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Proctor Creek Watershed Monitoring Final Summary Report

Fulton County, GA

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1.0 Introduction

Proctor Creek is an urban stream that drains the west side of Atlanta, Georgia, and flows into the Chattahoochee River. It is currently on the Georgia Environmental Protection Division (GAEPD) 303(d) list for impairment due to fecal coliform bacteria, resulting from exceedances of the GAEPD water quality standard of 200 CFU per 100 mL from May to October and 1000 CFU per 100 mL from November to April (Ga. Comp. R. & Regs. r. 391-3-6-.03). Prior to the listing, a 1998 federal consent decree to address combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) required the City of Atlanta (COA) to improve and expand sewer infrastructure in order to reduce the frequency of overflow events. Since then, the COA has separated some of the combined basins, developed a new CSO storage and treatment system, and repaired many collapsed sewer lines and cross-connections. However, ongoing monitoring by community watershed groups (ARC 2010, ARC 2011, CRK 2018) and by the EPA (USEPA 2013) has still indicated high levels of *Escherichia coli* in multiple reaches and tributaries of Proctor Creek.

There is also a lack of recent data from the Proctor Creek watershed for chemical parameters, including nutrients, metals and organic compounds. While community groups have been consistently monitoring for *E. coli*, which is a relatively easy and low-cost analysis, other parameters can be prohibitively expensive. Select ions and metals have been evaluated in association with suspended sediment studies, which have focused primarily on sediment-associated chemical parameters (*e.g.*, Horowitz *et al.* 2008, Horowitz 2009). A suite of organic wastewater indicators has also been analyzed to characterize spatial distribution in the watershed as well as detect any effects of flow rate or season (Lawrence and LaFontaine 2010). However, these assessments were performed between 2003 and 2006, before many of the sewer infrastructure improvements were completed. More recently, the United States Geological Survey (USGS) conducted a comprehensive water quality study at the James Jackson Parkway gauging station on Proctor Creek (Van Metre and Journey 2014). While this included an extensive list of inorganic and organic parameters, less is known about contaminant sources throughout the basin. Furthermore, there has not been a watershed-scale assessment to specifically compare concentrations of constituents in Proctor Creek to existing water quality standards.

The current study was designed to provide baseline data for water quality parameters throughout the Proctor Creek watershed. The primary goals were to assess current surface water conditions, during both baseflow and stormflow, and to identify any constituents which may exceed water quality standards. Sampling events included *in situ* water quality measurements, surface water and sediment sampling for chemical parameters, stream discharge calculations, macroinvertebrate and habitat assessments, and fish tissue analyses. Fifteen locations were monitored quarterly for two years, in order to account for potential seasonal and/or inter-annual variability, and to establish a sufficient database for statistical analyses and modeling efforts. This report provides a summary of the quarterly data collected throughout the watershed. A concurrent effort to sample stormwater during significant rain events has been led by USGS, the results of which will be presented in a separate report.

2.0 Methods

2.1 Site Description

The Proctor Creek watershed (HUC 031300020101) is located entirely within the City of Atlanta in Fulton County, GA. Its headwaters begin near the city center, then the stream flows northwest for approximately 9 miles to its confluence with the Chattahoochee River just west of Interstate-285 (Figure 1). The Chattahoochee (HUC 03130001) joins the Flint River at the Georgia-Florida border to form the Apalachicola, then drains across the Florida panhandle to the Gulf of Mexico.

Multiple types of point and nonpoint source pollution exist throughout the Proctor Creek watershed, which drains approximately 10,000 acres of land. The headwaters, most of which are either piped underground or channelized aboveground, receive urban runoff from the west side of downtown Atlanta, including large complexes such as the Atlanta University Center, the Georgia World Congress Center, the Philips Arena and the Mercedes-Benz Stadium. Two combined sewer overflow (CSO) facilities are located just west of downtown: North Avenue CSO and the now-decommissioned Greensferry CSO. Norfolk Southern railroad runs along the northern boundary of the watershed, with a large freight yard near the mid-point of Proctor Creek. Several landfills, automotive salvage yards, and illegal trash dumps are located throughout the basin. There are also dense residential and commercial neighborhoods with high proportions of impervious surface, as well as industrial areas at the downstream end of the watershed (ARC 2009).

2.2 Study Design

Fifteen sampling locations were established throughout the watershed, including seven in the main channel of Proctor Creek and eight in tributaries of various size (Table 1, Figure 2). Locations were selected to encompass areas with potential influence on water quality (*e.g.*, railyards, landfills, industrial parks, and the urban center), as well as points along the main channel downstream of larger tributaries. Most locations also overlapped long-term monitoring stations in use by volunteer groups, including the Chattahoochee Riverkeeper and the West Atlanta Watershed Alliance, so that project data could be compared with historical databases as well as ongoing monitoring activities.

Eight quarterly sampling events were conducted over a two-year period, starting in September 2015 and then in January, April, July and October 2016, and January, April and July 2017. The first event was more extensive, targeting a wider range of sample media and chemical parameters, in order to identify analytes of interest during baseflow conditions and to inform selection of subsequent parameters. Events were scheduled to capture a range of low-to-moderate baseflow conditions throughout the year. In February 2017, aquatic macroinvertebrate and habitat bioassessments were performed at four locations representative of upstream and downstream portions of the watershed. Fish were also collected from the main channel of Proctor Creek in April 2016 and July 2017, to evaluate the risk of fish tissue consumption on human health following detections of organic contaminants in water and sediment samples.

2.3 Sampling Methods

During each quarterly sampling event, measurements of flow and *in situ* physicochemical parameters were recorded at all 15 sampling locations, and water samples were collected for biological and chemical analyses according to methods outlined in the quality assurance project plan (USEPA 2015a). Discharge was estimated at most locations using a SonTek FlowTracker acoustic Doppler velocimeter and standard stream gauging techniques (SESDPROC-501). Discharge data for Hortense (PC6) and James Jackson (PC8) were obtained via the USGS real-time streamflow data for station numbers 02336517 and 02336526, respectively, available online at http://waterdata.usgs.gov. *In situ* water quality measurements of temperature, pH, specific conductance, dissolved oxygen and turbidity were obtained using YSI multi-parameter sondes (SESDPROC-111). Photographs were taken from water sampling locations, as well as from bridges, where present, to document site conditions during each visit (SESDPROC-005).

Water samples for fecal bacteria, nutrients, classical parameters, total recoverable metals and organic analytes were collected in accordance with the SESD standard operating procedure for surface water sampling (SESDPROC-201). A complete list of analytes with routine reporting limits is provided in the Appendix. The full suite of organic parameters was only analyzed in September 2015, but samples for pesticides and PCBs were collected again in April 2016 and July 2017. Sediment samples for total recoverable metals and organic parameters were collected during the September 2015 sampling event, except at Greensferry (PC2) where sediment is absent, in accordance with the SESD standard operating procedure for sediment sampling (SESDPROC-200). All samples, except those for fecal bacteria, were analyzed by the Analytical Support Branch (ASB) at SESD in accordance with the ASB Laboratory Operations and Quality Assurance Manual (USEPA 2018b), following methods listed in the Appendix. Water samples for fecal bacteria analysis were delivered to the EPA Office of Research and Development (ORD) laboratory in Athens, GA for processing and analysis within 6 hours of collection (USEPA 2017).

On February 6, 2017, during the Georgia Department of Natural Resources (GADNR) index period of mid-September through February, aquatic macroinvertebrates were collected at four locations for calculation of biotic indices according to GADNR methods (GADNR 2007). Macroinvertebrate taxonomy and metric calculations were performed by Rhithron Associates, Inc. in Missoula MT. Visual habitat assessments were conducted using the EPA Rapid Bioassessment Protocol for high-gradient streams (Barbour *et al*. 1999), both at macroinvertebrate sampling reaches during the collection period, and at all quarterly monitoring stations on July 18-19, 2017. Fish were also sampled for a range of potential contaminants in a screening study on April 20, 2016 and then a follow-up study on July 25, 2017 (USEPA 2016a, USEPA 2018a), according to GADNR sampling methods (GADNR 2016), EPA fish tissue screening protocols (USEPA 2000b), and SESD standard operating procedures for fish collection (SESDPROC-512) and tissue processing (SESDPROC-714). See Table 1 and Figure 2 for macroinvertebrate and fish sampling locations.

In conjunction with this project, stream flow conditions were monitored at automated USGS gauging stations. In addition to the existing gauge at Jackson Parkway (#02336526), a second was installed at a previously-gauged location on the main channel at Hortense Way (#02336517) and a third was installed at Spring Street on the largest tributary, which flows into Proctor Creek from the south (Figure 2). These stations have profiled discharge from the upper watershed, the lower watershed, and the tributary which drains approximately one-third of the watershed. Continuous water level and discharge data have been collected at each of the gauges, in addition to precipitation data at Hortense and Jackson Parkway, and *in* *situ* data (temperature, pH, specific conductance, dissolved oxygen and turbidity) at the Jackson Parkway station only. Stormwater samples for chemical analysis are being collected at these three locations during significant rain events by the USGS South Atlantic Water Science Center, and will be completed by October 2018.

2.4 Data Analysis

Water chemistry data were compared to Georgia Water Quality Standards (WQS) applicable to Proctor Creek, which has a designated use of Fishing. WQS include freshwater aquatic life criteria at both chronic and acute exposure levels, calculated using hardness concentrations at each station and conversion factors for total recoverable metals where applicable, as well as standards which apply at discharge above 7-day, 10-year minimum flow conditions (7Q10) and above annual average flow conditions (Ga. Comp. R. & Regs. r. 391-3-6-.03). Since Proctor Creek is not used as a drinking water source, water chemistry data were not compared to state drinking water standards. Sediment chemistry data were compared to EPA threshold effect levels (TEL) and probable effect levels (PEL) for impacts on aquatic life, which are used in risk assessment to provide guidance for follow-up investigations (USEPA 2000c). Fish tissue data were compared to EPA screening values (USEPA 2000b) as well as trigger values used to establish consumption advisories, provided by GAEPD (personal communication).

Precipitation data were obtained from the USGS gauges at Hortense Way and Jackson Parkway, available online at http://waterdata.usgs.gov. Total rainfall at each station was summed over the 1, 2, 3, and 7 days prior to sampling in order to assess precipitation as a causal variable in regression analyses. Since sampling was scheduled to avoid recent rainfall whenever possible, only two events were conducted following rain within 24 hours.

Data were analyzed using the statistical software R, version 3.1.2 (R Core Team 2014). Summary statistics (count, mean and standard error) were generated for all numerical data, organized by sampling event and station. Values below detection were replaced with a surrogate value of half the detection limit for calculation of summary statistics. Several metals were below detection in most water samples, so the following analytes were removed from further statistical analyses: aluminum, antimony, arsenic, lead, selenium, titanium, and vanadium. Spearman's Rank correlations were calculated to determine strength of relationships between relevant continuous variables, as well as to detect autocorrelation between related parameters. For each of the variables selected for multivariate analysis, Q-Q plots and Shapiro-Wilk tests were performed to detect violations of normality. Where appropriate, data transformations were applied and maintained throughout all further analyses. The majority of distributions were right-skewed due to fewer occurrences of high data points, and log transformations improved the normality of most of these variables. Multiple regression analysis was used to identify the strongest predictors of *E. coli*. Parameters were added sequentially and Akaike's Information Criterion (AIC) was used to evaluate the goodness of fit for each model. Individual parameters were also analyzed according to the categorical variables station and season, using repeated measures one-way analysis of variance or the Friedman rank sum test. Statistical results presented in this report were significant at $p<0.001$ unless otherwise indicated.

3.0 Results

3.1 Precipitation and Discharge

Total precipitation amounts during the study period are summarized in Table 2. As recorded at the Jackson Parkway gauge, rainfall in the week prior to sampling ranged from 0.03” in October 2016 to 4.38” in April 2017, with no precipitation in the 24 hours before most sampling events. However, there were storms totaling 1.08” and 0.36” over the 2 days prior to the January 2017 and July 2017 events, respectively. Total rainfall was likely higher in the upper watershed than was captured by this gauge in July 2017, since parts of downtown Atlanta received over 1” the day before sampling (http://water.weather.gov/precip/). Both of these events included samples collected during the receding limb of the hydrograph, after discharge had fallen below the annual average level and was closer to baseflow conditions. Annual average discharge at Jackson Parkway, calculated over 14 years of data (2004-2017), is approximately 18 cfs.

During the study period, flow at PC4, PC10, and PC14 was consistently too low to measure using acoustic Doppler current profilers for stream gauging, the quality control threshold for which is 0.1 cfs. Only shallow pools of water were present at PC14 in both July and October 2016, so samples were not collected during those periods and *in situ* measurements were not representative of flowing water. Discharge fluctuated across quarterly events according to seasonal variation and rainfall. For example, flow at the furthest site downstream (Northwest; PC9) ranged from 1.54 cfs in October 2016 to 12.01 cfs in July 2017.

3.2 Surface Water Data

3.2.1 *In Situ* Data

A summary of data from in situ measurements is provided in Table 3. Temperature and dissolved oxygen were both significantly different among seasons, with lower temperature and higher dissolved oxygen in winter and the inverse in summer (temperature $F_{3,100}$=181, DO $F_{3,100}$=62.8). Dissolved oxygen was significantly lower at North CSO (PC4), and slightly lower at Lillian Cooper (PC14), than all other stations ($F_{14,96}$=18.2). Measurements of pH were significantly lower at North CSO and Lindsay Street (PC10) than most other stations ($F_{14,96}$=3.65). These three stations had consistently low flows throughout the study, often forming stagnant pools. Specific conductance ranged from 104 to 1190 μS/cm across stations, with higher levels in North CSO (PC4), AD Williams (PC13) and West Highlands (PC15) (Figure 3). Turbidity was typically low (<10 NTU) during most sampling events, but increased up to 40 NTU in July 2017. Measurements of turbidity in the lower main channel (PC6-PC9) were higher and more variable overall, mainly because these stations were sampled first following the two storm events in January and July 2017, when flows were still slightly elevated. Turbidity was significantly correlated with precipitation totals in the 24, 48 and 72 hours prior to sampling, as well as aluminum and zinc (Table 4).

