2019 ANNUAL PROGRESS REPORT

City of Hampton Watershed Protection Plan

Prepared for

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1 INTRODUCTION

This document was prepared by nd comprises the 2019 Watershed Protection Plan (WPP) Annual Progress Report covering the timeframe from January 1, 2018 through December 31, 2018 for the City of Hampton (City).

To promote the goals of restoring and protecting Georgia's water resources Georgia Environmental Protection Division (GAEPD) requires the entity (permittee) holding a permit for a new water pollution control plant (WPCP), expansion of an existing WPCP, or WPCP that operates at 1 million gallons per day (MGD) or greater to participate in the state's Watershed Planning and Monitoring Program (WPMP). In 2009 the City completed the construction of a new WPCP to meet the needs of the City's growing population. The City's former WPCP capacity was 0.5 MGD; the new Bear Creek WPCP treats a design capacity of 1.75 MGD. As part of the initial permitting process for the expanded wastewater discharge, GAEPD required the City to participate in the state's WPMP. The state's WPMP consists of a three-phased program of implementing an approved Watershed Monitoring Plan; developing an approved Watershed Assessment (WA); and developing and implementing an approved Watershed Protection Plan (WPP) outlining strategies to be used to protect water quality as well as the steps necessary to improve and ultimately meet water quality standards.

The City was initially notified of the requirement to meet the state's WPMP obligations of developing a WA and WPP as part of the permitting process for expanding the wastewater discharge of the City's Bear Creek WPCP (NPDES Permit No. GA0020320). The City initiated their WA in October 2003, as required by GAEPD, in concurrence with permission to expand the discharge of the City's Bear Creek WPCP. As such, the City was one of the first municipalities to participate in the state's WPMP which started prior to the publication of GAEPD's 2005 *Watershed Assessment and Protection Plan Guidance* documents. The following activities were performed by the City of Hampton in complying with the stated requirements:

- **<u>Phase I - Watershed Monitoring Plan</u>:**

The City's Watershed Monitoring Plan was implemented in 2003. Sampling consisted of collection and analysis of water quality parameters and biological monitoring, including habitat assessment and collection of fish and benthic macroinvertebrate specimens, conducted by the biological staff of Georgia Perimeter College. The studies focused on verifying baseline conditions in the subbasins within the City's sewer service area. There were a total of six (6) monitoring sites used: three (3) sites were located on tributaries to the Towaliga River; one (1) on Thompson Creek; and two (2) on Bear Creek.

- **<u>Phase II - Watershed Assessment (WA)</u>:**

Based on the aforementioned sources of water quality and biological assessment data, the City submitted a WA to the GAEPD in December 2004 which was subsequently approved by the Agency. The assessment was conducted to determine the current condition of streams and tributaries within the service area, to assess the size and effects of various pollution sources, and to evaluate options for improving and protecting water quality.

The WA included:

- A characterization of streams in the service area, including an overview of existing conditions and potential pollution source identification;
- An assessment of stream water quality in the service area, including a historical data search and a current data assessment with reference to previous monitoring results and observations;
- An assessment of stream segments listed by the state of Georgia as having impaired water quality; and
- A discussion of the potential effects of land use and future growth on water quality in the service area.

- **Phase III - Watershed Protection Plan (WPP):**

The City's WPP was submitted to GAEPD in October 2009 and subsequently approved by the Agency triggering initiation of their long-term monitoring plan (LTMP). The WPP describes the watershed protection strategies and steps necessary to improve and meet water quality standards. It is organized into the following sections in accordance with GAEPD's March 2005 *Watershed Assessment and Protection Plan Guidance; Phase III Watershed Protection Plans*:

I. Legal Authority
II. Funding
III. Identification of Pollutant Sources
IV. Best Management Practices (BMPs)
V. Management Measures for 303(d) Listed Stream Segment(s)
VI. Management Measures for Water Supply Watersheds
VII. Schedule for Implementation
VIII. Long-Term Monitoring Plan (LTMP)
IX. Reporting Requirements

The ultimate goal of the state's WPMP (Watershed Monitoring Program, WA, and WPP) is to provide the City with a technically sound and defensible basis for making informed watershed protection decisions within their sewer service area. To ensure the WPP is being properly implemented, the City of Hampton is required to submit an Annual Progress Report by June 30th of each year for the activities conducted during the previous year.

The following information is to be provided in the WPP Annual Progress Report:

Annual Certification of WPP Implementation

Certification of WPP implementation is prepared each year and submitted to GAEPD by June 30th. The report summarizes all the data collected during the previous year and discussion concerning observed results. In addition, it includes both hard copy and electronic versions of the water quality data, and biological data, if appropriate, for use by GAEPD.

Electronic Submittal of Long-Term Trend Monitoring Data

Water quality and bioassessment data is submitted annually in electronic form on compact disk (CD) or flash drive using GAEPD's Microsoft Excel templates and other submittal guidance, as provided on their website.

Annual Progress Report per EPD's October 2015 Guidance Document

Summary of Best Management Practices

The City submits an Annual Progress Report by June 30th outlining any specific actions or BMPs that were implemented during the previous calendar year; continuous BMPs; and BMPs occurring as a result of other programs. The report also discusses the effectiveness of existing BMPs with regard to observed monitoring results including recommendations for future improvements.

Water Quality and Biological Monitoring

In the Annual Progress Report, the City provides a summary of the current water quality and biological monitoring programs; results from the previous calendar year; and any observed trends in comparison with previous years' observations.

Summary of Changes in the WPP

The WPP is a living document and may be modified based on changing conditions in concurrence with the assigned GAEPD reviewer. It may also be necessary to make temporary, contemporaneous changes or modifications to the WPP due to funding availability, scheduling conflicts, or climatic conditions. Any modifications or variances from the approved WPP are summarized in the Annual Progress Report.

The following information is provided by the City of Hampton to meet the 2019 Annual Progress Report requirements covering WPP activities conducted during the 2018 calendar year.

2 ANNUAL CERTIFICATION OF WPP IMPLEMENTATION

I certify, under penalty of law, that the approved Watershed Protection Plan for the City of Hampton is being implemented. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. This certification is made for the period of January 1, 2018 through December 31, 2018.

Certified correct this 30th day of June, 2019;

By: ______________________________

(Signature)

Alex S. Cohilas, City Manager

3 ELECTRONIC SUBMITTALS

Electronic versions of the available water quality data collected for the reporting period are submitted on the enclosed flash drive using the newly revised GAEPD Excel formats provided on GAEPD's website. Tabulated data are appended, as needed, for the supporting discussion regarding observed results of monitoring activities. The data available for submittal with this annual report includes the 2018 water quality sampling results.

The 2018 water quality sampling results consist of two (2) dry weather events conducted in May and October 2018 and one (1) wet weather event conducted in September 2018; and two (2) series of bacteriological sampling events to obtain 4-day geometric means conducted in May and September/October 2018. The City's 2018 water quality sampling results are provided in **Appendix A.**

4 SUMMARY OF BEST MANAGEMENT PRACTICES

In accordance with the approved WPP's implementation schedule and updates provided in previous years Annual Progress Reports, the City planned to implement the following activities on an annual basis, including 2018:

Annual WPP Activities

1. Comply with Land Disturbance Act;
2. One (1) stakeholder meeting;
3. One (1) weekend workshop;
4. Continuous education;
5. One (1) brochure mailed;
6. Septic tank surveys by County Health Department;
7. Illicit discharge detection and elimination program (inspect 30 outfalls per year);
8. Implement municipal separate storm sewer systems (MS4) ordinance; and
9. Conduct long-term chemical water quality monitoring in local streams.

A. Newly Implemented BMPs

There were no newly implemented BMPs scheduled for 2018.

