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Proctor Creek Watershed Monitoring: First Quarterly Sampling Event Final Report

Fulton County, GA
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Title & Approval Sheet

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1.0 Introduction

The Proctor Creek Watershed is located in Fulton County, Georgia, in the city of Atlanta (Figure 1). Nine miles of the main channel of Proctor Creek are currently on the Georgia Environmental Protection Division (EPD) 303(d) list for impairment due to fecal coliform bacteria. The current study is part of a multi-year water quality monitoring project to assess both baseflow and stormflow conditions in the watershed (USEPA 2015b). Multiple locations in the watershed will be sampled on a quarterly basis, while stormwater will be sampled periodically at up to three gauging stations during significant rain events. This report contains results from the first quarterly monitoring event, which included an extensive list of inorganic and organic water chemistry parameters, as well as sediment sampling, to provide baseline data for future monitoring efforts.

2.0 Methods

2.1 Study Design and Methods

This study was conducted in accordance with the methods outlined in the Proctor Creek Watershed Monitoring Quality Assurance Project Plan (USEPA 2015b). Field sampling for this first quarterly event was conducted on September 1-3, 2015. All fecal bacteria and sediment samples were collected on the first day, September 1, whereas the remaining water samples and flow measurements were collected September 2-3. Sampling locations, which included stations in the mainstem of Proctor Creek as well as seven of its tributaries, are listed in Table 1 and shown in Figure 2. While sampling locations are identified throughout this report by Station ID and Station Name, Table 1 provides a brief description of each location as well as GPS coordinates (USEPA 2015a). Discharge was estimated at all locations except PC4 (North CSO), PC10 (Lindsay Street) and PC14 (Lillian Cooper), where flow was too low to measure, using an acoustic Doppler velocimeter and standard stream gauging techniques (USEPA 2012b). Discharge at PC8 (James Jackson) was estimated via the United States Geological Survey (USGS) real-time streamflow data for Station Number 02336526: Proctor Creek at Jackson Parkway, 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 (USEPA 2013b). Because fecal bacteria samples were collected earlier than the remaining water samples, due to their short holding time, *in situ* data were recorded during both water sampling times for comparison.

Water samples for fecal bacteria, nutrients, classical parameters, total recoverable metals, and organic constituents were collected in accordance with the SESD standard operating procedure for surface water sampling (USEPA 2013c). Sediment samples were also collected at all sampling locations except for PC2 (Greensferry), where the channel is a concrete conveyance with no suitable substrate. Composite sediment samples were collected from the top 3-5 cm of one or more depositional areas throughout each sampling reach, then homogenized and subsampled according to the SESD standard operating procedure for sediment sampling (USEPA 2014). Sediment samples were analyzed for metals, select organic compounds, and total organic carbon. All samples, except those for fecal bacteria indicators, were analyzed by the Analytical Support Branch (ASB) at SESD in accordance with the ASB Laboratory Operations and Quality Assurance Manual (USEPA 2015c). Water samples for fecal bacteria analysis were delivered to the EPA Office of Research and Development (ORD) laboratory in Athens, GA for immediate processing (within 6 hours of collection).

Water chemistry data were compared to Georgia Water Quality Standards (WQS), which include freshwater aquatic life criteria at both chronic and acute exposure levels, calculated using hardness concentrations at each station where applicable (Ga. Comp. R. & Regs. r. 391-3-6-.03). Although samples were not collected according to methods used to determine chronic exposure level violations, which require more than one sampling event, these levels were still used for comparison because they are the most protective of aquatic life. Since Proctor Creek is not used as a drinking water source, water chemistry data were not compared to state drinking water standards.

While there are no state standards for sediment quality, there are a variety of screening level benchmarks in the literature that may be used to assess potentially harmful constituents in sediments (*e.g.*, Jones & Suter 1997, Wenning *et al.* 2005). For example, sediment quality guidelines (SQGs) have been derived from multiple independent studies by statistically analyzing laboratory toxicity data for various contaminants found in freshwater sediments (USEPA 2000). Probable effect concentrations (PECs) provide a benchmark for evaluating potential toxicity to aquatic organisms, with threshold effect concentrations (TECs) indicating the lowest level at which effects may occur.

3.0 Results

3.1 *In situ* Water Quality

In situ water quality data collected during the fecal bacteria sampling period and the remaining surface water sampling period were similar. However, conductivity increased slightly between the two sampling times, while dissolved oxygen and turbidity decreased slightly, likely due to declining water stage over the 3-day sampling period. Data shown in Table 2 are those measured during surface water chemistry sampling only, since patterns among stations were consistent regardless of measurement time, yet are most relevant to water chemistry parameters.

Dissolved oxygen (DO) was relatively low at Lillian Cooper (PC14), at approximately 3 mg/L, and extremely low downstream of the North Avenue CSO outfall (North CSO; PC4) where it was less than 1.0 mg/L. Both of these tributaries had very low flow during the sampling period. These DO levels are potentially below the state water quality standard of 4.0 mg/L to support warm water species of fish, depending on stream classification and other factors. Specific conductance was between 100-300 µS/cm throughout most of the watershed, but slightly higher in two tributaries: AD Williams (PC13; 460 µS/cm) and West Highlands (PC15; 514 µS/cm). The other *in situ* parameters, temperature, pH and turbidity, were at normal levels and within acceptable limits according to Georgia water quality criteria (Ga. Comp. R. & Regs. r. 391-3-6-.03).

3.2 Precipitation and Discharge

There was no precipitation during the sampling period, but two small rain events of approximately 0.6 and 0.2 inches occurred on August 30 and 31, respectively, the two days prior to sampling (http://waterdata.usgs.gov). The USGS Jackson Parkway gauge recorded discharge of 4.6 cubic feet per second (cfs) at the start of sampling, which had dropped to 3.5 cfs by the time of completion (Figure 3). These values are between the 25th percentile and the median daily statistic for this gauging station, with gauge height below the 10-year median; therefore, stream flow was within normal levels and representative of baseflow conditions for Proctor Creek. Discharge measurements are shown in Table 2. Water level and/or velocity was too low to obtain acceptable measurements at North CSO (PC4), Lindsay Street (PC10) and Lillian Cooper (PC14). Discharge increased from 0.2 to 7.0 cfs from upstream to downstream in the main channel of Proctor Creek, with individual tributaries contributing less than 1 cfs each (Figure 4).

3.3 *Escherichia coli*

Data for fecal coliform counts are provided in Table 2, reported as the most probable number (MPN) of *Escherichia coli* per 100 mL. While the Georgia state water quality standard 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 applicable standard for this sampling period (between May and October) is a geometric mean of 200 per 100 mL, for fishing or recreational waters, 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 this sampling event, which precludes the calculation of a geometric mean. However, all samples except one (West Highlands; PC15) contained concentrations of *E. coli* higher than the relevant standard (Table 2). Counts were extremely high downstream of the decommissioned Greensferry CSO facility (Greensferry; PC2), at over 21,000 MPN per 100 mL, which is well above the water quality criterion. Levels were still very high in Proctor Creek at the next station downstream, North Avenue (PC3), and rose again in middle of the watershed at Kerry Circle (PC7).

In addition to *E. coli* enumeration, the microbial source tracking (MST) marker HF183(MGB) was used to identify human-associated bacteria in surface water samples. In this technique, quantitative real-time PCR (qPCR) amplifies the HF183 gene cluster, attributed to human fecal sources of the bacterial genus *Bacteroides* (Green *et al.* 2014). Presence of the gene, reported as target sequence copies (TSC) per 100 mL, confirms that at least some of the bacteria in the water are from human sources. The stronger the signal, indicated by higher numbers of TSC, the stronger the evidence for human-associated fecal bacteria. MST data are shown in Table 2. High TSCs were generated from samples at Greensferry (PC2), North Avenue (PC3), and Hollowell (PC5), whereas no signal was detected at Spring Street (PC12) or West Highlands (PC15). At the remaining stations, the HF183 cluster was detected, but most samples contained levels below quantitation limits.

3.4 Surface Water Chemistry

3.4.1 Inorganics

Inorganic chemistry data for surface water samples are shown in Tables 3-4. Total nitrogen (TN) was highest at Greensferry (PC2) and Lindsay Street (PC10), the latter of which also had the highest nitrate-nitrite concentration at 3.4 mg/L. Ammonia was elevated at Greensferry (PC2), North CSO (PC4) and Lillian Cooper (PC14), but undetected at most other stations. Total phosphorus (TP) was highest at Greensferry (0.4 mg/L) and in receiving waters downstream. Dissolved phosphorus accounted for approximately 60-100% of TP at all locations except Lillian Cooper (PC14), where it was only 38% of the total. Both nutrients were highest overall in the upper watershed. Increases in the mainstem of Proctor Creek were evident below the Greensferry tributary confluence, after which concentrations declined steadily along the lower watershed (Figures 5-6). In contrast, total organic carbon (TOC) was below detection in the upper watershed, but detected in several of the tributaries (*i.e.*, North CSO, West Highlands, AD Williams) and elevated downstream of each of these in the main channel (Table 3).

