indicates a low amount of soil and other runoff entering the stream and is typically a good sign in streams similar to Fly Creek. Turbidity levels may rise in response to soil from poorly maintained construction sites releasing muddy stormwater runoff into the creek. Average turbidity at the site was 5.99 NTU.

Dissolved Oxygen – Dissolved oxygen at the site was below 6.0 ppm on five occasions. Average dissolved oxygen was 5.85. The cause of low dissolved oxygen levels at the site is not immediately clear.

Optical Brighteners – Optical brightener readings have also remained low, with highest reading of 43.41 ppm.

Bacteria – The location has contained low Enterococcus readings below the federal standards for swimming waters and infrequent swimming waters.

Legend	Note - All data contained herein is preliminary. * indicates duplicate samples for bacteria only	PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination		BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
					4.0-9.9		
			50-99		10.0-49.9		104-501
		<6.0	>100		>50.0	<6.0	>501

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL
11/16/17	14:20	FCCT	18.9	5.92	0	0.07	0.04	7.55	5.8	<20
11/30/17	13:01	FCCT	19.6	6.46	4.621	0.08	0.04	2.18	5.6	<20
12/7/17	11:30	FCCT	15.9	6.45	0	0.07	0.03	N/A	6.8	<20
12/14/17	11:03	FCCT	16.3	6.38	19.03	0.06	0.04	N/A	5	<20
12/20/17	10:41	FCCT	19.7	5.67	13.47	0.08	0.04	N/A	5.2	<20
1/11/18	11:27	FCCT	18.5	6.45	13.67	0.08	0.04	1.89	6.2	<20
1/23/18	11:35	FCCT	16.5	6.25	13.63	0.06	0.04	0.98	6.8	<20
2/1/18	12:13	FCCT	17.7	6.1	14.41	0.07	0.03	N/A	4	<20
2/1/18	*	*	*	*	*	*	*	*	*	<20
2/7/18	10:37	FCCT	18.6	6.95	17.47	0.07	0.03	N/A	6.1	82
2/14/18	10:07	FCCT	17.6	6.79	43.41	0.06	0.03	12.2	7.2	N/A
2/21/18	11:06	FCCT	20.6	6.19	18.49	0.05	0.03	13.1	6.2	20
2/28/18	11:30	FCCT	21.4	5.7	10	0.07	0.03	4.04	5.2	4.1
3/7/18	10:00	FCCT	17.1	6.08	14.47	0.06	0.03	N/A	6	1
3/7/18	*	*	*	*	*	*	*	*	*	<1

Table 4. FCCT sampling site water quality data

Site Summary: UTHR

Image 4 – UTHR – Unnamed Tributary to Fly Creek at Headwaters Road Representative Photo

Site Description: UTHR – an unnamed tributary to Fly Creek at Headwaters Rd is a small perennial stream that contributes flow to Fly Creek. Sampling took place on the south side of Headwaters Rd where the creek flows through a small wetland complex. The immediate area is forested however a subdivision is planned and some development has occurred nearby to the creek. Further away the neighborhoods of Sandy Ford and Rock Creek surround the creek. Upstream of the site there is the neighborhood of Bellaton, some agriculture including a tree nursery and a dirt pit. After leaving these areas the creek exits from a large private pond.

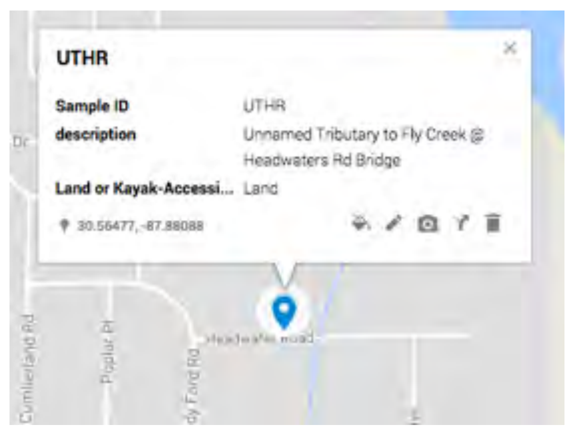

Figure 14. UTHR sampling site

Results:

<u>pH</u> – The pH levels at the site ranged from 6.15-7.23 with an average of 6.73.

<u>Turbidity</u> – Turbidity measurements at the site were low, with the highest reading of 7.67 NTU and an average of 4.80 NTU. After the time to settle in the large pond upstream of this site high turbidity values are not expected.

<u>Dissolved Oxygen</u> – Dissolved oxygen was lower at this site than many others; almost 50% of observations were under 6.6 ppm with the lowest measurement of 5 ppm. Though low, none of these values are outside of the range of water quality standards and don't pose a significant risk to aquatic life at these levels.

<u>Optical Brighteners</u> – Optical brightener readings were moderate, ranging from 6.57-25.11 ppm.

<u>Bacteria</u> – The only exceedance for bacteria occurred on 2/7/18, when sampling found 1382 CFU/100mL levels of Enterococcus. This sampling occurred right after a brief but intense thunderstorm that likely caused stormwater runoff to wash wildlife waste in the area into the creek and may have temporarily elevated bacteria values. The inventory of septic systems in the area shows no septic upstream of this site but if there are any older systems upstream they could have also contributed to high bacteria values on this date. Enterococcus averaged 136 CFU/100mL but if the one high sampling that took place immediately after a thunderstorm is excluded the creek averaged only 22.55 CFU/100mL.

Legend	Note - All data contained herein is preliminary.									
	* indicates duplicate samples for bacteria only			PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
					50-99			4.0-9.9		104-501
				<6.0	>100			10.0-49.9	<6.0	>501
								>50.0		
Date Sampled	**Time Sampled**	**Site ID**	**Water Temp (°C)**	**pH**	**Optical Brighteners (ppm)**	**Conductivity (mS/cm)**	**Total Dissolved Solids (ppt)**	**Turbidity (NTU)**	**Dissolved Oxygen (ppm)**	**MPN Enterococcus CFU/100mL**
11/16/17	12:35	UTHR	18.9	6.93	9.765	0.08	0.04	4.28	5.2	<20
11/30/17	12:38	UTHR	20	7.14	6.578	0.08	0.04	3.43	5.2	<20
12/7/17	11:04	UTHR	15.4	6.92	24.95	0.07	0.04	N/A	6.2	<20
12/14/17	10:35	UTHR	15.6	6.55	15.18	0.08	0.04	N/A	5.8	<20
12/20/17	10:15	UTHR	19.7	6.26	19	0.07	0.04	N/A	5.6	<20
1/11/18	10:54	UTHR	18	7.23	11.2	0.08	0.04	3.95	6	<20
1/23/18	10:50	UTHR	15.2	6.55	10.29	0.08	0.04	1.65	6.6	<20
2/1/18	11:44	UTHR	18	7.17	9.673	0.07	0.03	N/A	6.2	<20
2/7/18	10:11	UTHR	18.2	6.85	25.11	0.06	0.03	N/A	7.4	1382
2/14/18	9:41	UTHR	17.2	6.76	15.65	0.06	0.02	7.59	8.8	N/A
2/21/18	10:35	UTHR	20.6	6.46	14.91	0.01	0.03	7.67	6.8	62
2/28/18	11:03	UTHR	21.3	6.15	13.77	0.07	0.03	5.06	5	28.5
3/7/18	9:35	UTHR	16.4	6.49	10.63	0.07	0.03	N/A	6.2	2

Table 5. UTHR sampling site water quality data

Site Summary: FCHN

Image 5 – FCHN – Fly Creek US Highway 98 Representative Photo

Site Description: Fly Creek at U.S. Highway 98 is a site just upstream of U.S. Highway 98 box culvert. The sampling for this site took place at the approximate location of the new pedestrian bridge. The creek is approximately 25 feet across and 5 feet deep at this location. In the immediate vicinity is the Woodlands neighborhood and the Shoppes at Fairhope. The site is primarily surrounded by forest however a large new development is being constructed just upstream of this site. Immediately downstream of the site the creek flows through a large box culvert under U.S. Highway 98.

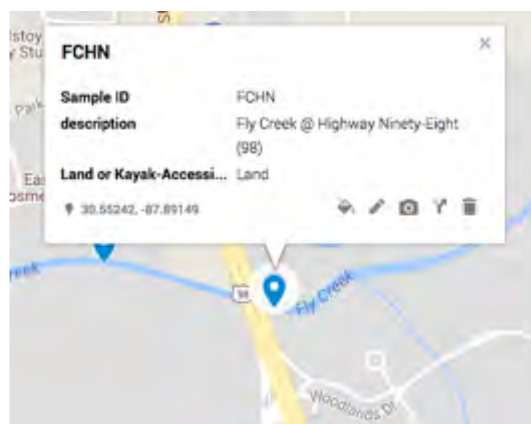

Figure 15. FCHN sampling site

Results:

pH –The pH levels ranged from 6.5-7.63 with an average of 6.94.

Turbidity – Turbidity measurements were relatively low, with the highest reading of 11.7 NTU. Turbidity averaged 6.89 NTU at the site.

Dissolved Oxygen - Dissolved oxygen at the site ranged from 6-8 ppm with an average of 7.08 ppm.

Optical Brighteners – Optical brightener readings were relatively low for this site, with readings between 0.986-40.19 ppm. Readings at the site averaged 18.90 ppm.

Bacteria – The location has contained low Enterococcus readings with a maximum of just 40 CFU/100mL and an average of 22.55 CFU/100mL.

Legend	Note - All data contained herein is preliminary.			PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
								4.0-9.9		
	* indicates duplicate samples for bacteria only				50-99			10.0-49.9		104-501
				<6.0	>100			>50.0	<6.0	>501
Date Sampled	**Time Sampled**	**Site ID**	**Water Temp (°C)**	**pH**	**Optical Brighteners (ppm)**	**Conductivity (mS/cm)**	**Total Dissolved Solids (ppt)**	**Turbidity (NTU)**	**Dissolved Oxygen (ppm)**	**MPN Enterococcus CFU/100mL**
11/16/17	13:43	FCHN	16.9	6.5	0	0.07	0.03	10.4	7	<20
11/16/17	*	*	*	*	*	*	*	*	*	20
11/30/17	10:54	FCHN	18.5	7.63	7.59	0.07	0.03	4.71	7	40
12/7/17	10:07	FCHN	14.6	7.51	6.788	0.07	0.03	N/A	7.2	20
12/14/17	9:36	FCHN	14.4	6.91	27.4	0.06	0.03	N/A	8	<20
12/20/17	9:23	FCHN	19.5	6.58	15.41	0.06	0.03	N/A	6.4	40
1/11/18	10:30	FCHN	17.8	7.13	26.5	0.07	0.04	3.65	7.4	<20
1/23/18	9:43	FCHN	16.1	6.89	15.89	0.08	0.04	2.92	8	20
2/1/18	10:29	FCHN	16.1	6.98	13.44	0.07	0.04	N/A	7.4	<20
2/7/18	9:21	FCHN	17.7	7.59	22.99	0.06	0.04	N/A	7.4	<20
2/14/18	8:53	FCHN	17.3	6.97	40.19	0.05	0.03	11.7	N/A	N/A
2/21/18	9:32	FCHN	20.5	6.53	21.07	0.05	0.03	8.87	6.2	<20
2/28/18	10:04	FCHN	21.2	6.42	14.28	0.07	0.04	5.97	6	19.9
3/7/18	8:50	FCHN	16.1	6.61	34.18	0.03	0.1	N/A	7	19.3

Table 6. FCHN sampling site water quality data

Site Summary: FCCS

Image 6 – FCCS – Fly Creek behind Eastern Shore Cosmetic Surgery Representative Photo

Site Description: FCCS – Fly Creek behind Eastern Shore Cosmetic Surgery is the site immediately downstream of U.S. Highway 98 (about 800 feet downstream). While there was little evidence of human activity in the area, anecdotal evidence suggests boats could once access this reach. It is now extremely shallow and shows the telltale signs of excessive siltation from poor upstream construction practices.

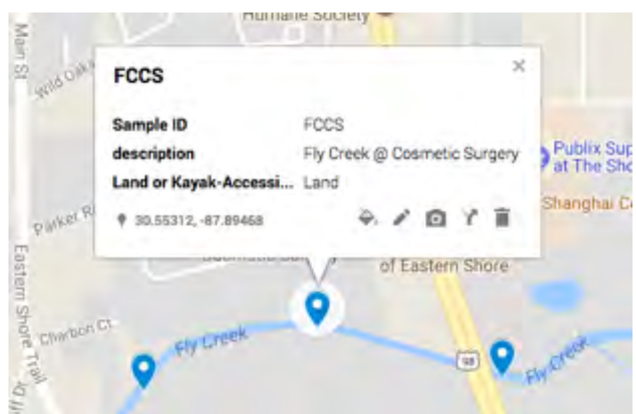

Figure 16. FCCS sampling site

pH – The pH level on average has been 6.99 with a maximum value of 8.13 observed on 1/11/2018.

Turbidity – Turbidity was very low with values ranging from 2.39 NTU – 18 NTU. The average turbidity at the site was 8.30 NTU.

Dissolved Oxygen

Dissolved oxygen at the site has been high, with all values recorded greater than 7.6 ppm. The average dissolved oxygen at the site was 8.08 ppm. This is a healthy level of dissolved oxygen for aquatic life.

Optical Brighteners

Optical brighteners concentrations have also remained low, with the highest reading of 33.71 ppm. The average optical brightener value at FCCS was 16.44 ppm. This indicates there was very little human wastewater in the creek at this location.

Bacteria

The location has frequently contained low Enterococcus readings below the federal standards for swimming waters and infrequent swimming waters, with the exception of 2/7/2018 and 2/21/2018. Enterococcus levels of 976 CFU/100mL measured on 2/7/2018 is likely due to stormwater runoff from wildlife waste, pet waste, and any failing septic or leaky sewer lines upstream of this location. The average enterococcus concentration at the site was 111 CFU/100mL but is reduced to 39 CFU/100mL if the post thunderstorm sample is not included.