Temperature and pH were both within acceptable ranges according to Georgia WQS. No numeric criteria exist for specific conductance or turbidity, but a narrative criterion states that turbidity should not create “a substantial visual contrast in a water body due to a man-made activity,” with comparisons of water clarity made upstream and downstream of that activity (Ga. Comp. R. & Regs. r. 391-3-6-.03(5)(d)). Although some portion of turbidity is generated by urban development in Proctor Creek, it is not solely attributed to ‘man-made activity’ during higher flows, which also erode stream banks and resuspend bedload sediments. At North CSO (PC4) on all dates, and at Lillian Cooper (PC14) on two occasions, dissolved oxygen was below the WQS of 4.0 mg/L required to support species of warm water fish. However, these two small tributaries were both very shallow, with little to no flow present during sampling events. Dissolved oxygen criteria are applicable at one meter below the surface, or at mid-depth if less than two meters, which suggests that the criterion may not apply to such streams with minimal discharge.

3.2.2 *Escherichia coli*

Data for fecal bacteria counts are provided in Table 3, reported as the most probable number (MPN) of *E. coli* per 100 mL. While the Georgia WQS for Proctor Creek is written in terms of fecal coliform, not specifically *E. coli*, the *E. coli* data provide a conservative estimate of fecal coliform since they are a subset of this group. Therefore, exceedance of the standard by *E. coli* indicates a likely exceedance by fecal coliform bacteria as a whole. The standard is also based on sampling period, with geometric mean limits of 200 MPN per 100 mL (May through October) or 1,000 MPN per 100 mL (November through April), calculated using at least four samples during a 30-day period (Ga. Comp. R. & Regs. r. 391-3-6-.03(6)). Only one sample was collected at each station during each sampling event, which precludes calculation of a geometric mean, so data are not directly comparable to WQS. However, counts are also not to exceed 4,000 MPN per 100 mL for any single sample collected between November and April, whereas there is no single sample threshold for May through October.

Counts were consistently above WQS at Burbank (PC1), Greensferry (PC2) and North Avenue (PC3), and above the 4,000 maximum threshold at these stations in three out of four sampling periods when this limit was applicable. There was a sanitary sewer overflow observed at West Highlands (PC15) in January 2017, which led to a count of 15,770 MPN per 100 mL, whereas all other samples from that station were below WQS. This incident was reported to the City of Atlanta and the blocked sewer pipe causing the overflow was cleared before the next sampling date. Another high value of 41,060 MPN per 100 mL was detected at PC10 in October 2016, which also likely resulted from a sewer leak, and counts were relatively high for this station again at 4,989 MPN per 100 mL in July 2017. Average *E. coli* counts over the study period were above 1,000 MPN per 100 mL, with high variability, at all stations except North CSO (PC4), Grove Park (PC11), AD Williams (PC13) and Lillian Cooper (PC14) (Table 3, Figure 4).

E. coli was significantly correlated with all nutrient species except ammonia, and most strongly associated with total phosphorus levels (Table 4). Counts were also significantly correlated with precipitation totals in the 24 hours, 48 hours and 72 hours prior to sampling, with higher counts throughout the watershed in January and July 2017 following storm events, but not correlated with turbidity. Counts were less significantly related to discharge, although flow measurements were not collected concurrently with fecal bacteria sampling at all locations, with some measurements in the upper watershed performed the following day. Total alkalinity, total organic carbon (TOC), pH, specific conductance, calcium, sodium and chloride were inversely related to *E. coli*. Based on results of the multiple linear regression model, total dissolved phosphorus (TDP; t = 5.82) and 24-hour precipitation totals (t = 5.17) were the best predictors of *E. coli* concentration ($F_{2,101}$ = 26.44, adjusted R^2 = 0.33, AIC=357).

3.2.3 Inorganic Water Chemistry

Nutrients were highest at the upper end of the watershed, then declined downstream, with moderate levels in the lower tributaries (Figures 5-6). Maximum values at upstream stations depended on the species of nutrient. Total nitrogen (TN) was highest at Greensferry (PC2) and Lindsay Street (PC10), with nitrate-nitrite comprising the majority of TN at Lindsay Street, versus organic sources and ammonia contributing approximately one-third of TN at Greensferry (Table 5). Total phosphorus (TP) was higher at Greensferry than all other stations, with elevated concentrations in the main channel below that tributary and decreasing downstream (Figure 6). About 90% of all phosphorus originating from Greensferry was in dissolved form, versus an average of approximately 65% dissolved P across the other seven tributaries (Table 5). While there are currently no numeric nutrient criteria in place for rivers and streams in Georgia, the EPA recommended criteria for Ecoregion IX (Southeastern Temperate Forested Plains and Hills), based on the 25th percentile of reference streams, are 0.69 mg/L TN and 0.036 mg/L TP (USEPA 2000a). Average concentrations were above that level of TN in all locations except Lillian Cooper (PC14), and above that level of TP in all locations except Grove Park (PC11), AD Williams (PC13), Lillian Cooper (PC14), and West Highlands (PC15).

Other classical parameters and metals varied more widely throughout the watershed (Tables 5-6). Bromide was only detected at AD Williams (PC13). Chloride was significantly higher at North CSO (PC4) and AD Williams (PC13) than all other stations (χ^2_{14}=66.95), and fluoride was somewhat higher at Greensferry (PC2) than all other stations. Specific conductance (χ^2_{14}=67.13), total alkalinity (χ^2_{14}=49.24), hardness (χ^2_{14}=62.80), calcium (χ^2_{14}=72.93), sodium (χ^2_{14}=65.47) and TOC (χ^2_{14}=41.07) were all higher at North CSO (PC4), AD Williams (PC13) and West Highlands (PC15) (Figure 3). These three stations generally had elevated arsenic, lead, strontium and titanium as well. Two other tributaries had slightly different detections of metals. In addition to elevated calcium and sulfate, Lindsay Street (PC10) samples contained antimony, barium, lead, strontium, titanium, and significantly higher zinc (χ^2_{14}=43.79). Lillian Cooper (PC14) did not have elevated conductivity or associated ions, but was higher in aluminum, iron, lead and zinc.

None of these metals were detected above the acute exposure WQS for protection of aquatic life. However, aluminum, lead and zinc were found at higher concentrations following the two rain events in January and July 2017, primarily in the main channel of the lower watershed, and were significantly correlated with precipitation totals (Table 4). These stations (PC6-PC9) were sampled while flows were still receding. During these two events, and in January 2016, concentrations of lead were above WQS for chronic exposure impacts on aquatic life at one or more locations: North CSO (PC4), four stations in the lower main channel (PC6-PC9) and Lillian Cooper (PC14). There was a total of 7 detections of lead above chronic criteria, distributed across these 6 locations and 3 events. In January 2017, cadmium and zinc were also detected at West Highlands (PC15) and Lillian Cooper (PC14), respectively, just above chronic criteria. Chronic criteria are defined as the "highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects" (Ga. Comp. R. & Regs. r. 391-3-6-.03(3)). Since the majority of these detections followed rain events, it is unlikely that exposure was maintained at these levels for more than 4 days. However, Georgia's listing assessment methodology indicates that a waterbody is not supporting its designated use if more than one sample exceeds the chronic criterion in three years. Thus, it may be necessary to examine concentrations of lead in the water column with respect to Georgia's 303(d) listing for Proctor Creek.

3.2.4 Organic Water Chemistry

A full suite of organic analytes, which included herbicides, pesticides, PCBs, semi-volatile organics and volatile organics, were analyzed during the initial sampling event in September 2015. Of the 163 organic compounds, only 8 were detected in one or more samples (USEPA 2016b). The pesticide gamma-chlordane was present at 0.099 µg/L at Greensferry (PC2) and 0.055 µg/L at North Avenue (PC3) (Figure 7), which are levels considerably higher than the WQS of 0.0043 µg/L of chlordane applicable at or above 7Q10 flow conditions (Ga. Comp. R. & Regs. r. 391-3-6-.03(5)). One or more volatile and/or semi-volatile organic compounds were also identified at about half of the stations, but were not consistent with any particular location and were not at levels near WQS (USEPA 2016b; Appendix).

Since the minimum reporting limits (MRLs) for many PCBs and pesticides were higher than their respective WQS, and there were potential exceedances, samples were collected for these groups again in April 2016 and July 2017. In April, the laboratory was able to reduce the detection limit by a factor of 10 using a lower extraction volume. During both follow-up sampling events, dieldrin, heptachlor epoxide and alpha- and gamma-chlordane were found at many locations in the watershed, but only above the 7Q10 WQS at a few stations. Heptachlor epoxide was above the standard at Burbank (PC1), Greensferry (PC2) and North Avenue (PC3) on both dates and at Hollowell (PC5) and Hortense (PC6) in July 2017 only. Total chlordane was above the standard at PC1 and PC2 in September 2015 and at PC2 in July 2017. During the July 2017 event, water samples for organics were collected at the beginning of the sampling period when flows were still elevated from rainfall, to assess potential storm effects on concentrations. Three locations in the main channel (PC1, PC5, PC7) were also sampled the next day for comparison, and concentrations of detected analytes were similar between the two time periods. A summary of pesticide data is provided in Figure 7.

3.3 Sediment Data

3.3.1 Inorganic Sediment Chemistry

The majority of targeted metals were found in sediment samples (Table 7), whereas mercury, molybdenum, selenium, silver and thallium were all below detection (Appendix). The highest concentrations of most metals were found at North CSO (PC4), with additional elevated values at North Avenue (PC3), Lindsay Street (PC10) and West Highlands (PC15). None of the metal concentrations found in sediment samples during this study were above the specific probable effect concentrations (PECs) examined (Jones & Suter 1997, USEPA 2000c). However, there were a few stations with copper and/or lead concentrations that were above a threshold effect concentration (TEC) at which some toxicity to aquatic organisms has been found to occur (Table 7).

3.3.2 Organic Sediment Chemistry

Organic compounds detected in sediment samples are shown in Table 8, while those not detected in any samples are listed in the Appendix. No herbicides were found, but four pesticides and two PCB-Aroclors were detected at a few locations. Of note were the relatively high deposits of 59 µg/kg gamma-chlordane and 24 µg/kg alpha-chlordane at Lindsay Street (PC10). Eighteen semi-volatiles were also present across the watershed, with many occurring at nearly half of all stations. These compounds also followed the pattern of elevated concentrations upstream, particularly at North CSO (PC4) where all 18 were present, with levels declining downstream. In general, organics were low in sediment at Burbank (PC1) and AD Williams (PC13), and nearly absent at Spring Street (PC12).

As with metals, organic compounds found in sediments were compared to several toxicity benchmarks to evaluate the potential for harmful effects on aquatic life. Total chlordane (summing alpha- and gamma-chlordane) of approximately 83 µg/kg at Lindsay Street (PC10) may be a concern, as one published PEC for chlordane is 17.6 µg/kg (USEPA 2000c). Several polycyclic aromatic hydrocarbons (PAHs), which are generally classified as coal tar and diesel exhaust byproducts, were also elevated at North Avenue (PC3), North CSO (PC4), and Hollowell (PC5). Concentrations were above either the PEC or TEC for several PAHs at these three locations in particular, and the total concentration of PAHs approached levels of potential concern for combined effects. Those compounds above PECs included benzo(a)pyrene, fluoranthene, and pyrene, all of which are associated with gasoline, motor oil, and wood preservatives. However, toxic effects *in situ* depend on a variety of environmental factors, including sediment characteristics, residence time and target organism (Wenning *et al*. 2005), so literature benchmarks are provided for comparison only.

3.4 Habitat Bioassessments

Habitat bioassessment scores ranged widely, from 55 to 149 points out of a possible 200 (Table 3). In the upper watershed, closer to downtown, stations generally had more channel alteration, less bank stability, less diverse riparian vegetation, and narrower buffer zones. In the main channel of Proctor Creek in the lower watershed, these parameters improved, but there was increased sediment deposition and embeddedness. Tributaries were more variable. For example, Lillian Cooper (PC14) received the lowest score due in part to low flow, high sediment deposition and heavily eroded banks. Spring Street (PC12) and AD Williams (PC13) scored similarly, each with relatively good benthic substrates and a variety of flow regimes, but some bank stability issues and suboptimal riparian zones. The Greensferry tributary (PC2) could not be scored appropriately using this method, since the stream is entirely contained within a concrete channel, which extends several meters on either side into the riparian zone. This provides very poor habitat conditions with only a single substrate, fast-shallow flow, and sparse organic detritus that is flushed downstream during periods of high discharge.

3.5 Macroinvertebrate Data

Macroinvertebrates were collected at four locations in February 2016, along with additional habitat assessments performed at these locations, two of which were in reaches that differed slightly from the regular water chemistry stations (Table 1 and Figure 2). Macroinvertebrate Multimetric Index (MMI) and habitat assessment scores are listed in Table 9. All stations received similar MMI scores, ranging from 21 to 26 out of 100. While there are currently no narrative rankings associated with the numeric scores, these low numbers would likely fall into the poor to very poor categories, which are those below the 25th percentile (Gore *et al*. 2005). All stream reaches had high proportions of midges (Chironomidae) and relatively high numbers of aquatic worms (Oligochaeta). Dominant taxa included two species of caddisfly (Trichoptera): *Hydropsyche betteni* and *Cheumatopsyche* sp. These species have tolerance values of 7.9 and 6.6 out of 10, respectively, with higher values indicating higher tolerance to pollution or degraded habitat conditions (NCDEQ 2016). At Spring Street (PC12), the dominant taxon was the crustacean subclass Copepoda, which is a type of zooplankton. Also present at all stations was the snail *Physella*. There were no mayflies (Ephemeroptera) or stoneflies (Plecoptera) found at any of the sampling locations.

Habitat assessment scores associated with macroinvertebrate sampling locations were more variable, ranging from 92 to 157 out of a possible 200 (Table 9). Hortense-Hollowell (PC5/6) and Spring Street

(PC12) received higher scores, with most parameters falling into the sub-optimal to optimal categories. Both are in less developed areas with wide riparian zones, but exhibited reduced bank stability. James Jackson (PC8) and Grove Park (PC11) received lower scores, mostly due to sedimentation and embeddedness issues, as well as infrequent riffles. James Jackson also had a poor rating for unstable banks. Grove Park, which was the most urban location, received the lowest score overall with a marginal rating for vegetative protection and a poor rating for riparian zone width.