B. Continuous BMPs

The City completed all of the approved long-term monitoring activities for calendar year 2018. They also continued implementing the following annual BMPs established during previous years.

1. **Comply with Land Disturbance Act** - In 2011, the City became an Issuing Agent for Land Disturbance Act. The City now issues the land disturbance permits for eligible construction activities and performs routine inspection and enforcement actions. The application for this permit is on the City's website.
2. **One (1) stakeholder meeting** - The City conducts stakeholder meetings for every significant development project for developers, City Council, and concerned citizens. The City staff also routinely meet with stakeholders as part of the land disturbance permit process.
3. **One (1) brochure mailed** – Stormwater informational notices or tips are periodically placed on and sent to all citizens with City utilities.

4. **Septic tank surveys by County Health Department** – Septic tank surveys are routinely conducted by the Henry County Health Department. As such, any resident septic tank within the City limits that fails inspection is required by City ordinance to connect to the City sewer system. Furthermore, the City requires all new development to connect to the City sewer system.
5. **Illicit discharge detection and elimination (IDDE) program** – The City routinely inspects 30 outfalls each year in accordance with their active IDDE program procedures. Copies of the screening form are located in the City Utility's Department files.
6. **Implement municipal separate storm sewer systems (MS4) ordinance** – The City operates a MS4 program under state general NPDES Stormwater Permit No. GAG610000. In compliance with permit requirements, annual BMP reports are submitted to GAEPD in February of each year for the previous calendar year activities.
7. **Conduct long-term chemical water quality monitoring in local streams** – Long-term water quality monitoring was conducted in local stream basins and are discussed in the following sections.

C. BMPs Supporting Other Programs

The City is responsible for a number of overlapping permits and programs which require implementation of complementary BMPs including but not limited to several NPDES permits, a Phase II MS4 program, MNGWPD requirements, and other relevant programs. Thus, many of the aforementioned BMPs have been in place since the initiation of the WPP activities and will continue into the future. Additional relevant BMPs may be implemented as part of the MS4 program the City operates under Georgia NPDES Permit No. GAG610000 and will be addressed as they occur in future annual reports.

D. Effectiveness of Existing BMPs

Overall, all monitoring locations continue to exhibit elevated bacteriological concentrations exceeding state standards, which is consistent with bacteriological issues identified in the City's WA. Additionally, dissolved oxygen (DO) observations continue to violate state standards at sites BR-6 and TC-1. During the 2018 monitoring period two (2) monitoring sites, BR-6 and TW-1, experienced dissolved metal concentrations for zinc (Zn) but all concentrations were well below EPD's acute and chronic criteria. However, copper (Cu) which has historically violated state standards, was found to be within the state limits for freshwater streams at all monitoring locations.

The 2018 water quality observations indicate that the relative concentrations continue near previous baseline levels with little noticeable trending. Therefore, it is concluded the BMPs appear to be effective in maintaining relatively stable conditions throughout the service area watersheds.

5 WATER QUALITY AND BIOLOGICAL MONITORING

A. Monitoring Site Information

In accordance with the approved WPP, previous Annual Progress Reports, and modifications to the LTMP, the long-term monitoring requirements during the 2018 calendar year consisted of: water quality monitoring for two (2) dry and one (1) wet weather events; and bacteriological monitoring for two (2) 4-day events. The dry weather water quality sampling events occurred in May and October 2018; the wet weather water quality sampling event occurred in September 2018; and the two (2) 4-day series bacteriological sampling events occurred in May and September/October 2018, respectively.

Water quality monitoring (including bacteriological sampling) was performed at three (3) sampling locations (BR-6, TC-1, and TW-1) in and around the City of Hampton in Henry County, Georgia in 2018. As mentioned in previous Annual Progress Reports, the three (3) monitoring stations sampled in this study were modified from the original WA stations in accordance with a revised LTMP approved by GAEPD in 2015 to begin January 1, 2016. Descriptions and locations of the revised LTMP monitoring sites are provided in **Table 5-1** and **Figure 5-1**.

Table 5-1: City of Hampton Revised LTMP Monitoring Sites

Site ID	Site Name	Coordinates	Ecoregion Level IV	Monitoring Site Type
Upper Flint Watershed (HUC-12: 031300050105)				
BR-6	Bear Creek	33°22'24" N 84°18'53" W	Southern Outer Piedmont (45b)	Water Quality
Upper Ocmulgee Watershed (HUC-12: 030701031101)				
TW-1	Unnamed tributary to Towaliga River	33°23'37" N 84°15'43" W	Southern Outer Piedmont (45b)	Water Quality
TC-1	Thompson Creek	33°21'59" N 84°16'36" W	Southern Outer Piedmont (45b)	Water Quality