Legend	Note - All data contained herein is preliminary. * indicates duplicate samples for bacteria only			PINK pH indicates more acidic water <6.0	YELLOW and RED indicate higher probability of septic/sewage contamination 50-99 >100			BROWNER values indicate cloudier water 4.0-9.9 10.0-49.9 >50.0	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water <6.0	YELLOW and RED indicate higher bacteria levels 104-501 >501
Date Sampled	**Time Sampled**	**Site ID**	**Water Temp (°C)**	**pH**	**Optical Brighteners (ppm)**	**Conductivity (mS/cm)**	**Total Dissolved Solids (ppt)**	**Turbidity (NTU)**	**Dissolved Oxygen (ppm)**	**MPN Enterococcus CFU/100mL**
11/16/17	15:40	FCCS	17.2	6.87	1.602	0.07	0.03	18	8.2	<20
11/30/17	12:00	FCCS	18.5	7.75	7.01	0.07	0.03	2.39	8	40
12/7/17	10:38	FCCS	14.8	7.52	8.049	0.07	0.03	N/A	8.6	40
12/14/17	10:04	FCCS	14.5	7.04	17.87	0.05	0.03	N/A	8.4	<20
12/20/17	9:49	FCCS	19.9	6.43	13.08	0.07	0.03	N/A	7.6	40
1/11/18	10:10	FCCS	17.9	8.13	15.42	0.07	0.04	4.43	8.2	20
1/23/18	10:25	FCCS	16	6.85	11.51	0.07	0.03	3.16	8.2	62
1/23/18	*	*	*	*	*	*	*	*	*	40
2/1/18	11:10	FCCS	16.2	7.26	15.59	0.08	0.03	N/A	8.6	<20
2/7/18	9:47	FCCS	18	6.8	21.6	0.05	0.03	N/A	N/A	976
2/14/18	9:19	FCCS	17.5	6.79	33.71	0.05	0.03	14	8.6	N/A
2/21/18	10:07	FCCS	20.7	6.52	30.7	0.06	0.03	5.63	7.6	126
2/28/18	10:36	FCCS	20.6	6.05	15.81	0.06	0.02	10.5	7.8	39.9
3/7/18	9:11	FCCS	16.7	6.82	21.71	0.05	0.03	N/A	7.2	7.3

Table 7. FCCS sampling site water quality data

Site Summary: FCSE

Image 7 – FCSE – Fly Creek East of Scenic 98 Representative Photo

Site Description: FCSE – Fly Creek just East of Scenic 98 was approximately 200 feet east (upstream) of Scenic 98. The creek was very shallow making it difficult to reach with a shallow draft kayak. There was some evidence of residential access on the banks of the creek but other than Scenic 98, the area was almost completely forested. The creek is approximately 35 feet across and 6 inches to 2 feet deep.

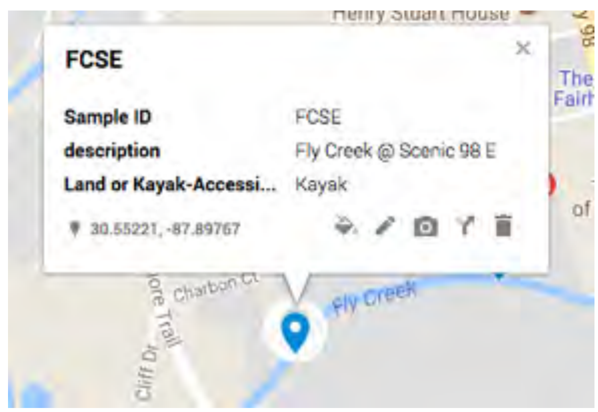

Figure 17. FCSE sampling site

pH – The pH level on average was 6.86 with one low value of 5.1 observed on 12/20/2017.

Turbidity – Turbidity measurements were lower than most sites, with the highest measurement being 2.92 NTU.

Dissolved Oxygen – Dissolved oxygen was higher at this site ranging from 7.4-8.4 ppm. This is a good level for aquatic life. The average dissolved oxygen at this site was 7.78 ppm

Optical Brighteners – Optical brightener readings were relatively low at FCSE, ranging between 10.79-21.92 ppm. Average optical brighteners at the site were 17.65 ppm

Bacteria – Three sampling results showed an enterococcus concentration equal to or more than 104 CFU/100mL. On 3/7/18, the bacteria sample may have been compromised during collection and so a "N/A" observation was made. The average bacteria value at this site was 55 CFU/100mL.

Legend	Note - All data contained herein is preliminary.									
	* indicates duplicate samples for bacteria only			PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
					50-99			4.0-9.9		104-501
				<6.0	>100			10.0-49.9	<6.0	>501
								>50.0		

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL
11/16/17	16:39	FCSE	17	6.76	0	0.07	0.04	3.04	7.8	20
11/30/17	8:18	FCSE	18	7.75	10.79	0.07	0.03	2.92	7.6	<20
12/7/17	7:37	FCSE	15	7.75	21.92	0.07	0.04	N/A	8.2	104
12/14/17	7:23	FCSE	14.3	6.29	21.44	0.07	0.03	N/A	8.4	40
12/20/17	7:29	FCSE	19.6	5.1	15.32	0.07	0.03	N/A	7.4	104
1/11/18	7:52	FCSE	17.7	7.03	18.76	0.07	0.03	3.57	8	20
1/23/18	7:35	FCSE	15.5	7.34	14.39	0.08	0.04	3.18	8	20
2/1/18	8:06	FCSE	15.5	6.83	13.88	0.06	0.03	N/A	8	62
2/7/18	7:23	FCSE	17.5	7.07	20.73	0.08	0.04	N/A	N/A	20
2/14/18	7:23	FCSE	17	7.35	34.59	0.05	0.03	13.2	8	N/A
2/21/18	7:19	FCSE	20.5	6.99	19.37	0.09	0.04	6.15	7.4	172
2/28/18	8:00	FCSE	19.7	6.48	23.03	0.07	0.03	4.24	6.8	24.1
3/7/18	7:07	FCSE	16.5	6.73	15.22	0.06	0.03	N/A	7.8	N/A

Table 8. FCSE sampling site water quality data

Site Summary: FCSW

Image 8 – FCSW – Fly Creek West of Scenic 98 Representative Photo

Site Description: FCSW – Fly Creek at Scenic 98 West is a site just west (downstream) of Scenic 98. The creek is much deeper than at the area upstream of the bridge and sampling was conducted from a kayak. The creek has a stronger flow on outgoing tides or after rain events here and is tidally influenced.

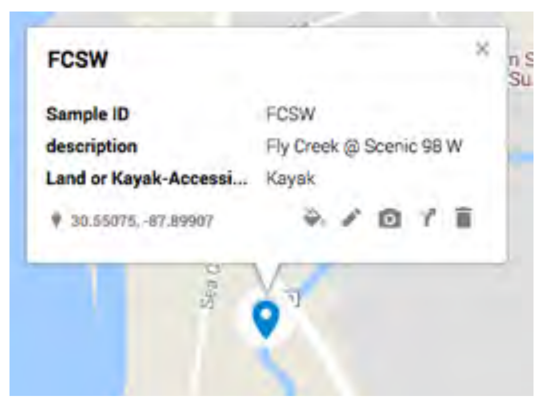

Figure 18. FCSW sampling site

<u>pH</u> – The pH level on average was 6.82 with one low value of 5.39 observed on 12/20/2017.

<u>Turbidity</u> – Turbidity measurements were relatively low, with the highest reading of 16 NTU. Average turbidity values at the site were 6.02 NTU.

<u>Dissolved Oxygen</u> – Dissolved oxygen was higher at this site ranging from 7.2-8.2 ppm with an average of 7.78 ppm.

<u>Optical Brighteners</u> – Optical brightener readings were relatively low, ranging from 10.66-31.28 ppm. The average optical brightener value at the site was 20.09

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Bacteria – There was one reading of enterococcus that was detected above 104 CFU/100mL. The average enterococcus reading at the site was 42 CFU/100mL

Legend	Note - All data contained herein is preliminary.									
				PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
	* indicates duplicate samples for bacteria only				50-99			4.0-9.9		104-501
								10.0-49.9		
				<6.0	>100			>50.0	<6.0	>501

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL
11/16/17	16:52	FCSW	17.3	6.52	10.66	0.4	0.21	4.69	8	170
11/30/17	8:37	FCSW	18	7.3	24.75	0.07	0.04	2.54	7.6	<20
11/30/17	*	*	*	*	*	*	*	*	*	20
12/7/17	8:22	FCSW	14.8	8	20.64	0.12	0.06	N/A	8	40
12/14/17	7:39	FCSW	14.3	6.36	19.33	0.08	0.04	N/A	8.2	<20
12/20/17	7:39	FCSW	19.7	5.39	14.09	0.18	0.09	N/A	7.2	<20
1/11/18	8:01	FCSW	17.7	7.09	19.11	0.07	0.04	3.43	8.2	20
1/23/18	7:50	FCSW	15.6	6.91	13.24	0.07	0.04	4.87	8.2	40
2/1/18	8:22	FCSW	15.4	6.96	12.1	0.09	0.04	N/A	8.2	40
2/7/18	7:32	FCSW	18.2	7.1	21.24	0.2	0.05	N/A	7.6	20
2/14/18	7:30	FCSW	19	6.86	31.28	0.05	0.03	16	7.8	N/A
2/14/18	*	*	*	*	*	*	*	*	*	N/A
2/21/18	7:30	FCSW	20.6	6.84	24.58	0.08	0.05	6.12	7.4	82
2/28/18	8:12	FCSW	19.9	6.8	28.03	0.14	0.06	4.51	7	35.9
3/7/18	7:18	FCSW	16.6	6.48	22.1	0.06	0.03	N/A	7.8	23.1

Table 9. FCSW sampling site water quality data

Site Summary: FCBA

Image 9 – FCBA – Fly Creek at the boathouse with an American flag Representative Photo

Site Description – FCBA – Fly Creek at the boathouse with an American flag, is approximately .25 miles downstream from Scenic Highway 98. With numerous boathouses nearby, it is a popular place for locals to swim, kayak, fish, and boat. The watershed at this location is a mix of forest and low-density residential neighborhoods.

pH – pH only fell below six on one occasion. Average of pH over the sampling period was 6.60.

Turbidity – As at most other sites in the watershed, turbidity measurements were low, ranging from 2.3-14.3 NTU. The average turbidity value was 6.22 NTU.

Dissolved Oxygen – Dissolved oxygen at the site was never below 6.0 and averaged 7.18 ppm. This indicates levels of oxygen that can support fish, and other aquatic life.

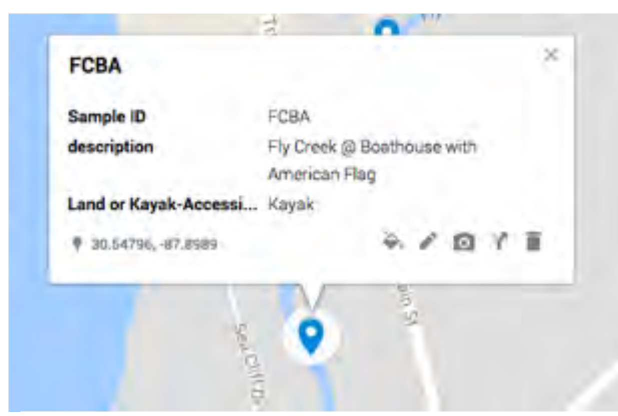

Figure 19. FCBA sampling site

Optical Brighteners – Optical brightener readings were consistently low with the highest reading of 38.63 ppm. The average over the course of the study was 22.34 ppm.

<u>Bacteria</u> – The location has frequently contained low Enterococcus readings below the federal standards for swimming waters and infrequent swimming waters. Only two of the 14 samples analyzed for bacteria at the site exceeded the EPA swimming standard (2/21/18 – 126 CFU/100 mL and a duplicate sample showed 192 CFU/100mL. The average enterococcus concentration at the site was 59 CFU/100mL.

Legend	Note - All data contained herein is preliminary.			PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
	* indicates duplicate samples for bacteria only				50-99			4.0-9.9		104-501
								10.0-49.9		
				<6.0	>100			>50.0	<6.0	>501
Date Sampled	**Time Sampled**	**Site ID**	**Water Temp (°C)**	**pH**	**Optical Brighteners (ppm)**	**Conductivity (mS/cm)**	**Total Dissolved Solids (ppt)**	**Turbidity (NTU)**	**Dissolved Oxygen (ppm)**	**MPN Enterococcus CFU/100mL**
11/16/17	17:01	FCBA	17.7	6.5	9.95	2.45	1.24	3.3	8.8	<20
11/30/17	8:59	FCBA	17.9	6.97	9.209	1.02	0.51	2.31	7.2	60
12/7/17	8:35	FCBA	15	6.95	35.81	3.22	1.56	N/A	7.4	62
12/14/17	7:52	FCBA	14.1	6.12	23.08	1.47	0.71	N/A	7.4	62
12/20/17	7:53	FCBA	19.7	5.82	16	2.12	1.06	N/A	6.8	20
1/11/18	8:12	FCBA	17.6	6.78	13.59	0.07	0.04	4.35	7	60
1/23/18	8:05	FCBA	15	6.78	26.43	5.3	0.3	5.32	7	40
1/23/18	*	*	*	*	*	*	*	*	*	20
2/1/18	8:36	FCBA	15.3	6.5	17.35	1.42	0.08	N/A	7.4	20
2/7/18	7:46	FCBA	18	6.88	17.8	0.43	2.2	N/A	6.4	62
2/14/18	7:40	FCBA	17.3	6.93	38.63	0.09	0.05	14.3	8	N/A
2/21/18	7:43	FCBA	20.9	6.78	24.74	0.07	0.04	7.43	6.8	126
2/21/18	*	*	*	*	*	*	*	*	*	192
2/28/18	8:27	FCBA	20.2	6.28	35.3	0.08	0.05	6.54	6.4	56.3
3/7/18	7:29	FCBA	16.3	6.7	22.58	0.08	0.03	N/A	6.8	24.3

Table 10. FCBA sampling site water quality data

Site Summary: FCDT

Image 10 – FCDT – Fly Creek at downed tree Representative Photo

Site Description: FCDT – Fly Creek at the downed tree is just downstream of the site FCBA. Stream and watershed characteristics are very similar.