There were few notable patterns in the classical inorganic parameters (Table 3) or metals (Table 4). Total alkalinity was highest at AD Williams (PC13), where chloride was also elevated, and at West Highlands (PC15), where sulfate was also elevated. Sulfate was particularly low at North CSO (PC4) and Lillian Cooper (PC14). Fourteen metals were below detection at all sampling locations, and the rest were variable throughout the watershed (Table 4). Spikes of calcium, magnesium, potassium and sodium occurred in AD Williams (PC13) and West Highlands (PC15), but were relatively consistent elsewhere. Several metals (aluminum, antimony, cadmium, lead, titanium and zinc) were only detected at Hortense (PC6), Lindsay Street (PC10), Grove Park (PC11), Lillian Cooper (PC14) and/or West Highlands (PC15). However, no samples were above the acute or chronic water quality criteria for any of the metals analyzed. Analytes not detected in any water chemistry samples are listed in the Appendix.

3.4.2 Organics

Of the 163 analytes targeted in surface water analyses for herbicides, pesticides, PCBs, semi-volatile organics and volatile organics, only 8 were detected in one or more samples (Table 5; Appendix). The pesticide gamma-chlordane was present at Greensferry (PC2) and North Avenue (PC3), at levels that potentially exceed the WQS of 0.0043 μg/L of chlordane applicable during “7-day, 10-year minimum flow (7Q10) or higher stream flow conditions” (Ga. Comp. R. & Regs. r. 391-3-6-.03(5)(e)(iii)). The semi-volatile compound 1,4-dioxane was present at both AD Williams (PC13) and West Highlands (PC15), while two tentatively-identified compounds (TICs), hexadecanoic and octadecenoic acid, were found at Lillian Cooper (PC14). However, there are no water quality criteria for these three compounds. Several volatile organics were identified at a few stations, but were not consistent with any particular location and were not at levels near WQS.

The minimum reporting limits (MRLs) for PCBs as well as several semi-volatile compounds and pesticides, including chlordane, are higher than their respective WQS. Therefore, potential exceedances of those parameters, or of chlordane at other stations, would not have been detected using the routine level methodology. See Table 5 and the Appendix for analyte-specific MRLs obtained during this study versus Georgia’s WQS. It may be feasible to reach lower MRLs using advanced techniques or more concentrated extraction volumes, depending on sample characteristics and quality control requirements. Alternative methods are currently being investigated for use in future sampling events in Proctor Creek for any parameters of concern.

3.5 Sediment Chemistry

3.5.1 Inorganics

The majority of targeted metals were found in sediment samples, whereas mercury, molybdenum, selenium, silver and thallium were all below detection (Table 6; 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). As with TN and TP, the source of these metals appears to be the upper watershed, with concentrations decreasing downstream. None of the metal concentrations found in sediment samples during this study were above the specific PECs examined (Jones & Suter 1997, USEPA 2000). However, there were a few stations with copper and/or lead concentrations that were above a threshold effect concentration at which some toxicity to aquatic organisms has been found to occur, and may warrant further investigation.

3.5.2 Organics

Organic constituents detected in sediment samples are shown in Table 7, 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, with the exception of Spring Street (PC12) where all were below detection. 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 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 in this study) 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 2000). 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 (Table 1). 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.

3.6 Quality Control

Quality control activities associated with field operations included trip blanks for volatile organic analysis, temperature blanks for sample coolers and multi-meter instrument calibration. No detections were found in either trip blank for volatile organic compounds. Temperature blank results indicate that water samples were below 4°C when received by the SESD Analytical

Support Branch (ASB), with the exception of those collected within hours of delivery, because they had not had time to chill prior to receipt. However, this is not considered a violation of sample preservation requirements. All samples arrived at ASB in good condition and with a complete chain of custody.

All YSI water quality instruments used during this study were maintained and calibrated according to requirements of the SESD Operating Procedure for Equipment Inventory and Management (USEPA 2013a). YSI instruments were operated within the ranges established by the manufacturer and therefore were within acceptable field measurement uncertainty guidelines (Table 8; USEPA 2012a). At the end of each sampling day, instruments were end-checked using the appropriate standard for each parameter measured. End check results indicate all instrument measurements were within acceptable limits, with the exception of a pH probe on sonde #20. This sonde was above the acceptance criterion for pH 10.0 following the *E. coli* sampling on September 1, but was used only at a subset of stations and did not appear to affect the circumneutral readings obtained in the field. Regardless, this sonde was not used during subsequent water chemistry sampling, and therefore, data collected with it are not presented in this report.

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 the North Avenue CSO tributary and an upstream tributary at Lindsay Street, the Greensferry tributary, and mainstem stations at North Avenue and Hollowell Parkway. In the water column, nutrients were elevated at all five of these locations, although there were distinct patterns between the two CSO tributaries. Below the decommissioned Greensferry CSO, both nitrogen and phosphorus were relatively high, with a large fraction of TN as ammonia, but TOC was below detection. *E. coli* levels at that location were more than 100X the fecal coliform water quality standard of 200 per 100 mL and 8X higher than at any other station. In contrast, the tributary below the active North Avenue CSO was lower in nutrients and higher in TOC, with an *E. coli* concentration only 2X the fecal coliform water quality standard. However, there was no discharge from the North Avenue CSO at the time of sampling. Total nitrogen was also relatively high in the Lindsay Street tributary, with 97% as nitrate-nitrite, but levels dropped 6-fold downstream of the CSO outfall where nitrate-nitrite was below detection.

Metals and organics followed a similar pattern, but this was much more visible in the sediment than in the water column. Several surface water metals were elevated in the Lindsay Street tributary and the other downtown area stations. Sediment concentrations of copper, lead and zinc were at levels of potential concern for aquatic organisms at one or more of these locations. The pattern of elevated contaminants near the downtown area was more pronounced for semi-volatile organics in the sediment. Polycyclic aromatic hydrocarbons (PAHs) were detected at levels of potential concern for aquatic biota, particularly in Proctor Creek at both North Avenue and Hollowell Parkway, as well as the North Avenue CSO tributary. PAHs include compounds associated with automotive fluids that accumulate on roads and parking lots, then wash into the stream during storm events. It is therefore unsurprising to find them in higher concentrations near downtown Atlanta. Furthermore, this mixture of contaminants found in Proctor Creek sediments is characteristic of urban streams across the country (Paul & Meyer 2001).

There were few locations where pesticides were detected in the watershed. However, chlordane was found at relatively high concentrations in the sediment at the Lindsay Street tributary, and detected in the water column at the Greensferry tributary and Proctor Creek at North Avenue. Chlordane was banned in the United States in 1988, but persists in the environment and can be toxic to aquatic organisms as well as humans via direct exposure or bioaccumulation (USEPA 1997). Given that concentrations were above both the sediment quality benchmark and the water quality criterion for protection of aquatic life, further analysis is recommended to assess potential toxicity.

4.2 Mainstem Proctor Creek

Proctor Creek originates along the western edge of downtown Atlanta, then flows northwest to its confluence with the Chattahoochee River. The upstream reach sampled at Burbank Drive did not have any substantial water quality issues, although the pesticide 4,4'-DDT and the PCB Aroclor 1254 were both detected in the sediment, below levels of potential concern. Both nitrogen and phosphorus concentrations were somewhat low at Burbank Drive, peaked in the North Avenue area, then declined steadily downstream of Hollowell Parkway and returned to consistent levels in the lower watershed (Figures 5-6). The majority of contaminants appear to enter Proctor Creek at the Greensferry and North Avenue CSO tributaries, as discussed above. Surface water concentrations of metals were low and relatively uniform throughout the main channel, but metals and organics in sediment followed a pattern similar to TN and TP with peaks near North Avenue and gradual decreases downstream. In contrast, organics in the water column were patchy and may have resulted directly from individual sources along the stream.

4.3 Proctor Creek Tributaries

Seven tributaries of Proctor Creek were sampled in this study, each with unique characteristics likely influenced by differing land uses in the associated subcatchment. The two tributaries which drain downtown Atlanta were the largest sources of nutrients, pesticides, PAHs and *E. coli*, a common finding in urban landscapes (Paul & Meyer 2001). The Lindsay Street tributary flows through a high-density residential neighborhood before eventually receiving the North Avenue CSO effluent, when discharging. The tributary that flows through the decommissioned Greensferry CSO facility, where fecal bacteria was found in the highest concentration, also originates in an area of high-density residential and commercial land use. In addition to increased surface water nutrients, these locations had elevated PAHs as well as the pesticide chlordane, primarily in sediments. Thus, these streams appear to contribute the most contaminants to the Proctor Creek watershed via urban runoff.