3.6 Fish Tissue Data

Because certain organochlorine pesticides and PCBs were detected in both the sediment and the water column of the upper watershed, there was concern that these parameters could bioaccumulate in aquatic species to levels potentially harmful to human health via consumption of fish. In a screening study in April 2016, fish were collected from a sampling reach in the main channel of Proctor Creek at North Avenue (PC3), including a fishing pond at the confluence of the tributary which flows past the North Avenue CSO (PC4). Redbreast sunfish and green sunfish were collected in sufficient quantities to analyze three composite samples for metals and organics. No metals were found at harmful levels, but concentrations of dieldrin, heptachlor epoxide and/or PCBs were above trigger values established by GADNR for no more than one meal per week of both species (USEPA 2016a). Dieldrin was above the trigger value for no more than one meal per month in redbreast sunfish only.

A follow-up sampling event in July 2017 was conducted both at the screening study location (PC3) and in the lower watershed at Jackson Parkway (PC8), to assess spatial variability (Table 1, Figure 2). Sufficient redbreast sunfish, green sunfish, and yellow bullhead catfish were collected at PC3, while only redbreast sunfish and brown bullhead catfish were collected at PC8 in adequate numbers to meet listing requirements. Levels of PCB Aroclor 1254 in redbreast and green sunfish in the upper watershed were above concentrations corresponding to a consumption advisory of no more than one meal per month (USEPA 2018a). Levels of PCB Aroclor 1254 in yellow bullhead catfish in the upper watershed, and in redbreast sunfish and brown bullhead catfish in the lower watershed, were above the threshold for a recommendation of no more than one meal per week. A summary of findings is shown in Table 10. More details are provided in the final reports for the Proctor Creek Fish Tissue Screening (USEPA 2016a) and the Proctor Creek Fish Tissue study (USEPA 2018a).

4.0 Discussion

4.1 Upper Watershed: Downtown and CSO Facilities

Overall, the majority of constituents found in both water and sediment samples were highest in tributaries draining the western Atlanta urban area, and in the main channel below their confluences with Proctor Creek. These stations included Greensferry, Lindsay Street, North Avenue CSO, and Proctor Creek at both North Avenue and Hollowell Parkway (Figure 2). In the water column, nutrients were elevated at all five of these locations, although the fractions of nitrogen and phosphorus varied according to location. A range of metals and organic compounds were also present in both the water column and the sediment at these stations, at concentrations higher than most other locations in the watershed.

The tributary that flows through the decommissioned Greensferry CSO facility originates in an area of high-density residential and commercial land use. Below the Greensferry station, both nitrogen and phosphorus were very high, with ammonia accounting for nearly 20% of TN and dissolved phosphorus accounting for approximately 90% of TP. *E. coli* levels there were typically 10-20X higher than the applicable fecal coliform water quality standard, and approximately 100X higher than the standard in September 2015 and July 2017. In an urban environment, these high dissolved nutrient and *E. coli* concentrations can be indications of leaking sewer infrastructure. This location is entirely channelized at the sampling point, receiving urban runoff from the neighborhood as well as the outskirts of downtown Atlanta. Most of this catchment is also channelized or piped underground, which can make it difficult to locate and repair potential sewage leaks.

The Lindsay Street tributary flows through a similar high-density residential neighborhood before eventually reaching the North Avenue CSO downstream. Upstream at Lindsay Street, this tributary had the highest total nitrogen concentrations in the watershed, with an average of 96% occurring as nitrate-nitrite, and the widest range in *E. coli* levels due to the single highest data point observed during the study, yet relatively low phosphorus concentrations. Lindsay Street also had high calcium, nitrate, and sulfate, a deposit of chlordane in the sediment, and several metals including lead, strontium, titanium, and zinc. All of these can occur in urban runoff, with major sources including the residential or commercial application of fertilizers and pesticides, and the accumulation of automotive fluids, exhaust and tire wear on roads.

Further downstream in this tributary, below the North Avenue CSO facility, there were higher proportions of organic nitrogen and particulate phosphorus compared to the Greensferry tributary, and significantly lower *E. coli* concentrations that were typically below the water quality standard. Effects of urban runoff were also evident at this station, which had higher conductivity, including component ions, as well as increased heavy metals including arsenic, lead and zinc. Both sodium and chloride were elevated, with maximum values of each following the January 2017 storm event, likely due to runoff of salt used to deice roads. There were also significantly higher levels of TOC, iron and manganese than most other stations, and significantly lower total nitrogen than upstream at Lindsay Street, with nitrate levels dropping approximately 10-fold. This tributary flows from the English Avenue neighborhood through an open field towards the North Avenue CSO facility, which could allow for increased microbial denitrification rates. Additionally, metabolic activity of iron-oxidizing bacteria at the sampling location, where iron was observed in high concentrations, could contribute to decreased nitrate as well as the low dissolved oxygen levels observed throughout the study.

Additional metals and organics were elevated primarily in the downtown area. In the water column, the organochlorine pesticides chlordane and heptachlor epoxide were above 7Q10 WQS at several downtown locations, while dieldrin was at lower levels. In the sediment, concentrations of copper, lead, and PAHs were at levels of potential concern for aquatic organisms, particularly in Proctor Creek at both North Avenue and Hollowell Parkway, and the North Avenue CSO tributary. PAHs include compounds associated with automotive emissions that accumulate on roads, then wash into receiving waters during storm events. It is therefore unsurprising to find them in higher concentrations near downtown Atlanta.

Together, the combination of parameters found in downtown tributaries of Proctor Creek is characteristic of urban streams across the country, which typically have elevated nutrients, fecal bacteria, pesticides and PAHs (Paul & Meyer 2001), as well as a range of metals including copper, lead, and zinc (Sansalone and Buchberger 1997). These contaminants are commonly found in urban runoff, as commercial properties and high-density residential areas create a high proportion of impervious surface in the form of roads, buildings and parking lots. Automotive fluids and exhaust, fertilizers and pesticides, and leaking sewer infrastructure all contribute to the mixture of contaminants entering the upper reaches of Proctor Creek.

4.2 Mainstem Proctor Creek

Proctor Creek originates in a medium-density residential neighborhood bordering I-20 to the north, then flows along the western edge of downtown Atlanta before heading northwest to its confluence with the Chattahoochee River. The upstream reach sampled at Burbank Drive had relatively low phosphorus and moderate nitrogen, but *E. coli* counts were consistently above fecal coliform water quality standards. The pesticides chlordane and dieldrin were also detected in the water column, and the breakdown product heptachlor epoxide was above the 7Q10 standard. Thus, both *E. coli* and pesticides originate from neighborhoods in the upper watershed as well as those closer to downtown. However, there were no elevated ions or metals in the upper reach, which appears to have primarily residential impacts versus the urban impacts evident further downstream.

The majority of contaminants appear to enter the main channel of Proctor Creek at the Greensferry and North Avenue CSO tributaries, as described above. Surface water concentrations of nutrients were low in the upper reach of the main channel, with peaks at North Avenue below the Greensferry tributary and gradual decreases downstream of Hollowell Parkway (Figures 5-6). Metals and organic compounds in the sediment followed a similar pattern in the main channel, with the highest concentrations at North Avenue and Hollowell Parkway (Tables 7-8). In contrast, organochlorine pesticides were elevated throughout the upper watershed, with detections at Burbank, then declined in the lower watershed (Figure 7).

The residual effects of storms were also evident in the main channel of Proctor Creek. Discharge following precipitation in this watershed is extremely flashy, with rapid rise and fall of the hydrograph due to the high proportion of impervious surfaces in the watershed contributing more overland runoff versus slower subsurface infiltration. Following the two storms that occurred prior to quarterly sampling events, aluminum, lead and zinc were elevated in the lower portion of the watershed, which was sampled while flows receded. These three metals are all associated with higher turbidity, as they bind to particulates that become suspended in the water column during storms (Horowitz et al. 2008, Horowitz 2009). The targeted pesticides and PCBs were not noticeably higher during post-storm sampling, but these compounds may increase during the ‘first flush’ of a rain event, during which certain chemicals are washed into receiving waters and spike in concentration earlier in the hydrograph. The stormwater sampling currently in progress should elucidate general patterns, and help to identify any parameters which potentially exceed water quality standards applicable at or above annual average flow conditions.

4.3 Proctor Creek Tributaries

Eight tributaries of Proctor Creek were sampled in this study, each with unique characteristics likely influenced by differing land uses in the associated subcatchment. The three tributaries which drain the upper watershed near downtown Atlanta were the largest sources of nutrients, *E. coli*, pesticides, and PAHs, as discussed previously. Urban effects were less evident in the Grove Park tributary, where metals and organics were not at levels of concern in the sediment or the water column during baseflow conditions, and *E. coli* was below the water quality standard for fecal coliform on most dates sampled. This subcatchment is also on the western edge of downtown, but land use transitions to medium-density residential here with fewer commercial properties and less impervious surface (ARC 2009).

Spanning the northern boundary of the watershed are two large rail yards operated by CSX and Norfolk Southern. Impacts of this infrastructure were evident downstream, in the tributary flowing through the West Highlands neighborhood. Some metals, such as cadmium and lead, were at sediment concentrations similar to those found near downtown, and other metals such as barium, manganese, strontium, and zinc were elevated in the water column. Total organic carbon and specific conductance, including component ions calcium, magnesium, sodium and potassium, were also relatively high in this tributary. All of these constituents could be attributed to the rail yard, with track beds composed of crushed rock, treated lumber and steel tracks, oil and grease lubricants, and various components of the train cars as well as materials hauled (Wilkomirski *et al.* 2011, Vo *et al.* 2015). There was also one extremely high measurement of *E. coli* during a sanitary sewer overflow in the neighborhood itself, caused by a blocked sewer pipe that was quickly resolved by the city, but otherwise *E. coli* levels were consistently below the water quality standard. The sampling reach was in a central part of the neighborhood, which is a new development still partially under construction, and common residential effects such as nutrients and pesticides were therefore low.

At the downstream end of the watershed, the Lillian Cooper Park and AD Williams tributaries are furthest removed from urban Atlanta. However, Lilian Cooper Park and AD Williams are both near industrial plants, and the latter flows along a large landfill. Each of these streams had some elevated metals as well as a few detections of organic parameters. AD Williams had higher arsenic, strontium and titanium levels, which could be associated with either industrial parks or the landfill. Conductivity was also higher here, possibly resulting from crushed rock fill material or runoff from the landfill. Lillian Cooper Park had higher turbidity, as well as higher aluminum, iron, lead and zinc, which can all bind to sediment particles (Horowitz *et al.* 2008). This stream was highly incised, with primarily sandy substrate. Additionally, the Lillian Cooper Park tributary was lower in dissolved oxygen, compared to other stations, which was likely due to the very low flows and shallow water levels on most sampling dates.

In contrast, the Spring Street tributary contributes nearly a third of the drainage area to Proctor Creek, yet was the lowest in nearly all parameters. This subcatchment is dominated by medium-density residential neighborhoods, with one large cemetery and several small parks that consist of both forested and open spaces. No contaminants were detected at levels of concern in either the surface water or sediment in this tributary except *E. coli*, which exceeded the fecal coliform standard during six of the eight quarterly events. All other analytes were at or below average levels for the watershed, with only low detections of organochlorine pesticides in the water column and no detections of organic compounds in the sediment.

4.4 Macroinvertebrate Bioassessments

The macroinvertebrate data collected in Proctor Creek indicated relatively poor conditions at all four locations, with habitat scores that were more variable according to location in the watershed. Biological assessments are useful in water quality studies because aquatic organisms integrate the effects of pollutants over time, and macroinvertebrates in particular have been shown to correlate well with ecological condition in urban environments, versus other biological indicators such as algae or fish (Paul & Meyer 2001). Chironomids (non-biting midges) and oligochaetes (aquatic worms) were the main taxa present, and are those commonly found in urban watersheds (Walsh *et al.* 2005). These organisms are well adapted to high deposition environments with sandy substrates that shift during storm events, which was a common habitat characteristic in most reaches of Proctor Creek assessed in this study. The dominant species identified at three of the four macroinvertebrate sampling locations, *Hydropsyche betteni*, is a net-spinning caddisfly with high tolerance to pollution. No individuals in the sensitive orders Ephemeroptera (mayflies) or Plecoptera (stoneflies) were found at any of the sampling locations, as these taxa are generally less tolerant to pollution, and require more stable substrates and higher detrital inputs for feeding and habitat (Merritt *et al.* 2008). Scouring and flushing of organic detritus during high flows can also hinder colonization, and frequent disturbances were evident from the incised banks and heavy sedimentation throughout the watershed.

4.5 Fish Consumption Advisories

Since concentrations of some organochlorine pesticides and PCBs were detected at several locations above sediment quality benchmarks and aquatic life criteria, fish tissue was examined to determine whether contaminants were at levels of concern for human health. Fish collected in the upper and lower watershed included redbreast and green sunfish, and yellow and brown bullhead catfish. No metals were found at harmful levels in any of the fish collected. However, the pesticides dieldrin and heptachlor epoxide were above trigger values for consumption advisories in the upper watershed, and the PCB Aroclor 1254 was above trigger values at both locations. These chemicals, known as persistent organic pollutants, were banned in the United States in the late 20^{th} century, but remain in the environment at levels that can be toxic or carcinogenic to aquatic organisms as well as humans via bioaccumulation (USEPA 2000b, Gilliom *et al.* 2006). Overall, these data point to a recommended consumption limit of no more than one meal per week for all fish species caught for food in Proctor Creek. An additional advisory is recommended for no more than one meal per month of both redbreast and green sunfish caught in the upper Proctor Creek watershed, where contaminants were found at higher levels.