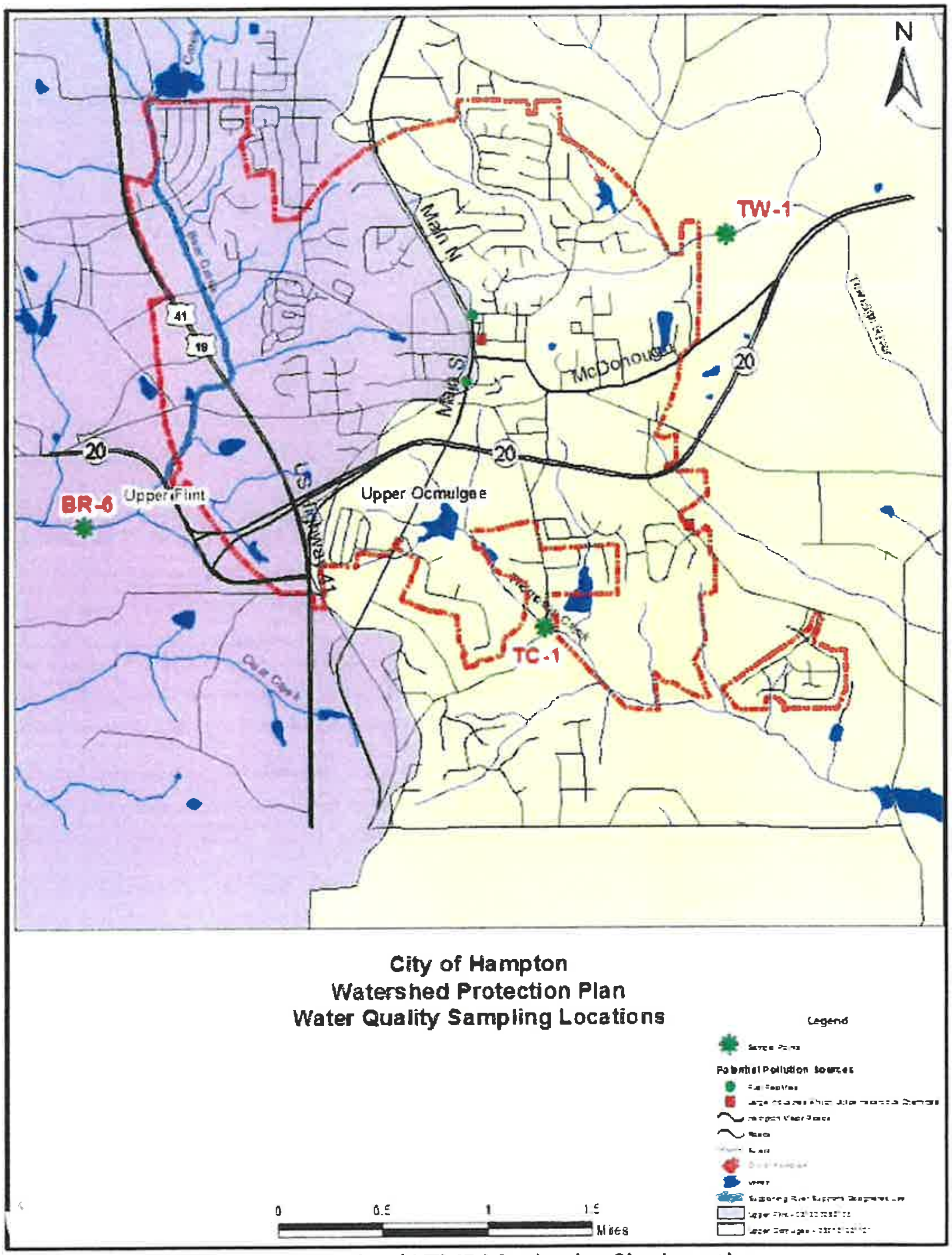

Figure 5-1: City of Hampton Revised LTMP Monitoring Site Locations

B. Summary of Water Quality Monitoring

In accordance with the approved LTMP and the previous Annual Progress Reports, City staff conducted annual water quality sampling from May 2018 through October 2018. Three (3) sampling events were conducted in 2018 at each of the three (3) monitoring locations; two (2) sampling events were dry weather conditions and one (1) was wet. The wet event was defined as 0.2 inches of rain with dry conditions (‹ 0.1 inches of rain) for 72 hours prior. The dry weather water quality sampling events occurred in May and October 2018 and the wet weather water quality sampling event occurred in September 2018. Additionally, annual bacteriological monitoring was conducted for two (2) 4-day events in May and September/October 2018.

Water quality samples from all three (3) study sites were analyzed in GAEPD-approved laboratories, Hampton and Analytical Services, Inc. (ASI) for the following parameters: chemical oxygen demand (COD), biochemical oxygen demand 5-day (BOD_5), total suspended solids (TSS), total dissolved solids (TDS), hardness, total phosphorus and ortho-phosphate, total Kjeldahl nitrogen (TKN), ammonia, nitrate-nitrite, and total dissolved metals (Ca, Cd, Cu, Mg, Pb, and Zn). In addition to the water chemistry sampling, 4-day fecal coliform and *Escherichia coli* (*E. coli*) sampling events were conducted during two (2) periods at all three (3) sampling sites. All analyses followed approved test procedures set forth in 40 CFR Part 136.

In situ measurements, parameters measured in the field during sampling events, included water temperature, pH, turbidity, dissolved oxygen (DO), and specific conductance.

The following discussion describes the importance and interpretation of these parameters, including a description of whether or not each parameter was observed at a level of concern. The complete 2018 water quality dataset for the City is provided in **Appendix A** of this report.

For additional discussion of observed results, a table is provided in **Appendix B** outlining the specific analytical parameters, guidelines, screening values, methods, and detection limits. Existing state standards are provided in bold type; for parameters without standards, a brief literature search was conducted to find some appropriate screening values. These consist of Bear Creek WPCP NPDES discharge limits specified for the 2018 calendar year and relevant regional United States Environmental Protection Agency (USEPA) guidance and studies, as footnoted. No screening values were identified for hardness, calcium, and magnesium.

In Situ Measurements

Temperature

Human activity has affected the temperature of rivers and streams in many ways. One of the most significant mechanisms that increase water temperature is thermal pollution. Industries, such as nuclear power plants, may cause thermal impacts by discharging water used to cool machinery. Thermal impacts may also come from stormwater running off warmed urban surfaces, such as streets, sidewalks, and parking lots. The temperature of streams and rivers is also affected by the loss of riparian buffers, e.g., trees that provide shade, thereby exposing the water to more direct sunlight.

Soil erosion can also contribute to warmer water temperature. Many types of activities, including the removal of streamside vegetation, overgrazing, poor farm practices, and construction, can cause soil erosion. Soil erosion raises water temperatures because it increases the amount of suspended solids carried by the river, making the water cloudy or turbid. Cloudy water absorbs the sun's rays, causing water temperature to rise.

Changes in water temperature can have a profound effect on stream ecosystems. As water temperatures rise, the rate of photosynthesis and plant growth also increases. The additional plant mass eventually dies and is decomposed by bacteria that consume oxygen. Therefore, as temperature and the rate of photosynthesis increases, so does the need for oxygen in the water (biochemical oxygen demand or BOD). The metabolic rate of organisms also rises with increasing water temperature, resulting in even greater oxygen demand. The life cycles of aquatic insects tend to speed up in warm water. Animals that feed on these insects can be negatively affected, particularly birds that depend on insects emerging at critical time periods during their migratory flights.

Most aquatic organisms have adapted to survive within a range of water temperatures. Some organisms, such as trout and stonefly nymphs, prefer cooler water while others thrive under warmer conditions, e.g., carp and dragonfly nymphs. As the temperature of a stream or river increases, the warm water organisms will replace the cool water species. Few organisms can tolerate extremes of heat or cold. Temperature also affects the sensitivity of aquatic life to toxic wastes, parasites, and disease. For example, thermal pollution may cause fish to become more vulnerable to disease, either due to the stress from rising water temperatures or the resulting decrease in dissolved oxygen.

Georgia Water Use Classifications and In-stream Water Quality Standards for designated uses require that discharge to a stream cannot produce a temperature change of more than 5° F from the ambient water temperature with a maximum water temperature not to exceed 90° F (32° C).

All 2018 *in situ* sampling results for water temperature were in compliance with the state standard for water temperature and did not to exceed 90° F (32° C).

Dissolved Oxygen

Dissolved Oxygen (DO) is essential for the maintenance of healthy streams and rivers. The primary source of DO in water comes from the atmosphere through physical mixing at the air-water interface. Algae and rooted aquatic plants also release oxygen into streams and lakes through photosynthesis. Most aquatic plants and animals need oxygen to survive. Waters with consistently high levels of DO are generally considered healthy and stable ecosystems capable of supporting many different species of aquatic organisms.

Levels of DO in aquatic ecosystems vary significantly depending on a number of factors. Physical influences such as volume of discharge and water temperature directly affect oxygen concentration with levels increasing with increased mixing rates as well as decreasing temperature. During dry periods, e.g. in the summer, flow may be reduced and air and water temperatures are often higher. Both of these factors tend to reduce DO levels. In the spring, wet weather increases flow resulting in greater mixing and dissolution of atmospheric oxygen. Large daily fluctuations in DO are also characteristic of bodies of water with extensive plant growth. Levels rise in the morning through the afternoon as a result of photosynthesis, reaching a peak in late afternoon. Photosynthesis stops at night, but plants and animals continue to respire and consume oxygen. As a result, DO levels fall to a low point just before dawn. This phenomenon is more common in lakes and impounded rivers, than in fast flowing streams.

The main factor contributing to significant changes in DO concentrations is the build-up of organic wastes, including leaves, feces, etc. Organic waste can enter rivers in many ways, such as in sewage, urban and agricultural runoff, or in the discharge of animal feeding operations and other industrial sources. A primary component of urban and agricultural runoff is fertilizers that stimulate the growth of algae and other aquatic plants. As plants die, aerobic bacteria consume oxygen in the process of decomposition. Many other kinds of bacteria also consume oxygen while decomposing sewage and other organic material in the river.

Depletions in DO concentration cause major shifts in the kinds of aquatic organisms found in water bodies. Species that cannot tolerate low oxygen levels – mayfly and stonefly nymphs, caddis fly and beetle larvae, bass and trout – will be replaced by fewer kinds of pollution tolerant organisms, such as worms and fly larva, carp and catfish. Nuisance algae and anaerobic organisms may also become abundant in waters with low levels of DO. DO levels below 4.0 milligrams per liter (mg/L) are generally considered an indicator of poor water quality.