Results:

<u>pH</u> - The pH levels ranged from 5.73-6.84 with one low value of 5.73 observed on 12/20/2017 the average at the site was 6.53.

<u>Turbidity</u> – Turbidity measurements were relatively low, with the highest reading of 17.3 NTU. The average at the site was 7.06 NTU.

<u>Dissolved Oxygen</u> – Dissolved oxygen at the site ranged between 6.2-7.6 ppm with an average of 6.95 ppm.

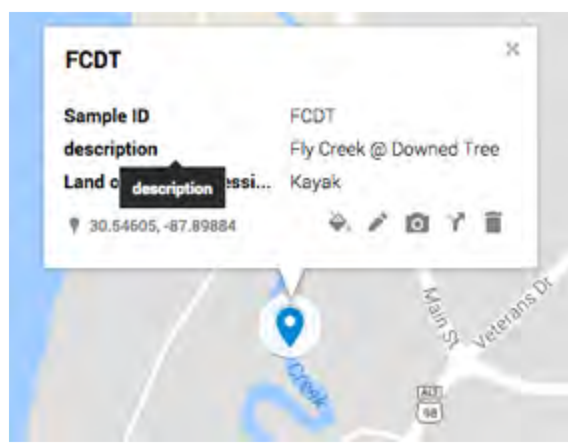

Figure 20. FCDT sampling site

Optical Brighteners – Optical brightener readings had a range of 14-36.4 ppm. The average optical brightener value at the site was 23.34 ppm.

Bacteria - There have been four readings of enterococcus that were equal to or more than 104 CFU/100mL (the federal standards for infrequent swimming waters). One of these high-bacteria samples was a duplicate. The average of enterococcus concentrations at the site was 74.69 CFU/100mL. As the sampling moves toward the mouth of the Bay, the average concentrations begin to rise.

Legend	Note - All data contained herein is preliminary.									
	* indicates duplicate samples for bacteria only			PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
					50-99			4.0-9.9		104-501
								10.0-49.9		
				<6.0	>100			>50.0	<6.0	>501

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL
11/16/17	17:09	FCDT	17.7	6.6	14	3.02	1.51	3.06	7.6	82
11/30/17	9:10	FCDT	17.9	6.84	15.02	1.81	0.9	5.4	7.2	20
12/7/17	8:45	FCDT	15.3	6.79	30.8	5.89	2.91	N/A	7	82
12/14/17	8:04	FCDT	14.1	6.16	24.54	2.2	1.1	N/A	7	82
12/20/17	8:03	FCDT	19.6	5.73	17.38	2.6	1.3	N/A	6.6	104
1/11/18	8:20	FCDT	17.3	6.68	27.77	1.85	0.89	3.67	6.8	40
1/11/18	8:20	FCDT	17.3	6.68	27.77	1.85	0.89	3.67	6.8	82
1/23/18	8:17	FCDT	14.6	6.58	28.34	1.93	0.99	5.5	7.2	82
2/1/18	8:45	FCDT	15.2	6.41	17.85	4.02	2	N/A	7.2	40
2/7/18	7:57	FCDT	17.5	6.84	17.32	1.08	0.54	N/A	7.2	40
2/7/18	*	*	*	*	*	*	*	*	*	150
2/14/18	7:52	FCDT	18.6	6.79	36.4	0.09	0.05	17.3	7.6	N/A
2/21/18	7:53	FCDT	20.8	12.8	6.66	0.08	0.04	9.36	6.2	124
2/21/18	*	*	*	*	*	*	*	*	*	126
2/28/18	8:38	FCDT	20	6.31	30.28	0.08	0.04	5.15	6.2	62.4
3/7/18	7:37	FCDT	16.3	6.65	37	0.07	0.04	N/A	6.6	37.9
3/7/18	*	*	*	*	*	*	*	*	*	40.8

Table 11. FCDT sampling site water quality data

Site Summary: FCDH

Image 11 - Fly Creek at the downed tree - FCDH

Site Description: FCDH – Fly Creek at Devil's Hole is just on the outside of Fly Creek where a small spring fled inlet flows into the creek. At this location there is a small backwater that is locally known as Devils Hole. The creek is quite wide and deep at this location and boats and boathouses line the creek. The watershed at this location is primarily low-density residential with light forest and some nearby commercial developments.

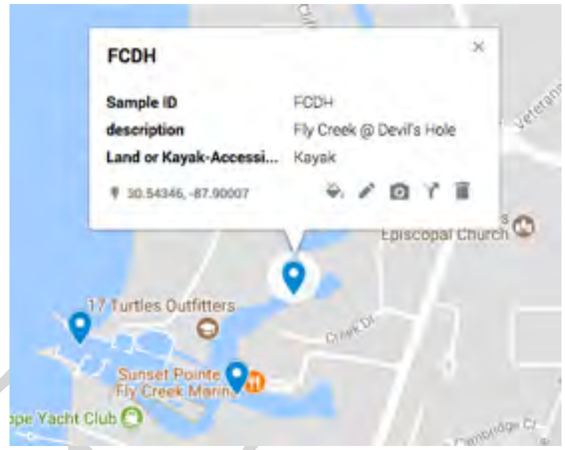

Figure 21. FCDH sampling site

Results:

pH – The pH level on average was 6.49 with one low value of 5.96 observed on 12/20/2017. The average pH value was 6.49.

Turbidity – Turbidity measurements were low, with the highest reading of 20.7 NTU. Turbidity averaged 8.87 NTU during the study.

Dissolved Oxygen – Dissolved oxygen at the site on average is 6.63 ppm with the lowest reading being 5.4 ppm.

Optical Brighteners – Optical brightener readings were slightly higher for this site, with the one reading being 91.41 ppm and other readings between 15.25-46.37 ppm. The average value was 34.59

Bacteria – Six sampling results indicated an enterococcus value above 104 CFU/100mL (above the federal standards for infrequent swimming waters). However, one of these values were a duplicate and taken on the same day. The average enterococcus concentration at the site was 310 CFU/100mL.

Legend	Note - All data contained herein is preliminary.			PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
	* indicates duplicate samples for bacteria only							4.0-9.9		
					50-99			10.0-49.9		104-501
				<6.0	>100			>50.0	<6.0	>501
Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL
11/16/17	17:17	FCDH	18.6	6.65	15.35	4.55	2.59	3.69	8.6	20
11/30/17	9:31	FCDH	18.1	6.7	91.41	4.89	2.36	8.07	6.8	40
12/7/17	8:57	FCDH	15.1	6.81	36.55	8.45	3.35	N/A	6.8	242
12/7/17	*	*	*	*	*	*	*	*	*	194
12/14/17	8:17	FCDH	13.6	6.33	39.42	4.26	2.12	N/A	7.6	104
12/14/17	*	*	*	*	*	*	*	*	*	62
12/20/17	8:15	FCDH	18.8	5.96	18.58	6.25	3.13	N/A	6.2	40
12/20/17	*	*	*	*	*	*	*	*	*	82
1/11/18	8:31	FCDH	15.8	6.46	36.45	10.8	5.13	2.87	6	60
1/23/18	8:33	FCDH	12.2	6.46	21.46	8.66	5.06	3.43	6.6	126
2/1/18	8:59	FCDH	14.7	6.51	32.66	10.27	5.13	N/A	7	20
2/7/18	8:10	FCDH	16.9	6.55	28.31	5.22	2.63	N/A	5.8	82
2/14/18	8:03	FCDH	20.2	6.61	46.37	0.94	0.47	20.7	7.2	N/A
2/21/18	8:11	FCDH	20.7	6.61	23.67	0.34	0.15	10.5	5.8	1108
2/28/18	8:52	FCDH	20.4	6.28	32.62	0.21	0.1	12.8	6.4	2628
2/28/18	*	*	*	*	*	*	*	*	*	82
3/7/18	7:46	FCDH	17.1	6.41	26.8	0.68	0.31	N/A	5.4	62

Table 12. FCDH sampling site water quality data

Site Summary: FCSP

Image 12 – FCSP – Fly Creek at Sunset Point Representative Photo

Site Description: FCSP – Fly Creek at Sunset Point is located just downstream of the Sunset Point restaurant and in the immediate vicinity of the Fly Creek Marina and the

Fairhope Yacht Club. The site is heavily influenced by incoming and outgoing tide and is used almost exclusively for boating.

Results:

<u>pH</u> – The pH levels had a relatively low range from 6.18-6.88. The average pH at the site was 6.59.

<u>Turbidity</u> – Turbidity measurements were relatively low. They ranged from 3.8 – 17.1 NTU with an average of 10.03 NTU.

<u>Dissolved Oxygen</u> - Dissolved oxygen at this site ranged from 6.0-8.6 ppm. However, on 2/14/18 and 2/21/18, we found dissolved oxygen levels to be 5.6 ppm and 5.4 ppm, respectively. The average dissolved oxygen value at the site was 6.72 ppm.

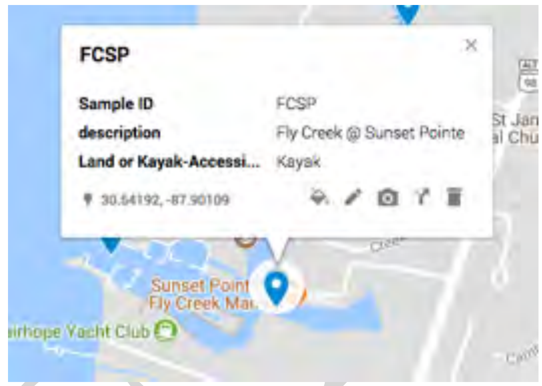

Figure 22. FCSP sampling site

Optical Brighteners - Optical brightener readings were comparable to most sites on average, with readings ranging from 20.89-45.45 ppm. The average optical brightener value at the site was 27.40 ppm.

<u>Bacteria</u> – Five sampling results indicated an enterococcus value at or above 104 CFU/100mL. The average bacteria value at the site was 118 CFU/100mL.

Legend	Note - All data contained herein is preliminary.									
	* indicates duplicate samples for bacteria only			PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
								4.0-9.9		
					50-99			10.0-49.9		104-501
				<6.0	>100			>50.0	<6.0	>501

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL
11/16/17	17:24	FCSP	19	6.7	22.51	7.58	3.8	3.8	7.4	<20
11/30/17	9:43	FCSP	18.4	6.84	20.97	18.34	4.09	14.5	6.6	<20
12/7/17	9:06	FCSP	14.8	6.88	36.16	10.75	5.39	N/A	6.2	196
12/14/17	8:29	FCSP	12.8	6.54	26.6	4.93	2.46	N/A	7.8	<20
12/20/17	8:25	FCSP	18.3	6.18	21.79	8.91	4.48	N/A	6	104
1/11/18	8:39	FCSP	16.1	6.58	20.89	15.29	7.72	3.85	7.8	60
1/23/18	8:45	FCSP	11.4	6.78	31.24	13.9	6.96	4.54	8.6	82
2/1/18	9:08	FCSP	14.5	6.66	22.67	12.44	6.2	N/A	7.6	62
2/1/18	*	*	*	*	*	*	*	*	*	148
2/7/18	8:18	FCSP	16.7	6.55	26.98	8.03	3.91	N/A	6.2	60
2/14/18	8:10	FCSP	18.8	6.52	44.45	3.86	1.92	17.1	5.6	N/A
2/21/18	8:20	FCSP	20.9	6.64	21.3	1.1	0.56	11.5	5.4	518
2/28/18	9:04	FCSP	20.8	6.27	27.4	0.45	0.22	14.9	6	82.3
2/28/18	*	*	*	*	*	*	*	*	*	84.2
3/7/18	7:55	FCSP	17.3	6.49	33.24	1.53	0.77	N/A	6.2	143.9

Table 13. FCSP sampling site water quality data

Site Summary: FCMO

Image 13 – FCMO– Fly Creek at the Mouth of Fly Creek/Confluence of Mobile Bay Representative Photo

Site Description: FCMO – Fly Creek at the Mouth of Fly Creek is a site located just prior to the point that Fly Creek enters Mobile Bay. The site is surrounded by Mobile Bay, the Fairhope Yacht Club, and the Fly Creek marina and is a popular area for boaters and kayakers leaving Fly Creek heading towards Mobile Bay.

Results:

pH - The pH levels at this site ranged from 6.34-7.33. Average pH during the study was 6.81.

Turbidity – Turbidity measurements were low, with the highest reading of 16.2 NTU. The average turbidity at FCMO was 11.15 NTU.

Dissolved Oxygen – Dissolved oxygen largely ranged at this site from 5.4 to 8.4 ppm, but also contained two low measurements of 5.4 ppm. The average dissolved oxygen was 7.07 ppm.

Optical Brighteners – Optical brightener readings were comparable to most sites, with readings ranging

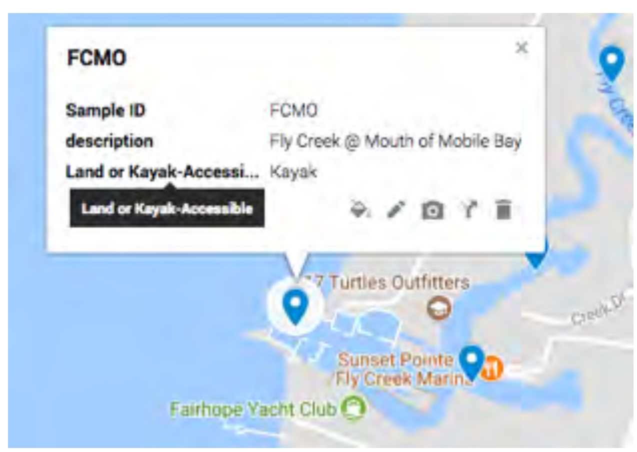

Figure 23. FCMO sampling site

from 25.33-45.79 ppm. The average value for optical brighteners was 32.55 ppm.