5.0 Conclusions

This monitoring study was designed to assess current baseline conditions in the Proctor Creek watershed. Results confirm that *E. coli* levels are still high throughout the watershed, with the most significant inputs occurring primarily at the Greensferry tributary near downtown. *E. coli* was strongly correlated with precipitation, as higher levels were detected following storm events, and with total dissolved phosphorus, which is also associated with sewer leaks in urban environments. Nutrients, both nitrogen and phosphorus, were also elevated in the downtown area. Metals and organic compounds were present at relatively low levels during baseflow conditions, mainly in downtown reaches, and generally not at levels of concern except for lead, which was found above chronic exposure limits for the protection of aquatic life. However, many of these constituents are exported during high flow events, especially during the ‘first flush’ of storms as contaminants are washed off impervious surfaces into receiving waters. Stormwater collections currently in progress will therefore assess whether any contaminants may be above annual average water quality standards during higher flows.

Potentially harmful concentrations of organochlorine pesticides and PCBs were also detected in Proctor Creek. Levels of chlordane and heptachlor epoxide in the water column were above 7Q10 water quality standards in the upper watershed, and chlordane was above probable effect thresholds in sediment at Lindsay Street. Dieldrin, heptachlor epoxide, and PCBs were all elevated in fish tissue at concentrations that correspond to a potential human health risk through consumption of fish, particularly in the upper watershed. Fish consumption advisories, along with community education efforts and signs posted at popular fishing locations in the watershed, will hopefully reduce human exposure to these contaminants.

Projects currently planned for the Proctor Creek watershed, including the installation of green infrastructure along roads and in public parks, should help to reduce stormwater runoff and improve water quality conditions. The replacement of impervious surface with permeable substrates allows more filtration of nutrients and contaminants, and can also reduce stream velocity during storm events, which can in turn decrease the rates of flooding and stream bank erosion. Ongoing efforts by the City of Atlanta to address leaking sewer infrastructure may also reduce nutrient and fecal bacteria levels. As these projects move forward in Proctor Creek, potential improvements in water chemistry, habitat quality, macroinvertebrate communities, and fish tissue contaminants may be tracked in comparison with data generated by this study.

6.0 References

ARC. 2009. Visual field survey for Proctor Creek impaired stream segment in the Chattahoochee River basin. Atlanta Regional Commission, Atlanta, GA.

ARC. 2010. Monitoring report for Proctor Creek: Headwaters to Chattahoochee River. Atlanta Regional Commission, Atlanta, GA.

ARC. 2011. Monitoring report for Proctor Creek watershed targeted sampling: Headwaters to North Avenue. Atlanta Regional Commission, Atlanta, GA.

Barbour, M.T., J. Gerritsen, B.D. Snyder and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. EPA, Office of Water, Washington, D.C.

CRK. 2018. Neighborhood water watch monitoring data. www.chattahoochee.org/nww. Chattahoochee Riverkeeper, Atlanta, GA. Accessed 04/30/18.

GADNR. 2007. Macroinvertebrate Biological Assessment of Wadeable Streams in Georgia. Standard Operating Procedures. Version 1.0. Watershed Protection Branch, Environmental Protection Division, Georgia Department of Natural Resources, Atlanta, GA.

GADNR. 2016. Georgia Department of Natural Resources Fish Consumption Guidance. Watershed Protection Branch, Environmental Protection Division, Georgia Department of Natural Resources, Atlanta, GA.

Gilliom, R.J., J.E. Barbash, C.G. Crawford, P.A. Hamilton, J.D. Martin, N. Nakagaki, L.H. Nowell, J.C. Scott, P.E. Stackelberg, G.P. Thelin and D.M. Wolock. 2006. The Quality of Our Nation's Waters: Pesticides in the Nation's Streams and Ground Water, 1992-2001. U.S. Geological Survey Circular 1291.

Gore, J.A., A. Middleton, D.L. Hughes, U. Rai and M. Brossett. 2005. Reference Conditions for Wadeable Streams in Georgia with a Multimetric Index for the Bioassessment and Discrimination of Reference and Impaired Streams. Georgia Department of Natural Resources, Atlanta, GA.

Horowitz, A.J. 2009. Monitoring suspended sediments and associated chemical constituents in urban environments: lessons from the city of Atlanta, Georgia, USA water quality monitoring program. Journal of Soils and Sediments 9:342-363.

Horowitz, A.J., K.A. Elrick and J.J. Smith. 2008. Monitoring urban impacts on suspended sediment, trace element, and nutrient fluxes within the City of Atlanta, Georgia, USA: program design, methodological considerations, and initial results. Hydrological Processes 22:1473-1496.

Jones, D.S. and G.W. Suter, II. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ES/ER/TM-95/R4.

Lawrence, S.J. and J.H. LaFontaine. 2010. Occurrence of organic wastewater-indicator compounds in urban streams of the Atlanta area, Georgia, 2003-2006: U.S. Geological Survey Scientific Investigations Report 2010-5209, 113 pp.

Merrit, R.W., K.W. Cummins and M.B. Berg, Eds. 2008. An Introduction to the Aquatic Insects of North America. Fourth Edition. Kendall Hunt, Dubuque, IA.

NCDEQ. 2016. Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates. Version 5.0. Division of Water Resources, North Carolina Department of Environmental Quality, Raleigh, NC.

Paul, M.J. and J.L. Meyer. 2001. Streams in the urban landscape. Annual Review of Ecology and Systematics 32:333-365.

R Core Team. 2014. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

Sansalone, J.J. and S.G. Buchberger. 1997. Partitioning and first flush of metals in urban roadway storm water. Journal of Environmental Engineering 123:134-143.

USEPA. 2000a. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria. Rivers and Streams in Nutrient Ecoregion IX. EPA 822-B-00-019. Office of Science and Technology, Office of Water, Washington, D.C.

USEPA. 2000b. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 1, Fish Sampling and Analysis. Third Edition. EPA 823-B-00-007. Office of Science and Technology, Office of Water, Washington, D.C.

USEPA. 2000c. Prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines. EPA-905/R-00/007. Great Lakes National Program Office, Chicago, IL.

USEPA. 2013. Proctor Creek Microbial Sampling Study, Atlanta, GA. Final Report. SESD Project ID #12-0300. Region 4, SESD, Athens, GA.

USEPA. 2015a. Proctor Creek Watershed Monitoring, Quality Assurance Project Plan. SESD Project ID #15-0425. Region 4, SESD, Athens, GA.

USEPA. 2016a. Proctor Creek Fish Tissue Screening. Final Report. Project ID #16-0373. Region 4, SESD, Athens, GA.

USEPA. 2016b. Proctor Creek Watershed Monitoring: First Quarterly Sampling Event. Final Report. SESD Project ID #15-0425. Region 4, SESD, Athens, GA.

USEPA. 2017. Procedure for Enumerating Total Coliforms and E. coli using Idexx Colilert. SOP ID D-EMMD-MEB-SOP-1062-0. Office of Research and Development, National Exposure Research Laboratory, Athens, GA.

USEPA. 2018a. Proctor Creek Fish Tissue. Final Report. Project ID #17-0445. Region 4, SESD, Athens, GA.

USEPA. 2018b. SESD Analytical Services Branch Laboratory Operations and Quality Assurance Manual (ASB LOQAM). United States Environmental Protection Agency. Region 4, SESD, Athens, GA.

Van Metre, P.C. and C.A. Journey. 2014. The Southeast Stream Quality Assessment: U.S. Geological Survey Fact Sheet 2014-3023, 2 p.

Vo, P.T., H.H. Ngo, W. Guo, J.L. Zhou, A. Listowski, B. Du, Q. Wei and X.T. Bui. Stormwater quality management in rail transportation: Past, present and future. Science of the Total Environment 512(353-363).

Walsh, C.J., A.H. Roy, J.W. Feminella, P.D. Cottingham, P.M. Groffman and R.P. Morgan II. 2005. The urban stream syndrome: current knowledge and the search for a cure. Journal of the North American Benthological Society 24(706-723).

Wenning, R.J., G.E. Batley, C.G. Ingersoll and D.W. Moore (Eds.). 2005. Use of sediment quality guidelines and related tools for the assessment of contaminated sediments. Pensacola, FL: Society of Environmental Toxicology and Chemistry (SETAC).

Wilkomirski, B., B. Sudnik-Qojcikowska, H. Galera, M. Wierzbicka and M. Malawska. 2011. Railway transportation as a serious source of organic and inorganic pollution. Water, Air, and Soil Pollution 218(333-345.

Table 1: Quarterly, macroinvertebrate and fish tissue sampling locations in the mainstem (MAIN) and tributaries (TRIB) of Proctor Creek.

	Station ID	Station Name	Location Type	Location Description	Location (Decimal Degrees)	
					Latitude	Longitude
quarterly sampling	PC1	Burbank	MAIN	Proctor Creek at Burbank Drive	33.75710	-84.42892
	PC2	Greensferry	TRIB	Tributary below decommissioned Greensferry CSO	33.76075	-84.42691
	PC3	North Avenue	MAIN	Proctor Creek at North Avenue	33.76800	-84.42769
	PC4	North CSO	TRIB	Tributary downstream of North Avenue CSO outfall	33.76863	-84.42689
	PC5	Hollowell	MAIN	Proctor Creek at Hollowell Parkway	33.77199	-84.42990
	PC6	Hortense	MAIN	Proctor Creek at Hortense Place	33.77562	-84.44072
	PC7	Kerry Circle	MAIN	Proctor Creek at Kerry Circle	33.79214	-84.45208
	PC8	James Jackson	MAIN	Proctor Creek at James Jackson Parkway	33.79461	-84.47417
	PC9	Northwest	MAIN	Proctor Creek at Northwest Drive	33.79931	-84.48682
	PC10	Lindsay Street	TRIB	Tributary at Lindsay Street Park	33.76941	-84.41611
	PC11	Grove Park	TRIB	Tributary at Grove Park	33.77406	-84.44029
	PC12	Spring Street	TRIB	Tributary at Spring Street	33.78849	-84.46597
	PC13	AD Williams	TRIB	Tributary at Northwest Drive	33.79633	-84.48602
	PC14	Lillian Cooper	TRIB	Tributary at Lillian Cooper Shepherd Park	33.79799	-84.47842
	PC15	West Highlands	TRIB	Tributary at Hollingsworth Boulevard	33.79076	-84.44724
macroinvertebrates	PC5/6	Hortense/ Hollowell	MAIN	Macroinvertebrate sampling reach: upstream end	33.77676	-84.43568
				Macroinvertebrate sampling reach: downstream end	33.77633	-84.43674
	PC8	James Jackson	MAIN	Macroinvertebrate sampling reach: upstream end	33.79497	-84.47330
				Macroinvertebrate sampling reach: downstream end	33.79458	-84.47411
	PC11	Grove Park	TRIB	Macroinvertebrate sampling reach: upstream end	33.77435	-84.44035
				Macroinvertebrate sampling reach: downstream end	33.77507	-84.44014
	PC12	Spring Street	TRIB	Macroinvertebrate sampling reach: upstream end	33.78577	-84.46365
				Macroinvertebrate sampling reach: downstream end	33.78649	-84.46378
fish tissue	PC3	North Avenue (UPPER)	MAIN	Fish sampling reach: upstream end	33.76862	-84.42725
				Fish sampling reach: downstream end	33.77199	-84.42990
	PC8	James Jackson (LOWER)	MAIN	Fish sampling reach: upstream end	33.79493	-84.47372
				Fish sampling reach: downstream end	33.79526	-84.47643

Table 2: Precipitation totals (inches) at 24, 48, 72 hours and 7 days prior to the start of each sampling event.

	Sampling Date							
Increment	**9/2/15**	**1/12/16**	**4/5/16**	**7/26/16**	**10/18/16**	**1/24/17**	**4/11/17**	**7/18/17**
24 hours	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.21
48 hours	0.19	0.03	0.00	0.00	0.03	1.08	0.00	0.36
72 hours	0.75	0.27	0.04	0.00	0.03	3.09	0.00	0.37
7 days	0.75	0.51	1.45	0.51	0.03	3.60	4.38	0.45

Table 3: Data from *in situ* water quality measurements, discharge calculations, fecal bacteria analysis (*E. coli*), and rapid visual habitat assessment scores (out of 200). Values are means and one standard error, with number of data points (n) listed.

Analyte	n	PC1 Burbank	PC2 Greens-ferry	PC3 North Avenue	PC4 North CSO	PC5 Hollowell	PC6 Hortense	PC7 Kerry Circle	PC8 James Jackson	PC9 North-west	PC10 Lindsay Street	PC11 Grove Park	PC12 Spring Street	PC13 AD Williams	PC14 Lillian Cooper	PC15 West Highlands
Temperature (°C)	8	18.28 (2.13)	20.13 (1.23)	19.08 (1.76)	17.55 (2.05)	17.78 (2.00)	18.27 (2.74)	19.12 (2.59)	17.91 (2.59)	17.02 (2.55)	19.08 (1.10)	17.69 (2.53)	17.91 (2.60)	17.03 (2.34)	15.02 (2.14)	17.76 (1.58)
pH (S.U.)	8	7.33 (0.09)	7.07 (0.03)	7.41 (0.09)	6.84 (0.07)	7.10 (0.09)	7.51 (0.12)	7.44 (0.04)	7.58 (0.15)	7.31 (0.13)	6.89 (0.06)	7.52 (0.12)	7.43 (0.04)	7.56 (0.06)	7.16 (0.17)	7.47 (0.06)
Sp Conductance (μS/cm)	8	187 (3)	303 (9)	281 (17)	506 (111)	286 (5)	262 (18)	284 (15)	248 (18)	252 (22)	381 (18)	205 (6)	180 (8)	514 (47)	137 (7)	578 (14)
Dissolved Oxygen (mg/L)	8	9.19 (0.45)	7.36 (0.42)	9.13 (0.43)	2.13 (0.36)	8.56 (0.71)	9.29 (0.63)	9.05 (0.55)	9.79 (0.62)	8.97 (0.66)	7.96 (0.37)	9.16 (0.63)	9.35 (0.53)	8.91 (0.52)	6.95 (1.22)	8.28 (0.33)
Turbidity (NTU)	8	1.93 (0.34)	1.80 (0.26)	2.06 (0.25)	1.95 (0.51)	1.60 (0.35)	5.30 (2.61)	7.60 (3.54)	7.10 (3.76)	9.25 (4.76)	0.51 (0.10)	2.44 (0.43)	3.13 (0.81)	2.31 (0.64)	9.22 (3.68)	6.71 (1.30)
Discharge (cfs)	8	0.35 (0.07)	1.07 (0.07)	1.45 (0.16)	<0.1 NA	1.69 (0.11)	2.57 (0.40)	3.93 (0.69)	7.06 (1.52)	7.88 (1.41)	<0.1 NA	0.59 (0.14)	1.25 (0.32)	0.34 (0.08)	<0.1 NA	0.20 (0.03)
E. coli (MPN/100 mL)	8	4,121 (1,114)	12,853 (2,956)	11,801 (3,247)	520 (221)	2,217 (986)	1,548 (657)	3,059 (1,581)	1,232 (752)	2,039 (1,117)	6,410 (4,988)	509 (155)	1,543 (493)	361 (116)	580 (163)	2,162 (1,946)
Habitat Score	1	97	NA	116	95	132	129	104	131	149	118	108	125	123	55	132

Table 4: Coefficients for Spearman Rank correlations between *E. coli* data, turbidity, precipitation totals in the 24h, 48h and 72h prior to sampling, select water chemistry parameters and discharge. All correlation coefficients shown in bold are significant at p<0.05.