Urban effects were also evident in the Grove Park tributary, where PAHs and some metals were elevated. This subcatchment is on the western edge of downtown, where the land use transitions to medium-density residential with fewer commercial properties (ARC 2009). On the opposite side of Proctor Creek, two large rail yards operated by CSX and Norfolk Southern span the northern boundary of the watershed. Industrial impacts were seen downstream of these yards, in the tributary flowing through the West Highlands neighborhood. Some metals, such as copper and lead, were at sediment concentrations similar to those found near downtown. Specific conductivity, composed of various ions including calcium, magnesium, sodium and potassium, was also elevated in this tributary.

At the downstream end of the watershed, the Lillian Cooper Park, AD Williams and Spring Street tributaries are furthest removed from the urban center. 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. Additionally, the Lillian Cooper Park tributary was higher in nutrients and lower in dissolved oxygen, compared to other stations, which may have been due in part to an animal carcass upstream of the sampling area as well as to the very low water level. 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. No contaminants were detected at levels of concern in either the surface water or sediment in this tributary.

5.0 Conclusions

Based on the data obtained during this first intensive sampling event, we are able to focus our efforts on a narrower list of parameters and possibly target areas of concern in future sampling events. During subsequent quarterly sampling, surface water analyses may include inorganic parameters only. However, stormwater sampling will initially include organic parameters as well, to determine whether these analytes may be present during the “first flush” of a storm event, when impervious surface runoff can significantly increase contaminant loads to the watershed. Furthermore, macroinvertebrate bioassessments and fish tissue analyses will provide additional details about long-term effects of potential contaminants and more specific advisories regarding recreational activities in the watershed.

6.0 References

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Table 1: 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
PC1	Burbank	MAIN	Proctor Creek at Burbank Drive	33.75710	-84.42892
PC2	Greensferry	TRIB	Tributary downstream of 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

Table 2: Data from *in situ* water quality measurements, discharge calculations, and fecal bacteria analyses. LOQ = limit of quantitation

Station ID	Station Name	Date	Time	Temp. (°C)	Sp. Cond. (µS/cm)	pH (S.U.)	Turbidity (NTU)	D.O. (mg/L)	Discharge (cfs)	*E. coli* (MPN/100mL)	HF183MGB (TSC/100mL)
PC1	Burbank	9/3/15	12:01	22.84	175	7.52	0.2	8.49	0.23	942	5,056
PC2	Greensferry	9/3/15	11:23	23.43	286	7.02	0.7	5.71	0.75	21,730	2,261,080
PC3	North Avenue	9/3/15	9:56	22.75	307	7.17	1.6	7.59	1.01	2,717	550,136
PC4	North CSO	9/3/15	10:53	21.92	242	6.83	0.4	0.74	NA	409	<LOQ
PC5	Hollowell	9/3/15	8:52	22.97	272	6.67	0.9	6.04	1.27	523	25,287
PC6	Hortense	9/2/15	15:56	25.15	268	7.67	1.7	8.88	1.94	406	8,564
PC7	Kerry Circle	9/2/15	14:18	24.74	269	7.36	1.4	8.19	2.85	1,794	9,559
PC8	James Jackson	9/2/15	11:40	23.19	210	7.53	2.0	8.28	3.6*	548	<LOQ
PC9	Northwest	9/2/15	9:21	22.73	195	7.12	1.9	7.11	7.02	465	<LOQ
PC10	Lindsay Street	9/3/15	12:56	21.69	288	6.66	0.3	7.29	NA	484	<LOQ
PC11	Grove Park	9/2/15	17:10	24.62	204	7.76	0.8	7.84	0.35	345	<LOQ
PC12	Spring Street	9/2/15	13:05	23.84	155	7.28	1.7	8.43	0.86	301	0
PC13	AD Williams	9/2/15	10:40	22.22	460	7.53	1.0	7.73	0.09	1,042	<LOQ
PC14	Lillian Cooper	9/2/15	12:26	22.43	104	6.57	6.3	3.09	NA	519	<LOQ
PC15	West Highlands	9/2/15	15:02	21.62	514	7.49	3.6	7.43	0.15	83	0

*Discharge at PC8 obtained from USGS gauge data available online at http://waterdata.usgs.gov/ga/nwis for station number 02336526, Proctor Creek at Jackson Parkway.

Table 3: Surface water data for nutrient and classical analyses.

SURFACE WATER NUTRIENTS/CLASSICALS															
	PC1	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**	**PC8**	**PC9**	**PC10**	**PC11**	**PC12**	**PC13**	**PC14**	**PC15**
Analyte (mg/L)	**Burbank**	**Greens-ferry**	**North Avenue**	**North CSO**	**Hollowell**	**Hortense**	**Kerry Circle**	**James Jackson**	**Northwest**	**Lindsay Street**	**Grove Park**	**Spring Street**	**AD Williams**	**Lillian Cooper**	**West Highlands**
Total Organic Carbon	1.0 U	1.0 U	1.0 U	4.3	1.8	1.0 U	2.6	1.5	1.9	1.0 U	1.2	1.5	4.5	2.5	4.3
Total Phosphorus	0.033	0.40	0.24	0.13	0.22	0.12	0.050	0.034	0.036	0.085	0.032	0.044	0.026	0.048	0.010 U
Total Dissolved Phosphorus	0.031	0.35	0.21	0.12	0.18	0.094	0.030	0.020 J,CR	0.025 J,CR	0.077	0.025 J,CR	0.029	0.023 J,CR	0.018 J,CR	0.010 U
Total Nitrogen	0.921	4.0	2.09	0.59	2.55	1.66	1.06	0.67	0.66	3.52	0.68	0.61	1.17	1.13	1.10
Total Kjeldahl Nitrogen	0.081 J,QR-1	1.6	0.29	0.54	0.35	0.26	0.19 J,QR-2	0.17 J,QR-2	0.18 J,QR-2	0.12 J,QR-1	0.21 J,QR-1	0.18 J,QR-2	0.27	0.93	0.21 J,QR-2
Ammonia as N	0.050 U	1.0	0.050	0.35	0.13	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.58	0.12
Nitrate/Nitrite as N	0.84	2.4	1.8	0.050 U	2.2	1.4 J,QM-2	0.87	0.50	0.48	3.4	0.47	0.43	0.90	0.20	0.89
Alkalinity, Total (as $CaCO_3$)	53	65	64	110 J,QM-4	110	98	67	59	81	58	52	45	130	38	190 J,QM-4
Bromide	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	1.3	0.10 U	0.10 U
Chloride	11	20	26	24	18	23	18	11	9.5	17	14	10	57	5.2	20
Fluoride	0.079	0.32	0.24	0.20	0.25	0.20	0.18	0.20	0.19	0.28	0.15	0.21	0.18	0.11	0.22
Sulfate as SO_4	12	33	29	2.4	28	25	32	26	22	42	23	12	8.8	3.0	55

CR = Analyte is found in the associated blank, at a level just above MDL, suspect minimal impact on reported sample.
J = The identification of the analyte is acceptable; the reported value is an estimate.
QM-2 = Matrix Spike Recovery greater than method control limits.
QM-4 = Matrix Precision outside method control limits.
QR-1 = MRL verification recovery less than lower control limits.
QR-2 = MRL verification recovery greater than upper control limits.
U = The analyte was not detected at or above the reporting limit.

Table 4: Surface water data for metals analyses. Detections are highlighted in grey for clarity, but no samples were above water quality criteria. Acute and chronic exposure levels for aquatic life, calculated using hardness values for each station according to Ga. Comp. R. & Regs. r. 391-3-6-.03(5)(e)(ii), are provided for comparison.