The state of Georgia criteria lists a minimum level of DO that should not fall below 4.0 mg/L for single measurement for streams other than trout streams.

The 2018 *in situ* results for DO showed concentrations were below 4.0 mg/L for three (3) sampling occurrences at site BR-6, two (2) sampling occurrences at site TC-1 and one (1) sampling occurrence at site TW-1. Site BR-6 continues to experience DO levels below the state standard for single measurements (4.0 mg/L).

This data indicates low DO concentrations could indicate a build-up of organic wastes entering the water systems potentially in the form of sewage, urban/agricultural runoff, or the discharge of other industrial sources to be a problem in the City of Hampton's watershed.

Specific Conductance

Specific conductance (temperature corrected conductivity) is a numerical expression of water's ability to conduct an electrical current. It is typically measured in microSiemens per centimeter (μS/cm). Values of high specific conductance reflect the presence of high concentrations of total dissolved solids or potentially dissolved metals. Specific conductance is generally a good indirect measure of the concentration of salinity and TDS and can be used as an indicator of water pollution. Wenner, Ruhlman, and Eggert (2003) investigated specific conductance levels in Piedmont streams in Georgia and found that minimally impacted streams in this area had specific conductance values around 50 μS/cm. The USEPA (2007), EPA 841-B-97-003, report specific conductance values of inland freshwater streams supporting good mixed fisheries range from 150 to 500 μS/cm.

Specific conductance levels for water quality samples in 2018 ranged between 37.3 and 90.94 μS/cm for all sites. All conductivity measurements were below 150 μS/cm.

Nutrients and Other Non-Bacteriological Parameters

Cultural eutrophication, the human-caused enrichment of water with nutrients (phosphorus and/or nitrogen), is the primary cause of most eutrophication today. Natural eutrophication also takes place today but is insignificant by comparison. For example, forest fires are natural events that cause eutrophication. Lakes that receive no inputs of nutrients from human activities age very slowly.

Phosphorus (Total Phosphorus and Orthophosphate)

Phosphorus (P) is an essential element for life. It is a plant nutrient needed for growth, and a fundamental element in the metabolic reactions of plants and animals. Phosphorus oxidizes very readily and occurs in the earth's rocks principally as orthophosphate (PO_4^{-3}). Inorganic phosphates (e.g., $H_2PO_4^-$, HPO_4^{-2} and PO_4^{-3}) are the most abundant form of phosphorus and are rapidly taken up by algae and larger aquatic plants for nutritional needs. Organic phosphate is a part of living plants and animals, their by-products, and their remains. Plant growth is usually limited by the amount of phosphorus available. In most waters, phosphorus functions as the growth limiting factor because it is usually present in very low concentrations. Because algae only require small amounts of this nutrient to live, excess phosphorus causes extensive algal growth called "blooms". Algal blooms are a classic symptom of cultural eutrophication.

Phosphorus comes from several sources, including: human wastes, animal wastes, industrial wastes, fertilizers, and human disturbance of the land and its vegetation. Sewage from wastewater treatment plants and septic systems are major sources of phosphorus in many aquatic ecosystems. According to the EPA, sewage effluent should not contain phosphorus at levels greater than 1.0 mg/L, but outdated wastewater treatment plants often fail to meet this standard. Also, some types of industrial wastes interfere with the removal of phosphorus during the wastewater treatment process. Storm sewers sometimes carry flow from leaking sanitary sewer connections. Sewage from these leaks can be carried into waterways from rainfall. Phosphorus from animal wastes sometimes finds its way into rivers and lakes in the runoff from animal feeding operations. Soil erosion from agricultural and construction activities is also a primary contributor of phosphorus to many water bodies. Fertilizers used for crops, lawns and home gardens usually contain phosphorus, and when used in excess, the nutrient usually ends up in streams, rivers, and lakes. Draining swamps and marshes for farmlands, housing, commercial, and/or industrial parks releases nutrients like phosphorus that have remained dormant in years of accumulated organic deposits. In addition, drained wetlands no longer function as filters of silt and phosphorus, allowing more runoff (and phosphorus) to enter waterways.

Shallow lakes and impounded river reaches, where the water is shallow and slow moving, are the most vulnerable to the effects of cultural eutrophication. As mentioned previously, phosphorus stimulates the growth of algae and rooted vegetation, the latter that takes up phosphorus previously locked in bottom sediments and releases it to water, causing further eutrophication. As eutrophication increases, swimming and boating may become impossible. Eventually, the entire lake or river stretch may fill with aquatic vegetation. The advanced stages of cultural eutrophication can produce anaerobic conditions in which oxygen in the water is completely depleted. These conditions occur near the bottom of a lake or impounded river stretch, and produce gases like hydrogen sulfide, unmistakable for its "rotten egg" smell.

It is important to evaluate both the total phosphorus (TP) as well as ortho-phosphate results to determine if phosphorous is a concern in any watershed. Ortho-phosphate is that portion of the total phosphorus measurement that promotes eutrophication. If ortho-phosphate is present in excess of the 0.1 mg/L threshold, it is likely that excessive nutrient input is occurring and causing impact to the stream ecosystem. If the concentration of ortho-phosphate is low, then phosphorus is not a concern regardless of measurements of TP exceed recommended thresholds. The state of Georgia does not have a standard for TP or ortho-phosphate, however, EPA Region 4 contends that aquatic resources that measure above 0.1 mg/L for TP or ortho-phosphate may be at risk from cultural eutrophication.

There were no TP or ortho-phosphate concentrations observed to exceed the 0.1 mg/L threshold in any of the 2018 data samples.

Nitrogen (Ammonia, Nitrate-Nitrite, and Total Kjeldahl Nitrogen)

Nitrogen is an element needed by all living plants and animals to make protein. In aquatic ecosystems, nitrogen is present in many forms. Nitrogen is a much more abundant nutrient than phosphorus in nature. It is more commonly found in its molecular form (N_2), which makes up 79% of the air we breathe. This form is useless for most aquatic plant growth. Blue-green algae, the primary algae of algal blooms, are able to use N_2 and convert it into other forms of nitrogen, specifically: ammonia (NH_3) and nitrate (NO_3), that plants can take up through their roots and use for growth.

Animals obtain the nitrogen they need by either eating aquatic plants or eating other aquatic organisms that feed upon the plants. As aquatic plants and animals die, bacteria break down large protein molecules into ammonia. Excretions of aquatic organisms are very rich in ammonia, although the amount of nitrogen they add to waters is usually small. Duck and geese, however, contribute a heavy load of nitrogen (from excrement) in areas where they are plentiful.

Ammonia is extremely toxic to fish populations even at low levels and can cause various problems including, a reduction in hatching success, reduction in growth rate and morphological development, and pathologic changes in tissues of gills, livers, and kidneys. Ammonia is rapidly oxidized by other bacteria to form nitrites (NO_2) and nitrates (NO_3).

Nitrate is the most common form of nitrogen found in water. There are also bacteria that can transform nitrates into free molecular nitrogen (N_2). The nitrogen cycle begins again if this free molecular nitrogen is converted by blue-green algae into ammonia and nitrates. Because nitrogen, in the form of ammonia and nitrates, acts as a plant nutrient, it also causes eutrophication. As described in the previous section on phosphorus, eutrophication promotes plant growth and decay, which in turn increases biological oxygen demand. However, nitrogen, unlike phosphorus, rarely limits plant growth, so plants are not as sensitive to increases in ammonia and nitrate levels.