	Spearman Rank Coefficients																
Parameter	**Turbidity**	**24h**	**48h**	**72h**	**TP**	**TDP**	**TN**	**TKN**	**NO3**	**TOC**	**Sp. Cond.**	**Total Alk.**	**pH**	**Ca**	**Na**	**Cl**	**Discharge**
E. coli	0.17	**0.35**	**0.32**	**0.29**	**0.50**	**0.45**	**0.39**	**0.33**	**0.34**	**-0.35**	**-0.33**	**-0.27**	**-0.29**	**-0.23**	**-0.28**	**-0.22**	**0.23**
Turbidity	--	**0.47**	**0.37**	**0.32**													
Aluminum	**0.49**	**0.34**	**0.29**	**0.23**													
Lead	0.16	**0.19**	0.13	0.05													
Zinc	**0.19**	**0.35**	**0.30**	**0.28**													

Table 5: Surface water data means (with one standard error) for nutrients and classical parameters, with the number of data points (n) from a maximum of eight sampling events. Dissolved nutrients are also expressed as a percentage of total nitrogen (TN) or total phosphorus (TP). Cells shaded in grey indicate values below detection at the minimum reporting limit indicated.

Analyte	n	PC1 Burbank	PC2 Greens-ferry	PC3 North Avenue	PC4 North CSO	PC5 Hollowell	PC6 Hortense	PC7 Kerry Circle	PC8 James Jackson	PC9 North-west	PC10 Lindsay Street	PC11 Grove Park	PC12 Spring Street	PC13 AD Williams	PC14 Lillian Cooper	PC15 West Highlands
Total Nitrogen (mg/L)	8	1.51 (0.17)	3.65 (0.23)	2.51 (0.22)	0.88 (0.20)	2.28 (0.14)	1.69 (0.10)	1.66 (0.17)	1.31 (0.17)	1.27 (0.15)	4.30 (0.18)	0.82 (0.09)	1.04 (0.11)	1.71 (0.19)	0.61 (0.18)	1.54 (0.17)
Total Kjehdal N (mg/L)	8	0.26 (0.06)	1.30 (0.17)	0.46 (0.09)	0.50 (0.07)	0.35 (0.02)	0.32 (0.03)	0.35 (0.04)	0.27 (0.04)	0.31 (0.04)	0.17 (0.01)	0.23 (0.03)	0.32 (0.05)	0.48 (0.10)	0.27 (0.14)	0.50 (0.17)
Nitrate/Nitrite (mg/L)	8	1.25 (0.13)	2.35 (0.10)	2.05 (0.21)	0.39 (0.22)	1.93 (0.12)	1.37 (0.10)	1.31 (0.17)	1.03 (0.17)	0.96 (0.15)	4.14 (0.18)	0.59 (0.09)	0.72 (0.06)	1.24 (0.10)	0.33 (0.16)	1.04 (0.04)
% of TN		83	64	82	44	85	81	79	79	76	96	72	69	72	55	68
Ammonia (mg/L)	8	0.04 (0.02)	0.69 (0.15)	0.14 (0.05)	0.23 (0.05)	0.09 (0.02)	0.06 (0.02)	0.04 (0.01)	0.04 (0.01)	0.05 (0.02)	0.03 (0.00)	0.03 (0.00)	0.10 (0.03)	0.15 (0.09)	0.13 (0.09)	0.27 (0.09)
% of TN		3	19	6	27	4	3	3	3	4	0	0	10	9	22	18
Total Phosphorus (mg/L)	8	0.04 (0.01)	0.41 (0.08)	0.24 (0.06)	0.13 (0.02)	0.17 (0.04)	0.08 (0.01)	0.05 (0.01)	0.04 (0.01)	0.04 (0.01)	0.05 (0.01)	0.03 (0.01)	0.05 (0.01)	0.03 (0.01)	0.03 (0.01)	0.02 (0.01)
Total Dissolved P (mg/L)	7	0.02 (0.01)	0.37 (0.09)	0.22 (0.07)	0.06 (0.02)	0.13 (0.04)	0.05 (0.01)	0.03 (0.01)	0.02 (0.01)	0.02 (0.00)	0.04 (0.01)	0.02 (0.01)	0.02 (0.01)	0.02 (0.00)	0.02 (0.00)	0.02 (0.01)
% of TP		58	90	89	46	76	59	49	52	54	82	65	49	63	45	100
Total Organic Carbon (mg/L)	6	1.00 (0.25)	2.23 (0.39)	1.73 (0.42)	5.65 (0.94)	1.92 (0.51)	1.63 (0.31)	2.62 (0.53)	2.72 (0.52)	2.95 (0.43)	1.90 (0.54)	1.78 (0.27)	2.47 (0.40)	7.08 (1.05)	2.60 (0.56)	7.85 (1.17)
Total Suspended Solids (mg/L)	4	4.00 (0.00)	4.00 (0.00)	4.00 (0.00)	4.95 (1.71)	4.00 (0.00)	4.00 (0.00)	4.00 (0.00)	4.00 (0.00)	4.00 (0.00)	4.75 (2.75)	4.00 (0.00)	4.00 (0.00)	4.00 (0.00)	4.00 (0.00)	4.00 (0.00)
Bromide (mg/L)	4	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	0.10 (0.00)	1.25 (0.35)	0.10 (0.00)	0.10 (0.00)
Chloride (mg/L)	8	11.75 (0.41)	20.13 (1.14)	22.00 (5.22)	82.50 (33.41)	21.13 (2.00)	19.96 (4.41)	14.89 (1.78)	12.98 (1.43)	14.58 (1.75)	18.00 (0.46)	13.64 (0.83)	12.25 (0.53)	58.63 (9.24)	9.32 (0.88)	21.38 (0.65)
Fluoride (mg/L)	8	0.11 (0.03)	0.31 (0.03)	0.24 (0.03)	0.20 (0.02)	0.22 (0.03)	0.19 (0.03)	0.18 (0.02)	0.19 (0.02)	0.19 (0.01)	0.14 (0.03)	0.14 (0.02)	0.21 (0.04)	0.23 (0.04)	0.11 (0.01)	0.22 (0.01)
Sulfate (mg/L)	8	15.50 (1.02)	35.88 (1.38)	30.00 (0.93)	22.21 (6.40)	30.13 (1.08)	28.25 (1.63)	39.88 (3.65)	33.13 (2.97)	30.38 (3.28)	66.25 (4.74)	24.50 (1.70)	16.75 (1.46)	18.20 (3.67)	13.03 (3.59)	67.25 (2.99)
Total Alkalinity (mg/L $CaCO_3$)	6	51.83 (2.44)	68.33 (2.36)	63.50 (2.64)	123.00 (32.28)	75.33 (7.17)	71.00 (5.57)	72.17 (2.68)	65.83 (3.45)	73.33 (3.62)	74.83 (4.90)	51.67 (1.96)	43.67 (1.71)	161.67 (10.14)	34.00 (6.16)	205.00 (8.85)
Hardness (mg/L $CaCO_3$)	7	60.44 (2.06)	88.44 (3.27)	82.89 (2.69)	129.46 (33.00)	89.16 (2.91)	80.45 (3.91)	93.70 (6.33)	80.69 (6.09)	79.30 (6.97)	129.55 (8.76)	64.19 (2.94)	52.60 (3.11)	127.59 (10.83)	37.68 (2.31)	214.81 (9.92)

Table 6: Surface water data means (with one standard error) for total recoverable metals, with the number of data points (n) from a maximum of eight sampling events. Metals not detected in any water samples are listed in the Appendix. Cells shaded in grey indicate values below detection at the minimum reporting limit indicated.

Analyte	n	PC1 Burbank	PC2 Greens-ferry	PC3 North Avenue	PC4 North CSO	PC5 Hollowell	PC6 Hortense	PC7 Kerry Circle	PC8 James Jackson	PC9 North-west	PC10 Lindsay Street	PC11 Grove Park	PC12 Spring Street	PC13 AD Williams	PC14 Lillian Cooper	PC15 West Highlands
Aluminum (µg/L)	8	100 (0)	100 (0)	100 (0)	100 (0)	100 (0)	118 (41)	206 (117)	189 (103)	240 (145)	100 (0)	100 (0)	100 (0)	100 (0)	238 (141)	100 (0)
Antimony (µg/L)	8	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	2.39 (1.42)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	1.23 (0.13)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.58 (0.08)
Arsenic (µg/L)	8	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.80 (0.15)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.56 (0.06)	0.50 (0.00)	0.61 (0.11)
Barium (µg/L)	8	60.50 (3.52)	59.00 (1.77)	56.88 (2.81)	59.75 (8.68)	60.00 (1.72)	51.38 (2.19)	51.13 (1.77)	44.75 (2.25)	45.63 (2.56)	86.50 (1.97)	37.13 (1.67)	38.50 (2.88)	58.38 (4.88)	55.83 (2.21)	106.38 (5.97)
Calcium (µg/L)	8	18250 (701)	26625 (1068)	25000 (866)	45875 (12558)	27125 (895)	24500 (1165)	28875 (1807)	24875 (1787)	24375 (2078)	41000 (2976)	19750 (861)	16375 (1085)	35375 (2803)	11333 (667)	67000 (3443)
Iron (µg/L)	8	206 (19)	244 (21)	311 (19)	1738 (210)	313 (20)	401 (46)	419 (96)	413 (102)	479 (148)	126 (33)	325 (38)	424 (56)	291 (72)	1038 (186)	606 (99)
Lead (µg/L)	8	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	2.00 (0.57)	0.63 (0.13)	2.25 (1.01)	1.66 (0.41)	1.33 (0.46)	1.36 (0.67)	1.43 (0.30)	0.50 (0.00)	0.50 (0.00)	0.50 (0.00)	0.72 (0.22)	1.20 (0.38)
Magnesium (µg/L)	8	3538 (112)	5500 (177)	4950 (124)	3950 (592)	5238 (169)	4725 (279)	5000 (363)	4500 (392)	4513 (448)	6425 (324)	3725 (186)	2888 (119)	9575 (869)	2217 (162)	11488 (429)
Manganese (µg/L)	8	20.90 (4.97)	81.38 (15.23)	64.63 (13.01)	491.25 (75.91)	65.25 (14.84)	57.00 (12.78)	58.00 (13.57)	49.75 (14.31)	54.56 (14.24)	24.75 (2.66)	52.00 (8.07)	48.23 (14.24)	137.90 (48.87)	173.50 (47.62)	553.75 (53.82)
Potassium (µg/L)	8	3100 (105)	5613 (287)	4725 (177)	5238 (410)	4975 (216)	4388 (180)	5450 (221)	4563 (146)	4638 (167)	5663 (223)	3100 (135)	3113 (120)	6225 (454)	2450 (126)	6675 (108)
Selenium (µg/L)	8	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)	2.15 (0.11)	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)	2.00 (0.00)
Sodium (µg/L)	8	9800 (292)	18000 (1134)	17625 (2890)	56625 (18751)	16750 (1048)	15850 (2558)	15413 (1302)	13650 (1302)	14838 (1557)	20125 (693)	11963 (565)	11588 (637)	51875 (6531)	9317 (908)	34875 (2048)
Strontium (µg/L)	8	90.00 (2.90)	108.00 (3.84)	108.25 (3.17)	183.63 (45.86)	117.50 (3.13)	101.88 (5.15)	110.63 (6.30)	103.63 (8.12)	104.50 (8.99)	222.50 (13.59)	83.75 (3.45)	80.00 (4.67)	182.50 (15.78)	81.83 (6.83)	321.25 (12.17)
Titanium (µg/L)	8	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	7.25 (3.69)	7.13 (3.47)	9.00 (4.96)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	7.12 (3.68)	5.00 (0.00)
Vanadium (µg/L)	8	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.00 (0.00)	5.03 (0.03)
Zinc (µg/L)	8	11.63 (3.33)	9.13 (1.61)	7.75 (1.36)	22.00 (7.96)	9.38 (1.83)	11.50 (2.10)	13.88 (4.62)	10.88 (3.29)	10.38 (2.80)	72.00 (4.99)	8.63 (1.85)	12.00 (3.01)	7.50 (1.68)	22.83 (8.79)	45.13 (19.77)

Table 7: Metals data from sediment samples collected in September 2015. Samples below detection (U) at the minimum reporting limit indicated are highlighted in grey. Additional data qualifiers are omitted for clarity. Sediment quality benchmarks are provided for comparison, with values above the TEC highlighted in orange.