SURFACE WATER METALS															
	PC1	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**	**PC8**	**PC9**	**PC10**	**PC11**	**PC12**	**PC13**	**PC14**	**PC15**
Analyte (µg/L)	**Burbank**	**Greens-ferry**	**North Avenue**	**North CSO**	**Hollowell**	**Hortense**	**Kerry Circle**	**James Jackson**	**Northwest**	**Lindsay Street**	**Grove Park**	**Spring Street**	**AD Williams**	**Lillian Cooper**	**West Highlands**
Aluminum	100 U	100 U	100 U	100 U	100 U	130	100 U	100 U	100 U	100 U	100 U	100 U	100 U	320	100 U
Antimony	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.3	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Barium	60	56	58	29	57	49	48	39	38	82	34	33	50	47	94
Cadmium	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.17	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U
Calcium	16000	24000	24000	19000	24000	22000	24000	20000	19000	27000	18000	14000	30000	9000	55000
Iron	130	130	240	1900	230	380	290 U,B-2	300 U,B-2	310 U,B-2	130	240	440 U,B-2	190 U,B-2	1600	450 U,B-2
Lead	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.6	1.0 U	1.0 U	1.0 U	1.4	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Magnesium	3300	5000	4900	2000	4700	4300	4300	3800	3400	4600	3300	2400	8200	1600	10000
Manganese	5.2	50	35	260	21	22	24	16	21	19	15	14	22	390	360
Potassium	3100	5400	5200	3700	5400	5000	5000	4000	4200	4700	3300	3000	5600	2600	6200
Sodium	8800	16000	18000	20000	15000	17000	15000	11000	10000	16000	12000	9400	44000	5600	31000
Strontium	90	100	110	79	110	98	110	93	89	150	83	71	170	60	280
Titanium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	6.7	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	7.7	5.0 U
Zinc	10 U,J,QR-1	10 U,J,QR-1	10 U,J,QR-1	10 U,J,QR-1	10 U,J,QR-1	19 J,QR-1	10 U,J,QR-1	10 U,J,QR-1	10 U,J,QR-1	71	10 U,J,QR-1	10 U,J,QR-1	10 U,J,QR-1	17 J,QR-1	11 J,QR-1
Hardness* (mg/L)	53.5	80.5	80.1	55.7	79.3	72.6	77.6	65.5	61.4	86.4	58.5	44.8	108.7	29.1	178.5
Freshwater Aquatic Life: Acute Criteria															
Cadmium	1.10	1.63	1.62	1.14	1.61	1.47	1.57	1.33	1.25	1.75	1.20	0.92	2.18	0.61	3.54
Lead	32.48	50.96	50.68	33.97	50.12	45.50	48.95	40.62	37.83	55.06	35.86	26.67	70.71	16.47	120.62
Zinc	68.97	97.51	97.10	71.37	96.27	89.34	94.52	81.88	77.51	103.53	74.40	59.34	125.76	41.17	191.46
Freshwater Aquatic Life: Chronic Criteria															
Cadmium	0.16	0.21	0.21	0.16	0.21	0.20	0.21	0.18	0.18	0.22	0.17	0.14	0.26	0.10	0.37
Lead	1.27	1.99	1.97	1.32	1.95	1.77	1.91	1.58	1.47	2.15	1.40	1.04	2.76	0.64	4.70
Zinc	69.54	98.30	97.89	71.95	97.06	90.07	95.30	82.55	78.15	104.38	75.01	59.83	126.79	41.51	193.02

Calculated using the formula: Hardness (as mg/L CaCO3) = (2.497(Ca, mg/L)) + (4.118*(Mg, mg/L)). (USEPA 2013d)

B-2 = Reporting level elevated due to trace amounts of anlyte present in the method blank.

J = The identification of the analyte is acceptable; the reported value is an estimate.

QR-1 = MRL verification recovery less than lower control limits.

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

Table 5: Surface water data for organic analyses. Detections are highlighted in grey for clarity. Levels of gamma-chlordane highlighted in yellow are potentially above the water quality criteria of 0.0043 µg/L (7Q10 flow or higher) and 0.00081 µg/L (annual average flow or higher) for chlordane (Ga. Comp. R. & Regs. r. 391-3-6-.03(5)(e)).

SURFACE WATER PESTICIDES

		PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15
Analyte (µg/L)	WQS* (µg/L)	Burbank	Greens-ferry	North Avenue	North CSO	Hollowell	Hortense	Kerry Circle	James Jackson	Northwest	Lindsay Street	Grove Park	Spring Street	AD Williams	Lillian Cooper	West Highlands
gamma-Chlordane**	0.00081	0.052 U	0.099	0.055	0.051 U	0.050 U	0.051 U	0.049 U	0.049 U	0.051 U	0.050 U	0.051 U	0.049 U	0.050 U	0.052 U	0.049 U

SURFACE WATER SEMI-VOLATILE ORGANICS

		PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15
Analyte (µg/L)	WQS (µg/L)	Burbank	Greens-ferry	North Avenue	North CSO	Hollowell	Hortense	Kerry Circle	James Jackson	Northwest	Lindsay Street	Grove Park	Spring Street	AD Williams	Lillian Cooper	West Highlands
1,4-Dioxane		2.0 U	2.1 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.9 U	2.0 U	2.0 U	2.0 U	12	2.1 U	3.7
Hexadecanoic acid (TIC)		-	-	-	-	-	-	-	-	-	-	-	-	-	10 NJ	-
Octadecenoic Acid (TIC)		-	-	-	-	-	-	-	-	-	-	-	-	-	20 NJ	-

SURFACE WATER VOLATILE ORGANICS

		PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15
Analyte (µg/L)	WQS (µg/L)	Burbank	Greens-ferry	North Avenue	North CSO	Hollowell	Hortense	Kerry Circle	James Jackson	Northwest	Lindsay Street	Grove Park	Spring Street	AD Williams	Lillian Cooper	West Highlands
Acetone		4.0 U	4.0 U	24	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0	4.0 U
Bromodichloromethane	17	0.50 U	0.18 J,Q-2	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.24 J,Q-2	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroform	470	0.50 U	1.3	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	1.1	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Methyl Ethyl Ketone		4.0 U	4.0 U	1.5 J,Q-2	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
Tetrachloroethene (Tetrachloroethylene)	3.3	0.50 U	0.50 U	0.50 U	0.50 U	0.19 J,Q-2	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.20 J,Q-2	0.50 U	0.50 U	0.18 J,Q-2
cis-1,2-Dichloroethene		0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.18 J,Q-2

NJ = Presumptive evidence that analyte is present; reported as tentative identification with an estimated value.
J = The identification of the analyte is acceptable; the reported value is an estimate.
Q-2 = Result greater than MDL but less than MRL.
U = The analyte was not detected at or above the reporting limit.

* WQS = Water quality standard for annual average or higher stream flow conditions.
** WQS listed is for chlordane. The 7Q10 standard for chlordane = 0.0043 µg/L.

Table 6: Sediment data for metals analyses. Detections are highlighted in grey for clarity. Sediment quality benchmarks are provided for comparison, with values above the TEC highlighted in orange.

SEDIMENT METALS																	
			PC1	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15
Analyte (mg/kg dry)	ARCS TEC	ARCS PEC	Burbank	North Avenue	North CSO	Hollowell	Hortense	Kerry Circle	James Jackson	Northwest	Lindsay Street	Grove Park	Spring Street	AD Williams	Lillian Cooper	West Highlands
Aluminum		58030	2500 J,QM-2	3500	4100	2800	1900 J,QM-2	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,J,D-4	0.37
Calcium			490 J,QM-2	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 J,QM-2	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 J,QM-2	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 J,QM-2	350	360	260	170 J,QM-2	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)

TEC = Threshold Effect Concentration

PEC = Probable Effect Concentration

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

J = The identification of the analyte is acceptable; the reported value is an estimate.

D-4 = MRL elevated due to interferences.

QM-2 = Matrix Spike Recovery greater than method control limits.

Table 7: Sediment data for organic analyses. Detections are highlighted in grey for clarity. Sediment quality benchmarks are provided for comparison, with values above the TEC in orange and above either of the PECs in yellow. PAH compounds are indicated in green.

SEDIMENT PESTICIDES AND PCBs																	
				PC1	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15
Analyte (µg/kg dry)	ARCS TEC	ARCS PEC	CB PEC	Burbank	North Avenue	North CSO	Hollowell	Hortense	Kerry Circle	James Jackson	Northwest	Lindsay Street	Grove Park	Spring Street	AD Williams	Lillian Cooper	West Highlands
4,4'-DDT (p,p'-DDT)			62	5.0	11 U,D-4	13 U,D-4	11 U,D-4	11 U,D-4	2.2 U	2.2 U	11 U,D-4	2.2 U	2.2 U	12 U,D-4	2.2 U	2.3 U	11 U,D-4
Dieldrin			61.8	2.3 U,J,QR-1	11 U,J,D-4, QR-1	13 U,J,D-4, QR-1	11 U,J,D-4, QR-1	11 U,D-4	2.2 U	2.2 U	11 U,D-4	5.8 J, QR-1	2.2 U,J, QR-1	12 U,D-4	2.2 U	2.3 U,J, QR-1	11 U,D-4
alpha-Chlordane	CB PEC = 17.6 for chlordane			2.3 U	11 U,D-4	13 U,D-4	11 U,D-4	11 U,D-4	2.2 U	2.2 U	11 U,D-4	24 J,Q-4	2.2 U	12 U,D-4	2.2 U	2.3 U	11 U,D-4
gamma-Chlordane				2.3 U	11 U,D-4	13 U,D-4	11 U,D-4	11 U,D-4	2.2 U	2.2 U	11 U,D-4	59	2.5	12 U,D-4	2.2 U	2.3 U	11 U,D-4
PCB-1254 (Aroclor 1254)				85	27 U,CRc	12 U	21 U,CRc	13 U,CRa	46 J,I-5	11 U	18 U,D-4	54 U,D-4	11 U	11 U	22 U,CRc	11 U	12 U,CRa
PCB-1260 (Aroclor 1260)				86 U,CRb	26	12 U	20	12 J,I-5	47 U,CRa	11 U	11 U	54 U,D-4	11 U	11 U	21	11 U	11 J,I-5