Sewage is the main source of nitrates added by humans to rivers. Sewage enters waterways in inadequately treated wastewater from sewage treatment plants, in the effluent from leaking sanitary sewer connections, and from poorly functioning septic systems. Septic systems, more common in rural areas, generally treat waste from a single household. If these systems are located too close to the water table or if the systems are not emptied periodically, nutrients and bacteria can get into the drinking water supply from a nearby well or can travel through the ground or through surface runoff to nearby streams and lakes. Although it is not toxic itself water containing high nitrate levels can cause a serious condition called methemoglobinemia, if used to make infant milk formula. This condition prevents the baby's blood from carrying oxygen; hence the nickname "blue baby" syndrome. Therefore, a drinking water standard exists for both nitrates and nitrites.

Two other important sources of nitrates in water are fertilizers and runoff from cattle feedlots, dairies, and barnyards. High nitrate levels have been found in groundwater beneath croplands due to excessive fertilizer use, especially in heavily irrigated areas with sandy soils. Stormwater runoff can carry nitrate-containing fertilizers from farms and lawns into waterways. Similarly, places where animals are concentrated, such as feedlots and dairies, produce large amounts of waste rich in ammonia and nitrates. If not properly contained and treated, bacteria and nutrients can seep into groundwater or be transported to surface waters. As discussed previously, eutrophication can limit organism diversity, recreational opportunities, and property values.

Typically, concentrations of total nitrate (NO_3) above 10.0 mg/L, nitrite (NO_2) above 0.1 mg/L, ammonia (NH_3) above 2.0 mg/L, and total Kjeldahl nitrogen (TKN – a measure of both the ammonia and organic forms of nitrogen) above 2.0 mg/L are a concern and suggest that actions should be taken to identify sources and limit inputs of nitrogen in the ecosystem of concern.

There were no recordings above 2.0 mg/L for ammonia (NH_3) in 2018. All observed TKN concentrations were below detection limits (<0.4 mg/L) except for one (1) sample collected on September 19, 2018 at site TC-1 which had a value of 0.76 mg/L, which is well below the 2.0 mg/L concentration of concern. Nitrate-Nitrite [(NO_3) - (NO_2)] levels ranged from 0.12 to 0.41 mg/L. This data continues to indicate nitrogen, or nutrients as a whole, do not appear to be a problem in the City of Hampton's watershed.

Biochemical Oxygen Demand (BOD)

BOD_5 is a 5-day measure of substances in the water which are consumed by biological processes requiring oxygen depletion in the water column. BOD_5 discharge limitations are included in all wastewater treatment plant permits and are contemporarily around a monthly average of 10.0 mg/L. Water quality in aquatic ecosystems are generally considered healthy when BOD_5 concentrations do not exceed 5.0 mg/L.

The BOD_5 levels in the streams remained well below typical NPDES permit levels for all sites during 2018. No exceedances of the BOD_5 screening value of 5.0 mg/L were observed.

Chemical Oxygen Demand (COD)

COD is a chemical measure of the amount of organic substances in water oxidized by all processes and includes non-biodegradable and recalcitrant compounds, which are not detected by the test for BOD. COD is not currently a typical regulated parameter.

COD levels were low for all sites, less than 50 mg/L, during dry and wet sampling events in 2018. The highest COD level observed in 2018 occurred at site BR-6 and was 16.36 mg/L.

pH

Water (H_2O) contains both hydrogen (H+) ions and hydroxyl (OH-) ions. pH measures the H+ ion concentration of liquids and substances, with resulting values reported on an exponential logarithmic scale from 0 to 14 standard units (s.u.). Pure deionized water contains equal numbers of H+ and OH- and has a neutral pH of 7 s.u. If a water sample has more H+ than OH- ions, it is considered acidic and has a pH of less than 7 s.u. If a sample contains more OH- than H+ ions, it is considered basic with a pH greater than 7 s.u. It is important to note that for every one-unit change on the pH scale, there is approximately a ten-fold change in how acidic or basic the sample.

Changes in the pH value of water are important to many organisms as they have adapted to life in water of a specific pH and may die if it changes even slightly. This has occurred to brook trout in some streams in the Northeast. Impacts to biological communities are observed in streams that receive acid rain and acid snow melts in the spring. Immature stages of aquatic insects and young fish are extremely sensitive to pH values at or below 5.0 s.u. Very acidic waters can also cause heavy metals, such as lead, copper, and aluminum, to be released into the water. Heavy metals accumulate in the gills of fish or cause deformities in young fish, reducing their chance of survival. At extremely high or low pH values (e.g., 9.6 or 4.5 s.u.) the water becomes unsuitable for most organisms. *Georgia Water Use Classifications and In-stream Water Quality Standards* for all designated uses require that pH levels remain between 6.0 and 8.5 s.u.

Levels of pH were near neutral (7.0 s.u.) and between the state standard of 6.0 and 8.5 s.u. for all sampling sites in 2018.

Hardness

Hardness is a measure of multivalent cations, assumed as primarily calcium and magnesium, in the water sample. Hardness is most typically estimated by determining the amounts of calcium and magnesium present in the stream sample, converting to their equivalent weights of calcium carbonate, summing them, and taking the result as hardness reported as concentrations of calcium carbonate ($CaCO_3$).

The problems hard water presents to water supply systems are well known. Hard water produces a sticky, gummy deposit called "soap curd" as it reacts with detergents. Most people are familiar with this phenomenon if they shower with hard water. Most groundwater is hard and has to be treated if used as a water supply source. Another problem is the scaling hard water produces, after being heated, in water supply pipes. Calcium carbonate and magnesium hydroxide readily precipitate out of solution forming a rocklike scale that clogs and reduces the useable life of water supply pipe systems.

The effect of hardness on surface water quality is less severe and there is currently no federal and state standard to evaluate the absolute measurement in aquatic systems. Aquatic organisms can live in varying degrees of soft or hard water. For example, organisms with shells, such as crayfish, prefer harder water as it produces a tougher shell. Other organisms can prefer softer water depending on the environment to which they have adapted. What is more important is the introduction of extremes to the normal water environment. For example, if soft water is the normal environment, the addition of extremely hard water to that environment could have a deleterious effect on many of the aquatic organisms, and vice-versa.

Hardness of less than 60.0 mg/L, is generally very low, indicating extremely soft water. All samples evaluated had average hardness levels of around 16.1 to 24.1 mg/L, indicating extremely soft water. However, water hardness tends to be relatively soft in Georgia streams compared to the U.S. average around 100 mg/L of $CaCO_3$. The 2018 monitoring results for hardness are consistent with historic baseline trends.

Sediment Load

The nature of suspended solids varies depending upon the source of the material, ranging from clay, silt, and plankton, to industrial wastes and sewage. High turbidity may be caused by soil erosion, waste discharge, urban runoff, abundant bottom feeders (such as carp) that stir up sediments, or algal growth. The presence of suspended solids may cause color changes in water, from nearly white to red-brown or green from algal blooms.

At higher levels of turbidity, water loses its ability to support a diversity of aquatic organisms. Murkier waters become warmer as suspended particles absorb-heat from sunlight, causing oxygen levels to fall. Photosynthesis decreases because less light penetrates the water causing further decreases in oxygen content. The combination of warmer water, less light, and oxygen depletion makes it impossible for some forms of aquatic life to survive.

Suspended solids affect aquatic life in other ways. Suspended solids can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larvae development. Particles of silt, clay and organic materials settle to the bottom, especially in slower moving rivers and streams. These settled particles could smother the eggs of fish and aquatic insects, as well as suffocate newly hatched insect larvae. Material that settles into spaces between rocks makes these microhabitats unsuitable for mayfly nymphs, stonefly nymphs, caddis fly larvae, and other aquatic insects living there.