<u>Bacteria</u> – Four sampling results indicated an enterococcus value at or above 104 CFU/100mL (the federal standards for infrequent swimming waters). The average enterococci value during this study was 76 CFU/100mL.

Legend	Note - All data contained herein is preliminary.			PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels
	* indicates duplicate samples for bacteria only				50-99			4.0-9.9		104-501
				<6.0	>100			10.0-49.9	<6.0	>501
								>50.0		
Date Sampled	**Time Sampled**	**Site ID**	**Water Temp (°C)**	**pH**	**Optical Brighteners (ppm)**	**Conductivity (mS/cm)**	**Total Dissolved Solids (ppt)**	**Turbidity (NTU)**	**Dissolved Oxygen (ppm)**	**MPN Enterococcus CFU/100mL**
11/16/17	17:32	FCMO	19.5	7.15	32.83	12.5	6.5	4.69	7.6	82
11/30/17	9:56	FCMO	18.5	7.33	31.92	>20	>10	8.64	5.4	<20
12/7/17	9:15	FCMO	14.4	6.97	31.72	14.38	7	N/A	7	104
12/14/17	8:38	FCMO	12.8	6.71	33.01	6.11	3.04	N/A	7.8	<20
12/20/17	8:35	FCMO	17.8	6.34	29.52	13.87	6.87	N/A	6.2	62
12/20/17	*	*	*	*	*	*	*	*	*	82
1/11/18	8:46	FCMO	14.3	6.79	28.96	19.16	9.61	4.07	8	62
1/23/18	8:56	FCMO	11	6.95	25.61	15.92	8	4.42	8.4	126
2/1/18	9:18	FCMO	14.3	7.1	27.27	13.3	6.63	N/A	8	126
2/7/18	8:24	FCMO	16.2	6.63	25.33	11.3	6.69	N/A	7	104
2/14/18	8:16	FCMO	16.9	6.74	45.79	4.06	2.03	16.2	7.4	N/A
2/14/18	*	*	*	*	*	*	*	*	*	N/A
2/21/18	8:28	FCMO	20.9	6.7	35.8	2.1	1.01	12.6	5.4	40
2/28/18	9:15	FCMO	20.7	6.49	34.63	0.76	0.38	27.4	N/A	86
3/7/18	8:05	FCMO	16.7	6.62	40.77	2.81	1.42	N/A	6.6	72.7

Table 14. FCMO sampling site water quality data

<u>CONCLUSIONS</u>

Intermittent High Levels of Bacteria in Lower Watershed Likely Resulting From Sewage/Septic, Stormwater, Lack of Boat Pumpouts:

Sites at Devil's Hole (FCDH), Sunset Point (FCSP), and the Mouth of Fly Creek (FCMO), had sporadic spikes for bacteria. These spikes typically correlated with rainstorms and often moderate to high levels of optical brighteners were found in the creek. Based on the fact that 60 miles of Fairhope's sewage infrastructure is unlined, uninspected clay pipe, it is possible that some of the high bacteria levels at these sites is from nearby sewer lines. It is also demonstrated from ADPH data that a large amount of septic systems are present in portions of the watershed. Where these septic systems are in close proximity to the creek or and/or subject to very high water tables, they likely struggle to complete adequate treatment after rain events. Older systems that were not engineered and/or have not been pumped out in some time are likely the primary septic systems contributing to high bacteria levels in the watershed. Finally, at the time sample collection took place there was no pump out at the marina (an ownership change was taking place). It is very possible that boaters who need to empty waste from their vessel but do not have access to a pump out station are emptying wastewater directly into the creek. If this happens in conjunction with a rising tide, the wastewater and resultant high bacteria levels can be pushed up the creek.

Probable Sources of High Bacteria Levels in Upper Fly Creek: Livestock and Septic Systems:

Some of the highest bacteria levels were found at site FCHO. Land use in the watershed contributing to FCHO is entirely agricultural/livestock (*Figure 24*). Runoff from livestock is the most likely cause of high bacteria concentrations at this location. It is probable that sewage/septic is also entering the stream since optical brighteners are consistently found at high levels at this site. Maps of sewer lines from the City of Fairhope and Baldwin County Sewer Service (BCSS) show there are no sewer lines in the immediate vicinity of FCHO. However, there are septic systems in the area and these systems likely are contributing to the high bacteria levels found at this site.

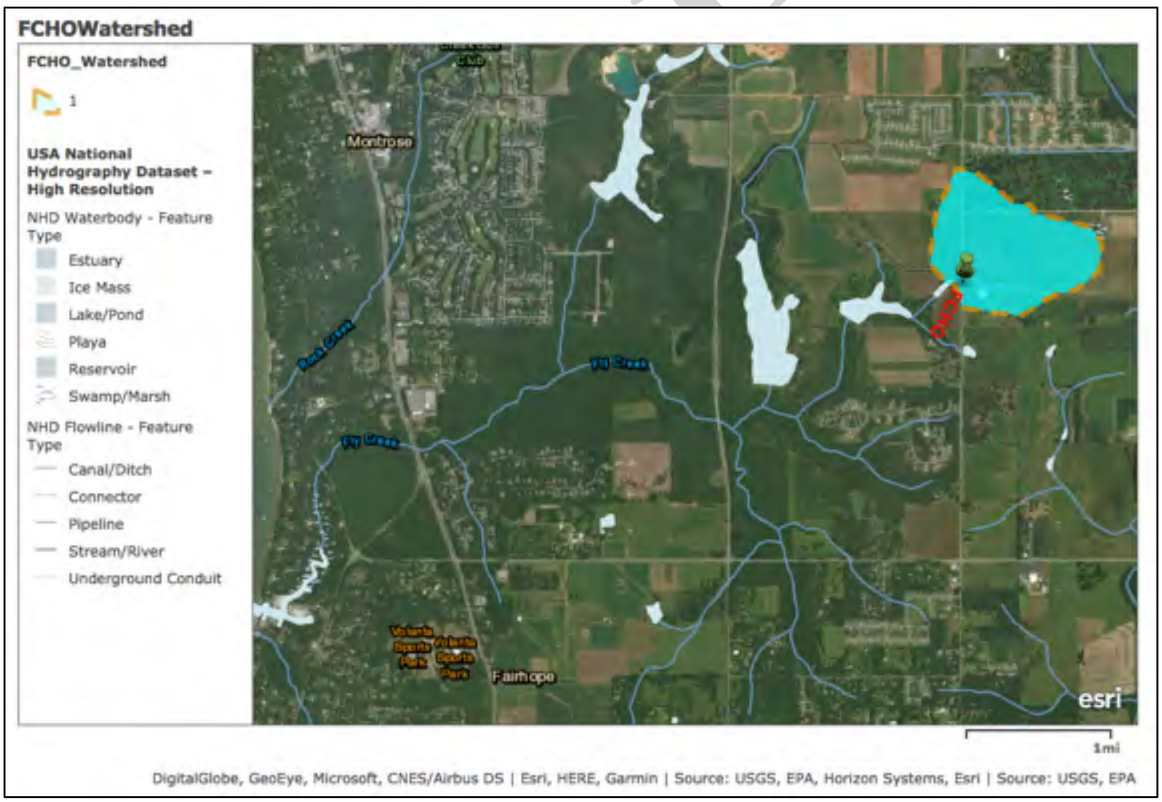

Figure 24. Map illustrating FCHO sampling site watershed

Downstream Ponds and Small Volume of Water in Upper Watershed Sites Lessen Impact of High Bacteria Levels:

Although high bacteria levels were found at FCHO, the site immediately downstream of FCHO (FCCT) at County Rd. 13 did not have a single test for bacteria that resulted in a value above the EPA threshold for swimming. This is a positive sign and likely stems from two influences.

1.) The site at FCHO is a very small stream and while it did have flow at every instance during sampling efforts, anecdotal evidence and visual observations indicate the stream is dry during portions of the year (intermittent), this highlights the very small volume of water moving through the stream. Therefore, while there is an elevated concentration of bacteria at this site, it is quickly diluted and shows up in much lower concentrations downstream.

2.) The second factor to consider is that the stream moves through two ponds after passing under Highway 181. The Fly Creek Restoration Plan notes that man-made lakes and ponds within the watershed have resulted in improved water quality downstream. This likely also plays a factor in reducing downstream bacteria concentrations.

Overall Water Quality is Generally Good: Key Measures Needed to Protect from Degradation:

While some sites did display high bacteria levels occasionally, the concentrations rarely were much in excess of the EPA threshold for swimming. Typically, all other parameters were in ranges that indicate good water quality and minimal pollution. However, the occasional high bacteria levels do indicate issues, most likely with aging septic systems and sewage lines in the watershed. With the frequency that Fairhope citizens swim and kayak in the creek, it is critical to implement key recommendations below to protect public health, water quality in Fly Creek, and the watershed's value to Mobile Bay and the quality of life of Fairhope residents. The averages for the sites with challenges is high and the goal must be clean water for swimming, fishing and boating without question.

RECOMMENDATIONS:

Measures Aimed at Lowering Bacteria Levels

1. Creek Dr/Sunset Point Sewer Main And Lift Station Investigation

Located just to the east of FCDH is a Sewer Force Main that runs under Creek Drive (*Figure 25*). We would recommend conducting further investigations (CCTV, dye tests for cross connections, etc.) of that sewer line in order to determine if this might be the source for high bacteria levels in the FCDH sampling site.

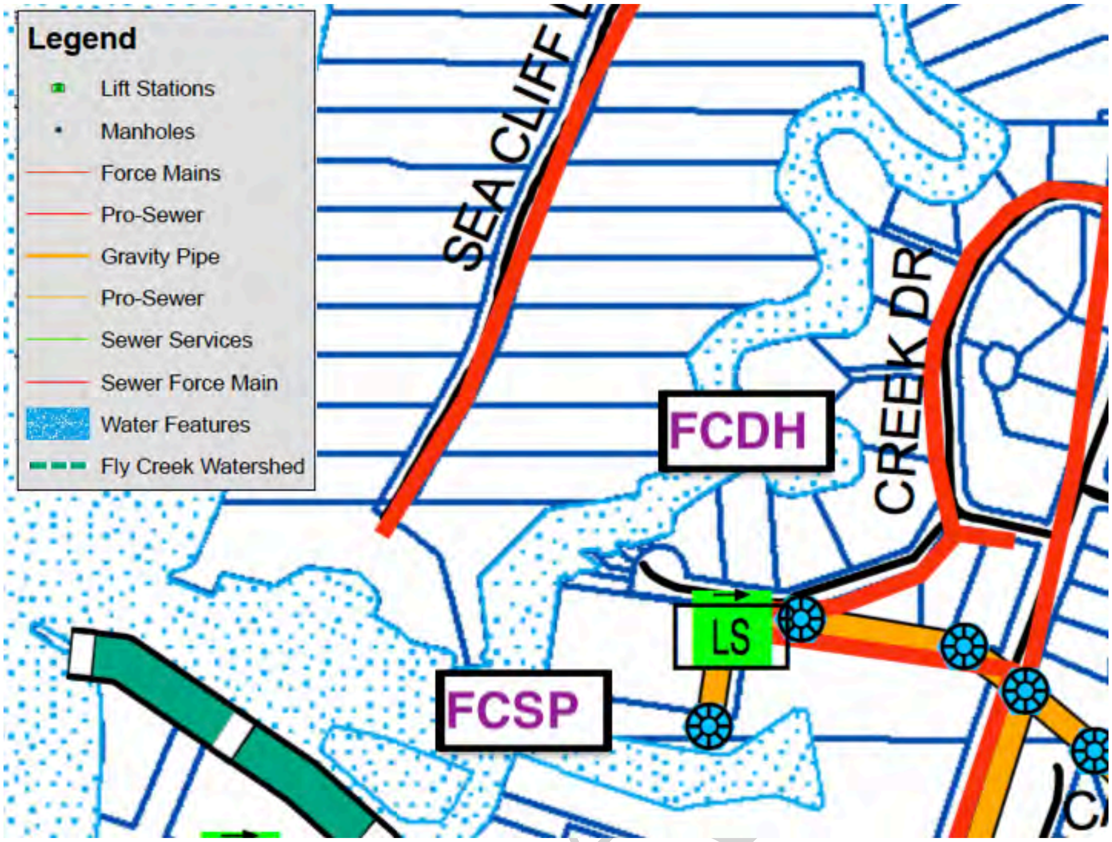

Figure 25. FCDH and FCSP Located Near Sewer Main Line

This sewer line seems to be connected with the Sunset Pointe Restaurant, which is located by the FCSP sampling site. We would also recommend evaluating that section of the sewer line and associated lift station to determine if it is contributing to high bacteria levels at FCSP and FCDH (*Figure 25*).

Generally, the 60+ miles of unlined uninspected clay pipe leaking sewage into the watershed and other watersheds throughout Fairhope is a serious issue that should be addressed as soon as possible. The $10 million dollars from RESTORE should be a great way to kick-start those projects but continued priority and funding should be given to projects to rehabilitate the sewer system in order to protect the Fly Creek Watershed, Fairhope's environment, and health of citizens.

The above recommendation is aligned with recommendations presented in GMC's Capacity study of Fairhope Sewer Utilities.