SEDIMENT SEMI-VOLATILES																	
				PC1	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15
Analyte (µg/kg dry)	ARCS TEC	ARCS PEC	CB PEC	Burbank	North Avenue	North CSO	Hollowell	Hortense	Kerry Circle	James Jackson	Northwest	Lindsay Street	Grove Park	Spring Street	AD Williams	Lillian Cooper	West Highlands
(3-and/or 4-) Methylphenol				460 U	430 U	99 J,Q-2	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 J,Q-2	57 J,Q-2	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 J,Q-2	64 J,Q-2	89	78 J,Q-2	87 U	90 U	86 U	110	84 U
Benzo(a)pyrene	350	393.7		91 U	850	830	650	370	88	82 J,Q-2	120	86	55 J,Q-2	90 U	86 U	110	44 J,Q-2
Benzo(b)fluoranthene				48 J,Q-2	1000	1200	770	460	100	85 J,Q-2	110	110	80 J,Q-2	90 U	44 J,Q-2	150	57 J,Q-2
Benzo(g,h,i)perylene	290	6300		91 U	570	530	460	250	51 J,Q-2	59 J,Q-2	76 J,Q-2	92	47 J,Q-2	90 U	86 U	83 J,Q-2	84 U
Benzo(k)fluoranthene				47 J,Q-2	890	890	620	390	85 J,Q-2	83 J,Q-2	100	87	65 J,Q-2	90 U	86 U	120	49 J,Q-2
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 J,Q-2	86 U	86 U	87 U	85 U	87 U	90 U	86 U	89 U	84 U
Chrysene	500	5200	1290	49 J,Q-2	1000	970	740	420	94	80 J,Q-2	110	99	71 J,Q-2	90 U	86 U	150	47 J,Q-2
Dibenz(a,h)anthracene		28.2		91 U	240	180	170	84 J,Q-2	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 J,Q-2	1900	1500	1300	600	150	130	130	160	120	90 U	51 J,Q-2	250	76 J,Q-2
Fluorene	34.64	651.9	536	91 U	59 J,Q-2	66 J,Q-2	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 NJ	4000 NJ	-	-	-	-	-	-	-	-	-	-	-
Indeno (1,2,3-cd) pyrene	78	836.7		91 U	530	480	420	230	47 J,Q-2	53 J,Q-2	65 J,Q-2	72 J,Q-2	87 U	90 U	86 U	75 J,Q-2	84 U
Phenanthrene			1170	91 U	1000	860	590	210	47 J,Q-2	71 J,Q-2	87 U	120	87 U	90 U	86 U	110	84 U
Pyrene	570	3225	1520	80 J,Q-2	1800	1500	1200	580	150	150	170	170	100	90 U	58 J,Q-2	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)
TEC = Threshold Effect Concentration; PEC = Probable Effect Concentration
CB = Consensus-Based sediment quality guidelines (USEPA 2000)
CRa = MRL raised due to the presence of a mixture of Aroclors.
CRb = MRL raised due to the presence of Ar1254.
CRc = MRL raised due to the presence of Ar1260.
D-4 = MRL elevated due to interferences.
I-5 = Mixture of Aroclors in sample; predominant Aroclors reported.
J = The identification of the analyte is acceptable; the reported value is an estimate.
NJ = Presumptive evidence that analyte is present; reported as tentative identification with an estimated value.
Q-2 = Result greater than MDL but less than MRL.
Q-4 = Greater than 40% difference between primary and confirmatory GC columns.
QR-1 = MRL verification recovery less than lower control limits.
U = The analyte was not detected at or above the reporting limit.

Table 8: Field measurement uncertainty ranges for YSI 6920 data sondes used to collect *in situ* water chemistry data.

Parameter	Units	Measurement Technology	Sensitivity of Primary Equipment
Dissolved Oxygen	mg/L	Luminescent dissolved oxygen probe	± 0.1 mg/L or ± 1% of reading
Temperature	°C	Thermistor	± 0.3 °C
pH	SU	Glass electrode	± 0.2 SU
Specific Conductivity	µS/cm	Nickel electrode cell	± 0.5% of reading
Turbidity	NTU	Optical probe	Greater of: ± 10% or 2 NTU

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.

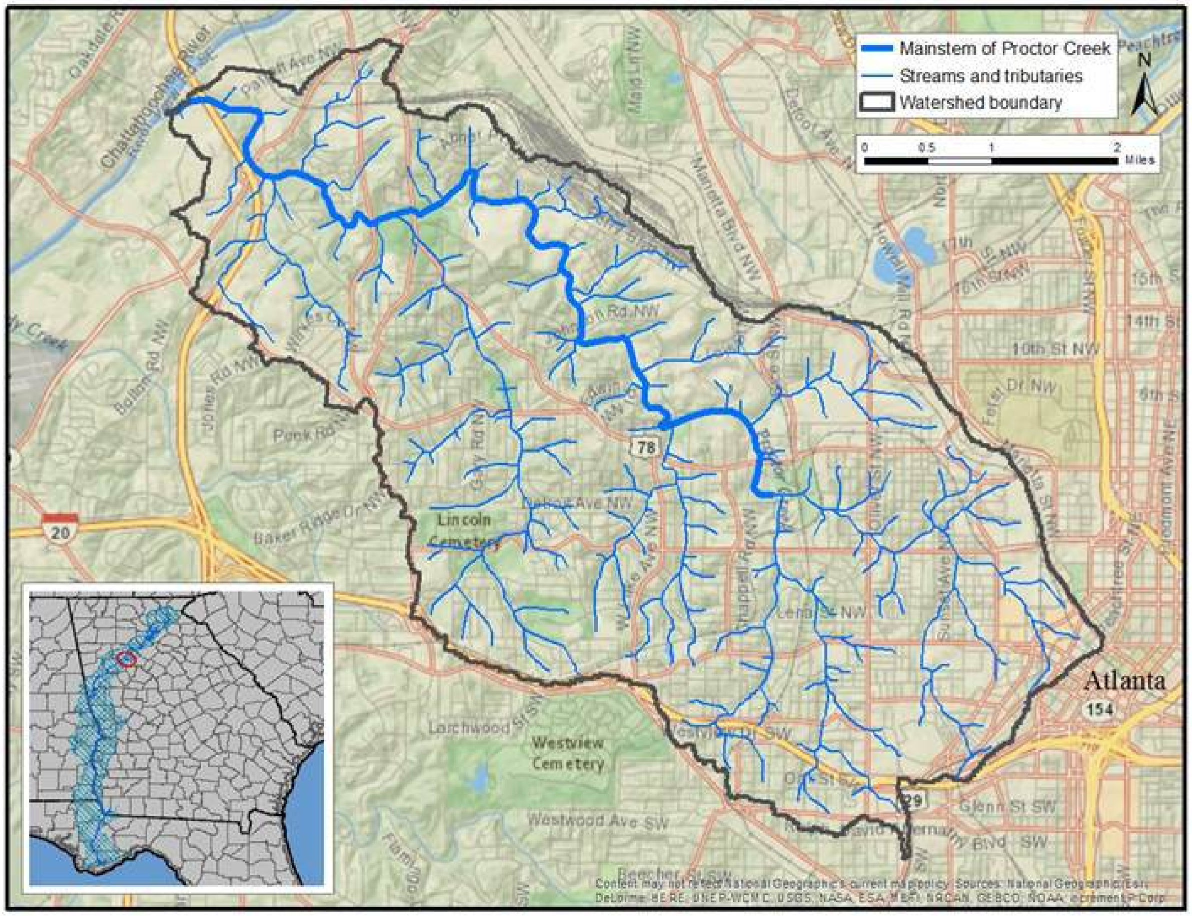


Figure 2: Map of sampling locations in the Proctor Creek watershed. The darker blue line indicates the mainstem of Proctor Creek, with tributaries shown in lighter blue. See Table 1 for station descriptions.