Turbidity and total suspended solids (TSS) are measurements of the relative clarity of water - the greater the level, the murkier the water. Sediment load can be estimated through the use of either test. The turbidity meter is relatively easy to use in the field but the result sometimes does not correlate well with estimates of sediment load based on TSS. This is probably because very fine particulates (e.g., clays) remain in suspension much longer than larger particles, and so turbidity readings of samples with large amounts of fines will cause less consistency between samples. The TSS test generally provides more consistent measurements among samples containing the same total amount of material but of differing grain sizes, however, the test is performed in the laboratory and so takes more time to complete.

Turbidity

Turbidity measurements are reported as nephelometric turbidity units (NTU). A Georgia Board of Regent's Scientific Panel recommended a 25 NTU instream limit for the protection of aquatic communities in streams with a "fishing" classification (Kundell and Rasmussen, 1995) although, most construction site stormwater permits require BMPs to achieve 50 NTU in runoff leaving land disturbed areas.

Only one turbidity sample exceed 50 NTUs. During dry weather sampling on 5/23/18, turbidity measured 63 NTUs at Site TW-1.

Total Suspended Solids (TSS) and Total Dissolved Solids (TDS)

There is no current state standard for total suspended solids (TSS) in Georgia. The USEPA has recommended that TSS measurements exceeding 20 mg/L may pose some stress to aquatic organisms. Additionally, there is not currently a state standard for total dissolved solids (TDS) in Georgia. However, the USEPA reports a maximum contaminate level for TDS from secondary drinking water standards is 500 mg/L.

No TSS values from any monitoring sites in 2018 exceeded the potential aquatic stress value of 20 mg/L. No TDS values from any monitoring sites in 2018 exceeded 500 mg/L.

Metals (Ca, Cd, Cu, Mg, Pb, and Zn)

Volcanic eruptions, weathering of rock and other natural processes continually introduce and cycle metals in the environment. This geological weathering is responsible for the background levels of metals found in rivers and lakes. Natural processes and cycles are often disrupted by human activity such as mining (e.g., lead, silver, copper, and iron ore) and manufacturing processes that redistribute and concentrate metals in the environment. Metals are often found in the effluent of various manufacturing processes, including: lead and nickel in battery manufacturing, copper from the textile industry, silver in photographic film production, and iron ore in steel production. Other point sources, like sewage effluent, may contain elevated levels of copper, lead, zinc, and cadmium. Some of this increase has been linked to corrosion within the wastewater collection system.

Non-point sources of pollution include both urban and rural runoff. Urban stormwater runoff carries increased metal loadings, especially during the initial "first flush" phase of the rain event. Stormwater carries lead deposited on streets and parking lots from car exhaust, oil and grease, zinc in motor oil and grease, and copper worn from metal plating and brake linings. In rural areas, sediments eroding from croplands carry cadmium, and even uranium, which are both found in some phosphate fertilizers. Herbicides used to control weeds may also contain arsenic. In addition, metals used in products common to our daily life, like cars, eventually end up in landfills, or their by-products can be transported via stormwater to a nearby water body.

Many metals are essential for plant and animal growth and metabolism. Nickel, zinc, and copper are considered essential elements. Essential trace metals, at excessive levels, become toxic to invertebrates and fish. Often the difference between non-toxic and toxic levels is minute. Non-essential elements, such as cadmium, mercury, and lead, are toxic even at very low levels. Toxicity refers to the potential harmful effects, both lethal as well as non-lethal, of a chemical upon a living organism. Potential effects may include the inability to reproduce, behavioral changes, and/or changes in growth and development. It is often difficult to differentiate the many interconnected effects related to toxic metals. For example, a fish that is stressed by accumulation of metals may become physically less able to avoid predation.

The toxicity of heavy metals to aquatic organisms depends upon many factors, including the bioavailability of metals to organisms. Organisms take up metals through ingestion of food, through adsorption onto membranes (gills), and transport through the skin. Bioavailability, in turn, is influenced by water hardness, pH, life cycle, and age of the organism, and water temperature. With increasing water hardness, the toxicity of metals decreases, as they are adsorbed onto insoluble carbonate compounds. A lowering of the pH increases the solubility of metals in solution. Below a pH of 5.5 s.u., aluminum and mercury levels may be a threat to aquatic life. Concentrations of metals, like mercury, are often higher in older organisms. An increase in water temperature increases metabolism and quickens the intake of metals as well. Metals are adsorbed onto organic material and so are found concentrated in bottom sediments. Organisms that inhabit metal-laden sediments (e.g., *Tubjfex)* exhibit high levels of metals. People who eat bottom-feeding fish like carp and catfish on a frequent basis may be at increased health risk.

The USEPA has defined acute and chronic water quality standards for many individual metals which have generally been adopted by all states; unless they chose to be more protective. For example, GAEPD has set for freshwater ecosystems an acute maximum standard of 65 µg/L and a chronic maximum standard of 65 µg/L for zinc, a typical metal found in Georgia's streams. There are also acute and chronic standards specified for many other metals, including arsenic, copper, lead, and mercury, to name a few. Acute levels are those in which aquatic life will suffer deleterious effects after a short period of exposure, typically one to 24 hours. Chronic levels are those in which aquatic life will suffer deleterious effects after a prolonged exposure, typically four days.

Concentrations of cadmium, lead, and Copper were below levels of detection (0.01 mg/L, 0.025 mg/L, and 0.02 mg/L respectively) in all 2018 samples. Zinc was detected at BR-6 and TW-1 but all concentrations were well below EPD's acute and chronic criteria of 65 µg/L.

<u>Bacteriological Parameters (Fecal Coliform and *E. coli*)</u>

Fecal coliform bacteria are found in the feces of humans and other warm-blooded animals. These bacteria can enter rivers through direct discharge from mammals and birds, from agricultural and storm runoff carrying animal waste, and from human sewage discharged into the water. Fecal coliform bacteria by themselves are not pathogenic. Pathogenic organisms that cause diseases and illnesses include not only bacteria, but viruses and parasites as well. Fecal coliform bacteria occur naturally in the human digestive tract and aid in the digestion of food. In infected individuals, pathogenic organisms are found along with fecal coliform bacteria.

Pathogens are relatively scarce in water, making them difficult and time-consuming to monitor. Instead, fecal coliform levels are monitored because of the correlation between fecal coliform counts and the presence of pathogenic organisms. If an analysis indicates the presence of fecal coliform counts are higher than 200 colony forming units (cfu) per 100 milliliters (cfu/100 mL) of stream water sampled, the potential for pathogenic organisms to be present also exists. A person swimming in such waters has a greater chance of getting sick from swallowing disease-causing organisms, or from pathogens entering the body through cuts in the skin or nose, mouth, or ears. Diseases and illness such as typhoid fever, gastroenteritis, dysentery, and ear infections can be contracted in waters with high fecal coliform counts.

Cities and small towns sometimes contribute human wastes to local rivers through their sewer systems. A sewer system is a network of underground pipes that carry wastewater. In a *separate sewer system,* sanitary wastes flow through sanitary sewers and are treated at the wastewater treatment plant. Storm sewers carry stormwater runoff from streets, and discharge untreated stormwater directly into streams and rivers. Rainfall can wash animal wastes produced by pets, birds, squirrels, etc. from lawns, sidewalks, and streets into streams. Rainfall can also flush fecal coliform from sanitary sewer overflows into streams. In a combined sewer system, both sanitary wastes and storm runoff are treated at the wastewater treatment plant.

Georgia has several sets of standards depending on the water use classification of the water body in question. The fecal coliform standard applied to this classification is as follows: "For the months of May through October, when water contact recreation activities are expected to occur, fecal coliform not to exceed a geometric mean of 200 cfu per 100 mL based on at least four (4) samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. Should water quality and sanitary studies show fecal coliform levels from non-human sources exceed 200 cfu per 100 mL (geometric mean) occasionally, then the allowable geometric mean fecal coliform shall not exceed 300 cfu per 100 mL in lakes and reservoirs and 500 cfu per 100 mL in free-flowing freshwater streams. For the months of November through April, fecal coliform not to exceed a geometric mean of 1,000 cfu per 100 mL based on at least four (4) samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 cfu per 100 mL for any sample."