2. Septic Tank Inventory & Improvement

Mobile Baykeeper recommends the City of Fairhope work with the Alabama Public Health Department to generate a comprehensive inventory of existing septic tanks in the Fly Creek Watershed. ADPH does not have complete records prior to 2001. However, there is a great deal of information on 109 septic systems. A voluntary citizen survey where residents can identify if they have septic tanks and give any details known about the system could complete the current inventory. This inventory should include specifics on the age of the septic tanks, maintenance needs. This will assist in identifying which systems need an upgrade or repair. The Weeks Bay Watershed Management Plan produced a similar inventory. Mobile Baykeeper has already worked with ADPH to gain much of this data and will provide that data to the City of Fairhope to assist in this effort.

This information could then be used in grant applications, additional opportunities for funding with BP Oil Disaster funds (NRDA and RESTORE) as well as future decision making for Fairhope sewer upgrades and planning purposes.

3. Fly Creek Marina Pump-Out Station Construction

Mobile Baykeeper understands there is not currently a pump-out station built in the Fly Creek Marina that would prevent sailors from dumping their sewage out into Mobile Bay or nearer to the Fly Creek waterway. The lack of a pump-out station might help explain the high bacteria levels found in FCSP. We would recommend City of Fairhope look into building a pump out station as soon as possible so Mobile Bay and the lower reaches of Fly Creek are not impaired by human wastewater.

4. Implement Best Management Practices

Specific Best Management Practices (BMPs) should be identified and implemented to protect against bacteria introduction from both pet waste and livestock. Generating a pet waste management program that includes pet waste collection, education and signage, and pet waste ordinances will help reduce the amount of bacteria introduced by this source. Similarly, BMPs for livestock will reduce bacteria contributions, for instance, BMPs that limit access of livestock to water bodies or designs to minimize the amount of manure runoff from fields. There are additional funding opportunities through the Natural Resource Damage Assessment and US Department of Agriculture to address nutrient loading due to farming practices.

Measures Aimed at Protecting Fly Creek From Other Threats

5. Long-Term Monitoring Plan

We recommend the City of Fairhope consider continual monitoring of critical sites identified through this research project. By continuing to monitor FCDH, FCCT, and FCHN, the City can measure progress from projects implemented, notify citizens of any threats to public health and ensure water quality in Fly Creek is protected and improves.

6. Develop a Comprehensive Land Use Plan for the Watershed

High turbidity is the next biggest threat to the watershed as it can cause several negative impacts including depleting fish populations important to recreational fisheries and filling in waterways greatly diminishing their value for recreation. These conditions are often brought on by development and associated construction stormwater runoff. As Fairhope continues to be one of the fastest growing cities in the state, the need for comprehensive planning for growth becomes more important. The City has recently undergone a number of planning efforts including a building moratorium, and is in the process of updating certain ordinances based on lessons learned during the moratorium. However, the City should continue to evaluate planning and zoning to ensure they give decision makers the knowledge and tools to adequately protect Fly Creek, Mobile Bay, and all of the natural resources that contribute significantly to Fairhope's economy, quality of life, and charm. A comprehensive land use plan can create a literal and figurative map to ensure responsible growth.

7. Fly Creek Watershed Management Plan

To adequately identify threats to Fly Creek and all the necessary projects to be implemented as well as funding mechanisms, a watershed management plan (WMP) will be crucial. The Mobile Bay National Estuary Program has prioritized the greater Fly Creek Watershed as one of the remaining watersheds to study. To ensure the success of these crucial efforts the City of Fairhope must assist as much as practicable in gaining sufficient access to lands within the Fly Creek Watershed to support the development of a WMP. A Fly Creek WMP will identify critical management measures and restoration projects that can result in resources and funds that result in major improvements in the condition of Fly Creek. This plan will be a great value to the City, its residents, and environment.

Citations

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2. Thompson Engineering. 2013. *Fly Creek Watershed Restoration Project,* 5. Project prepared by Thompson Engineering for the City of Fairhope.
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5. Goodwyn, Mills & Cawood, Inc. 2017. *Capacity Study for Gas, Water And Sewer Utilities – Phase I*, 14-15. Prepared for City of Fairhope.
6. Isphording, Wayne C. 2011. *Environmental Impact of Regency Centers/Fairhope LLC Shoppes at Fairhope Village Construction on Fly Creek, Baldwin County, Alabama.* Report of Investigation prepared by Consulting Geologist Wayne Isphording for David A. Ludder, Attorney at Law. Mobile, Alabama.
7. Alabama Department of Environmental Management (ADEM). 2004. *An Impervious Surface Study over Three Regimes: Three Mile Creek, Fly Creek, and Bay Minette Creek Subwatersheds.* Alabama Department of Environmental Management. Mobile, Alabama.
8. U.S. Census Bureau, Population Estimates Program (PEP), Updated annually. Population and Housing Unit Estimates

APPENDIX A – DATA TABLES

Data Tables

Legend — Note - All data contained herein is preliminary.

* indicates duplicate samples for bacteria only

- PINK pH indicates more acidic water: <6.0
- YELLOW and RED indicate higher probability of septic/sewage contamination: 50-99; >100
- BROWNER values indicate cloudier water: 4.0-9.9; 10.0-49.9; [illegible]
- BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water: <6.0
- YELLOW and RED indicate higher bacteria levels: 104-501; >501

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL	Latitude	Longitude
11/16/17	17:01	FCBA	17.7	6.5	9.95	2.45	1.24	3.3	8.8	<20	30.54796	-87.8989
11/30/17	8:59	FCBA	17.9	6.97	9.209	1.02	0.51	2.31	7.2	60	30.54796	-87.8989
12/7/17	8:35	FCBA	15	6.95	35.81	3.22	1.56	N/A	7.4	62	30.54796	-87.8989
12/14/17	7:52	FCBA	14.1	6.12	23.08	1.47	0.71	N/A	7.4	62	30.54796	-87.8989
12/20/17	7:53	FCBA	19.7	5.82	16	2.12	1.06	N/A	6.8	20	30.54796	-87.8989
1/11/18	8:12	FCBA	17.6	6.78	13.59	0.07	0.04	4.35	7	60	30.54796	-87.8989
1/23/18	8:05	FCBA	15	6.78	26.43	5.3	0.3	5.32	7	40	30.54796	-87.8989
1/23/18	*	*	*	*	*	*	*	*	*	20	*	*
2/1/18	8:36	FCBA	15.3	6.5	17.35	1.42	0.08	N/A	7.4	20	30.54796	-87.8989
2/7/18	7:46	FCBA	18	6.88	17.8	0.43	2.2	N/A	6.4	62	30.54796	-87.8989
2/14/18	7:40	FCBA	17.3	6.93	38.63	0.09	0.05	14.3	8	N/A	30.54796	-87.8989
2/21/18	7:43	FCBA	20.9	6.78	24.74	0.07	0.04	7.43	6.8	126	30.54796	-87.8989
2/21/18	*	*	*	*	*	*	*	*	*	192	*	*
2/28/18	8:27	FCBA	20.2	6.28	35.3	0.08	0.05	6.54	6.4	56.3	30.54796	-87.8989
3/7/18	7:29	FCBA	16.3	6.7	22.58	0.08	0.03	N/A	6.8	24.3	30.54796	-87.8989
11/16/17	15:40	FCCS	17.2	6.87	1.602	0.07	0.03	18	8.2	<20	30.55312	-87.89468
11/30/17	12:00	FCCS	18.5	7.75	7.01	0.07	0.03	2.39	8	40	30.55312	-87.89468
12/7/17	10:38	FCCS	14.8	7.52	8.049	0.07	0.03	N/A	8.6	40	30.55312	-87.89468
12/14/17	10:04	FCCS	14.5	7.04	17.87	0.05	0.03	N/A	8.4	<20	30.55312	-87.89468
12/20/17	9:49	FCCS	19.9	6.43	13.08	0.07	0.03	N/A	7.6	40	30.55312	-87.89468
1/11/18	10:10	FCCS	17.9	8.13	15.42	0.07	0.04	4.43	8.2	20	30.55312	-87.89468
1/23/18	10:25	FCCS	16	6.85	11.51	0.07	0.03	3.16	8.2	62	30.55312	-87.89468
1/23/18	*	*	*	*	*	*	*	*	*	40	*	*
2/1/18	11:10	FCCS	16.2	7.26	15.59	0.08	0.03	N/A	8.6	<20	30.55312	-87.89468
2/7/18	9:47	FCCS	18	6.8	21.6	0.05	0.03	N/A	N/A	376	30.55312	-87.89468
2/14/18	9:19	FCCS	17.5	6.79	33.71	0.05	0.03	14	8.6	N/A	30.55312	-87.89468
2/21/18	10:07	FCCS	20.7	6.52	30.7	0.06	0.03	5.63	7.6	126	30.55312	-87.89468
2/28/18	10:36	FCCS	20.6	6.05	15.81	0.06	0.02	10.5	7.8	39.9	30.55312	-87.89468
3/7/18	9:11	FCCS	16.7	6.82	21.71	0.05	0.03	N/A	7.2	7.3	30.55312	-87.89468
11/16/17	14:20	FCCT	18.9	[illegible]	0	0.07	0.04	7.55	5.8	<20	30.55419	-87.86997
11/30/17	13:01	FCCT	19.6	6.46	4.621	0.08	0.04	2.18	5.6	<20	30.55419	-87.86997
12/7/17	11:30	FCCT	15.9	6.45	0	0.07	0.03	N/A	6.8	<20	30.55419	-87.86997
12/14/17	11:03	FCCT	16.3	6.38	19.03	0.06	0.04	N/A	5	<20	30.55419	-87.86997
12/20/17	10:41	FCCT	19.7	5.67	13.47	0.08	0.04	N/A	5.2	<20	30.55419	-87.86997
1/11/18	11:27	FCCT	18.5	6.45	13.67	0.08	0.04	1.89	6.2	<20	30.55419	-87.86997
1/23/18	11:35	FCCT	16.5	6.25	13.63	0.06	0.04	0.98	6.8	<20	30.55419	-87.86997
2/1/18	12:13	FCCT	17.7	6.1	14.41	0.07	0.03	N/A	4	<20	30.55419	-87.86997
2/1/18	*	*	*	*	*	*	*	*	*	<20	*	*
2/7/18	10:37	FCCT	18.6	6.95	17.47	0.07	0.03	N/A	6.1	82	30.55419	-87.86997
2/14/18	10:07	FCCT	17.6	6.79	43.41	0.06	0.03	12.2	7.2	N/A	30.55419	-87.86997
2/21/18	11:06	FCCT	20.6	6.19	18.49	0.05	0.03	13.1	6.2	20	30.55419	-87.86997
2/28/18	11:30	FCCT	21.4	[illegible]	10	0.07	0.03	4.04	5.1	4.1	30.55419	-87.86997
3/7/18	10:00	FCCT	17.1	6.08	14.47	0.06	0.03	N/A	6	1	30.55419	-87.86997
3/7/18	*	*	*	*	*	*	*	*	*	<1	*	*

Table 1A. Sites FCBA, FCCS, and FCCT water quality data from the Fly Creek Sampling Plan

Legend — Note - All data contained herein is preliminary.

* indicates duplicate samples for bacteria only

PINK pH indicates more acidic water: <5.0

YELLOW and RED indicate higher probability of septic/sewage contamination: 50-99 / >100

BROWNER values indicate cloudier water: 4.0-9.9 / 10.0-49.9 / >50.0

BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water: <6.0

YELLOW and RED indicate higher bacteria levels: 104-501 / >501

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL	Latitude	Longitude
11/16/17	17:17	FCDH	18.6	6.65	15.35	4.55	2.59	3.69	8.6	20	30.54346	-87.90007
11/30/17	9:31	FCDH	18.1	6.7	91.41	4.89	2.36	8.07	6.8	40	30.54346	-87.90007
12/7/17	8:57	FCDH	15.1	6.81	36.55	8.45	3.35	N/A	6.8	242	30.54346	-87.90007
12/7/17	*	*	*	*	*	*	*	*	*	194	*	*
12/14/17	8:17	FCDH	13.6	6.33	39.42	4.26	2.12	N/A	7.6	104	30.54346	-87.90007
12/14/17	*	*	*	*	*	*	*	*	*	62	*	*
12/20/17	8:15	FCDH	18.8	5.96	18.58	6.25	3.13	N/A	6.2	40	30.54346	-87.90007
12/20/17	*	*	*	*	*	*	*	*	*	82	*	*
1/11/18	8:31	FCDH	15.8	6.46	36.45	10.8	5.13	2.87	6	60	30.54346	-87.90007
1/23/18	8:31	FCDH	12.2	6.46	21.46	8.66	5.06	3.43	6.6	126	30.54346	-87.90007
2/1/18	8:59	FCDH	14.7	6.51	32.66	10.27	5.13	N/A	7	20	30.54346	-87.90007
2/7/18	8:10	FCDH	16.9	6.55	28.31	5.22	2.63	N/A	5.8	82	30.54346	-87.90007
2/14/18	8:03	FCDH	20.2	6.61	46.37	0.94	0.47	20.7	7.2	N/A	30.54346	-87.90007
2/21/18	8:11	FCDH	20.7	6.61	23.67	0.34	0.15	30.5	5.3	[illegible]	30.54346	-87.90007
2/28/18	8:52	FCDH	20.4	6.28	32.62	0.21	0.1	12.8	6.4	[illegible]	30.54346	-87.90007
2/28/18	*	*	*	*	*	*	*	*	*	82	*	*
3/7/18	7:46	FCDH	17.1	6.41	26.8	0.68	0.31	N/A	5.4	62	30.54346	-87.90007
11/16/17	17:09	FCDT	17.7	6.6	14	3.02	1.51	3.06	7.6	82	30.54605	-87.89884
11/30/17	9:10	FCDT	17.9	6.84	15.02	1.81	0.9	5.4	7.2	20	30.54605	-87.89884
12/7/17	8:45	FCDT	15.3	6.79	30.8	5.89	2.91	N/A	7	82	30.54605	-87.89884
12/14/17	8:04	FCDT	14.1	6.16	24.54	2.2	1.1	N/A	7	82	30.54605	-87.89884
12/20/17	8:03	FCDT	19.6	5.73	17.38	2.6	1.3	N/A	6.6	104	30.54605	-87.89884
1/11/18	8:20	FCDT	17.3	6.68	27.77	1.85	0.89	3.67	6.8	40	30.54605	-87.89884
1/11/18	8:20	FCDT	17.3	6.68	27.77	1.85	0.89	3.67	6.8	82	30.54605	-87.89884
1/23/18	8:17	FCDT	14.6	6.58	28.34	1.93	0.99	5.5	7.2	82	30.54605	-87.89884
2/1/18	8:45	FCDT	15.2	6.41	17.85	4.02	2	N/A	7.2	40	30.54605	-87.89884
2/7/18	7:57	FCDT	17.5	6.84	17.32	1.08	0.54	N/A	7.2	40	30.54605	-87.89884
2/7/18	*	*	*	*	*	*	*	*	*	150	30.54605	-87.89884
2/14/18	7:52	FCDT	18.6	6.79	36.4	0.09	0.05	17.3	7.6	N/A	30.54605	-87.89884
2/21/18	7:53	FCDT	20.8	12.8	6.66	0.08	0.04	9.36	6.2	124	30.54605	-87.89884
2/21/18	*	*	*	*	*	*	*	*	*	126	*	*
2/28/18	8:38	FCDT	20	6.31	30.28	0.08	0.04	5.15	6.2	62.4	30.54605	-87.89884
3/7/18	7:37	FCDT	16.3	6.65	37	0.07	0.04	N/A	6.6	37.9	30.54605	-87.89884
3/7/18	*	*	*	*	*	*	*	*	*	40.8	*	*
11/16/17	13:43	FCHN	16.9	6.5	0	0.07	0.03	10.4	7	<20	30.55242	-87.89149
11/16/17	*	*	*	*	*	*	*	*	*	20	*	*
11/30/17	10:54	FCHN	18.5	7.63	7.59	0.07	0.03	4.71	7	40	30.55242	-87.89149
12/7/17	10:07	FCHN	14.6	7.51	6.788	0.07	0.03	N/A	7.2	20	30.55242	-87.89149
12/14/17	9:36	FCHN	14.4	6.91	27.4	0.06	0.03	N/A	8	<20	30.55242	-87.89149
12/20/17	9:23	FCHN	19.5	6.58	15.41	0.06	0.03	N/A	6.4	40	30.55242	-87.89149
1/11/18	10:30	FCHN	17.8	7.13	26.5	0.07	0.04	3.65	7.4	<20	30.55242	-87.89149
1/23/18	9:43	FCHN	16.1	6.89	15.89	0.08	0.04	2.92	8	20	30.55242	-87.89149
2/1/18	10:29	FCHN	16.1	6.98	13.44	0.07	0.04	N/A	7.4	<20	30.55242	-87.89149
2/7/18	9:21	FCHN	17.7	7.59	22.99	0.06	0.04	N/A	7.4	<20	30.55242	-87.89149
2/14/18	8:53	FCHN	17.3	6.97	40.19	0.05	0.03	11.7	N/A	N/A	30.55242	-87.89149
2/21/18	9:32	FCHN	20.5	6.53	21.07	0.05	0.03	8.87	6.2	<20	30.55242	-87.89149
2/28/18	10:04	FCHN	21.2	6.42	14.28	0.07	0.04	5.97	6	19.9	30.55242	-87.89149
3/7/18	8:50	FCHN	16.1	6.61	34.18	0.03	0.1	N/A	7	19.3	30.55242	-87.89149

Table 2A. FCDH, FCDT, and FCHN water quality data from the Fly Creek Sampling Plan

MOBILE BAYKEEPER®

Legend — Note - All data contained herein is preliminary.

* indicates duplicate samples for bacteria only

Legend				PINK pH indicates more acidic water	YELLOW and RED indicate higher probability of septic/sewage contamination			BROWNER values indicate cloudier water	BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water	YELLOW and RED indicate higher bacteria levels		
					50-99			4.0-9.9		104-501		
				<6.0	>100			10.0-49.9	<6.0	>501		
								>50.0				

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL	Latitude	Longitude
11/16/17	14:45	FCHO	19.7	6.65	102.1	0.16	0.08	10.6	7	3784	30.56324	-87.8523
11/30/17	13:29	FCHO	20	6.51	142.6	0.17	0.08	3.13	6.4	48392	30.56324	-87.8523
11/30/17	*	*	*	*	*	*	*	*	*	15402	*	*
12/7/17	11:48	FCHO	10.2	6.49	178.7	0.17	0.09	N/A	6.8	918	30.56324	-87.8523
12/7/17	11:48	FCHO	10.2	6.49	178.7	0.17	0.09	N/A	6.8	1300	30.56324	-87.8523
12/14/17	11:24	FCHO	12.4	6.23	58.42	0.39	0.19	N/A	7.4	20	30.56324	-87.8523
12/14/17	*	*	*	*	*	*	*	*	*	40	*	*
12/20/17	11:01	FCHO	21	5.81	63.17	0.33	0.17	N/A	5	268	30.56324	-87.8523
1/11/18	11:39	FCHO	18.7	6.25	102	0.22	0.11	71.8	5	270	30.56324	-87.8523
1/23/18	12:02	FCHO	15.9	6.15	83.56	0.2	0.1	0.98	10	172	30.56324	-87.8523
2/1/18	12:38	FCHO	16.5	6.4	77.48	0.14	0.06	N/A	5.6	192	30.56324	-87.8523
2/7/18	10:59	FCHO	19.5	6.54	26.69	0.7	0.3	N/A	6	>48392	30.56324	-87.8523
2/7/18	*	*	*	*	*	*	*	*	*	>48392	*	*
2/14/18	10:26	FCHO	18.2	6.52	75.54	0.09	0.05	20.6	4.8	N/A	30.56324	-87.8523
2/21/18	11:34	FCHO	22.7	6.32	77.29	0.13	0.06	33.8	5.2	3870	30.56324	-87.8523
2/28/18	11:52	FCHO	25.1	5.78	88.43	0.18	0.01	17.9	8.2	778	30.56324	-87.8523
3/7/18	10:19	FCHO	16.8	6.27	134.7	0.27	0.14	N/A	8	543.3	30.56324	-87.8523
11/16/17	17:32	FCMO	19.5	7.15	32.83	12.5	6.5	4.69	7.6	82	30.54268	-87.90392
11/30/17	9:56	FCMO	18.5	7.33	31.92	>20	>10	8.64	5.4	<20	30.54268	-87.90392
12/7/17	9:15	FCMO	14.4	6.97	31.72	14.38	7	N/A	7	104	30.54268	-87.90392
12/14/17	8:38	FCMO	12.8	6.71	33.01	6.11	3.04	N/A	7.8	<20	30.54268	-87.90392
12/20/17	8:35	FCMO	17.8	6.34	29.52	13.87	6.87	N/A	6.2	62	30.54268	-87.90392
12/20/17	*	*	*	*	*	*	*	*	*	82	*	*
1/11/18	8:46	FCMO	14.3	6.79	28.96	19.16	9.61	4.07	8	62	30.54268	-87.90392
1/23/18	8:56	FCMO	11	6.95	25.61	15.92	8	4.42	8.4	126	30.54268	-87.90392
2/1/18	9:18	FCMO	14.3	7.1	27.27	13.3	6.63	N/A	8	126	30.54268	-87.90392
2/7/18	8:24	FCMO	16.2	6.63	25.33	11.3	6.69	N/A	7	104	30.54268	-87.90392
2/14/18	8:16	FCMO	16.9	6.74	45.79	4.06	2.03	16.2	7.4	N/A	30.54268	-87.90392
2/14/18	*	*	*	*	*	*	*	*	*	N/A	*	*
2/21/18	8:28	FCMO	20.9	6.7	35.8	2.1	1.01	12.6	5.4	40	30.54268	-87.90392
2/28/18	9:15	FCMO	20.7	6.49	34.63	0.76	0.38	27.4	N/A	86	30.54268	-87.90392
3/7/18	8:05	FCMO	16.7	6.62	40.77	2.81	1.42	N/A	6.6	72.7	30.54268	-87.90392
11/16/17	16:39	FCSE	17	6.76	0	0.07	0.04	3.04	7.8	20	30.55221	-87.89767
11/30/17	8:18	FCSE	18	7.75	10.79	0.07	0.03	2.92	7.6	<20	30.55221	-87.89767
12/7/17	7:37	FCSE	15	7.75	21.92	0.07	0.04	N/A	8.2	104	30.55221	-87.89767
12/14/17	7:23	FCSE	14.3	6.29	21.44	0.07	0.03	N/A	8.4	40	30.55221	-87.89767
12/20/17	7:29	FCSE	19.6	5.1	15.32	0.07	0.03	N/A	7.4	104	30.55221	-87.89767
1/11/18	7:52	FCSE	17.7	7.03	18.76	0.07	0.03	3.57	8	20	30.55221	-87.89767
1/23/18	7:35	FCSE	15.5	7.34	14.39	0.08	0.04	3.18	8	20	30.55221	-87.89767
2/1/18	8:06	FCSE	15.5	6.83	13.88	0.06	0.03	N/A	8	62	30.55221	-87.89767
2/7/18	7:23	FCSE	17.5	7.07	20.73	0.08	0.04	N/A	N/A	20	30.55221	-87.89767
2/14/18	7:23	FCSE	17	7.35	34.59	0.05	0.03	13.2	8	N/A	30.55221	-87.89767
2/21/18	7:19	FCSE	20.5	6.99	19.37	0.09	0.04	6.15	7.4	172	30.55221	-87.89767
2/28/18	8:00	FCSE	19.7	6.48	23.03	0.07	0.03	4.24	6.8	24.1	30.55221	-87.89767
3/7/18	7:07	FCSE	16.5	6.73	15.22	0.06	0.03	N/A	7.8	N/A	30.55221	-87.89767

Table 3A. FCHO, FCMO, and FCSE water quality data from the Fly Creek Sampling Plan

Legend — Note - All data contained herein is preliminary.

* indicates duplicate samples for bacteria only

PINK pH indicates more acidic water: <6.0

YELLOW and RED indicate higher probability of septic/sewage contamination: 50-99; >100

BROWNER values indicate cloudier water: 4.0-9.9; 10.0-49.9; >50.0

BLUE Dissolved Oxygen values indicate lower concentrations of oxygen detected in the water: <6.0

YELLOW and RED indicate higher bacteria levels: 104-501; >501

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL	Latitude	Longitude
11/16/17	17:24	FCSP	19	6.7	22.51	7.58	3.8	3.8	7.4	<20	30.54192	-87.90109
11/30/17	9:43	FCSP	18.4	6.84	20.97	18.34	4.09	14.5	6.6	<20	30.54192	-87.90109
12/7/17	9:06	FCSP	14.8	6.88	36.16	10.75	5.39	N/A	6.2	196	30.54192	-87.90109
12/14/17	8:29	FCSP	12.8	6.54	26.6	4.93	2.46	N/A	7.8	<20	30.54192	-87.90109
12/20/17	8:25	FCSP	18.3	6.18	21.79	8.91	4.48	N/A	6	104	30.54192	-87.90109
1/11/18	8:39	FCSP	16.1	6.58	20.89	15.29	7.72	3.85	7.8	60	30.54192	-87.90109
1/23/18	8:45	FCSP	11.4	6.78	31.24	13.9	6.96	4.54	8.6	82	30.54192	-87.90109
2/1/18	9:08	FCSP	14.5	6.66	22.67	12.44	6.2	N/A	7.6	62	30.54192	-87.90109
2/1/18	*	*	*	*	*	*	*	*	*	148	*	*
2/7/18	8:18	FCSP	16.7	6.55	26.98	8.03	3.91	N/A	6.2	60	30.54192	-87.90109
2/14/18	8:10	FCSP	18.8	6.52	44.45	3.86	1.92	17.1	5.6	N/A	30.54192	-87.90109
2/21/18	8:20	FCSP	20.9	6.64	21.3	1.1	0.56	11.5	5.4	518	30.54192	-87.90109
2/28/18	9:04	FCSP	20.8	6.27	27.4	0.45	0.22	14.9	6	82.3	30.54192	-87.90109
2/28/18	*	*	*	*	*	*	*	*	*	84.2	*	*
3/7/18	7:55	FCSP	17.3	6.49	33.24	1.53	0.77	N/A	6.2	143.9	30.54192	-87.90109
11/16/17	16:52	FCSW	17.3	6.52	10.66	0.4	0.21	4.69	8	170	30.55075	-87.89907
11/30/17	8:37	FCSW	18	7.3	24.75	0.07	0.04	2.54	7.6	<20	30.55075	-87.89907
11/30/17	*	*	*	*	*	*	*	*	*	20	*	*
12/7/17	8:22	FCSW	14.8	8	20.64	0.12	0.06	N/A	8	40	30.55075	-87.89907
12/14/17	7:39	FCSW	14.3	6.36	19.33	0.08	0.04	N/A	8.2	<20	30.55075	-87.89907
12/20/17	7:39	FCSW	19.7	5.39	14.09	0.18	0.09	N/A	7.2	<20	30.55075	-87.89907
1/11/18	8:01	FCSW	17.7	7.09	19.11	0.07	0.04	3.43	8.2	20	30.55075	-87.89907
1/23/18	7:50	FCSW	15.6	6.91	13.24	0.07	0.04	4.87	8.2	40	30.55075	-87.89907
2/1/18	8:22	FCSW	15.4	6.96	12.1	0.09	0.04	N/A	8.2	40	30.55075	-87.89907
2/7/18	7:32	FCSW	18.2	7.1	21.24	0.2	0.05	N/A	7.6	20	30.55075	-87.89907
2/14/18	7:30	FCSW	19	6.86	31.28	0.05	0.03	16	7.8	N/A	30.55075	-87.89907
2/14/18	*	*	*	*	*	*	*	*	*	N/A	*	*
2/21/18	7:30	FCSW	20.6	6.84	24.58	0.08	0.05	6.12	7.4	82	30.55075	-87.89907
2/28/18	8:12	FCSW	19.9	6.8	28.03	0.14	0.06	4.51	7	35.9	30.55075	-87.89907
3/7/18	7:18	FCSW	16.6	6.48	22.1	0.06	0.03	N/A	7.8	23.1	30.55075	-87.89907
11/16/17	12:35	UTHR	18.9	6.93	9.765	0.08	0.04	4.28	5.2	<20	30.56477	-87.88088
11/30/17	12:38	UTHR	20	7.14	6.578	0.08	0.04	3.43	5.2	<20	30.56477	-87.88088
12/7/17	11:04	UTHR	15.4	6.92	24.95	0.07	0.04	N/A	6.2	<20	30.56477	-87.88088
12/14/17	10:35	UTHR	15.6	6.55	15.18	0.08	0.04	N/A	5.8	<20	30.56477	-87.88088
12/20/17	10:15	UTHR	19.7	6.26	19	0.07	0.04	N/A	5.6	<20	30.56477	-87.88088
1/11/18	10:54	UTHR	18	7.23	11.2	0.08	0.04	3.95	6	<20	30.56477	-87.88088
1/23/18	10:50	UTHR	15.2	6.55	10.29	0.08	0.04	1.65	6.6	<20	30.56477	-87.88088
2/1/18	11:44	UTHR	18	7.17	9.673	0.07	0.03	N/A	6.2	<20	30.56477	-87.88088
2/7/18	10:11	UTHR	18.2	6.85	25.11	0.06	0.03	N/A	7.4	1387	30.56477	-87.88088
2/14/18	9:41	UTHR	17.2	6.76	15.65	0.06	0.02	7.59	8.8	N/A	30.56477	-87.88088
2/21/18	10:35	UTHR	20.6	6.46	14.91	0.01	0.03	7.67	6.8	62	30.56477	-87.88088
2/28/18	11:03	UTHR	21.3	6.15	13.77	0.07	0.03	5.06	5	28.5	30.56477	-87.88088
3/7/18	9:35	UTHR	16.4	6.49	10.63	0.07	0.03	N/A	6.2	2	30.56477	-87.88088

Table 3A. FCSP, FCSW, and UTHR water quality data from the Fly Creek Sampling Plan

Date Sampled	Time Sampled	Site ID	Water Temp (°C)	pH	Optical Brighteners (ppm)	Conductivity (mS/cm)	Total Dissolved Solids (ppt)	Turbidity (NTU)	Dissolved Oxygen (ppm)	MPN Enterococcus CFU/100mL	Latitude	Longitude
Date the sample was taken written in mm/dd/yy	Time Sample was taken in Military Time	4 Letter Site Code	Water Temperature in °C	Measure of Acidity/Alkalinity of water	Measure of Optical Brighteners	Measure of Conductivity	Measure of Dissolved Solids	Measure of "cloudiness of water"	Measure of Oxygen Dissolved in water	Measure of number of fecal indicator organism in 100mL of sample water	GPS Coordinates of Site	

Table 4A. Table of Fly Creek Metadata

Site ID	Long Name	Description	Latitude	Longitude	Water Body
FDBK	Field Blank	Distilled Water control group made before sampling in the lab and taken into the field during sampling	N/A	N/A	N/A
LBBK	Lab Blank	Distilled Water control group made after sampling in the lab to measure any threats of sample contamination in the lab	N/A	N/A	N/A
FCBA	Fly Creek @ Boathouse with American Flag	Fly Creek stream beside the boathouse with an American flag	30.54796	-87.8989	Fly Creek
FCCS	Fly Creek @ Eastern Shore Cosmetic Surgery	Fly Creek deep in the woods behind the parking lot of Eastern Shore Cosmetic Surgery building	30.55312	-87.89468	Fly Creek
FCCT	Fly Creek @ County Rd Thirteen (13)	Fly Creek stream underneath County Road 13 Bridge in Fairhope, AL	30.55419	-87.86997	Fly Creek
FCDH	Fly Creek @ Devil's Hole	Fly Creek stream at the intersection of Fly Creek & Devil's Hole	30.54346	-87.90007	Fly Creek
FCDT	Fly Creek @ Downed Tree	Fly Creek stream underneath the downed tree	30.54605	-87.89884	Fly Creek
FCHN	Fly Creek @ Highway Ninety-Eight (98)	Fly Creek stream that is below US Highway 98 in Fairhope, AL	30.55242	-87.89149	Fly Creek
FCHO	Fly Creek @ Highway One-Eighty-One (181)	Fly Creek stream underneath US Highway 181 between 2 farms in Fairhope, AL	30.56324	-87.8523	Fly Creek
FCMO	Fly Creek @ Mouth of Mobile Bay	The mouth of Fly Creek that exits into Mobile Bay	30.54268	-87.90392	Fly Creek
FCSE	Fly Creek @ Scenic Nighty-Eight (98) East	Fly Creek stream east of Scenic 98 about 300-500 ft upstream of it	30.55221	-87.89767	Fly Creek
FCSP	Fly Creek @ Sunset Pointe	Fly Creek stream in front of Sunset Pointe restaurant	30.54192	-87.90109	Fly Creek
FCSW	Fly Creek @ Scenic Nighty-Eight (98) West	Fly Creek stream west of Scenic 98 about 100 ft downstream of it	30.55075	-87.89907	Fly Creek
UTHR	Unnamed Tributary to Fly Creek @ Headwaters Rd	Unnamed tributary leading to Fly Creek underneath Headwaters Rd Bridge	30.56477	-87.88088	Fly Creek

Table 5A. Fly Creek Sampling Site ID Key

APPENDIX B - PARAMETERS TESTED

Dissolved Oxygen

What is it?

Measures how much oxygen is dissolved in the water.

Why do we test it?

Aquatic life, like land animals, need oxygen to life. We measure dissolved oxygen to understand the health of a waterbody. The amount of oxygen in a waterway can be influenced by both natural phenomenon and from pollution.

Bacteria (Enterococcus)

What is it?

Enterococcus is a type of bacteria that when found in local waterways, indicates fecal contamination from human or animal waste entering directly or through stormwater runoff.

Why do we test it?

Enterococcus is often used as an indicator for the presence of other harmful organisms or pollutants in the waters. We test this parameter to know whether or not it is safe for the community to fish, swim, and play in a local waterway.

Fluorometry (Optical Brighteners)

What is it?

Fluorometry measures the amount of optical brighteners (detergents, soaps, cleaning agents) in the waterway.

Why do we test it?

Since soaps (and therefore optical brighteners) are most commonly found in sewage, measuring optical brighteners is a way to detect human sewage is entering a waterway. This helps us understand the source of fecal contamination.

pH

What is it?

pH measures how acidic or how basic the water is. The pH of 7.0 is neutral and values less than 7.0 are acidic and values greater than 7.0 are considered basic.

Why do we test it?

Certain pH levels can have negative effects on aquatic life. pH can be influenced by a number of factors including industrial, municipal, and agricultural pollution.

Turbidity

What is it?

Measures the amount of suspended material such as silt, clay, and fine organic matter in water.

Why do we test it?

High levels of turbidity can cause a number of problems. It prohibits light from penetrating into the water, prohibiting plants to grow and fish to see their food. High turbidity can indicate erosion problems nearby or pollution from poor construction practices.

Salinity

What is it?

Measures the concentration of salts in water.

Why do we test it?

Salinity levels often dictate what types of plants and animals are present in a waterway. Salinity also affects the level of dissolved oxygen present.

Conductivity

What is it?

Measures the water's ability to conduct electricity (or water's ionic activity). The more salts (which have higher ionic content) in the water, the more conductivity.

Why do we test it?

Large changes in conductivity can indicate a source of pollution may have entered the waterway.

Water Temperature

What is it?

Measures how hot or how cold the water is.

Why do we test it?

The temperature of water affects aquatic life in a number of ways including their ability to feed and reproduce. Temperature also impacts how much dissolved oxygen water can hold and how quickly it can cycle nutrients through the aquatic system.

By Jay

COMMON TERMS AND DEFINITIONS

Collection system: a network of pumps, gravity lines, manholes and force mains that get sewer (wastewater) to the plant for treatment

Detention time: the amount of time or capacity a wet well, manhole or main line will hold sewer before there is an overflow

Force mains: pipes of various diameter, usually made of PVC or iron, that carry sewer to either a manhole, another force main, a lift station or directly to the plant. The lines are under pressure.

Gravity sewer: pipes of various diameter that carry sewer from a home to a lift station or directly to the plant. These pipes are not under pressure, but are one of the main sources of I & I

I and I (inflow and infiltration): any water that enters the collection system that is not sewer, i.e. rain water. I & I robs the system of capacity and can quickly overwhelm a system

Lateral: a pipe, usually PVC and 4 inches in diameter, that runs from a home to our main lines.

Lift station: a set of pumps that is housed in a defined area that are used to move sewer, under pressure, to another lift station or directly to the plant. Solely maintained by the city.

Low pressure sewer: this type of sewer requires the homeowner to purchase and maintain a grinder pump. A low pressure system is used when gravity sewer isn't available.

Main lines: pipes 6 inches or bigger in diameter, usually made of PVC, iron or clay, that move sewer from a home to a manhole, lift station or directly to the plant. These are gravity lines, not under pressure and a main source of I and I

Manholes: access points for workers to inspect and work on main lines. The are usually made of brick, concrete or fiberglass. These are another main source of I and I

Rehabilitation as it relates to sewer: the city uses contractors to video, clean and inspect our collection system. We use this information to decide the areas of greatest needs. Then another contractor lines the main lines, manholes and lift station wet wells. This process greatly reduces I and I

SCADA: this is a digital alarm system to alert us to potential problems

SSO: sewer overflows. Some of the main causes are I and I, illegal dumping, grease, power outages, vandalism, storms, cable companies, commercial contractors, etc.

Wet well: a hold tank, usually directly underneath the lift station, a collection point for sewer before it is pumped to its next destination

WWTP: waste water treatment plant, where the sewer is treated before it is released

January 2019

Scope of Work

ASSESSMENT OF WATER QUALITY, SEDIMENT TRANSPORT, AND LAND-USE IMPACTS FOR STREAM ALONG THE EASTERN SHORE OF MOBILE BAY, BALDWIN COUNTY, ALABAMA

For

THE MOBILE BAY NATIONAL ESTUARY PROGRAM

By
MARLON R. COOK
BARRY A VITTOR AND ASSOCIATES, INC.

INTRODUCTION

Streams along the eastern shore of Mobile Bay from Daphne to Gum Swamp at Weeks Bay flow westward to Mobile Bay and drain an area three to four miles inland. Land use in the area includes commercial and residential development in the towns of Daphne and Fairhope and residential development throughout the remaining area. The topography of the area is unique to the eastern shore and is characterized by relatively high elevation uplands to 160 feet above mean sea level (ft MSL) and steep slopes related to stream channels. Streams have relatively high gradients and flow is flashy with some streams intermittent, only flowing during rain events. Surface-water flow in the area is erosive so that some streams most likely carry large sediment loads and are impacted by high concentrations of nutrients and bacteria.

The following scope of work for a watershed assessment by Marlon Cook, Barry Vittor and Associates, Inc. is designed to characterize general water quality, erosion and sediment transport, nutrient concentrations, e-coli pathogen counts in streams throughout the project area, and to characterize land use to identify sources of sediment and other water-quality impacts. These data will be used assist development of watershed management plans and remedial actions and to establish baseline data and sedimentation regression curves that can be used to evaluate future changes in erosion and sediment load transport. The monitoring project includes 16 monitoring sites from Yancy Branch in Daphne (1.9 miles south of I-10) to Baily Creek, south of Point Clear (fig. 1).

Monitoring is based on precipitation and resulting stream discharge and includes basic field acquired physical and water-quality parameters as well as sediment transport rates, nitrate

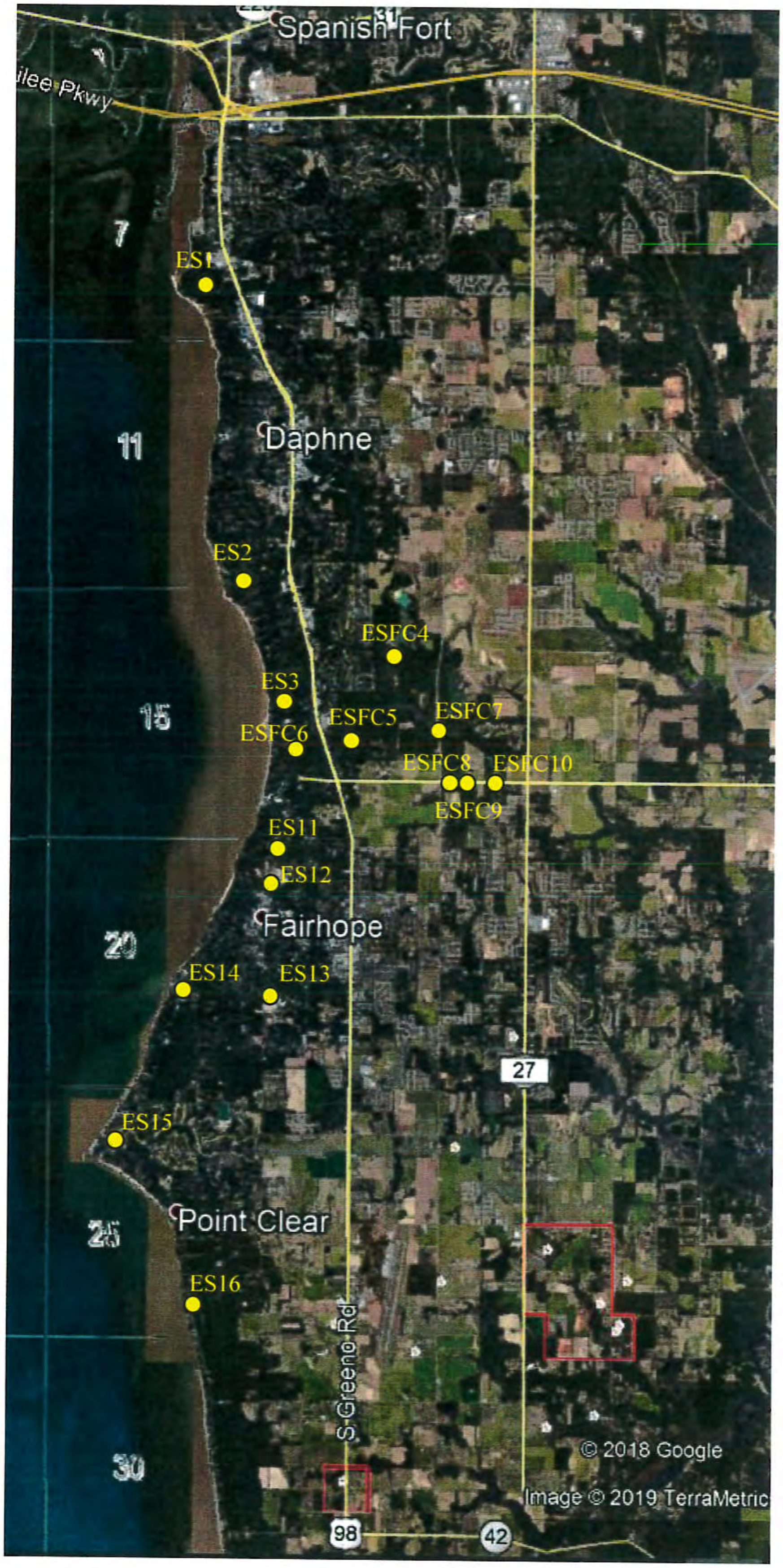

Figure 1.—Eastern shore project area and monitoring sites.

and total phosphorus concentrations, and e-coli counts. These data may be used to determine watershed management strategies and to focus resources in areas of greatest need for remedial action. The project will utilize modeling techniques to determine bed and suspended sediment and nutrient loads. The project will begin in January 2019 and will continue through December 2019.

METHODOLOGY

ASSESSMENT SITES

The assessment of streams along the eastern shore of Mobile Bay is designed to determine general water quality, physical characteristics, volumes and sources of sediment, nutrient loading, and pathogen counts. Characteristics of eastern shore monitoring sites include location, proximity to wetlands, impoundments, and tidal influence, accessibility, and stream channel morphology and flow characteristics. Sites were selected in all accessible tributary and main stem locations along the eastern shore from Daphne to Point Clear (table 1).

Table 1—Monitoring sites for the Fish River watershed assessment.

Site	Site description	Flow and sediment characteristics
ES1	Yancy Branch 1,500 ft upstream from Village Point, Lat 30.62615°N Long -087.91600°W	Unrestricted flow, sand bed, suspended and bed sediment
ES2	Red Gully at Bay Shore Drive, section 30, township 5 south, range 2 east Lat 30.57741°N Long -087.91000°W	Unrestricted flow, sand bed, suspended and bed sediment
ES3	Rock Creek at Main St (Scenic US Hwy 98) section 7, township 6 south, range 2 east Lat 30.55799°N Long -087.89978°W	Unrestricted flow, sand bed, suspended and bed sediment
ESFC4	Unnamed tributary to Fly Creek at Headwater Road, ne/4-sw/4, section 33, township 5 south, range 2 east Lat 30.56470°N Long -087.88013°W	Unrestricted flow, sand bed, suspended and bed sediment

Table 1 continued

ESFC5	Unnamed tributary to Fly Creek at Woodlands Drive section 8, township 6 south, range 2 east Lat 30.55160°N Long -087.88832°W	Unrestricted flow, sand bed, suspended and bed sediment
ESFC6	Fly Creek at Main St. (Scenic US 98) Lat 30.55122°N Long -087.89874°W	Unrestricted flow, sand bed, suspended and bed sediment
ESFC7	Fly Creek at AL Highway 13, se/4-ne/4, section 4, township 6 south, range 2 east Lat 30.64640°N Long 087.82041°W	Unrestricted flow, suspended sediment only
ESFC8	Unnamed tributary to Fly Creek at AL Highway 104, sw/4-sw/4, section 3, township 6 south, range 2 east Lat 30.54537°N Long -087.86796°W	Unrestricted flow, suspended sediment only
ESFC9	Unnamed tributary to Fly Creek at AL Highway 104, sw/4-sw/4, section 3, township 6 south, range 2 east Lat 30.54530°N Long -087.86497°W	Unrestricted flow, suspended sediment only
ESFC10	Unnamed tributary to Fly Creek at AL Highway 104, se/4-sw/4, section 3, township 6 south, range 2 east Lat 30.54548°N Long -087.86023°W	Unrestricted flow, suspended sediment only
ES11	Volanta Gully at N. Section St and Rosa Ave, Lat 30.53677°N Long -087.90037°W	Unrestricted flow, sand bed, suspended and bed sediment
ES12	Big Mouth Gully at N. Bancroft St, Lat 30.52857°N Long -087.90176°W	Unrestricted flow, sand bed, suspended and bed sediment
ES13	Tatumville Gully at Pecan Ave and S. Section St Lat 30.50954°N Long -087.90276°W	Unrestricted flow, sand bed, suspended and bed sediment, Large storm flow only
ES14	Tatumville Gully at S. Mobile St (Scenic US 98), Lat 30.51199°N Long -087.91859°W	Unrestricted flow, sand bed, suspended and bed sediment

Table 1 continued

ES15	Point Clear Creek at Scenic US Highway 98, section 36, township 6 south, range 2 east Lat 30.48570°N Long -087.93219°W	Tidal influence, suspended sediment during storm events only
ES16	Baily Creek at Scenic US Highway 98, nw/4-sw/4, section 6, township 7 south, range 2 east Lat 30.46119°N Long -087.91671°W	Tidal influence, suspended sediment during storm events only

SUSPENDED SEDIMENT

The basic concept of constituent loads in a river or stream is simple. However, the mathematics of determining a constituent load may be quite complex. A constituent load is the mass or weight of a constituent that passes a cross section of a stream in a specified interval of time. Loads are expressed in mass units (*e.g.*, tons, kilograms) and are considered for time intervals that are relative to the type of pollutant and the watershed area for which the loads are calculated. Loads are calculated from concentrations of constituents obtained from analyses of water samples and stream discharge, which is the volume of water that passes a cross section of the stream in a specific amount of time.

Suspended sediment is defined as that portion of a water sample that is separated from the water by filtering. This solid material may be composed of organic and inorganic material that includes algae, industrial and municipal wastes, urban and agricultural runoff, and eroded material from geologic formations (for example, sand and silt). These materials are transported to stream channels by overland flow related to storm-water runoff and cause varying magnitudes of turbidity. Concentrations of total suspended solids (TSS) in mg/L are determined by laboratory analysis of periodic water grab samples. Annual suspended sediment loads are estimated using the computer regression model Regr_Cntr.xls (*Regression with Centering*). The program is an EXCEL adaptation of the U.S. Geological Survey seven-parameter regression model for load estimation (Cohn et al., 1992). The regression with centering program uses average daily discharge and TSS to estimate annual loads.

BED SEDIMENT

Transport of streambed material is controlled by a number of factors primarily related to stream discharge and flow velocity, erosion and sediment supply, stream base level, and physical properties of the streambed material. Most streambeds are in a state of constant flux in order to maintain a stable base level elevation. The energy of flowing water in a stream is constantly changing to supply the required force for erosion or deposition of bed load to maintain equilibrium with the local water table and regional or global sea level. Stream base level may be affected by regional or global events including fluctuations of sea level or tectonic movement. Local factors affecting base level include fluctuations in the water table elevation, changes in the supply of sediment to the stream caused by changing precipitation rates, and/or land use practices that promote excessive erosion in the floodplain or upland areas of the watershed.

Bed sediment is composed of particles that are too large or too dense to be carried in suspension by stream flow. These particles roll, tumble, or are periodically suspended as they move downstream. Traditionally, bed sediment has been difficult to quantify due to deficiencies in monitoring methodology or inaccuracies of estimating volumes of sediment being transported along the streambed. This is particularly true in streams that flow at high velocity or in streams with excessive sediment loads.

Marlon Cook developed a portable stream bed sedimentation rate-monitoring device that was designed to accurately measure bed sediment in shallow sand or gravel bed streams (Cook and Puckett, 1998). Stream discharge and mean stream flow velocities are measured and used with estimates of bed sediment loads to facilitate comparison of sediment transport and stream flow conditions with other monitored streams.

NUTRIENTS

Excessive nutrient enrichment is a major cause of water-quality impairment. Excessive concentrations of nutrients, primarily nitrogen and phosphorus, in the aquatic environment may lead to increased biological activity, increased algal growth, decreased dissolved oxygen concentrations at times, and decreased numbers of species

NITRATE

The U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) for nitrate in drinking water is 10 mg/L. Typical nitrate (NO_3 as N) concentrations in streams vary from 0.5 to 3.0 mg/L. Concentrations of nitrate in streams without significant nonpoint sources of pollution vary from 0.1 to 0.5 mg/L. Streams fed by shallow groundwater draining agricultural areas may approach 10 mg/L (Maidment, 1993). Nitrate concentrations in streams without significant nonpoint sources of pollution generally do not exceed 0.5 mg/L

(Maidment, 1993).

PHOSPHORUS

Phosphorus in streams originates from the mineralization of phosphates from soil and rocks or runoff and effluent containing fertilizer or other industrial products. The natural background concentration of total dissolved phosphorus is approximately 0.025 mg/L. Phosphorus concentrations as low as 0.005 to 0.01 mg/L may cause algae growth, but the critical level of phosphorus necessary for excessive algae is around 0.05 mg/L (Maidment, 1993). Although no official water-quality criterion for phosphorus has been established in the United States, total phosphorus should not exceed 0.05 mg/L in any stream or 0.025 mg/L within a lake or reservoir in order to prevent the development of biological nuisances (Maidment, 1993).

Concentrations of nitrate and total phosphorus, in mg/L, are determined by laboratory analysis of periodic water grab samples. Annual nitrate and total phosphorus loads are estimated using the computer regression model Regr_Cntr.xls (*Regression with Centering*). The program is an EXCEL adaptation of the U.S. Geological Survey seven-parameter regression model for load estimation (Cohn et al., 1992). The regression with centering program uses average daily discharge and constituent concentrations to estimate annual loads.

PATHOGENS

Microorganisms are present in all surface waters and include viruses, bacteria, fungi, algae, and protozoa. Analyses of bacteria levels may be used to assess the quality of water and to indicate the presence of human and animal waste in surface and ground water. The flushing action of storm-water runoff causes increased concentrations of nonpoint-source pollutants in receiving streams. Previous studies have demonstrated excellent correlations between increased stream discharge and increased concentrations of in-stream bacteria. Possible sources of fecal contamination to surface waters include wastewater treatment plants, on-site septic systems, domestic and wild animal manure, and storm runoff.

Samples will be collected under base flow and high flow conditions at sites with no saline water influence and processed to determine counts of e-coli bacteria. The primary purpose of base-flow sampling is to determine contributions of bacteria from point sources such as leaking sewer pipes or unregulated discharges to streams. The primary purpose of high-flow sampling is to determine contributions of bacteria from nonpoint source runoff.

ADEM standards for streams classified as fish and wildlife are 487 colonies per 100 milliliters from June to October and 2,507 colonies per 100 milliliters from October to June. If counts exceed the standard, sampling to determine the geometric mean is required.

LAND USE

Land use is directly correlated with water quality, hydrologic function, ecosystem health, biodiversity, and the integrity of streams and wetlands. Land-use patterns, when evaluated with stream discharge and water-quality data, can be an essential part of an overall assessment strategy to determine sources of water-quality impacts, to support watershed management, and to develop remedial actions. Land use classification for this project area will be determined from the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service 2013 Alabama Cropland Data Layer (NASS CDL) raster dataset.

SCOPE OF WORK

Work elements and deliverables will include:

1. Measure stream discharge over a range from low to high flow at 16 monitoring sites along the eastern shore of Mobile Bay.
2. Collect field parameters at 16 monitoring sites for each monitored discharge event, including pH, specific conductance, turbidity, temperature, and dissolved oxygen.
3. Measure bed sediment transport rates at 10 sites for each monitored discharge event. Bed sediment transport rates and stream discharge will be used to prepare a bed sediment load regression model to determine bed sediment loads at each monitored site.
4. Collect water samples at 16 monitoring sites for each monitored discharge event and submit samples to the Polyenviromental Corporation certified geochemical laboratory for analysis of TSS concentrations. TSS concentrations and stream discharge will be used with the *Regression with Centering* digital model to estimate suspended sediment loads at each monitored site.
5. Collect water samples for each monitored discharge event at 16 monitoring sites and submit samples to the Polyenviromental Corporation certified geochemical laboratory for analysis of nitrate and total phosphorus concentrations. Analytical results and stream discharge will be used with the *Regression with Centering* digital model to estimate nitrate and phosphorus loads at each monitored site.
6. Collect samples under base flow and high flow conditions at sites with no saline water influence and process to determine counts of e-coli bacteria.

7. Evaluate current land use with acquired field data and sediment and nutrient loads to determine likely sources of sediment and other water-quality impacts in the watershed.
8. Prepare final report including descriptive text and supporting charts, graphs, and maps. A digital version of the report will be provided.

PROJECT PERFORMANCE TIME

Project initiation will be in January 2019. Data collection is dependent on climate conditions, but will be completed as soon as possible. The maximum period of project performance will be 12 months.

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