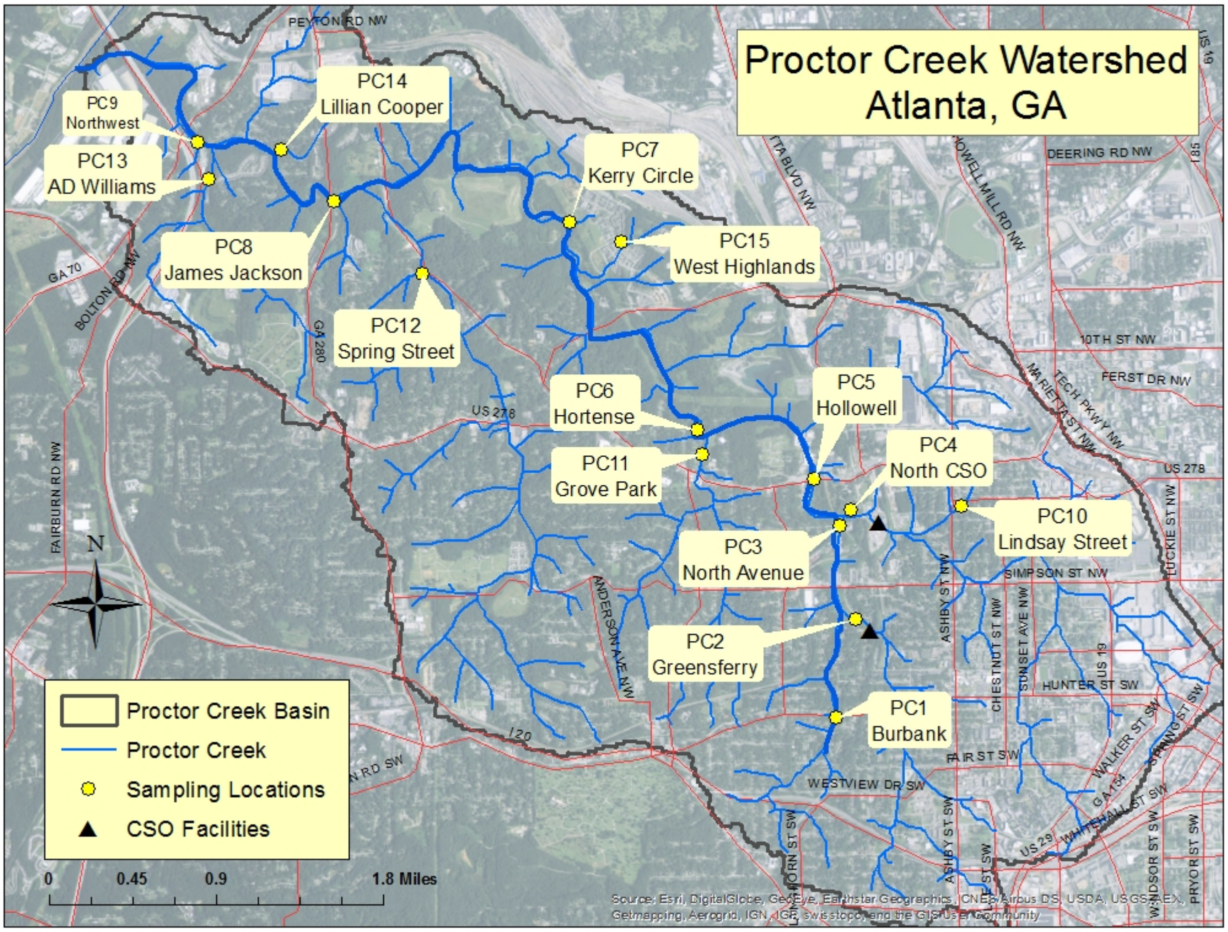


Figure 3: Discharge data from the USGS gauge #02336526, Proctor Creek at Jackson Parkway, for the weeks prior to and during the sampling dates of September 1-3 (http://waterdata.usgs.gov).

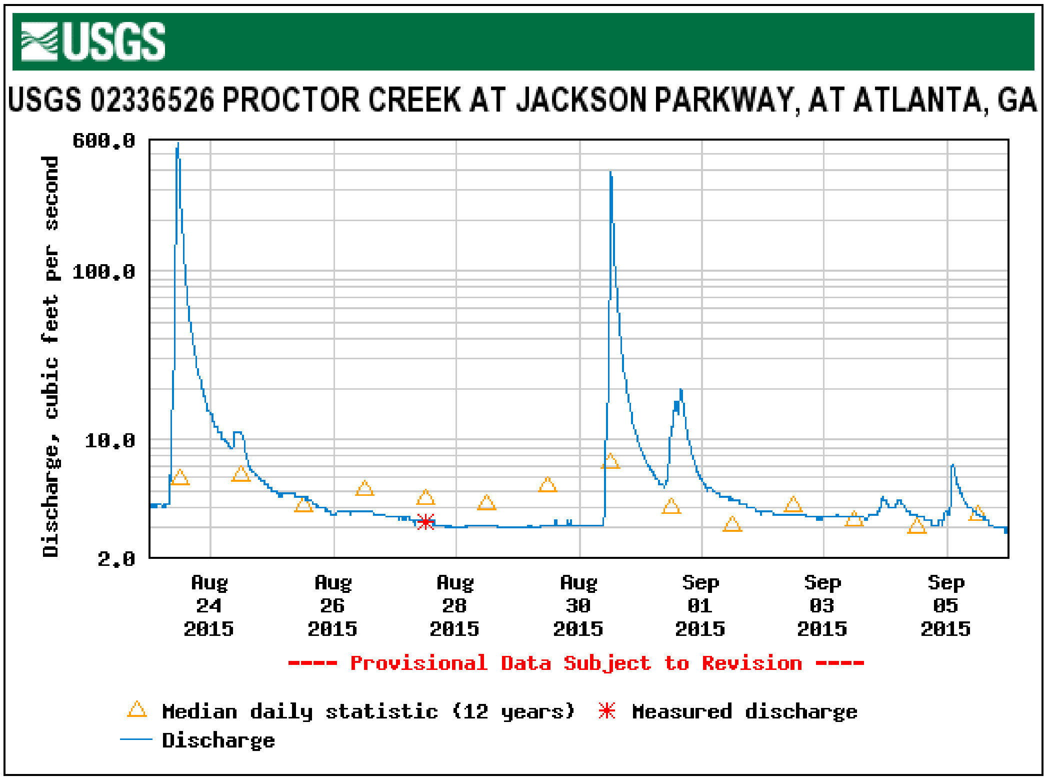


Figure 4: Discharge measured throughout Proctor Creek during the sampling event.

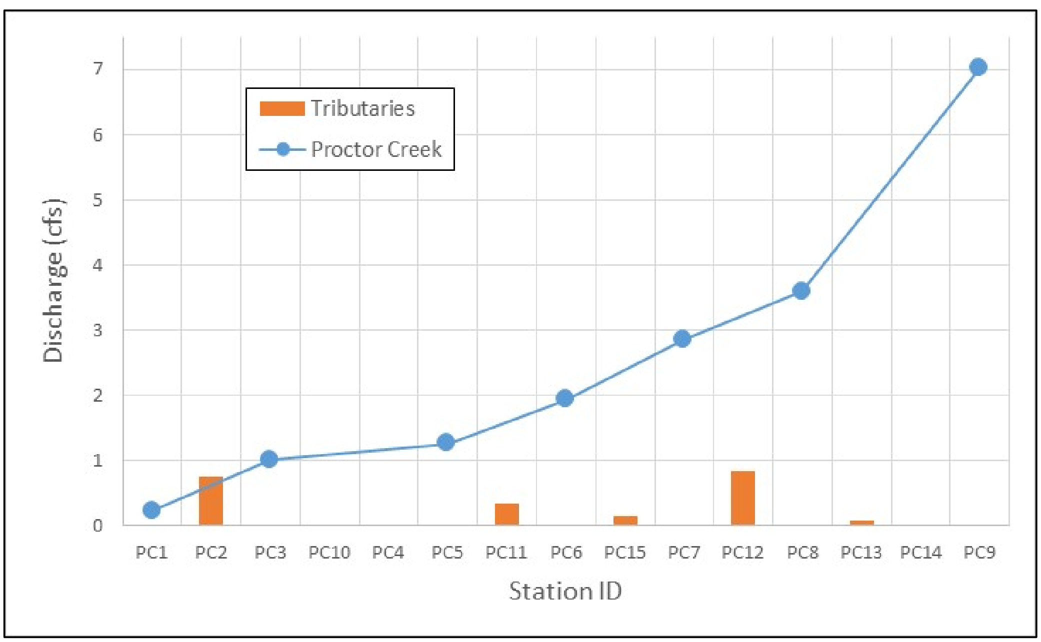


Figure 5: Total nitrogen (mg/L) in Proctor Creek and its tributaries. Locations are shown from upstream to downstream, in order from left to right.