Fecal coliform and *E. coli* bacteria analysis were collected for every sampling event at all three (3) study sites in 2018 (**Appendix A**). Fecal coliform 4-day geometric means were above 1,000 cfu/100 mL and exceeded the state's standard of 200 cfu/100 mL for all three (3) sites during the May and October 2018 sampling events. Additionally, all sampling sites exceeded the USEPA standards for *E. coli* (126 cfu/100 mL) in both sampling events (May and October) except at Site BR-6 were one geomean (71.5 CFUs/100ml) was within EPD's guidelines. The fecal coliform and *E. coli* geometric means are tabulated in the 2018 Water Quality Report (**Appendix A**).

C. Summary of Macroinvertebrate Assessments

The City of Hampton has previously been required to perform biennial biologic assessments of the targeted watersheds. Biologic assessments were last conducted in June and December 2015 by CCR Environmental, Inc. and provided in the 2016 Annual Progress Report. However, in 2015 GAEPD changed the biologic assessment sampling frequency requirements from biennial to two (2) assessments per five-year period. Therefore, the next biologic assessment for benthic macroinvertebrates will be performed in 2019.

Detailed biological assessment results were last provided in the 2016 Annual Progress Report which compared habitat assessment scores from the 2012, 2014, and 2016 Annual Progress Reports. As reported in the 2016 Annual Progress Report habitat conditions at the monitoring sites were severely degraded and habitat assessment scores for all bioassessment sites remain in the "marginal" condition rating range for ecological condition. Erosion and sedimentation were identified as the primary causes of habitat degradation for the sites during the previous 2015 monitoring period.

Benthic macroinvertebrate community conditions from the 2012 study to the 2016 study ranged from "poor" to "good" and did not correlate very well with habitat assessment scores, although this is often the case with conservatively-biased risk and ranking systems. Multi-metric scoring indicated site BR-6 is ranked "poor"; site TW-1 is ranked "fair"; and site TC-1 is ranked "good". However, these results can vary year to year and will not be too meaningful until a more substantial baseline and trend duration is available.

D. Summary of Fish Assessments

The City of Hampton has previously been required to perform biennial biologic assessments of the targeted watersheds. Biologic assessments were last conducted in 2015 by CCR Environmental, Inc. and provided in the 2016 Annual Progress Report. However, in 2015 GAEPD changed the biologic assessment sampling frequency requirements from biennial to two (2) assessments per five-year period. Therefore, the next biologic assessment for fish assessment (IBI scores) will be performed in 2019.

Detailed fish assessment results provided in the 2016 Annual Progress Report compare fish assessment scores from the 2012, 2014, and 2016 Annual Progress Reports. Fish community condition ratings, index of biotic integrity (IBI scores), were "poor" at all of the monitoring sites in the 2016 Annual Progress Report, which was more in line with observed habitat ratings. However, pollutant impacts tend to be more severe in higher order specimens.

Biological Monitoring Summary

With reference to recent trends, it appears habitat scores remained pretty close to previous studies, and multi-metric and IBI scores varied slightly but with no discernible trending. Since these results vary year to year; it is unlikely to be too meaningful until a more substantial baseline and trend duration is available.

6 SUMMARY OF ANY CHANGES IN THE WPP

The format of this annual progress report has been updated to reflect the new 2015 GAEPD Guidance and the water quality data spreadsheet has been updated to reflect the new March 2019 format. Additional program changes included changing the biennial biologic assessment requirement to a frequency of two (2) assessments for each five-year period. As such, one of the recommended changes to the approved WPP and previous year's annual progress report is to postpone initiating the proposed 2018 biological assessment monitoring for the City of Hampton until their next assessment activity in 2019.

There are no other pending changes and/or modifications to the approved WPP at this time.

APPENDIX A

City of Hampton 2018 Water Quality Monitoring Report

CITY OF HAMPTON
WATERSHED PROTECTION PLAN MONITORING 2018
TESTS

Collected Dates	Collected Times	Tests Dates	[illegible]	SAMPLES	Tested by Hampton Lab. Temperature (°C)*	DO (mg/l)*	Conductivity (µmhos/cm)*	Turbidity (NTU)	PH	BOD (mg/l)	COD (mg/l)	TSS (mg/l)	TDS (mg/l)	Ammonia (mg/l)	Total Phos (mg/l)	Tested by ASI Lab. E.Coli (MPN/100ml)	Fecal Coliform (MPN/100ml)	NO3-NO2 (mg/l)	TKN (mg/l)	Ortho Phos (mg/l)	Total Hardness as CaCO3 (mg/l)	METALS Ca (mg/l)	Mg (mg/l)	Cd (mg/l)	Cu (mg/l)	Pb (mg/l)	Zn (mg/l)		COMMENTS
05/02/2018	[illegible] AM	5/11/2017	[illegible]	BB-6	16.5	3.36	83	8.05	6.6	1	11.3	0.9	135	ND	ND	76	44	5.33	ND	ND	13.6	7.76	1.86	ND	ND	ND	0.04	Dry Weather	BB-6 = [illegible]
	8:40 AM			TC-1	25.0	5.27	77.9	14.9	6.3	3	11.6	0.4	167	ND	ND	4042	1909	1.98	ND	0.449	16.1	6.4	2.2	ND	ND	ND	ND		TW-1 = Mr Henderson
	[illegible] AM			TW-1	15.5	6.57	85.1	8.21	6.5	3	12.8	5.9	60	ND	ND	36	58	0.41	ND	ND	15.2	7.67	1.65	ND	ND	ND	[illegible]		TC-1 = [illegible] creek
05/09/2018	8:00 AM	5/18/2017	[illegible]	BB-6	17.4	5.81	88.9	32.6	6.6							109	442											Dry Weather	* = Determine on site (by Hampton Lab)
	8:11 AM			TC-1	18.0	6.1	66.6	8.04	6.3							37	182												ND = None Detected
	8:30 AM			TW-1	17.8	8.29	90	11.9	6.6							443	243												
05/16/2018	8:19 AM	6/4/2017	[illegible]	BB-6	28.8	3.77	89.2	43.8	6.4							1310	5200											Dry Weather	**Detection Limits**
	8:30 AM			TC-1	21	6.1	66.1	41.8	6.5							1420	4500												Ca = 1.00 mg/l , Mg = [illegible] mg/l
	8:42 AM			TW-1	21.3	4.39	68.6	10.2	6.5							382	4800												Cd = [illegible] mg/l , Cu = [illegible] mg/l
05/23/2018	7:55 AM	6/11/2017	1264.00	BB-6	22.4	6.45	87.3	8.32	6.9							758	5500											Dry Weather	Pb = 0.025 mg/l , Zn = 0.020 mg/l
	7:45 AM			TC-1	22.1	6.61	66.4	4.35	6.6							629	7500												TKN = 0.4 mg/l , Ortho Phos = [illegible] mg/l
	8:22 AM			TW-1	21.9	7.08	78.6	45	6.5							1600	3800												E.Coli = 1.00 mpn/100 ml
[illegible]	9:40 AM	[illegible]/2017	[illegible]	BB-6	[illegible]	3.47	51.7	5.7	6.8	1	11.20	9.6	168	ND	ND	74	[illegible]	3.51	ND	ND	17.4	7	1.6	ND	ND	ND	[illegible]	[illegible] Weather	Fecal Coliform = 1.00 mpn/100 ml
	9:59 AM			TC-1	22.8	3.79	40.5	22.9	7.2	2	14.9	15.2	216	ND	ND	495	[illegible]	ND	0.75	ND	20.1	6.1	2.2	ND	ND	ND	ND		Ammonia = 0.1 mg/l
	10:06 AM			TW-1	23.2	6.79	60.4	10	6.7	1	10	4.2	[illegible]	ND	ND	437	[illegible]	[illegible]	ND	ND	24.1	8.7	1.1	ND	ND	ND	ND		Total Phosphorus = 0.22 mg/l
10/10/2018	9:48 AM	10/16/2017	5410.00	BB-6	20.3	6.06	46	4.38	6.8	2	16.86	2.8	130	ND	ND	688	3300	0.32	ND	ND	17.5	7	0.85	ND	ND	ND	0.044	Dry Weather	
	12:11 AM			TC-1	32.6	2.59	27.9	11.3	6.7	1.6	9.85	8.9	148	0.21	ND	752	1164	3.12	0.43	ND	21.8	6.6	3.8	ND	ND	ND	ND		
	12:26 AM			TW-1	26.2	4.88	69.6	12.3	6.9	3	13.3	6.4	60	ND	ND	1721	1461	5.27	ND	ND	20.6	8.3	7	ND	ND	ND	ND		
10/17/2018	9:34 AM	10/17/2017	[illegible]	BB-6	21.4	3.93	61.8	4.4	6.8							33	1816											Dry Weather	
	9:48 AM			TC-1	20.3	5.42	61.4	18.6	6.6							420	183												
	10:07 AM			TW-1	20.2	6.2	41.3	44.5	6.6							410	99												
10/24/2018	9:30 AM	10/24/2017	[illegible]	BB-6	14.8	5.18	49	5.25	6.3							16	68											Dry Weather	
	9:45 AM			TC-1	12.1	7.31	63.7	24.3	6.5							261	184												
	10:00 AM			TW-1	13.8	7.73	61.73	21.9	6.6							613	990												
11/07/2018	9:22 AM	11/07/2017	[illegible]	BB-6	18	6.75	71.3	15.8	6.6							208	873											Dry Weather	
	9:38 AM			TC-1	14.4	5.19	64.1	35.8	6.5							121	109												
	9:53 AM			TW-1	16	7.02	40	40.3	6.5							1066	6300												