Analyte (mg/kg dry)	ARCS TEC	ARCS PEC	PC1 Burbank	PC3 North Avenue	PC4 North CSO	PC5 Hollowell	PC6 Hortense	PC7 Kerry Circle	PC8 James Jackson	PC9 Northwest	PC10 Lindsay Street	PC11 Grove Park	PC12 Spring Street	PC13 AD Williams	PC14 Lillian Cooper	PC15 West Highlands
Aluminum		58030	2500	3500	4100	2800	1900	1900	1200	1800	2600	2300	1400	1400	2200	2900
Antimony			0.20 U	0.23	0.43	1.2	0.20 U	0.20 U	0.20 U	0.20 U	0.59	0.20 U	0.20 U	0.24	0.20 U	2.0
Arsenic	12.1	57	0.24	0.49	0.67	0.37	0.26	0.28	0.23	0.26	0.95	0.20 U	0.20 U	0.37	0.27	2.8
Barium			41	50	64	35	18	18	12	17	41	23	19	28	26	42
Beryllium			0.30 U	0.30 U	0.29 U	0.30 U	0.30 U	0.30 U	0.30 U	0.29 U	0.35	0.30 U	0.29 U	0.30 U	0.30 U	0.30 U
Cadmium	0.59	11.7	0.099 U	0.099 U	0.20	0.13	0.11	0.099 U	0.099 U	0.098 U	0.23	0.10 U	0.098 U	0.099 U	0.52 U	0.37
Calcium			490	1100	3200	650	430	320	220	370	990	340	200	610	170	950
Chromium	56	159	8.5	12	8.0	11	4.8	7.7	3.0	4.3	6.2	4.5	2.5	3.1	13	5.8
Cobalt			2.2	3.1	2.4	2.1	1.3	1.2	0.95	1.1	2.1	1.5	1.6	1.7	1.6	3.2
Copper	28	77.7	15	17	43	19	6.7	6.7	6.0	5.8	41	7.3	3.1	11	4.2	18
Iron			5100	8100	7100	5800	3500	4000	2600	2700	7900	4200	2400	3900	4700	7900
Lead	34.2	396	19	36	30	44	15	20	7.0	22	95	20	5.9	12	6.4	100
Magnesium			1200	1800	2100	1400	810	740	440	440	1100	930	430	490	740	1400
Manganese	1673	1081	91	130	110	80	54	58	38	47	94	67	73	290	60	320
Nickel	39.6	38.5	2.7	4.6	3.7	3.5	1.7	2.3	1.4	1.1	3.5	1.3	0.98 U	3.7	1.5	5.5
Potassium			1000	1600	1500	1200	770	760	490	510	760	900	550	570	900	1200
Sodium			99 U	99 U	140	99 U	99 U	99 U	99 U	98 U	140	100 U	98 U	99 U	99 U	99 U
Strontium			3.8	5.9	21	4.0	3.9	3.3	1.7	14	11	2.1	1.6	2.7	1.9	4.6
Tin			3.4	3.8	5.0	14	1.5 U	6.7	2.4	1.7	20	1.6	1.5 U	2.3	1.5 U	6.1
Titanium			240	350	360	260	170	170	110	120	200	220	120	110	200	230
Vanadium			10	13	12	10	7.0	6.8	3.7	4.4	6.9	8.4	3.5	4.2	9.1	9.8
Yttrium			1.8	3.4	4.1	2.5	1.8	2.1	1.0	1.3	2.7	2.0	1.3	1.7	1.8	2.7
Zinc	159	1532	44	69	92	61	28	34	19	21	130	33	16	43	23	120

ARCS = Assessment & Remediation of Contaminated Sediments Program (Jones & Suter 1997)

U = The analyte was not detected at or above the reporting limit.

TEC = Threshold Effect Concentration

PEC = Probable Effect Concentration

Table 8: Organic chemistry data from sediment samples collected in September 2015. Samples below detection (U) at the minimum reporting limit indicated are highlighted in grey. Additional data qualifiers are omitted for clarity. Sediment quality benchmarks are provided for comparison, with values above the TEC highlighted in orange and those above the PEC highlighted in yellow. Compounds contributing to Total PAHs are indicated in green.

SEDIMENT PESTICIDES AND PCBs

Analyte (µg/kg dry)	ARCS TEC	ARCS PEC	CB PEC	PC1 Burbank	PC3 North Avenue	PC4 North CSO	PC5 Hollowell	PC6 Hortense	PC7 Kerry Circle	PC8 James Jackson	PC9 Northwest	PC10 Lindsay Street	PC11 Grove Park	PC12 Spring Street	PC13 AD Williams	PC14 Lillian Cooper	PC15 West Highlands
4,4'-DDT (p,p'-DDT)			62	5.0	11 U	13 U	11 U	11 U	2.2 U	2.2 U	11 U	2.2 U	2.2 U	12 U	2.2 U	2.3 U	11 U
Dieldrin			61.8	2.3 U	11 U	13 U	11 U	11 U	2.2 U	2.2 U	11 U	5.8	2.2 U	12 U	2.2 U	2.3 U	11 U
alpha-Chlordane	CB PEC = 17.6 for chlordane			2.3 U	11 U	13 U	11 U	11 U	2.2 U	2.2 U	11 U	24	2.2 U	12 U	2.2 U	2.3 U	11 U
gamma-Chlordane				2.3 U	11 U	13 U	11 U	11 U	2.2 U	2.2 U	11 U	59	2.5	12 U	2.2 U	2.3 U	11 U
PCB-1254 (Aroclor 1254)				85	27 U	12 U	21 U	13 U	46	11 U	18 U	54 U	11 U	11 U	22 U	11 U	12 U
PCB-1260 (Aroclor 1260)				86 U	26	12 U	20	12	47 U	11 U	11 U	54 U	11 U	11 U	21	11 U	11

SEDIMENT SEMI-VOLATILES

Analyte (µg/kg dry)	ARCS TEC	ARCS PEC	CB PEC	PC1 Burbank	PC3 North Avenue	PC4 North CSO	PC5 Hollowell	PC6 Hortense	PC7 Kerry Circle	PC8 James Jackson	PC9 Northwest	PC10 Lindsay Street	PC11 Grove Park	PC12 Spring Street	PC13 AD Williams	PC14 Lillian Cooper	PC15 West Highlands
(3-and/or 4-) Methylphenol				460 U	430 U	99	430 U	430 U	430 U	430 U	430 U	420 U	430 U	450 U	430 U	450 U	420 U
Acenaphthene				91 U	45	57	85 U	87 U	86 U	86 U	87 U	85 U	87 U	90 U	86 U	89 U	84 U
Anthracene	31.6	547.7	845	91 U	170	150	90	87 U	86 U	86 U	87 U	85 U	87 U	90 U	86 U	89 U	84 U
Benzo(a)anthracene	260	4200		91 U	750	750	540	290	74	64	89	78	87 U	90 U	86 U	110	84 U
Benzo(a)pyrene	350	393.7		91 U	850	830	650	370	88	82	120	86	55	90 U	86 U	110	44
Benzo(b)fluoranthene				48	1000	1200	770	460	100	85	110	110	80	90 U	44	150	57
Benzo(g,h,i)perylene	290	6300		91 U	570	530	460	250	51	59	76	92	47	90 U	86 U	83	84 U
Benzo(k)fluoranthene				47	890	890	620	390	85	83	100	87	65	90 U	86 U	120	49
Bis(2-ethylhexyl) phthalate				460 U	430 U	590	430 U	430 U	430 U	430 U	430 U	420 U	430 U	450 U	430 U	450 U	420 U
Carbazole				91 U	180	180	120	50	86 U	86 U	87 U	85 U	87 U	90 U	86 U	89 U	84 U
Chrysene	500	5200	1290	49	1000	970	740	420	94	80	110	99	71	90 U	86 U	150	47
Dibenz(a,h)anthracene		28.2		91 U	240	180	170	84	86 U	86 U	87 U	85 U	87 U	90 U	86 U	89 U	84 U
Fluoranthene	64.23	834.3	2230	76	1900	1500	1300	600	150	130	130	160	120	90 U	51	250	76
Fluorene	34.64	651.9	536	91 U	59	66	85 U	87 U	86 U	86 U	87 U	85 U	87 U	90 U	86 U	89 U	84 U
Hexadecanoic acid (TIC)				-	800	4000	-	-	-	-	-	-	-	-	-	-	-
Indeno (1,2,3-cd) pyrene	78	836.7		91 U	530	480	420	230	47	53	65	72	87 U	90 U	86 U	75	84 U
Phenanthrene			1170	91 U	1000	860	590	210	47	71	87 U	120	87 U	90 U	86 U	110	84 U
Pyrene	570	3225	1520	80	1800	1500	1200	580	150	150	170	170	100	90 U	58	220	91
Total PAHs	3553	13660	22800	300	10804	9963	7550	3884	886	857	970	1074	538	0	153	1378	364

ARCS = Assessment & Remediation of Contaminated Sediments Program (Jones & Suter 1997)

U = The analyte was not detected at or above the reporting limit.

TEC = Threshold Effect Concentration; PEC = Probable Effect Concentration

CB = Consensus-Based sediment quality guidelines (USEPA 2000)

Table 9: Individual metrics, dominant taxa, and the macroinvertebrate multimetric index (MMI) score, as well as habitat scores, for data collected at macroinvertebrate sampling locations in February 2017.

Station ID	**PC5/6**		**PC8**		**PC11**		**PC12**	
Station Name	**Hortense-Hollowell**		**James Jackson**		**Grove Park**		**Spring Street**	
Metrics	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**
Coleoptera Taxa	0	0	0	0	1	11.36	0	0
% Oligochaeta	0.42%	99.51	7.27%	91.39	4.00%	95.26	8.49%	89.94
% Plecoptera	0.00%	0	0.00%	0	0.00%	0	0.00%	0
Shredder Taxa	0	0	1	9.09	3	27.27	3	27.27
Scraper Taxa	5	56.82	2	22.73	2	22.73	3	34.09
Swimmer Taxa	0	0	0	0	0	0	0	0
Dominant Taxa	*Hydropsyche betteni*		*Hydropsyche betteni*		*Hydropsyche betteni*		Copepoda	
	Hydropsychidae		*Cheumatopsyche* sp.		*Polypedilum flavum*		*Cricotopus bicinctus*	
	Cheumatopsyche sp.		*Hydropsyche* sp.		*Thienemannimyia* gp.		*Thienemannimyia* gp.	
MMI Score (of 100)	**26**		**21**		**26**		**25**	
Habitat Score (of 200)	**157**		**114**		**92**		**145**	

Table 10: Summary of consumption advisory recommendations from the fish tissue screening study conducted in April 2016 and the follow-up study conducted in July 2017. Advisories are suggested for no more than one meal per month (1/MONTH) or no more than one meal per week (1/WEEK), as indicated, for fish species collected in the upper watershed near North Avenue (PC3) or in the lower watershed near Jackson Parkway (PC8).

SUMMARY OF RECOMMENDATIONS	**UPPER WATERSHED**				**LOWER WATERSHED**	
	redbreast sunfish	**green sunfish**	**yellow bullhead**	**brown bullhead**	**redbreast sunfish**	**brown bullhead**
	1/MONTH	1/MONTH	1/WEEK	1/WEEK	1/WEEK	1/WEEK

Figure 1: Study site location in Fulton County, GA. The Proctor Creek watershed drains to the Chattahoochee River, which flows across the Florida panhandle to the Gulf of Mexico.

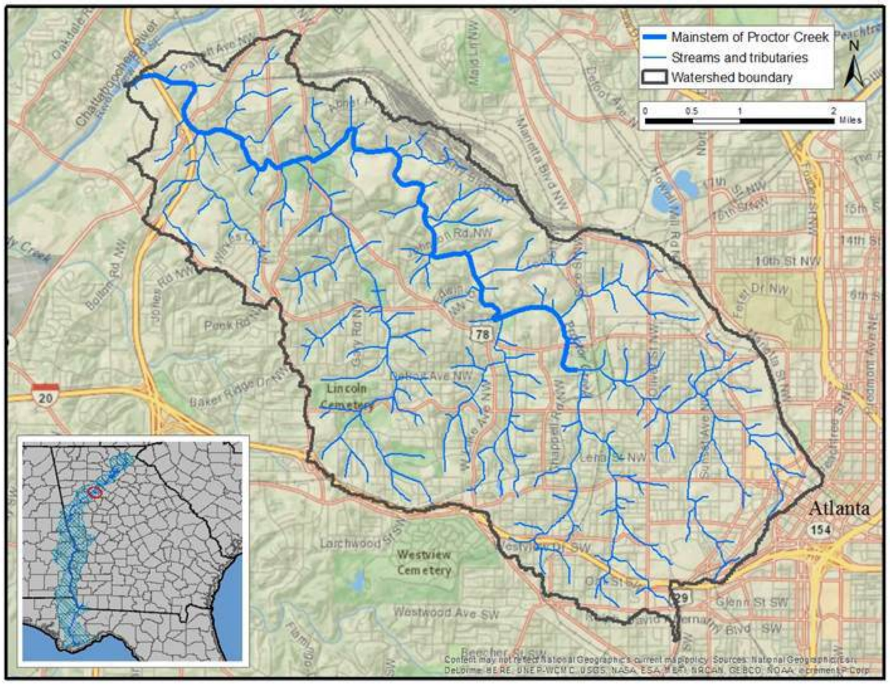

Figure 2: Map of sampling locations in the Proctor Creek watershed. The darker blue line indicates the mainstem of Proctor Creek, with tributaries shown in lighter blue. See Table 1 for station descriptions.

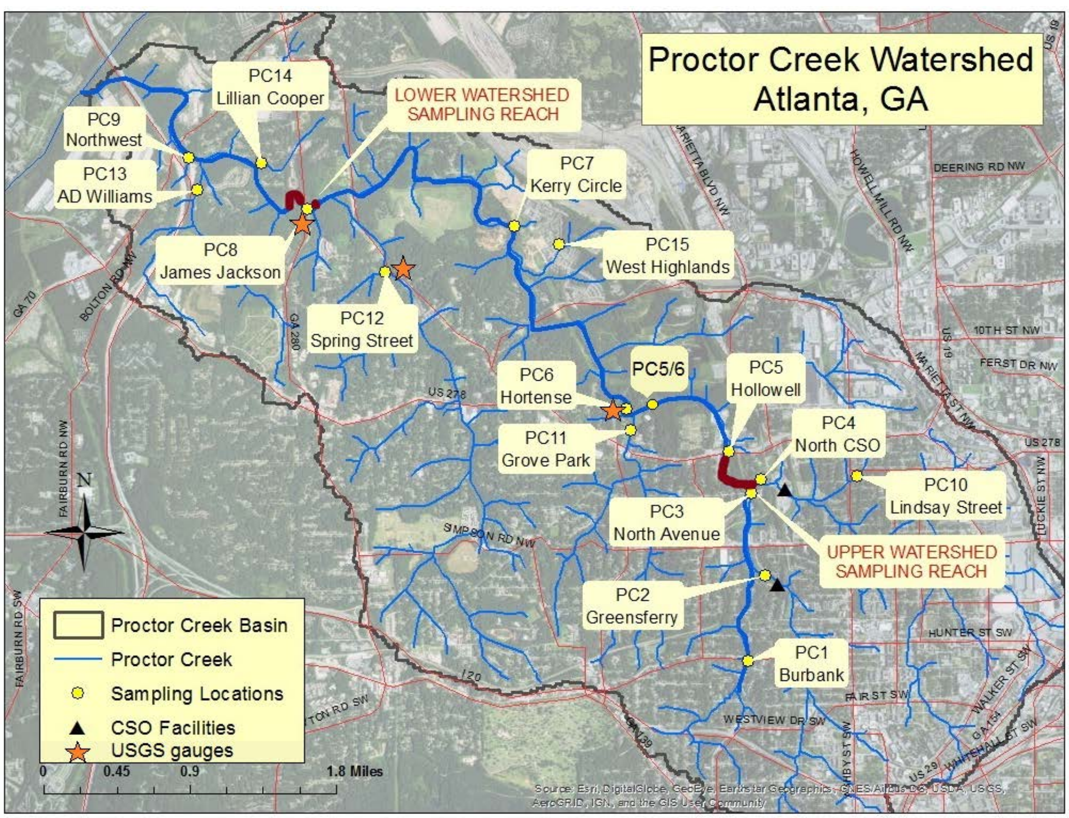

Figure 3: Specific conductance (µS/cm) ± 1SE in Proctor Creek and its tributaries. Locations are shown from upstream to downstream, in order from left to right. Similar patterns in concentration were found for component ions, including Ca, K, Mg, and Na.

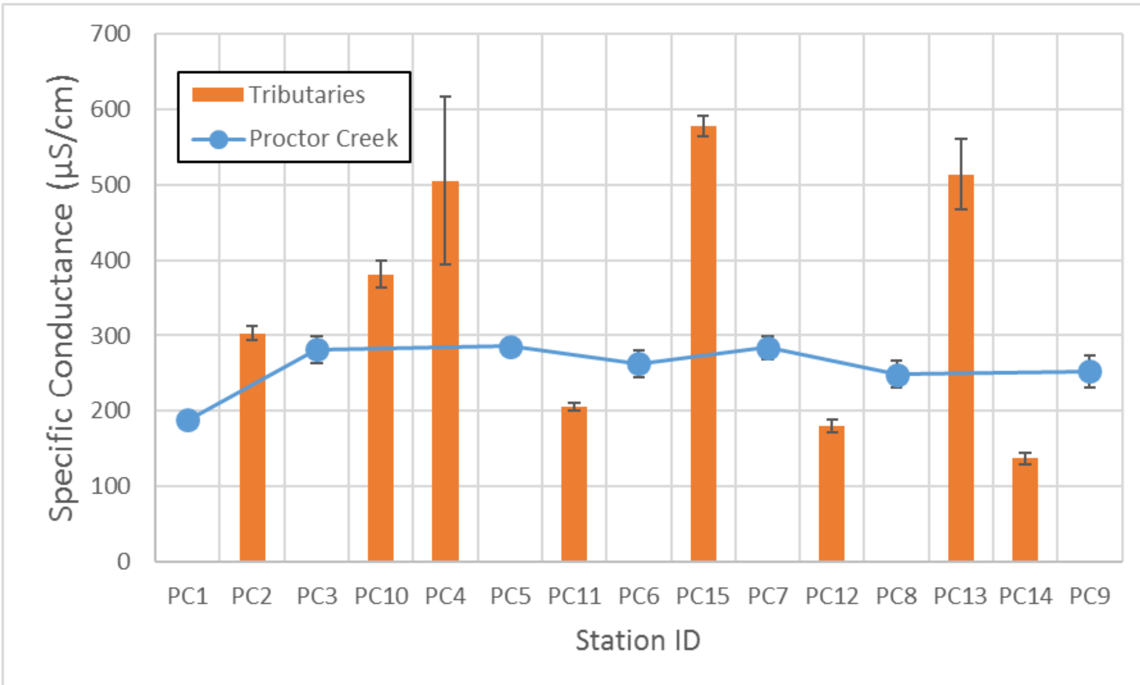

Figure 4: *E. coli* (MPN per 100 mL) ± 1SE in Proctor Creek and its tributaries. Locations are shown from upstream to downstream, in order from left to right.

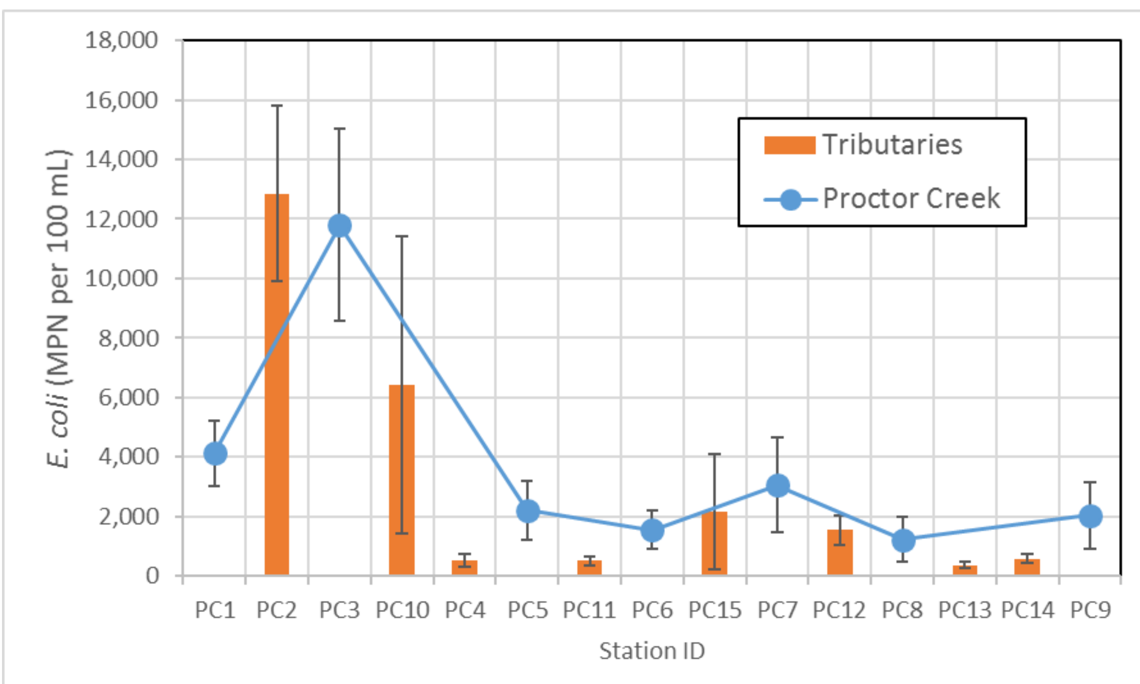

Figure 5: Total nitrogen (mg/L) ± 1SE in Proctor Creek and its tributaries. Locations are shown from upstream to downstream, in order from left to right.

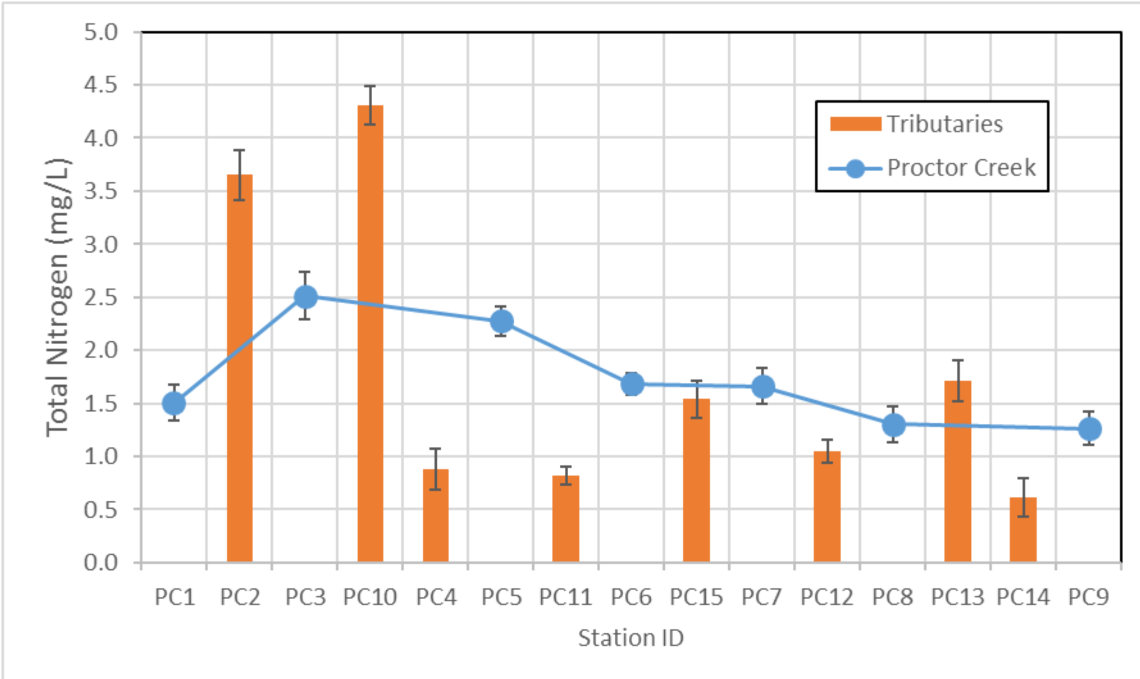

Figure 6: Total phosphorus (mg/L) ± 1SE in Proctor Creek and its tributaries. Locations are shown from upstream to downstream, in order from left to right.

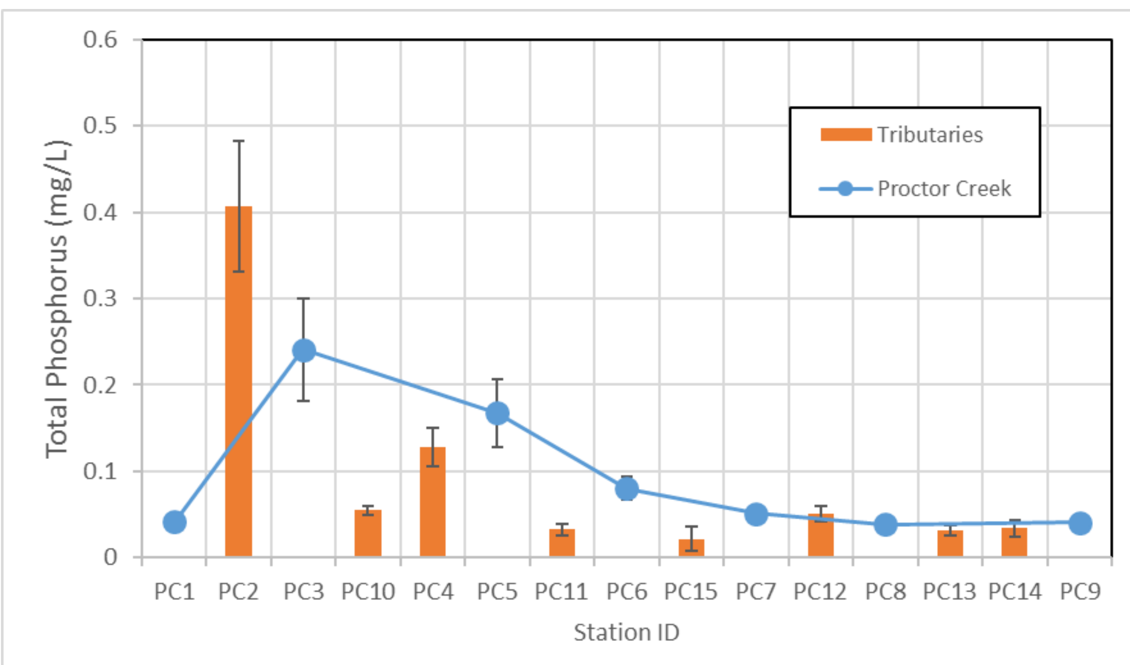

Figure 7: Summary of pesticide data collected in the water column in April 2016 and July 2017, including post-storm sampling in July 2017. Only chlordane was detected in September 2015, at a minimum reporting limit (MRL) of 0.05 µg/L for each pesticide. Those values are plotted on a secondary axis due to scale. Locations are shown from upstream to downstream, in order from left to right. BD = below detection.

APPENDIX

Analytical methods, routine minimum reporting limits for water and sediment matrices, and water quality standards (WQS) for each of the parameters analyzed during this study, according to analyte group. WQS are shown where applicable only, and are for annual average criteria unless otherwise indicated. 1Q10 = one-day 10-year minimum low flow. 7Q10 = 7-day 10-year minimum low flow.

NUTRIENTS & CLASSICALS		
Analyte	**Method**	**WATER (µg/L)**
Alkalinity	SM 2320B	1.0
Ammonia	EPA 350.1	0.05
Bromide	EPA 300.0	0.1
Chloride	EPA 300.0	0.1
Fluoride	EPA 300.0	0.05
Hardness	SM 2340B	1.654
Nitrate+Nitrite	EPA 353.2	0.05
Sulfate	EPA 300.0	0.1
Total Dissolved Phosphorus	EPA 365.1	0.01
Total Kjeldahl Nitrogen	EPA 351.2	0.05
Total Organic Carbon	SM5310/ASB 107C	1.0
Total Phosphorus	EPA 365.1	0.01
Total Suspended Solids	USGS I-3765-85	4.0

MICROBIOLOGY		
Analyte	**Method**	**(MPN/ 100mL)**
Escherichia coli	IDEXX Colilert	1.0

* This analyte was NOT detected at the reporting limit indicated in this sample matrix.

** WQS for these metals are calculating using the total hardness of the water body. Formulae are listed in Ga. Comp. R. & Regs. r. 391-3-6-.03(5)(e)(ii). Values shown assume a hardness of 50 mg/L CaCo3.

*** This pollutant is addressed in section 391-3-6-.06 of Georgia's Water Quality Control regulations.

TOTAL RECOVERABLE METALS				
Analyte	**Method**	**WATER (µg/L)**	**WQS (µg/L)**	**SEDIMENT (mg/kg dry)**
Antimony	EPA 200.8	0.5	640	0.05
Arsenic	EPA 200.8	0.5	50 1Q10 = 340 **7Q10 = 150**	0.05
Aluminum	EPA 6010C	100		10
Barium	EPA 6010C	5.0		0.5
Beryllium	EPA 6010C	3.0*	***	0.3
Cadmium**	EPA 200.8	0.25	1Q10 = 1.0 **7Q10 = 0.15**	0.025
Calcium	EPA 6010C	250		25
Chromium III**	EPA 6010C	5.0*	1Q10 = 320 **7Q10 = 42**	0.5
Chromium VI**	EPA 6010C	5.0*	1Q10 = 16 **7Q10 = 11**	0.5
Cobalt	EPA 6010C	5.0*		0.5
Copper**	EPA 6010C	10*	1Q10 = 7.0 **7Q10 = 5.0**	1.0
Iron	EPA 6010C	100		10
Lead**	EPA 200.8	0.5	1Q10 = 30 **7Q10 = 1.2**	0.05
Magnesium	EPA 6010C	250		25
Manganese	EPA 6010C	5.0		0.5
Mercury**	EPA 245.1 (water) EPA 7473 (sediment)	0.10*	1Q10 = 1.4 **7Q10 = 0.012**	0.05*
Molybdenum	EPA 6010C	10*		1.0*
Nickel**	EPA 6010C	10*	1Q10 = 260 **7Q10 = 29**	1.0
Potassium	EPA 6010C			100
Selenium	EPA 200.8	1.0	**7Q10 = 5**	0.10*
Silver	EPA 6010C	5.0*	***	0.5*
Sodium	EPA 6010C	1000		100
Strontium	EPA 6010C	5.0		0.5
Thallium	EPA 200.8	0.5*	0.47	0.05*
Tin	EPA 6010C	15*		1.5
Titanium	EPA 6010C	5.0		0.5
Vanadium	EPA 6010C	5.0*		0.5
Yttrium	EPA 6010C	3.0*		0.3
Zinc**	EPA 6010C	10	1Q10 = 165 **7Q10 = 65**	1.0

PESTICIDES				
Analyte	**Method**	**WATER (µg/L)**	**WQS (µg/L)**	**SEDIMENT (mg/kg dry)**
4,4'-DDD (p,p'-DDD)	Mod. 8270/EPA 8081B	0.04	0.00031	1.3
4,4'-DDE (p,p'-DDE)	Mod. 8270/EPA 8081B	0.04	0.00022	1.3
4,4'-DDT (p,p'-DDT)	Mod. 8270/EPA 8081B	0.04	0.00022 **7Q10 = 0.001**	1.3*
Aldrin	Mod. 8270/EPA 8081B	0.04	0.00005	1.3
Dieldrin	Mod. 8270/EPA 8081B	0.04*	0.000054 **7Q10 = 0.056**	1.3*
Endosulfan I (alpha)	Mod. 8270/EPA 8081B	0.04	89 **7Q10 = 0.056**	1.3
Endosulfan II (beta)	Mod. 8270/EPA 8081B	0.04	89 **7Q10 = 0.056**	1.3
Endosulfan Sulfate	Mod. 8270/EPA 8081B	0.04	89 **7Q10 = 0.056**	1.3
Endrin	Mod. 8270/EPA 8081B	0.04	0.060 **7Q10 = 0.036**	1.3
Endrin aldehyde	Mod. 8270/EPA 8081B	0.04	0.30	1.3
Endrin ketone	Mod. 8270/EPA 8081B	0.04*		1.3
Heptachlor	Mod. 8270/EPA 8081B	0.04	0.000079 **7Q10 = 0.0038**	1.3
Heptachlor epoxide	Mod. 8270/EPA 8081B	0.04*	0.000039 **7Q10 = 0.0038**	1.3
Methoxychlor	Mod. 8270/EPA 8081B	0.04	**7Q10 = 0.03**	1.3
Toxaphene	Mod. 8270/EPA 8081B	5.0	0.00028 **7Q10 = 0.0002**	170
alpha-BHC	Mod. 8270/EPA 8081B	0.04	0.0049	1.3
alpha-Chlordane	Mod. 8270/EPA 8081B	0.04*	0.00081 **7Q10 = 0.0043**	1.3*
gamma-Chlordane	Mod. 8270/EPA 8081B	0.04*		1.3*
trans-Nonachlor	Mod. 8270/EPA 8081B	0.5		20
cis-Nonachlor	Mod. 8270/EPA 8081B	0.5		20
beta-BHC	Mod. 8270/EPA 8081B	0.04	0.017	1.3
delta-BHC	Mod. 8270/EPA 8081B	0.04		1.3
gamma-BHC (Lindane)	Mod. 8270/EPA 8081B	0.04	1.8 **1Q10 = 0.95**	1.3

HERBICIDES				
Analyte	**Method**	**WATER (µg/L)**	**WQS (µg/L)**	**SEDIMENT (mg/kg dry)**
2,4,5-T	EPA 8321B	1.0		300
2,4,5-TP (Silvex)	EPA 8321B	1.0	**7Q10 = 50**	300
2,4-D	EPA 8321B	1.0	**7Q10 = 70**	NA
2,4-DB	EPA 8321B	2.0		NA
Dicamba	EPA 8321B	1.0		NA
Dichlorprop	EPA 8321B	1.0		NA

PCB AROCLORS				
Analyte	**Method**	**WATER (µg/L)**	**WQS (µg/L)**	**SEDIMENT (mg/kg dry)**
PCB-1016 (Aroclor 1016)	EPA 8082A	1.0	for all PCBs: 0.000064 **7Q10 = 0.014**	33
PCB-1221 (Aroclor 1221)	EPA 8082A	1.0		33
PCB-1232 (Aroclor 1232)	EPA 8082A	1.0		33
PCB-1242 (Aroclor 1242)	EPA 8082A	1.0		33
PCB-1248 (Aroclor 1248)	EPA 8082A	1.0		33
PCB-1254 (Aroclor 1254)	EPA 8082A	1.0*		33*
PCB-1260 (Aroclor 1260)	EPA 8082A	1.0*		33*
PCB-1262 (Aroclor 1262)	EPA 8082A	1.0		33
PCB-1268 (Aroclor 1268)	EPA 8082A	1.0		33

* This analyte was detected above the reporting limit in one or more samples, in the water column or sediment, as indicated.

SEMI-VOLATILE ORGANICS							
Analyte	**WATER (µg/L)**	**WQS (µg/L)**	**SEDIMENT (mg/kg dry)**	**Analyte**	**WATER (µg/L)**	**WQS (µg/L)**	**SEDIMENT (mg/kg dry)**
(3-and/or 4-)Methylphenol	10		330*	Benzo(a)pyrene	2.0	0.018	66*
1,1-Biphenyl	2.0		66	Benzo(b)fluoranthene	2.0	0.018	66*
1,4-Dioxane	2.0*		66	Benzo(g,h,i)perylene	2.0	**	66*
1-Methylnaphthalene	2.0		66	Benzo(k)fluoranthene	2.0	0.018	66*
2,3,4,6-Tetrachlorophenol	10		330	Benzyl butyl phthalate	10	1900	330
2,4,5-Trichlorophenol	10		330	Bis(2-chloroethoxy)methane	10		330
2,4,6-Trichlorophenol	10	2.4	330	Bis(2-chloroisopropyl) ether	10	65000	330
2,4-Dichlorophenol	10	290	330	Bis(2-ethylhexyl) phthalate	10	2.2	330*
2,4-Dimethylphenol	10	850	330	Caprolactam	10		330
2,4-Dinitrophenol	20	5300	330	Carbazole	2.0		66*
2,4-Dinitrotoluene	10	3.4	330	Chrysene	2.0	0.018	66*
2,6-Dinitrotoluene	10		330	Di-n-butylphthalate	10	4500	330
2-Chloronaphthalene	10	1600	330	Di-n-octylphthalate	10		330
2-Chlorophenol	10	150	330	Dibenz(a,h)anthracene	2.0	0.018	66*
2-Methyl-4,6-dinitrophenol	10	280	330	Dibenzofuran	2.0		66
2-Methylnaphthalene	2.0		66	Diethyl phthalate	10	44000	330
2-Methylphenol	10		330	Dimethyl phthalate	10	1100000	330
2-Nitroaniline	10		330	Fluoranthene	2.0	140	66*
2-Nitrophenol	10		330	Fluorene	2.0	5300	66*
3,3'-Dichlorobenzidine	10	0.028	330	Hexachlorobenzene (HCB)	10	0.00029	330
3-Nitroaniline	10		330	Hexachlorocyclopentadiene (HCCP)	10	1100	330
4-Bromophenyl phenyl ether	10		330	Hexachloroethane	10	3.3	330
4-Chloro-3-methylphenol	10	**	330	Indeno (1,2,3-cd) pyrene	2.0	0.018	66*
4-Chloroaniline	10		330	Isophorone	10	960	330
4-Chlorophenyl phenyl ether	10		330	Naphthalene	2.0		66
4-Nitroaniline	10		330	Nitrobenzene	10	690	330
4-Nitrophenol	10		330	Pentachlorophenol	10	3.0 **7Q10=15**	330
Acenaphthene	2.0	990	66	Phenanthrene	2.0	**	66*
Acenaphthylene	2.0	**	66*	Phenol	10	857000 **7Q10=300**	330
Acetophenone	10		330	Pyrene	2.0	4000	66*
Anthracene	2.0	40000	66*	bis(2-Chloroethyl) Ether	10	0.53	330
Atrazine	10		330	n-Nitroso di-n-Propylamine	10	0.51	330
Benzaldehyde	10		330	n-Nitrosodiphenylamine/ Diphenylamine	10	6.0	330
Benzo(a)anthracene	2.0	0.018	66*				

All semi-volatile compounds were analyzed by EPA Method 8270D.

* This analyte was detected above the reporting limit in one or more samples, in the water column or sediment, as indicated.

** Special rules for these pollutants are found in section 391-3-6-.06 of Georgia's Water Quality Control regulations.

VOLATILE ORGANICS					
Analyte	**WATER (µg/L)**	**WQS (µg/L)**	**Analyte**	**WATER (µg/L)**	**WQS (µg/L)**
(m- and/or p-)Xylene	1.0		Chloromethane	0.5	**
1,1,1,2-Tetrachloroethane	0.5		Cyclohexane	0.5	
1,1,1-Trichloroethane	0.5		Dibromochloromethane	0.5	13
1,1,2,2-Tetrachloroethane	0.5	4.0	Dibromomethane	0.5	
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	0.5		Dichlorodifluoromethane (Freon 12)	0.5	
1,1,2-Trichloroethane	0.5	16	Ethyl Benzene	0.5	2100
1,1-Dichloroethane	0.5		Hexachlorobutadiene	0.5	18
1,1-Dichloroethene (1,1-Dichloroethylene)	0.5	7100	Isopropylbenzene	0.5	
1,1-Dichloropropene	0.5		Methyl Acetate	0.5	
1,2,3-Trichlorobenzene	0.5		Methyl Butyl Ketone	1.0	
1,2,3-Trichloropropane	0.5		Methyl Ethyl Ketone	4.0*	
1,2,4-Trichlorobenzene	0.5	70	Methyl Isobutyl Ketone	1.0	
1,2,4-Trimethylbenzene	0.5		Methyl T-Butyl Ether (MTBE)	0.5	
1,2-Dibromo-3-Chloropropane (DBCP)	1.0		Methylcyclohexane	0.5	
1,2-Dibromoethane (EDB)	1.0		Methylene Chloride	0.5	590
1,2-Dichlorobenzene	0.5	1300	Napthalene	0.5	
1,2-Dichloroethane	0.5	37	Styrene	0.5	
1,2-Dichloropropane	0.5	15	Tetrachloroethene	0.5*	3.3
1,3,5-Trimethylbenzene	0.5		Toluene	0.5	5980
1,3-Dichlorobenzene	0.5	960	Trichloroethene (Trichloroethylene)	0.5	30
1,3-Dichloropropane	0.5		Trichlorofluoromethane (Freon 11)	0.5	
1,4-Dichlorobenzene	0.5	190			
2,2-Dichloropropane	0.5		Vinyl chloride	0.5	2.4
Acetone	4.0*		cis-1,2-Dichloroethene	0.5*	
Benzene	0.5	51	cis-1,3-Dichloropropene	0.5	
Bromobenzene	0.5		n-Butylbenzene	0.5	
Bromochloromethane	0.5		n-Propylbenzene	0.5	
Bromodichloromethane	0.5*	17	o-Chlorotoluene	0.5	
Bromoform	1.0	140	o-Xylene	0.5	
Bromomethane	2.0	1500	p-Chlorotoluene	0.5	
Carbon Tetrachloride	0.5	1.6	p-Isopropyltoluene	0.5	
Carbon disulfide	2.0		sec-Butylbenzene	0.5	
Chlorobenzene	0.5	1600	tert-Butylbenzene	0.5	
Chloroethane	2.0		trans-1,2-Dichloroethene	0.5	10000
Chloroform	0.5*	470	trans-1,3-Dichloropropene	0.5	

All volatile compounds were analyzed by EPA Method 8260C, in water samples only.
* This analyte was detected above the reporting limit in one or more samples, in the water column or sediment, as indicated.
** Special rules for these pollutants are found in section 391-3-6-.06 of Georgia's Water Quality Control regulations.

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