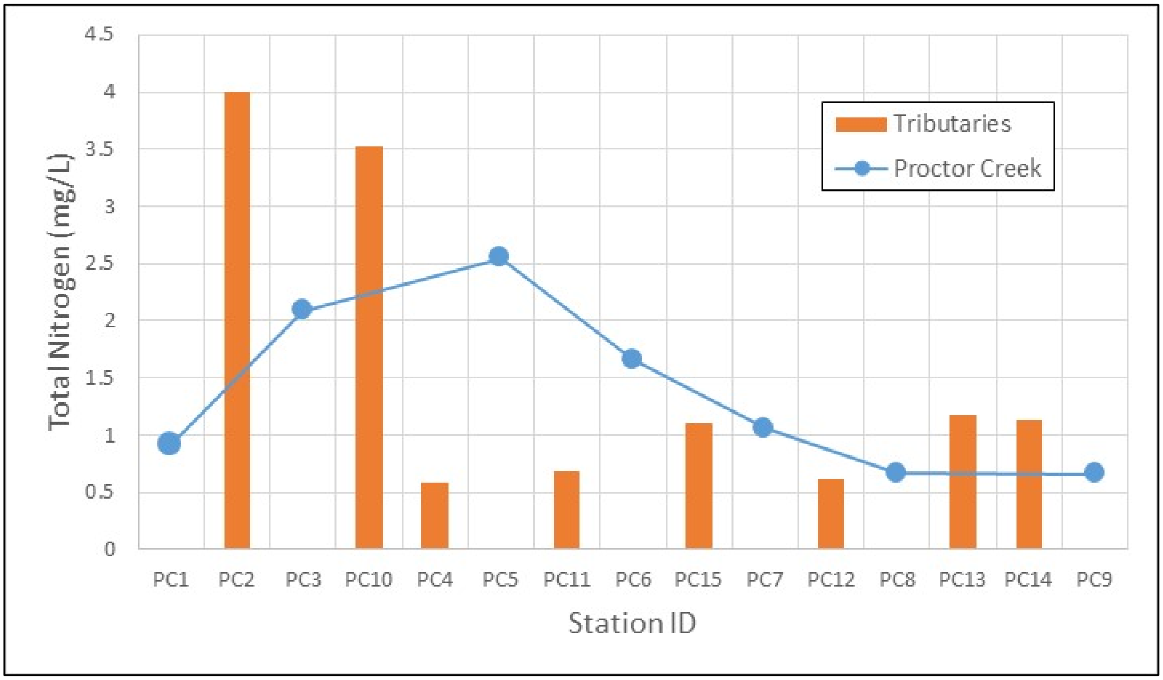
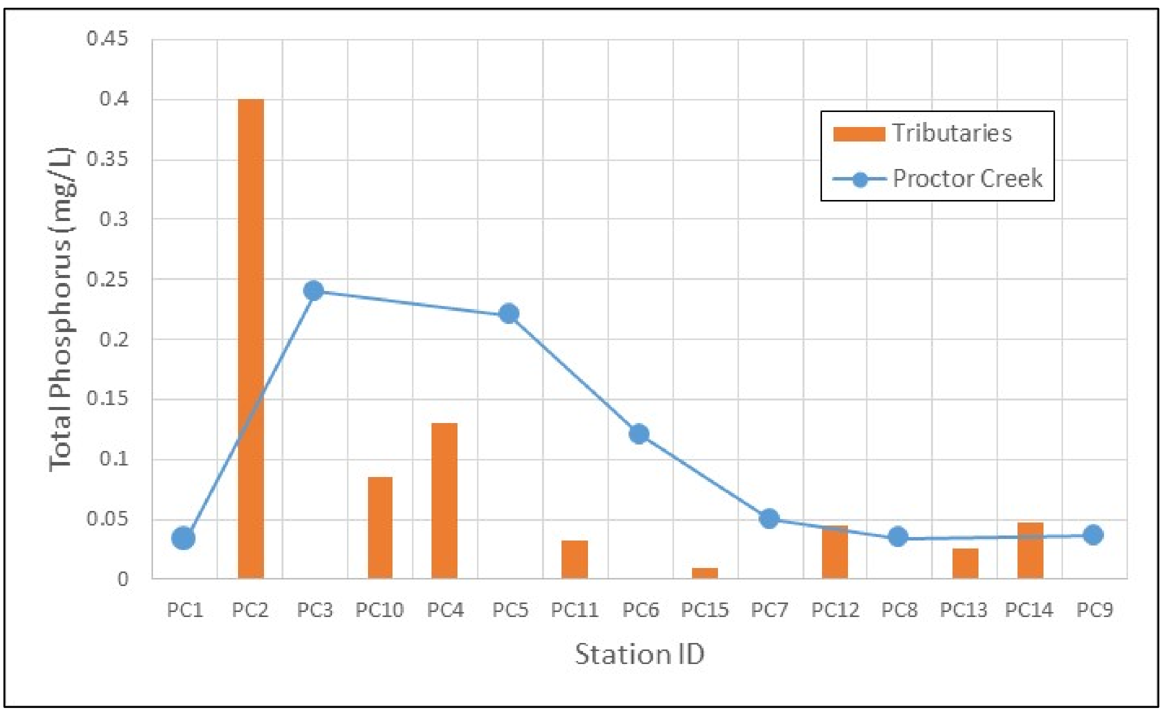


Figure 6: Total phosphorus (mg/L) in Proctor Creek and its tributaries. Locations are shown from upstream to downstream, in order from left to right.



APPENDIX:
Tables of Analytical Chemistry Non-Detections and Water Quality Standards

The following tables list analytes not detected in water and/or sediment samples, at the minimum reporting limit (MRL) indicated. A range is given for those analytes with MRLs that varied according to laboratory QC per batch, as well as any qualifiers. Water quality standards (WQS) listed are for annual average or higher stream flow conditions, which may not be applicable to conditions during the sampling event. WQS for 7Q10 or higher flow conditions, for which analytes they exist, are listed in bold. A few analytes have 1Q10 (1-day, 10-year) criteria. Sediment samples were not analyzed (NA) for select herbicides and volatile organics. *See Tables 5-7 for detected analytes.

TOTAL RECOVERABLE METALS

Analyte	WATER (µg/L)	WQS (µg/L)	SEDIMENT (mg/kg dry)
Arsenic	1.0 U	1Q10 = 340 **7Q10 = 150**	*
Beryllium	3.0 U		*
Chromium	5.0 U	**	*
Cobalt	5.0 U		*
Copper	10 U	**	*
Mercury	0.10 U	1Q10 = 1.4 **7Q10 = 0.012**	0.046-0.049 U
Molybdenum	10 U		0.98-1.0 U
Nickel	10 U	**	*
Selenium	2.0 U	**7Q10 = 5**	0.39-0.40 U
Silver	5.0 U	***	0.49-0.50 U
Thallium	0.20 U		0.20 U
Tin	15 U		*
Vanadium	5.0 U		*
Yttrium	3.0 U		*

PCB AROCLORS

Analyte	WATER (µg/L)	WQS (µg/L)	SEDIMENT (mg/kg dry)
PCB-1016 (Aroclor 1016)	0.24-0.26 U	for all PCBs: 0.000064 **7Q10 = 0.014**	11-54 U
PCB-1221 (Aroclor 1221)	0.49-0.53 U		21-110 U
PCB-1232 (Aroclor 1232)	0.24-0.26 U		11-54 U
PCB-1242 (Aroclor 1242)	0.24-0.26 U		11-54 U
PCB-1248 (Aroclor 1248)	0.24-0.26 U		11-54 U
PCB-1254 (Aroclor 1254)	0.24-0.26 U		*
PCB-1260 (Aroclor 1260)	0.24-0.26 U		*
PCB-1262 (Aroclor 1262)	0.24-0.26 U		11-54 U
PCB-1268 (Aroclor 1268)	0.24-0.26 U		11-54 U

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

J = Identification is acceptable; reported value is an estimate.

D-4 = MRL elevated due to interferences.

QM-3 = Matrix Spike Precision outside method control limits.

** 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).

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

HERBICIDES

Analyte	WATER (µg/L)	WQS (µg/L)	SEDIMENT (mg/kg dry)
2,4,5-T	1.0-1.1 U,D-4		300-350 U,D-4
2,4,5-TP (Silvex)	1.0-1.1 U,D-4	**7Q10 = 50**	300-350 U,D-4
2,4-D	1.0-1.1 U,D-4	**7Q10 = 70**	NA
2,4-DB	1.0-1.1 U,D-4		NA
Dicamba	1.0-1.1 U,D-4		NA
Dichlorprop	1.0-1.1 U,D-4		NA

PESTICIDES

Analyte	WATER (µg/L)	WQS (µg/L)	SEDIMENT (mg/kg dry)
4,4'-DDD (p,p'-DDD)	0.49-0.53 U	0.00031	2.2-13 U
4,4'-DDE (p,p'-DDE)	0.49-0.53 U	0.00022	2.2-13 U
4,4'-DDT (p,p'-DDT)	0.49-0.53 U	0.00022 **7Q10 = 0.001**	*
Aldrin	0.49-0.53 U	0.00005	2.2-13 U
Chlordane	0.12-0.13 U	0.00081 **7Q10 = 0.0043**	11-31 µg/kg dry U,J,D-4,QM-3
Dieldrin	0.49-0.53 U	0.000054 **7Q10 = 0.056**	*
Endosulfan I (alpha)	0.49-0.53 U	89 **7Q10 = 0.056**	2.2-13 U
Endosulfan II (beta)	0.49-0.53 U	89 **7Q10 = 0.056**	2.2-13 U
Endosulfan Sulfate	0.49-0.53 U	89 **7Q10 = 0.056**	2.2-13 U
Endrin	0.49-0.53 U	0.060 **7Q10 = 0.036**	2.2-13 U
Endrin aldehyde	0.49-0.53 U	0.30	2.2-13 U
Endrin ketone	0.49-0.53 U		2.2-13 U
Heptachlor	0.49-0.53 U	0.000079 **7Q10 = 0.0038**	2.2-13 U
Heptachlor epoxide	0.49-0.53 U	0.000039 **7Q10 = 0.0038**	2.2-13 U
Methoxychlor	0.49-0.53 U	**7Q10 = 0.03**	2.2-13 U
Toxaphene	1.9-2.1 U	0.00028 **7Q10 = 0.0002**	86-500 U
alpha-BHC	0.49-0.53 U	0.0049	2.2-13 U
alpha-Chlordane	0.49-0.53 U		*
beta-BHC	0.49-0.53 U	0.017	2.2-13 U
delta-BHC	0.49-0.53 U		2.2-13 U
gamma-BHC (Lindane)	0.49-0.53 U	1.8 1Q10 = 0.95	2.2-13 U

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	9.7-11 U		*	Benzo(a)pyrene	0.097-0.11 U	0.018	*
1,1-Biphenyl	1.9-2.1 U		84-99 U	Benzo(b)fluoranthene	0.097-0.11 U	0.018	*
1,4-Dioxane	*		84-99 U	Benzo(g,h,i)perylene	1.9-2.1 U	**	*
1-Methylnaphthalene	1.9-2.1 U		84-99 U	Benzo(k)fluoranthene	0.097-0.11 U	0.018	*
2,3,4,6-Tetrachlorophenol	9.7-11 U		420-490 U	Benzyl butyl phthalate	9.7-11 U	1900	420-490 U
2,4,5-Trichlorophenol	9.7-11 U		420-490 U	Bis(2-chloroethoxy)methane	9.7-11 U		420-490 U
2,4,6-Trichlorophenol	9.7-11 U	2.4	420-490 U	Bis(2-chloroisopropyl) ether	9.7-11 U	65000	420-490 U
2,4-Dichlorophenol	9.7-11 U	290	420-490 U	Bis(2-ethylhexyl) phthalate	2.9-3.2 U	2.2	*
2,4-Dimethylphenol	9.7-11 U	850	420-490 U	Caprolactam	9.7-11 U		420-490 U
2,4-Dinitrophenol	19-21 U	5300	910 U,QM-6	Carbazole	1.9-2.1 U		*
2,4-Dinitrotoluene	2.9-3.2 U	3.4	420-490 U	Chrysene	0.097-0.11 U	0.18	*
2,6-Dinitrotoluene	9.7-11 U		420-490 U	Di-n-butylphthalate	9.7-11 U	4500	420-490 U
2-Chloronaphthalene	9.7-11 U	1600	420-490 U	Di-n-octylphthalate	9.7-11 U		420-490 U
2-Chlorophenol	9.7-11 U	150	420-490 U	Dibenz(a,h)anthracene	0.097-0.11 U	0.018	*
2-Methyl-4,6-dinitrophenol	9.7-11 U	280	420-490 U	Dibenzofuran	1.9-2.1 U		84-99 U
2-Methylnaphthalene	1.9-2.1 U		84-99 U	Diethyl phthalate	9.7-11 U	44000	420-490 U
2-Methylphenol	9.7-11 U		420-490 U	Dimethyl phthalate	9.7-11 U	1100000	420-490 U
2-Nitroaniline	9.7-11 U		420-490 U	Fluoranthene	1.9-2.1 U	140	*
2-Nitrophenol	9.7-11 U		420-490 U	Fluorene	1.9-2.1 U	5300	*
3,3'-Dichlorobenzidine	9.7-11 U	0.028	420-490 U	Hexachlorobenzene (HCB)	0.97-1.1 U	0.00029	420-490 U
3-Nitroaniline	9.7-11 U		420-490 U	Hexachlorocyclopentadiene (HCCP)	9.7-11 U	1100	420-490 U
4-Bromophenyl phenyl ether	9.7-11 U		420-490 U	Hexachloroethane	9.7-11 U	3.3	420-490 U
4-Chloro-3-methylphenol	9.7-11 U	**	420-490 U	Indeno (1,2,3-cd) pyrene	0.097-0.11 U	0.018	*
4-Chloroaniline	9.7-11 U		420-490 U	Isophorone	9.7-11 U	960	420-490 U
4-Chlorophenyl phenyl ether	9.7-11 U		420-490 U	Naphthalene	1.9-2.1 U		84-99 U
4-Nitroaniline	9.7-11 U		420-490 U	Nitrobenzene	9.7-11 U	690	420-490 U
4-Nitrophenol	9.7-11 U		420-490 U	Pentachlorophenol	2.9-3.2 U	3.0 **7Q10=15**	420-490 U
Acenaphthene	1.9-2.1 U	990	*	Phenanthrene	1.9-2.1 U	**	*
Acenaphthylene	1.9-2.1 U	**	84-99 U	Phenol	9.7-11 U	857000 **7Q10=300**	420-490 U
Acetophenone	9.7-11 U		420-490 U	Pyrene	1.9-2.1 U	4000	*
Anthracene	1.9-2.1 U	40000	*	Tentatively Identified Compounds	9.7-11 U		400 U
Atrazine	9.7-11 U		420-490 U	bis(2-Chloroethyl) Ether	9.7-11 U	0.53	420-490 U
Benzaldehyde	9.7-11 U		420-490 U	n-Nitroso di-n-Propylamine	9.7-11 U	0.51	420-490 U
Benzo(a)anthracene	0.097-0.11 U	0.018	*	n-Nitrosodiphenylamine/ Diphenylamine	9.7-11 U	6.0	420-490 U

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

QM-6 = Matrix Spike Recovery less than 10%.

** 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 U		Chloromethane	0.50 U	**
1,1,1,2-Tetrachloroethane	0.50 U		Cyclohexane	0.50 U	
1,1,1-Trichloroethane	0.50 U		Dibromochloromethane	0.50 U	13
1,1,2,2-Tetrachloroethane	0.50 U	4.0	Dibromomethane	0.50 U	
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	0.50 U		Dichlorodifluoromethane (Freon 12)	0.50 U	
1,1,2-Trichloroethane	0.50 U	16	Ethyl Benzene	0.50 U	2100
1,1-Dichloroethane	0.50 U		Hexachlorobutadiene	0.50 U	18
1,1-Dichloroethene (1,1-Dichloroethylene)	0.50 U	7100	Isopropylbenzene	0.50 U	
1,1-Dichloropropene	0.50 U		Methyl Acetate	1.0 U	
1,2,3-Trichlorobenzene	0.50 U		Methyl Butyl Ketone	1.0 U	
1,2,3-Trichloropropane	0.50 U		Methyl Isobutyl Ketone	1.0 U	
1,2,4-Trichlorobenzene	0.50 U	70	Methyl T-Butyl Ether (MTBE)	0.50 U	
1,2,4-Trimethylbenzene	0.50 U		Methylcyclohexane	0.50 U	
1,2-Dibromo-3-Chloropropane (DBCP)	1.0 U		Methylene Chloride	0.50 U	590
1,2-Dibromoethane (EDB)	0.50 U		Styrene	0.50 U	
1,2-Dichlorobenzene	0.50 U	1300	Tentatively Identified Compounds	10 U	
1,2-Dichloroethane	0.50 U	37	Toluene	0.50 U	5980
1,2-Dichloropropane	0.50 U	15	Trichloroethene (Trichloroethylene)	0.50 U	30
1,3,5-Trimethylbenzene	0.50 U		Trichlorofluoromethane (Freon 11)	0.50 U	
1,3-Dichlorobenzene	0.50 U	960	Vinyl chloride	0.50 U	2.4
1,3-Dichloropropane	0.50 U		cis-1,3-Dichloropropene	0.50 U	
1,4-Dichlorobenzene	0.50 U	190	n-Butylbenzene	0.50 U	
2,2-Dichloropropane	0.50 U		n-Propylbenzene	0.50 U	
Benzene	0.50 U	51	o-Chlorotoluene	0.50 U	
Bromobenzene	0.50 U		o-Xylene	0.50 U	
Bromochloromethane	0.50 U		p-Chlorotoluene	0.50 U	
Bromoform	1.0 U	140	p-Isopropyltoluene	0.50 U	
Bromomethane	2.0 U,QC-1,QC-6, QL-1,QL-3	1500	sec-Butylbenzene	0.50 U	
Carbon Tetrachloride	0.50 U	1.6	tert-Butylbenzene	0.50 U	
Carbon disulfide	2.0 U		trans-1,2-Dichloroethene	0.50 U	10000
Chlorobenzene	0.50 U	1600	trans-1,3-Dichloropropene	0.50 U	
Chloroethane	2.0 U				

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

QC-1= Analyte concentration low in continuing calibration verification standard.

QC-6= Calibration check standard greater than method control limits.

QL-1= Laboratory Control Spike Recovery less than method control limits.

QL-3= Laboratory Control Spike Precision outside method control limits.

END OF DOCUMENT