APPENDIX B

Parameter List and Screening Values

STATE GUIDELINES, ANALYTICAL METHODS, DETECTION LIMITS, AND SCREENING VALUES FOR PARAMETERS MEASURED UNDER THE CITY OF HAMPTON'S 2018 WATERSHED PROTECTION PLAN MONITORING

Parameter	State Guidelines (Screening Values)	Analytical Method	Detection Limit*
In Situ			
Dissolved Oxygen (DO)[a]	**Not < 4.0 mg/L (single sample)**	*In Situ*	0.01 mg/L
Water Temperature	**NTE 90°F (32°C)**	*In Situ*	0.1 °
Specific Conductance	(150 µS/cm) [b]	*In Situ*	0.1 µS/cm
Bacteriological			
Fecal Coliform [c]	**May-Oct 200 cfu/100 mL (GM)** **Nov-April 1,000 cfu/100 mL (GM)**	SM # 9222 D	20 - 2,000 colonies/100 mL [d]
E. coli [c]	126 *E. coli* cfu/100 mL (GM) [l]	SM # 9223B/ Quantitray	1-10 MPN/100 mL [d]
Nutrients and Other Parameters			
Turbidity	(50 NTU) [k]	EPA 180.1	0.1 NTU
pH	6.0-8.5 s.u.	EPA 150.1	0.1 s.u.
Biochemical Oxygen Demand (BOD_5)	(5.0 mg/L)	SM # 5210 B 20th Edition	2.0 mg/L
Chemical Oxygen Demand (COD)	(50.0 mg/L) [m]	EPA 410.1	0.10 mg/L
Nitrate-Nitrite Nitrogen	(10.0 mg/L – 1.0 mg/L) [o] (10.0 mg/L – 0.1 mg/L) [f]	EPA 300.0	0.10 mg/L
Ammoniacal Nitrogen (Ammonia)	(2.0 mg/L) [f] (monthly average 2.7 mg/L) [g]	EPA 350.1	0.10 mg/L
Total Kjeldahl Nitrogen (TKN)	(2.0 mg/L) [f]	EPA 351.2	0.4 mg/L
Total Phosphorous	(0.1 mg/L) [f] (monthly average 1.0 mg/L) [g]	SM #4500-PE	0.10 mg/L
Ortho-Phosphate	(0.1 mg/L) [e]	SM 4500-PE	0.02 mg/L
Total Suspended Solids (TSS)	(monthly average 20.0 mg/L) [g]	SM #2540 D 20th Edition	None
Hardness	< 60 mg/L (Soft) 60 -v 120 mg/L (Moderately Hard) 120 – 180 mg/L (Hard) ➢ 180 mg/L (Very Hard)	EPA 200.7	2.5 mg/L
Total Dissolved Solids (TDS)	(500 mg/L) [p]	SM #2540 C 20th Edition	None
Metals [h, i]			
Calcium	**None**	EPA 200.7	1.00 mg/L
Cadmium	**1.0/0.15 µg/L**	EPA 200.7	0.01 mg/L
Copper [j]	**7.0/5.0 µg/L**	EPA 200.7	0.02 mg/L
Magnesium	**None**	EPA 200.7	0.05 mg/L
Lead	**30/1.2 [j] µg/L**	EPA 200.7	0.025 mg/L
Zinc	**65/65 µg/L**	EPA 200.7	0.02 mg/L

* Detection Limits can vary slightly, dependent upon sample-specific matrix interference.

[a] Daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for water supporting warm water species of fish (391-3-6-.03).

[b] Screening value based on USEPA (2007) studies of inland fresh water streams supporting good mixed fisheries at a range of 150-500 µS/cm (https://archive.epa.gov/water/archive/web/html/vms59.html) EPA 841-B-97-003.

[c] Limits are geometric means for at least four samples collected over a 30-day period at intervals not less than 24 hours; For November – April period, no sample is to exceed 4,000 cfu/100 mL (391-3-6-.03).
[d] Dependent on dilution factor, *i.e.*, x1, x10, or x100. Detection limits shown at lowest dilution (x1).
[e] Screening value based on Fox and Absher (2003) recommended level for total phosphorus not to exceed 0.10 mg/L.
[f] Screening value from City of Hampton draft WA reference to Fox and Absher, 2003.
[g] Screening value based on 2013 NPDES permitted discharge limit for Bear Creek WPCP.
[h] Metals expressed in terms of the dissolved fraction in the water column (391-3-6-.03).
[i] Criterion is for adjusted acute/chronic levels based on a water hardness of 25 mg/L $CaCO_3$ (391-3-6-.03).
[j] In-stream criterion may be higher than or lower than GAEPD laboratory detection limits depending upon the hardness of the water (391-3-6-.03).
[k] Screening value based on Appendix B allowable stormwater discharge for warm water fisheries under GAEPD General NPDES Permit #GAR100001.
[l] Screening value is geometric mean based on USEPA's *1986 Ambient Water Quality Criteria for Bacteria* recommendation for fresh recreational waters.
[m] Screening value from City of Hampton draft WA reference to Sabine River Authority of Texas, 2001.
[n] Screening value based on a maximum limit increase of 25 NTUs from upstream levels in the Georgia Construction Activity NPDES discharge permit (Permit No. GAR100001).
[o] Screening value based on maximum contaminate level (MCL) from USEPA National Primary Drinking Water Regulations. (https://www.nrc.gov/docs/ML1307/ML13078A040.pdf).
[p] Screening value base on MCL from USEPA Secondary Drinking Water Standards (https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals).