PAH Contamination Variability in the Lower Tar River N.C. From a Legacy Hazardous Waste Site as a Function of Hydrological Conditions

By

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Polycyclic aromatic hydrocarbons (PAHs) are a class of trace organic contaminants that can enter the environment from both natural and anthropogenic sources. Of these compounds, 16 are listed as high-priority contaminants by the EPA. PAHs are either petrogenic or pyrogenic. One potential anthropogenic source of PAHs is fuel seeps. The Tar River has been and is currently being affected by a legacy fuel seep from underground storage tanks in the area that have undergone remediation. Although research has been done on PAHs in fuel seeps and on PAH remediation, that research addressed sites soon after remediation. Research has generally not addressed how PAH contamination from a legacy seep historically remediated. This research aims to determine how a legacy seep affects PAH contamination in the Tar River as a function of river flow.

To determine how the legacy seep is affecting the Tar River at different flow conditions, sites at and around the potential contamination site, Town Creek, were sampled over several months in 2022 and 2023. These samples were then filtered to separate particulates and dissolved PAHs. The identity and concentration of PAHs were determined using a gas chromatograph-

mass spectrometer. The total PAHs and ratio of parent PAHs to the total PAHs were found to have no correlation with the gauge height of the river or the dissolved organic carbon (DOC) of the sites sampled. This suggests that the PAH contamination in the Tar River was not driven by river flow. Parent-to-total PAH ratio of less than 0.5 in the dissolved phase at the upstream (TC1) sampling site during 10-2-22 and 11-20-22 sampling events, and at a downstream site (D1) during a 11-20-22 sampling event, suggest that a petrogenic source affected these sites during these events. Individual PAH distributions at D1 had a petrogenic signature during a low flow period in the Tar River suggesting that it may have been affected by Town Creek during low flow events. This research adds to the knowledge base of contamination sites that have undergone remediation in the past and how they may still affect their environments.

Polycyclic aromatic hydrocarbon (PAH) Variability in the Lower Tar River N.C. from a Legacy Hazardous Waste Site as a Function of Hydrological Conditions

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Table of Contents

List of Tables

List of Figures

List of Symbols and Abbreviations

Alk	Alkylated
Anth	Anthracene
APES	Albermarle-Pamlico Estuarine System
ASE	Assisted Solvent Extractor
C	Alkylated
C_P	Particulate Concentrations
C_P-PAH	Total Particulate PAHs
C_W	Dissolved Concentration
C_W-PAHs	Total Dissolved PAHs
C-n	Number of alkylated groups
D	Downriver
DOC	Dissolved Organic Carbon
d-n	number of deuterium groups
Flua	Fluoranthene
GC-MS	Gas Chromatography Mass Spectrometer
GFF	Glass Fiber Filter
K_D	Particulate Dissolved PAH Ratio
K_{ow}	Octanol Water Partition Coefficient
MDQ	Minimum Detectable Quantity
$N_2(g)$	Nitrogen Gas
PAH	Polycyclic Aromatic Hydrocarbon
Phen	Phenanthrene
PSU	Practical Salinity Units
Pyr	Pyrene
QA QC	Quality Assurance Quality Control
RRF	Relative Response Factor
SIM	Selected Ion Monitoring
TC	Town Creek
TDN	Total Dissolved Nitrogen
TSS	Total Suspended Solids
U	Upriver

1. Introduction

1.1 Estuarine Systems

Estuaries are areas where water from rivers meets the sea. Estuaries play an important structural, recreational, and economic role for communities and adjacent areas surrounding them. Up to 90% of recreational fishing and 75% of commercial fishing catches occur in estuaries nationally.[1] Water within an estuary varies in salinity from freshwater (0 psu) to that of oceanic seawater (35 psu). This mixture is dependent on several factors, including river flow as well as tidal activity.

The Albemarle-Pamlico Estuarine System (APES) is the second-largest estuary in the lower United States. This estuary brings in millions of dollars of revenue annually to North Carolina through its recreational uses including fishing and tourism.[2] The estuary has 9,115 miles of shoreline. The watershed, or land area influencing the estuary, is 28,000 mi^2 (Fig. 1.1), which drains into the open water with a surface area of 3,000 mi^2. The APES estuary acts as the habitat for half of the juvenile fish from Florida to Maine.[2] Due to the estuary's diversity of flora and fauna, and importance to the surrounding area's economy, its overall ecosystem

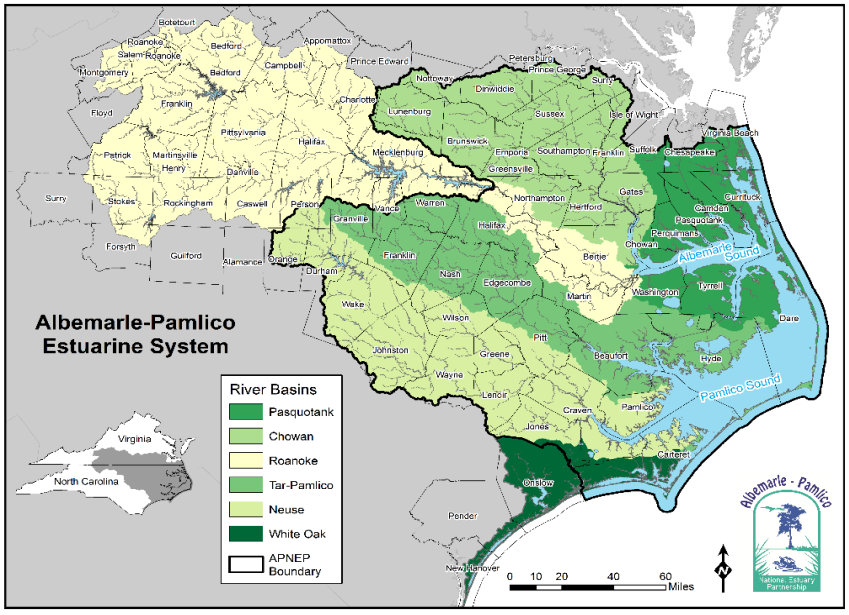

Fig. 1.1: A map of the Albemarle-Pamlico Estuary with the six river basins indicated using different colors.[2]

health is important to assess.

The APES system has six separate river basins; these are the Roanoke, Neuse, Tar-Pamlico, Pasquotank, Chowan, and White Oak River basins. These rivers directly influence the amount and quality of water that enters the APES. Thus, understanding the contaminants that are in any of these rivers will aid in understanding the quality of the estuary as a whole and provide information on the potential adverse effects of that contamination. For example, streams in the Neuse watershed are substantially contaminated with trace organic contaminants, heavy metals, fecal contamination, etc. which adversely affect its resident organisms and their habitats.[3,4,5,6] In contrast to the Neuse River basin, however, the Tar River's water quality has been minimally assessed beyond a study on streambeds in the APES by the USGS.[7]

The Tar-Pamlico River basin had a population over 450,000 people in 2010 which can lead to a variety of anthropogenic sources of contamination.[2] The Tar River has various potential sources for contaminants to enter it due to varying land use and anthropogenic activities in the watershed that drains to it (e.g., pharmaceutical manufacturing, farms, urban runoff, and fuel seeps).[8,5]

1.2 Historic Contamination

One specific source of contamination affecting the Tar River is a previously remediated fuel seep in Greenville, NC that drains into the Tar via a small urban creek, Town Creek. Legacy contamination from underground storage tanks that leaked fuel oil has been historically discharged into the Tar River via Town Creek (Fig. 1.2).[8] The legacy contamination in the seep area was remediated in 1992-1996, with 2.3×10^7 liters of contaminated groundwater pumped and treated to remove the hydrocarbons derived from the fuel oil. Despite the cessation of

remediation in 1996, residual hydrocarbon contamination, such as benzene was detectable at Town Creek as recently as 2021.[9] Moreover, the ambient air surrounding the region still has a faint gasoline-like odor. Lastly, several surface water and air samples collected from the seep area exceed environmental standards for hydrocarbon contamination.[9] Notably, research at Town Creek has identified a population of hydrocarbon-reducing, and benzene-reducing bacteria within the creek.[10]

There have been studies addressing legacy environmental contaminants in rivers, post-remediation. For example, Sower et al 2008. studied the effects of remediation that had occurred within a year of remediation at Portland harbor specifically around a Superfund site containing coal tar and creosote contamination. That research addressed contamination in the river after two separate remediation attempts consisting of capping the creosote and removing coal tar. It was found that removing the coal tar was less effective than the sediment capping remediation.[11] This shows that contamination can persist even after a contaminated site has been remediated.

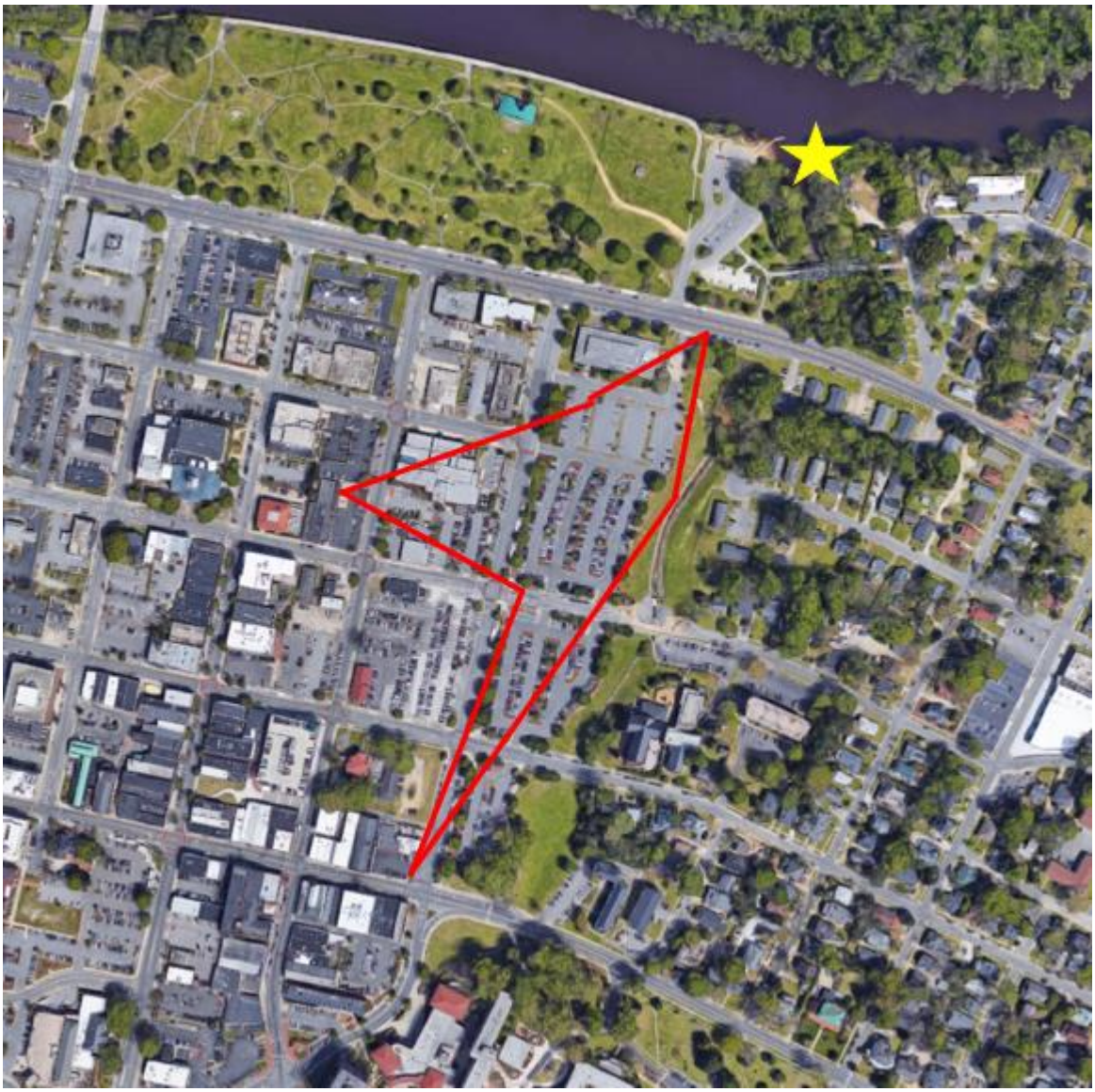

Fig. 1.2: A map of the area surrounding Town Creek, the yellow star Indicates where Town Creek Enters the Tar River, the area within the red lines is the suspected seep area.[8, 12]

One of the classes of hydrocarbons entering the Tar River, in Greenville, NC during the initial fuel oil seep into Town Creek was polycyclic aromatic hydrocarbons, or PAHs. PAHs are a class of compounds that contain two or more benzene rings. PAHs with differing numbers of rings can be seen in Fig. 1.3.[13] Functional groups in PAHs as well as their isomer ratios can be used to determine their sources.[14,15] Thus, PAH analysis in surface waters in Town Creek and

downstream of the seep may be used to determine if the seep continues to affect the Tar River's water quality.

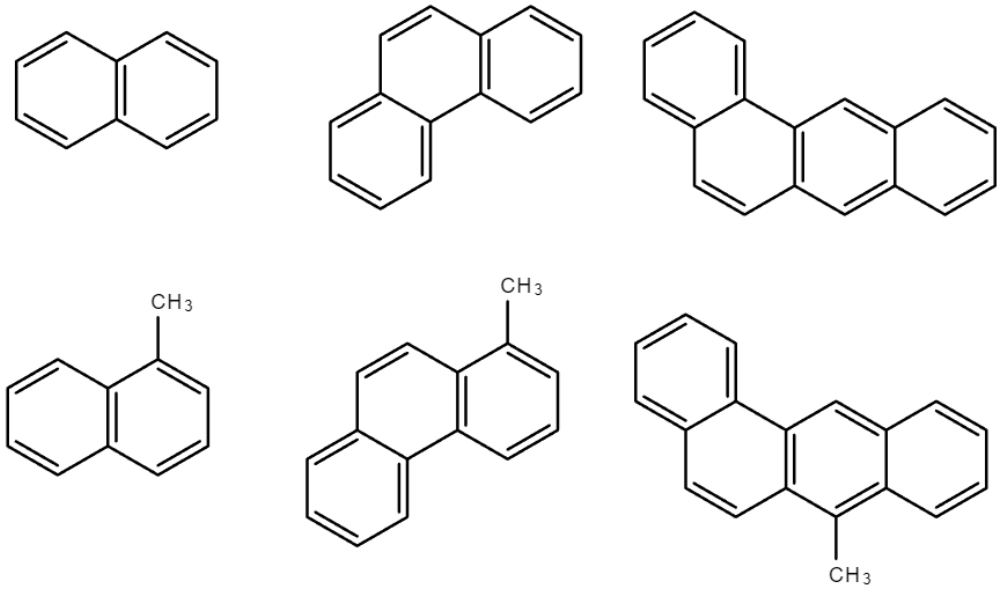

Fig. 1.3: PAH structures with differing numbers of rings; the bottom row of compounds are alkylated homologs of the PAHs noted in the top row.

1.3 PAH Formation

PAHs can be found in unburned oils, produced biogenically, and can be found as products of incomplete combustion. The formation process from incomplete combustion has been studied and can give insight into how PAHs could be formed under various environmental conditions. As organic matter is burned, the large primary organic molecules such as lipids, carbohydrates, and proteins, are decomposed into free radicals. In the presence of sufficient oxygen, that organic matter would be completely combusted into carbon dioxide and water. However, when oxygen is limited or absent, the organic matter cannot be fully combusted, and pyrolysis occurs. This incomplete combustion leads to the formation of PAHs and ultimately black carbon. One potential pathway for PAH formation is through the clustering of acetylene to resonance stabilized radicals. However, after the addition of acetylene the resulting compound

remains a radical, allowing for further additions of acetylenes, clustering into larger and larger compounds.[16,17] This process can also occur with the addition of larger hydrocarbons.[18]

1.4 PAH Sources

The potential origins of PAHs can be determined by close examination of the relative abundance of each compound extracted from an environmental sample. For example, along a continuum of sizes, the larger PAHs with a greater number of rings would be more particle reactive and likely derived from pyrolysis or combustion. Another potential distinguishing characteristic is the degree of alkylation. Higher temperatures tend to cleave alkyl functional groups.[19] Thus, alkylated PAHs are generally considered to have originated from petrogenic sources, whereas non-alkylated PAHs are typically derived from pyrogenic sources. The type of alkylation can also aid in distinguishing sources.[14] However, the combustion of some fuels, such as diesel, can produce alkylated PAHs and some petrogenic sources such as crude oil can lack alkylated PAHs.[14].

Information on PAH sources can also be gathered by looking at the ratios of PAH isomers. Certain PAH isomers can dominate over their isomers depending on the source of PAH, either petrogenic or pyrogenic, or the fuel source of the combustion. For example, the ratio of phenanthrene to anthracene can be used to distinguish between pyrogenic and petrogenic sources. When anthracene dominates the source is likely pyrogenic, whereas phenanthrene dominating indicates a petrogenic source.[14] By using multiple ratios simultaneously, a more comprehensive view of the origin of PAH contamination may be gained.

1.5 PAH Toxicity

There are currently 16 PAHs categorized as high priority by the EPA due to their potential health risks to the environment and people (table 7.3).[20] PAH contamination can pose a potential threat to the local environment and people who interact with it due to its potential carcinogenic and non-carcinogenic effects when exposed long-term. For example, benzo(a)pyrene has been found to have adverse impacts on the lungs of workers exposed to it through rubber manufacturing.[21] Specifically, PAHs have been found to have carcinogenic effects in humans when exposed chronically. This was first discovered in 1775 when a correlation was found between chimney sweeps, soot, and cancer.[22]

When PAHs are metabolized, epoxide groups are formed on the molecule. The epoxides then can form adducts with DNA potentially leading to cancer. The epoxide groups formed on the PAHs are affected by the structure of the PAH itself. PAHs that contained a bay region were more likely to be potent carcinogens than those without, PAHs with hindered bay regions or fjord regions were even more likely to be carcinogens than those with just the bay region, these regions can be seen in Fig. 1.4. PAHs also have the potential to cause the formation of tumors without the formation of DNA adducts.[22]

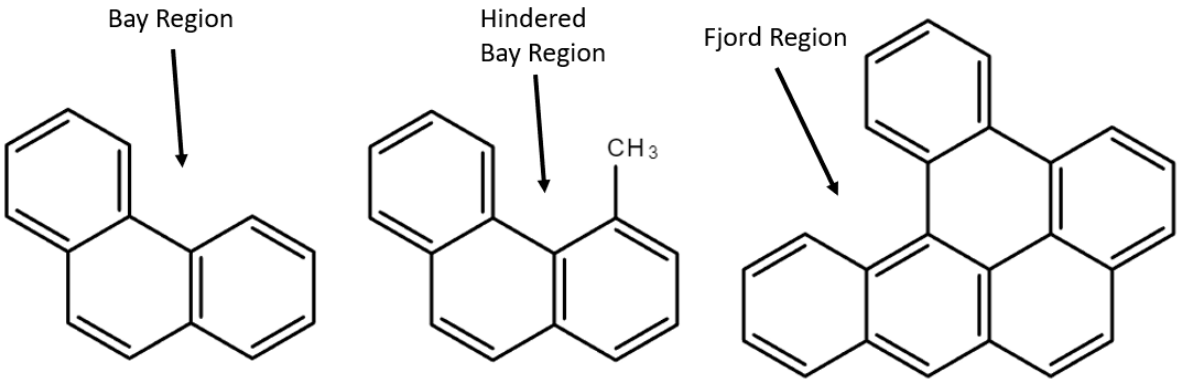

Fig. 1.4: Bay, Hindered Bay, and Fjord regions shown on PAHs.

1.6 PAH Fate and Transport

The size and structure of PAHs can affect how they are transported in the environment and their stability in the environment. Collectively, these physicochemical properties effect their persistence. The size of PAHs and other organic pollutants plays a role in their solubility in water and vapor pressure. Although PAHs are non-polar and thus hydrophobic, this hydrophobicity changes with the number of rings.[23] PAH solubility can decrease by orders of magnitude as the number of rings increases.[24] This difference in solubility leads to larger PAHs typically associating with particulate matter, and thus persisting in the environment, whereas PAHs with fewer rings more readily dissolve in water and may then be transported in the gas phase by evaporation.[23]

PAHs can also be oxidized in the environment, depending on their structure. For example, phenanthrene and anthracene, two PAH isomers, have different rate constants for photooxidation and microbial oxidation, and hence varying stabilities. Phenanthrene has a higher thermodynamic and kinetic stability and thus will persist in the environment longer.[25],[26]

Because of the economic importance of the APES to North Carolina and its surrounding areas, understanding riverine pollution from its tributaries is critical to the assessment of its water quality. Of the APES' six tributaries, the Tar-Pamlico (Tar-Pam) and Neuse flow through urbanized areas such as Raleigh and Greenville, NC, with populations of 460,000 and 70,000, respectively.[27] This increases the likelihood of urban-derived pollutants such as PAHs and other hydrocarbons in these rivers from runoff and other non-point sources.[28] Despite these impacts from urbanization and the legacy contamination at Town Creek, the Tar-Pam currently has few research studies regarding organic surface water contaminants. Thus, investigating PAH contamination in the Tar River fills an important research gap and helps address its underappreciated role in affecting the water quality of the APES. Lastly, the role of legacy

hazardous waste sites and their adverse environmental effects post-remediation may serve a basic scientific need to hazardous waste site managers on the efficacy of their remediation strategies.

1.7 Hypotheses and Objectives

The goal of this study is to answer the question; how do PAHs in the legacy seep at Town Creek affect the levels of PAHs in the Tar River downgradient, as a function of its hydrology? There are two hypotheses in this study:

1)the legacy seep at Town Creek continues to adversely impact water quality in the Tar River by releasing elevated levels of PAHs into the Tar at its point of entry (Town Commons), and

2)water collected at sites downriver of the legacy seep will have a PAH "fingerprint" (i.e. relative abundance of low and high molecular weight PAHs compounds) similar to that of the contaminated site seasonally.

These hypotheses were tested by sampling water over several months of the year in the Tar River at four sites, with two sites being upriver (i.e., U1 and U2), one at the Town Creek site (TC1), and one downriver of it (D1). A group of 45 PAHs were extracted and quantified at each site.

2. Methods

2.1 Field Sampling

Three primary sampling sites in the Tar River and one in the lower section of the Town Commons Creek which drains the legacy fuel-oil site, were chosen to address the research question. Two of the Tar River sites are upriver of (U1 and U2), one is downriver of the Town Commons Creek (D1), and the Town Commons Creek sampling site was sampled within the creek before it reached the river (TC1) (Figs. 2.1 and 2.3). These sites were sampled monthly from August 2022 to April 2023, with one sample being taken per site. Primary sites were sampled based on expected contamination levels; thus, the sites were sampled in the order U1, U2, D1, ending with TC1 to avoid potential contamination. A single cross-river transect sampling event was executed on 3-26-2023. This event consisted of sampling 5 sites across Town Creek (TC1, TC2, TC3, TC4, TC5, and 1 site across the river from the mouth of Town Creek and located on its northern bank (TC6); these sites are shown in Fig. 2.2. In addition to ancillary bulk water quality variables such as temperature, dissolved organic carbon (DOC), total dissolved nitrogen (TDN), and total suspended solids (TSS), sites were sampled for both particulate (C_P) and dissolved phase PAHs (C_W).

Fig. 2.1: Locations of each sampling site; U represents upriver, TC represents Town Creek, and D represents downriver image taken from Google Earth ©.[12]

Fig. 2.2: Locations of each Town Creek sampling sites (TC1 – TC6); samples TC3, TC4, and TC5 were taken proceeding from the legacy site (TC1) to the other bank of the Tar River TC6. TC2 was upriver of TC1.[12]

Fig. 2.3: Pictures of sites U1 in the top left, U2 in the top right, TC1 in the bottom left, and D1 in the bottom right.

The temperature was determined in situ using a YSI Pro-1030 pH and Conductivity meter. One liter Nalgene bottles (pre-cleaned using a dilute solution of Liquinox© and rinsed with tap water and distilled de-ionized water), were used to collect water for DOC and TDN.

Fig. 2.4: The filtration rig used to filter samples, the two tanks with lids on the left are the water samples, and the two tanks in the cooler are used to collect wastewater, the two tripods are filter heads and will contain the retentate.

Bottles were pre-rinsed in triplicate at each sampling station after which the rinse was discarded. Particulate and dissolved phase PAHs were isolated using 20 L pre-cleaned stainless steel pressure vessels (Fig. 2.4). The pressure vessels were pre-cleaned between sampling events by three rinses with a Liquinox© solution and allowed to dry. Prior to collecting water samples, the pressure vessels were rinsed with 50 ml of acetone in

the lab. In the field, sampling vessels were rinsed in triplicate using water from each respective station. These rinses were discarded. Approximately 15-20 l of water was collected after which the pressure vessels were sealed.

2.2 TSS, DOC, and TDN

A Shimadzu TOC-V_{CPN} was used to determine the DOC and TDN. Water collected in the Nalgene bottles was filtered using pre-cleaned (ashed at 450 °C for 4h) 47 mm diameter, 0.7 μm pore size Whatman GFF. The filtrates were analyzed for DOC and TDN using the TOC-V_{CPN}. The retentate on the filters was allowed to dry in a drying oven at 60 °C until their mass no longer changed. Their dry mass was divided by the volume of water filtered through them to determine (TSS).

2.3 Isolation of Particulate and Dissolved Phases for PAH Analysis

Samples for Cp and Cw were isolated by filtration with pre-cleaned glass fiber filters (GFF) (Whatman, Type A/E, 142 mm diameter, 0.7 μm pore size (GFF); combusted at 450 ºC for 4h) by pressurizing the tanks with ultrahigh purity N_2(g). The (GFF) was then folded, placed into an aluminum foil pouch, and frozen until analysis. The filtrate was collected in 1 L pre-cleaned precleaned glass bottles (combusted at 450 ºC for 4h) and refrigerated at ~4 ºC until analysis. The particles in the retentate were operationally defined to contain particulate phase PAHs whereas the aqueous filtrate was operationally defined to contain both the dissolved (colloidal [0.7 μm ≥ colloidal ≥ 0.2 μm]) and truly dissolved [≤ 0.2μm] phase PAHs.

2.4 Extraction of PAHs

A Dionex 350 Accelerated Solvent Extractor (ASE) was used to extract particulate-phase PAHs. GFF samples were extracted in 100 mL volume stainless steel ASE cells. Proceeding upwards from the bottom of the vessel to the top, each vessel was packed with a pre-cleaned GFF (Ahlstrom Munksjo, 30 mm diameter, 0.7 μm pore size), then pre-cleaned glass wool (450 °C for 4h), and the frozen GFF sample which was cut into smaller strips using scissors pre-rinsed in hexane in between samples. The top of the cell was loosely packed with another slug of pre-cleaned glass wool to the top of the cell. Then ~1 ml of the surrogate standard was added, and the vessel was sealed. The surrogate standard contained 5 deuterated PAHs (d_8-naphthalene, d_{10}-anthracene, d_{12}-benzo(a)anthracene, d_{12}-benzo(a)pyrene, and d_{12}-benzo(g,h,i)perylene), in a solution of acetone. An acetone: hexane cocktail (1:2; vol: vol) was used to extract the samples.

Initially, the sample cells were packed with pre-cleaned Na_2SO_4. However, the ASE repeatedly aborted its runs when using Na_2SO_4, likely due to the water content of the samples causing the sodium sulfate desiccant to cake.[29] Thus, sodium sulfate use was eventually discontinued.[29] Without an anhydrous reagent in the cells, post-extraction residual water in sample extracts were "back-extracted" with hexane to recover any residual PAHs. Sample extracts were collected in a precleaned glass bottle (combusted at 450 degrees C for 4h). This extraction method was adapted from O'Connell et. Al. 2007.[30] The extracts were concentrated by evaporating them to ~ 1 mL in a rotary evaporator. The concentrated extract was then transferred to a 15 ml pre-cleaned glass conical tube. The rotary evaporator flask was then rinsed three times with ~1 mL hexane, with each rinse combined in the conical tube to minimize losses from sorption to glassware. The extract in the conical tube was then gently evaporated under a stream of nitrogen to 1 ml.

PAHs were isolated in the dissolved phase by shaking 800-1000 mL of filtrate with 400-500 mL of hexane in a 2 L separatory funnel (combusted at 450 ºC for 4h) after adding 1 mL of a deuterated mixed PAH surrogate standard. The ratio of the solvent to sample was generally 1:2; v:v). Samples were shaken three times and extracts were combined in a precleaned (combusted at 450 ºC for 4h) rotary evaporator flask. The hexane extract was then evaporated under a vacuum at 23 ºC to ~1 mL and transferred to a 15 mL precleaned glass conical tube. Rotary evaporator flasks were then triple-rinsed with 100% hexane and rinses combined with the original concentrated extract in the 15 mL conical tube. The extract was then gently evaporated to prepare for purification using silica gel chromatography, using a water bath at 45 ºC and UHP N_2.

Both solid phase and dissolved extracts were purified using a 5 mm diameter glass column packed with pre-cleaned silica. The pre-cleaned silica columns (Fig. 2.5) were packed with precleaned glass wool to which 1 g of silica gel (mesh size 30-200, combusted at 450 degrees C for 4h), and a quarter inch of sodium sulfate (combusted at 450 degrees C for 4h) were added. Once the sample was added to the silica column, three sequential 1 mL rinses of hexane were added with the eluent collected as waste. As the third and final rinse of hexane reached the silica-solvent interface, 7.5 mL of an 80:20 hexane: DCM (v:v) cocktail was gently added to the column while simultaneously switching a 15

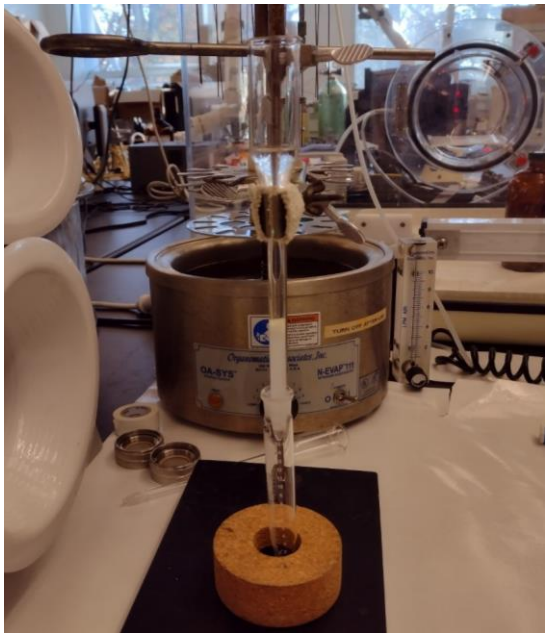

Fig. 2.5: A silica gel column used for sample purification.

mL precleaned glass conical tube for the waste flask. This fraction of the purified sample contained the aromatic compounds. After collection of the extract from this portion of the purification column ~1 mL of internal standard (d-8 acenaphthylene, d-10 phenanthrene, d-12 chrysene, d-12perylene, and d-12 indeno(123cd)pyrene) dissolved in hexane was added gravimetrically to the tube. This sample was then evaporated gently at 25 °C to ~0.25 ml and transferred to a 2 mL GC-MS autosampler vial. The conical tube was rinsed 3 times with hexane and the rinses combined.

2.5 Quantification of PAHs

All PAHs were quantified using a Shimadzu QP2010S GC-MS. The conditions of injection were as follows: the syringe of the Shimadzu AOC-20i+3 injector (250° C) was pre-rinsed with neat solvents (methanol, then dichloromethane, and finally hexane) once each. The syringe was then pre-conditioned with a rinse of the samples, which was also discarded. Following this conditioning step, the sample (2 mL) was injected in splitless mode into the injector, after which the syringe was then re-cleaned using the series of solvents noted above. The GC oven was initially held at a temperature of 55.0 ºC and ramped to a final temperature of 320 ºC. Other details of the temperature profile may be found in Table 2.1. The column used for analysis was a Restek RXI-5SIL-MS column with a length of 30.0 m, thickness of 0.25 μm, and a diameter of 0.25 μm. The total flow of helium, the carrier gas was 51.8 mL min^{-1}, with column flow set at 0.96 mL min^{-1}, and purge flow at 3.0 mL min^{-1}. The GC-MS interface temp was set at 310 ºC and the ion source temp of the detector was set at 200 ºC. A total of 45 naturally abundant PAHs and 10 deuterated PAHs were quantified, with the deuterated PAHs being associated with surrogate and internal standards. Data on PAH abundances were collected by using the MS in selected ion monitoring (SIM) mode. Final concentrations were determined by comparing the

responses of the sample to those of the relative response factor (RRF), injected immediately before sample injection. After manual confirmation of each compound peak's shape and size and additional, the mass of each individual PAH compound in a sample was converted to a concentration by dividing by the sample mass or volume. Data for PAHs were considered quantifiable only if surrogate recovery for the MS time window associated with the PAH was above 60-70% and sample peaks were 2 times greater than those in (lab + field) blanks (see below for details).

Table 2.1: Gas chromatographic over temperature profile and hold times for the PAH analysis method

Rate (ºC min^{-1})	Final Temp (ºC)	Hold Time (min)
-	55.0	2.00
25.00	150.0	3.00
5.00	165.0	3.00
10.00	175.0	5.00
25.00	225.0	5.00
20.00	265.0	10.00
5.00	300.0	0.00
20.00	320.0	12.00

2.6 QA/QC

PAHs were identified based on their retention time and mass fragmentation patterns in comparison with the PAH relative response factor (RRF) standard consisting of 55 PAHs. Deuterated PAH standards were purchased from Cambridge Isotope Labs and PAH standards were purchased from Accustandard. Concentrations were only reported if the overall recovery of their eluting time window was > 60% recovery for windows 1 and 5 and > 70% recovery for windows 2-4. The windows 1 and 5 had lower recovery barriers due to volatility and ASE extraction issues respectively. The barriers for quantifiability were shared for both particulate and dissolved phase compounds. The second check for compounds was based on the minimum

detectable quantity (MDQ). MDQ was determined via serial dilutions of the RRF after maintenance of the GC-MS. A signal-to-noise of 7 or above was used as the baseline for MDQ, if a compound was below this it was considered nonquantifiable, and not present MDQs for each compound are shown in the appendix table 7.5. Finally, to be considered quantifiable, the compound peak area (i.e., mass) in each sample had to be greater than twice its area in blanks averaged across integrated across time within the lab and those collected from the field.

3. Results

3.*1 Hydrograph and Ancillary Environmental Data*

Tar River stage (gauge height) was monitored from May 2022 to April 2023 using the USGS station at site U2, coinciding with the period of water sampling. During this sampling period, the maximum gauge height and river stage occurred on April 14th, 2023 with a height of 13.7 ft. The minimum gauge height during the period sampled was on November 20th, 2022 with a height of 2.68 ft (Fig. 3.1). The mean gauge height during the sampling period was 5.1 ± 1.7 ft. Gauge height for Town Creek directly was not available for the time period of this study.

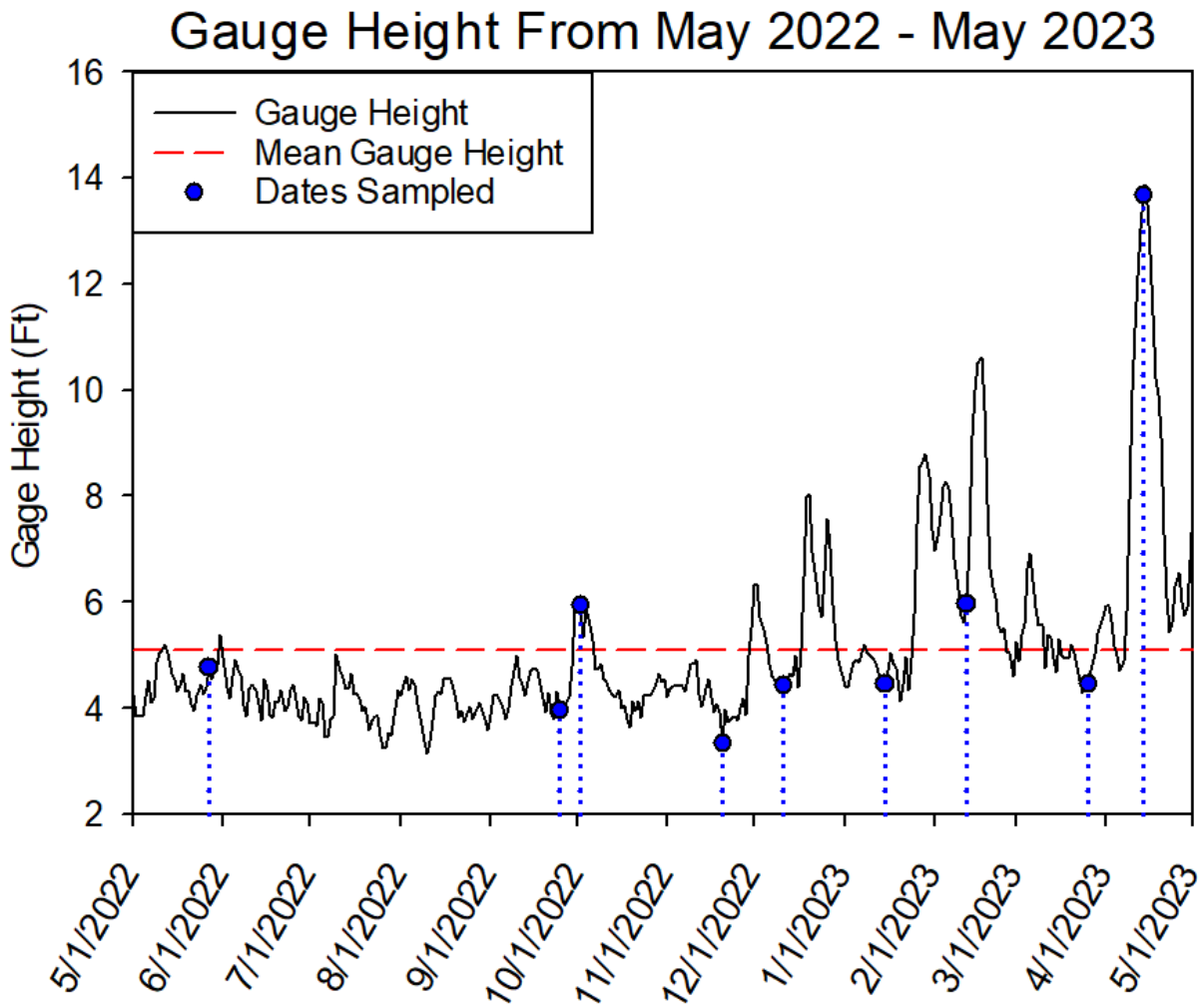

Fig. 3.1: River gauge height throughout the period May 2022 – May 2023. Gauge height is directly related to water level. The red dashed line represents the mean gauge height of the sampling period, and the blue points indicate the dates that the river was sampled.

TSS was highest during the May 27,2022 sampling event with a value of 625 mg L^{-1}, specifically at TC1. The minimum TSS observed (1.5 mg L^{-1}), was also observed at site TC1 during the sampling event 3-26-23 (Fig. 3.2). However, the minimum TSS quantified during the 3/26/23 cross-river sampling event was 0.429 mg L^{-1}, at site TC3 (Fig. 3.3). The range in TSS in the Tar River and TC1 spanned 3 orders of magnitude throughout the sampling period. The range in TSS across Town Creek varied between 0.429 – 8.2 mg L^{-1}.

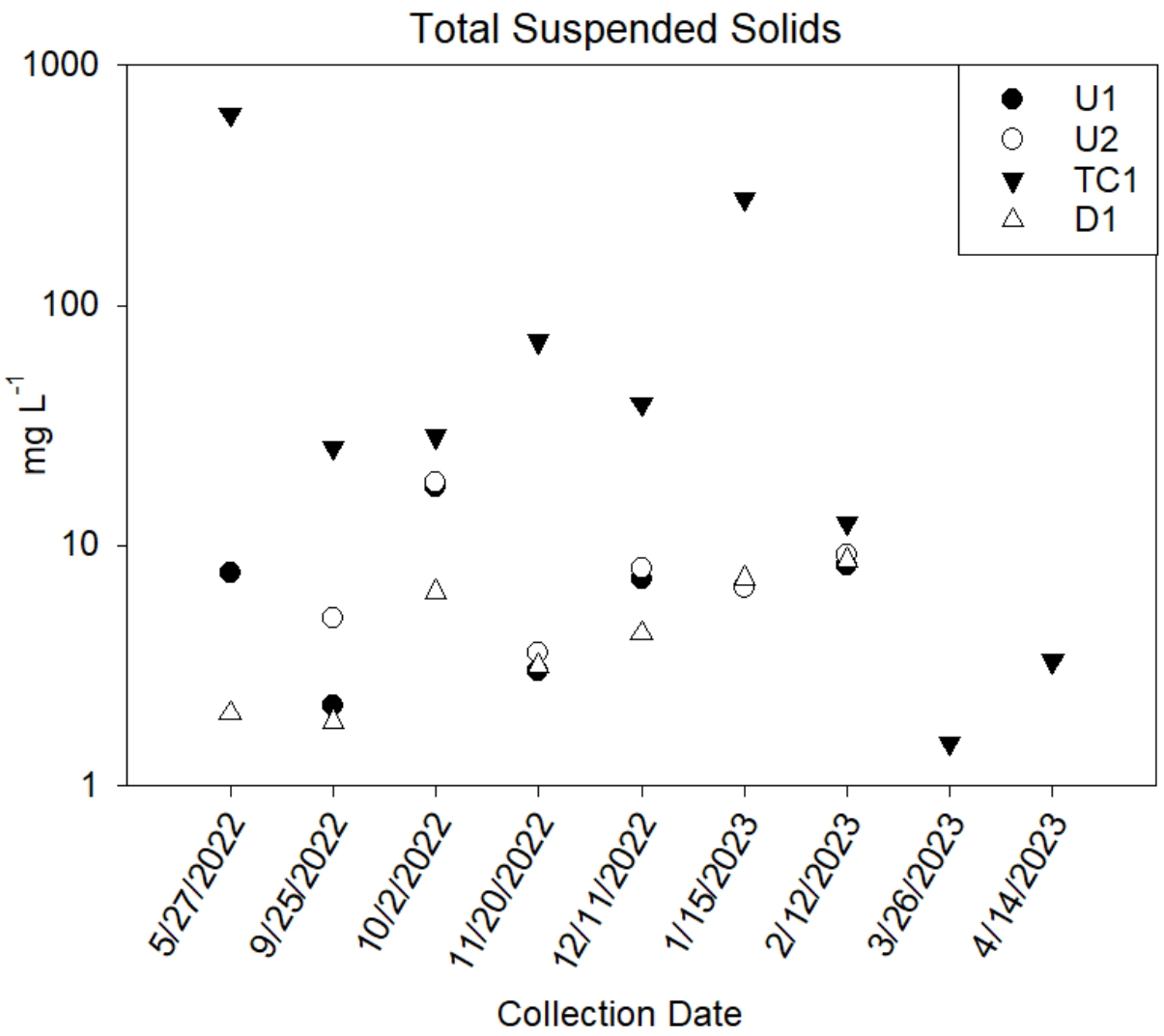

Fig. 3.2: TSS in units of mg L^{-1} for each sampled site during each sampled event. TSS at Site U1 was non-quantifiable during the 1-25-23 event, and TC1 was the only primary site sampled during the 3-26-23 and 4-14-23 sampling events.

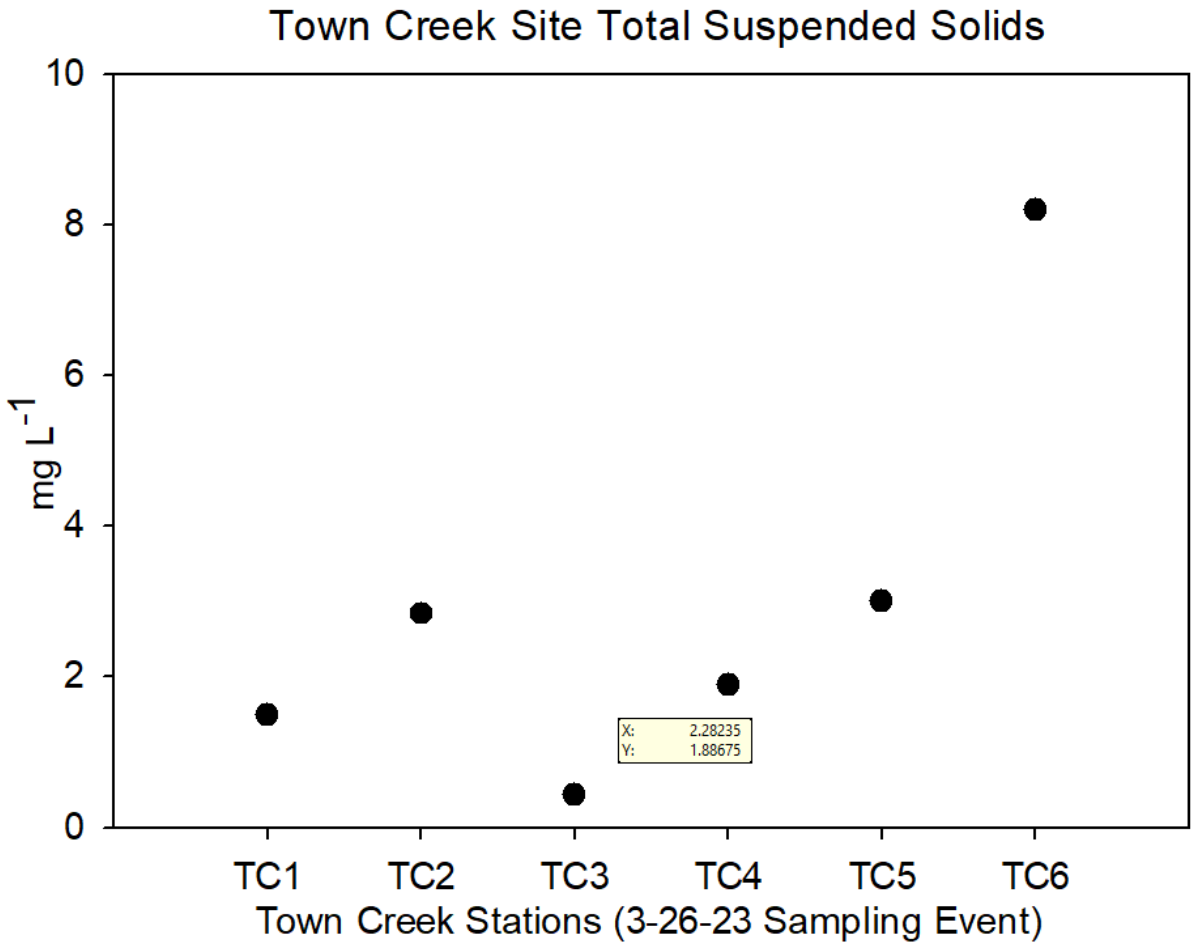

Fig. 3.3: TSS in mg L^{-1} for each Town Creek site during the 3-26-23 sampling event.

Fig. 3.4 shows each of the DOC and TDN values for each site through the sampling period. Average concentrations of DOC from 5-27-22 to 4-14-23 were 7.17, 7.69, 5.96, and 7.38 mg L^{-1} for sites U1, U2, TC1, and D1, respectively. The minimum [DOC] was 2.03 mg L^{-1} at site TC1 during the sampling event on 5-27-22. The maximum [DOC] value was 29.33 mg L^{-1} also at TC1 during the sampling event on 4-14-23. In general, [DOC] was lower at TC1 than the other sites, except during the 4-14-23 sampling event when it had the highest [DOC] value across all stations during that sampling event. TDN was more consistent throughout the sampling period; all sites' TDN values were ~ 0.5 mg L^{-1} throughout the entire sampling period. Despite the [DOC] values of the TC1 site generally being lower than those of the river sites, during the 3-26-

23 sampling event each of the TC sites sampled had DOC values within a similar range to those of the Tar River sites, as seen in Fig. 3.5.

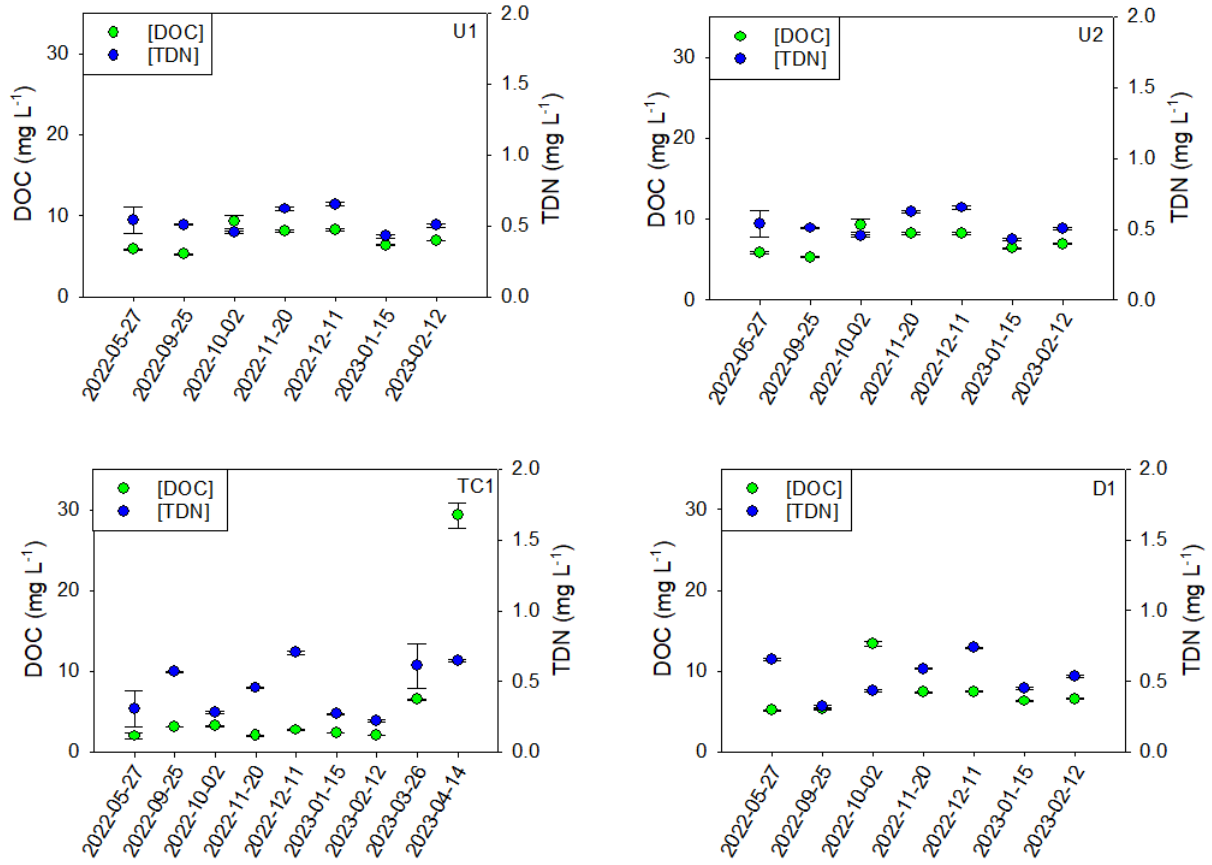

Fig. 3.4: [DOC] and [TDN] for each site. The TC1 site was the only primary site sampled during the 3-26-23 and 4-14-23 events. Error bars reflect the standard deviation of 3-5 injections.

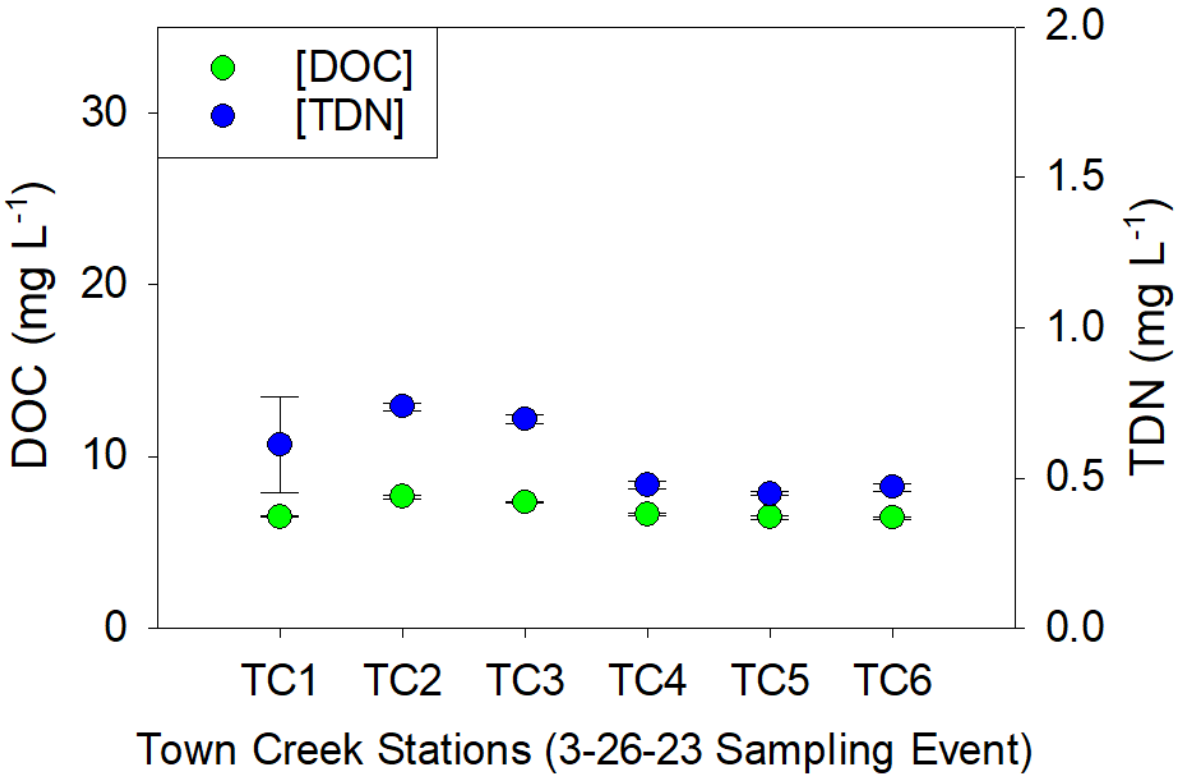

Fig. 3.5: [DOC] and [TDN] for the Town Creek stations during the 3-26-23 sampling event. Error bars reflect the standard deviation of 3-5 injections.

During each sampling event except 2-12-23, 3-26-23, and 4-14-23 a biofilm, seen in Fig. 3.6, was present at Town Creek. When present, this biofilm was collected in the sample tanks and was included with the particulate phase samples.

Fig. 3.6: Site TC1 with the biofilm present. The orange color is the biofilm and is caused by reduced iron (Brooks, 2021).

3.2 Surface water PAH concentrations

Total particulate PAH concentrations [C_P-PAH] expressed as mass of PAH per mass of particulates in the sample, are listed in Table 7.7 in the Appendix and displayed in Fig. 3.7. The highest total C_P-PAH for the main sampling sites (i.e., U1, U2, D1, and TC1 [other than 3-26-23]) was 5.1 x 10^5 ng g^{-1} during the 2-12-23 sampling event at Station TC1. However, TC1 did not have the highest total PAH concentrations during previous sampling events. In general, the 2-12-23 sampling event had the highest C_P-PAHs in the particulate phase. The minimum concentration measured was 301 ng g^{-1} at the TC1 site during the sampling event 1-15-23.

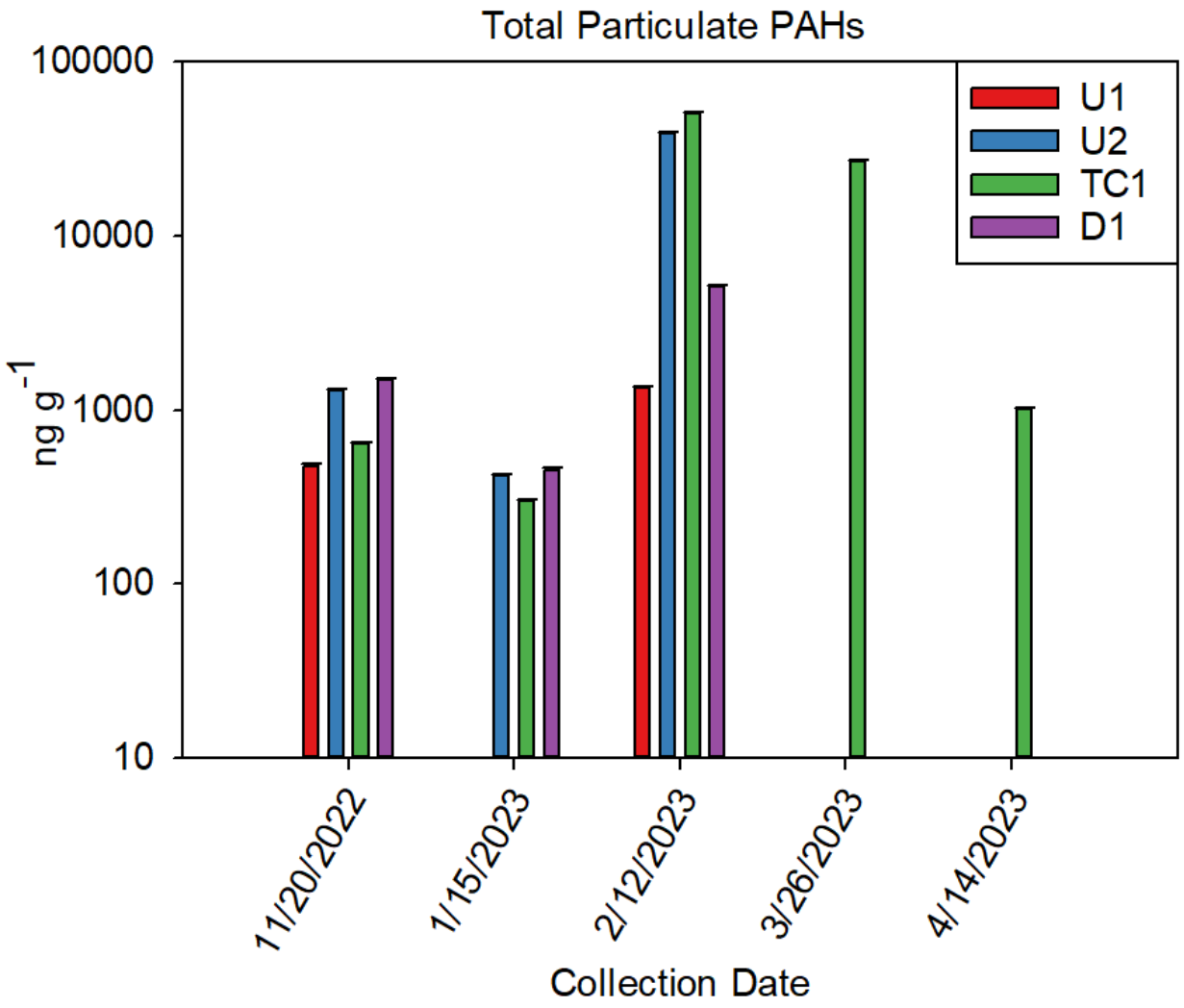

Fig. 3.7: Total C_P-PAH (ng g^{-1}) for each primary sampling site. The TC1 site was the only site sampled during the 3-26-23 and 4-14-23 events.

The highest observed C_P-PAH during the cross-river sampling event on 3-26-23, was at TC3 with a total concentration of 3.4 x 10^6 ng g^{-1}. The lowest C_P-PAH was at TC6 with a concentration of 1300 ng g^{-1} (Fig. 3.8).

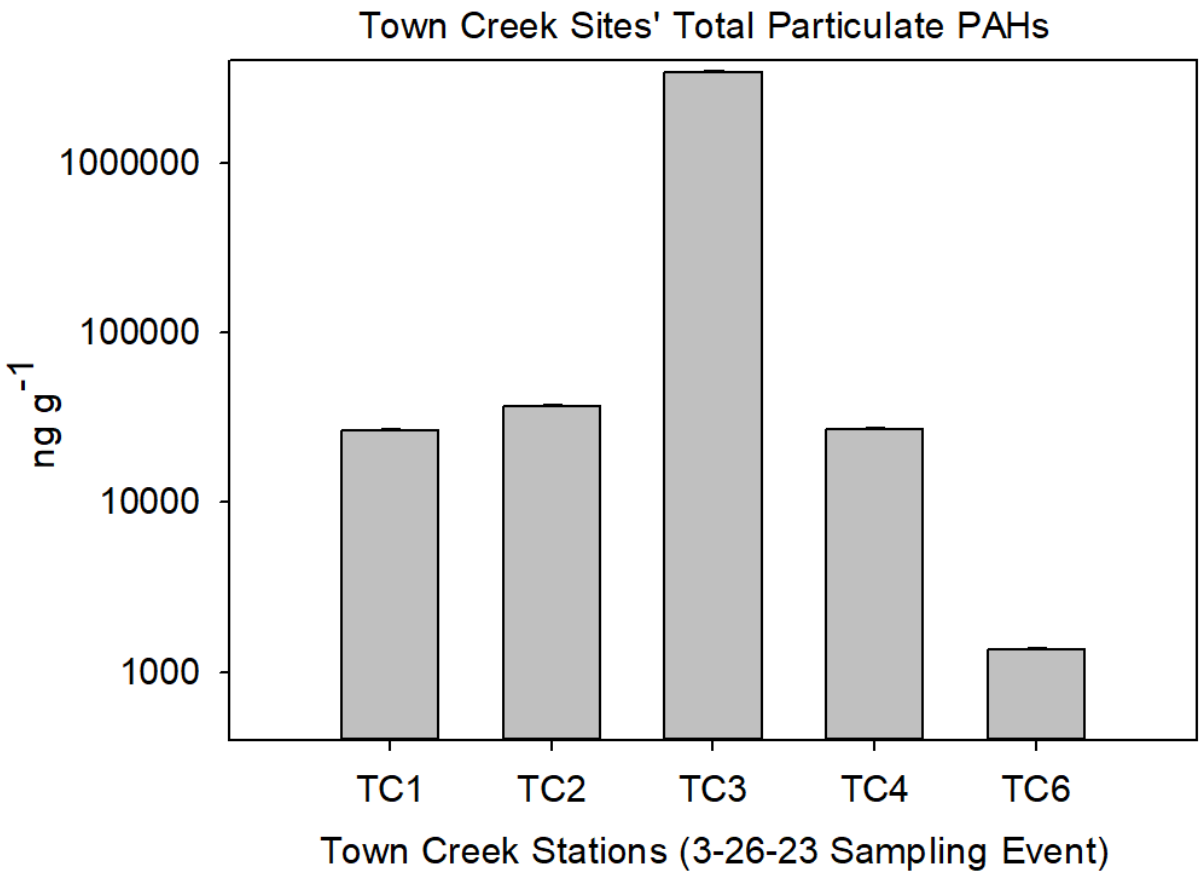

Fig. 3.8: Total C_p-PAH for cross-river Town Creek sites during the sampling event 3-26-23.

Total dissolved PAH concentrations [C_W-PAHs] are noted in Table 7.8 in the Appendix and displayed in Fig. 3.8. The highest concentration, 230 ng L^{-1}, was detected at TC1 during the 10-2-22 sampling event. In general, C_W-PAHs were higher at TC1 for three of the sampling events, however during the event 9-25-22 it was the lowest relative to the other sites sampled on the same day (1.53 ng L^{-1}; Fig. 3.9).

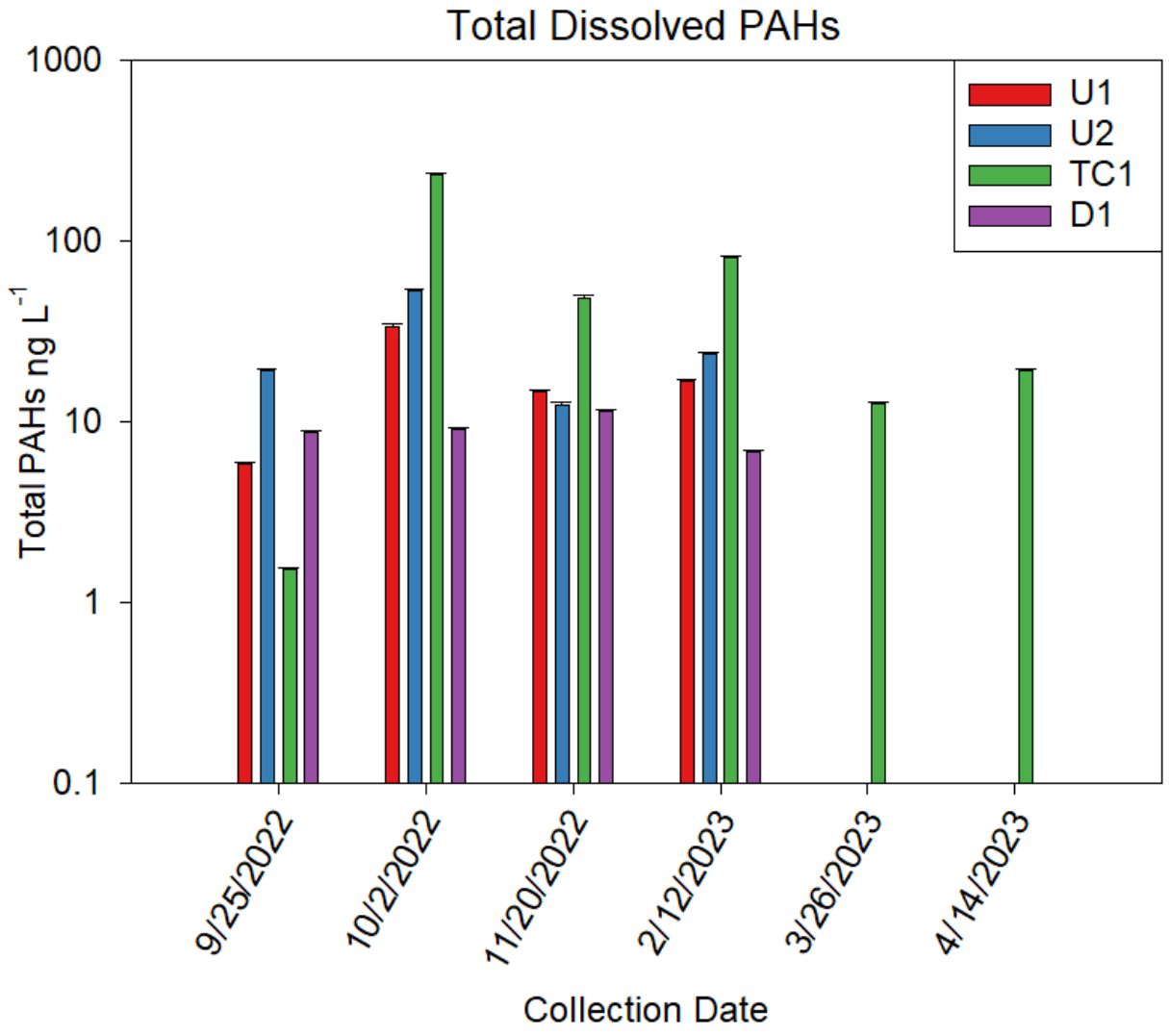

Fig. 3.9: Cw-PAH (ng L^{-1}) for primary sampling sites. The TC1 site was the only primary site sampled during the 3-26-23 and 4-14-23 events.

C_W-PAHs during the cross-river transect sampling event on 3-26-23 follow a similar trend to that of the particulate phase, with the highest total C_W-PAH concentration, 315 ng L^{-1} at TC3, and concentrations being lower down gradient closer to the Tar River (Fig. 3.10).

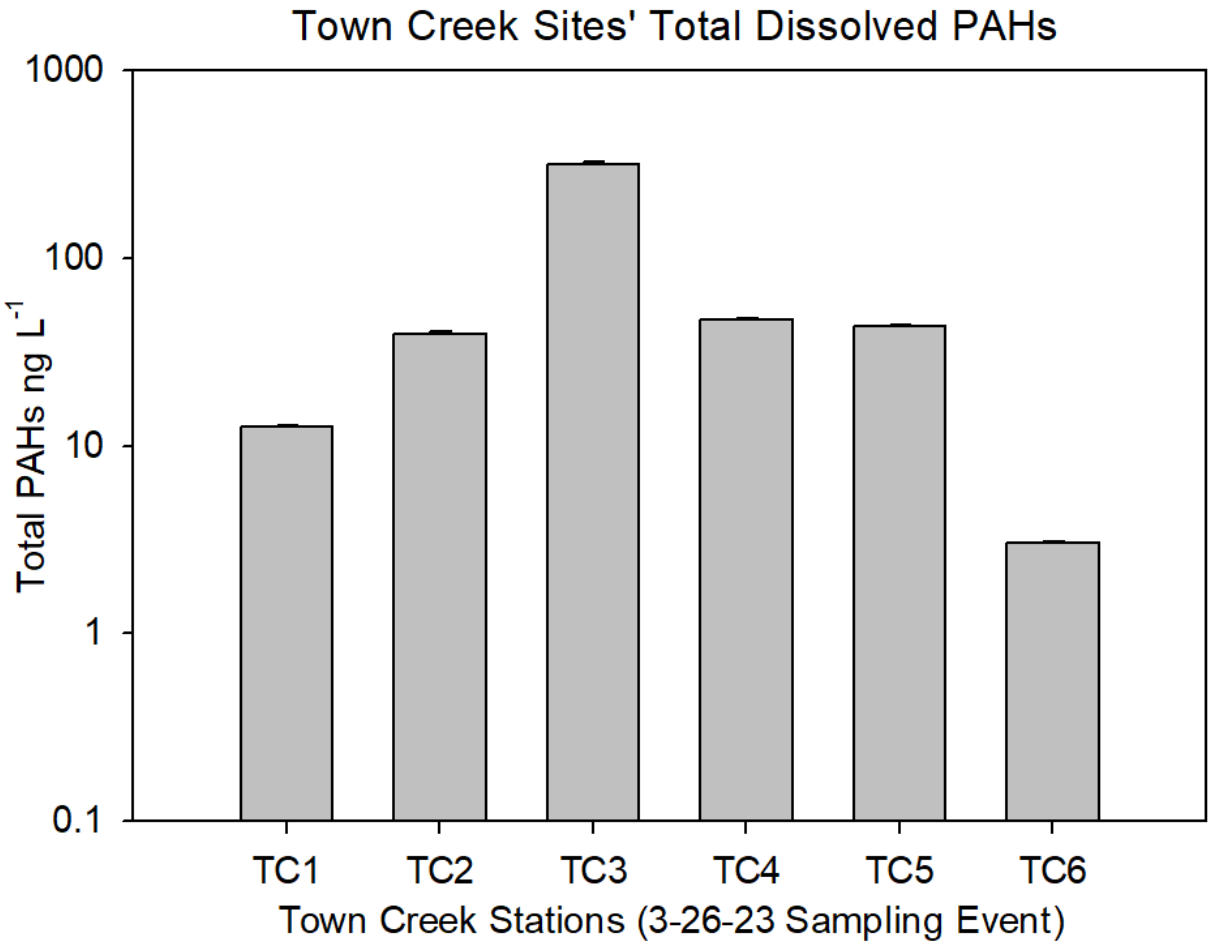

Fig. 3.10: Cw-PAHs for cross-river Town Creek sites during the 3-26-23 sampling event.

3.3 PAH Homologs

Trends in PAH homolog concentrations have been used to discriminate PAH sources. The particulate homolog concentrations for the sampling events 11-20-22 and 2-12-23 can be seen in Figs. 3.11 to 3.14, respectively. During both sampling events, the same parent PAH homologs were present at sites U2 and D1. In contrast, more parent PAH homologs were present at site TC1 than the other sites, and site U1 had fewer parent homologs. The concentrations of PAHs present, and the amount of parent PAH homologs present were both greater during the 2-12-23 sampling event when compared with the 11-20-23 sampling event. A similar trend was

noted for the alkylated homologs. More homologs were present at site TC1 and fewer at site U1, and concentrations and the number of homologs were both higher for the 2-12-23 sampling event. Alkylated PAH homolog concentrations were also lower during each sampling event for each site when compared to the parent homolog concentrations.

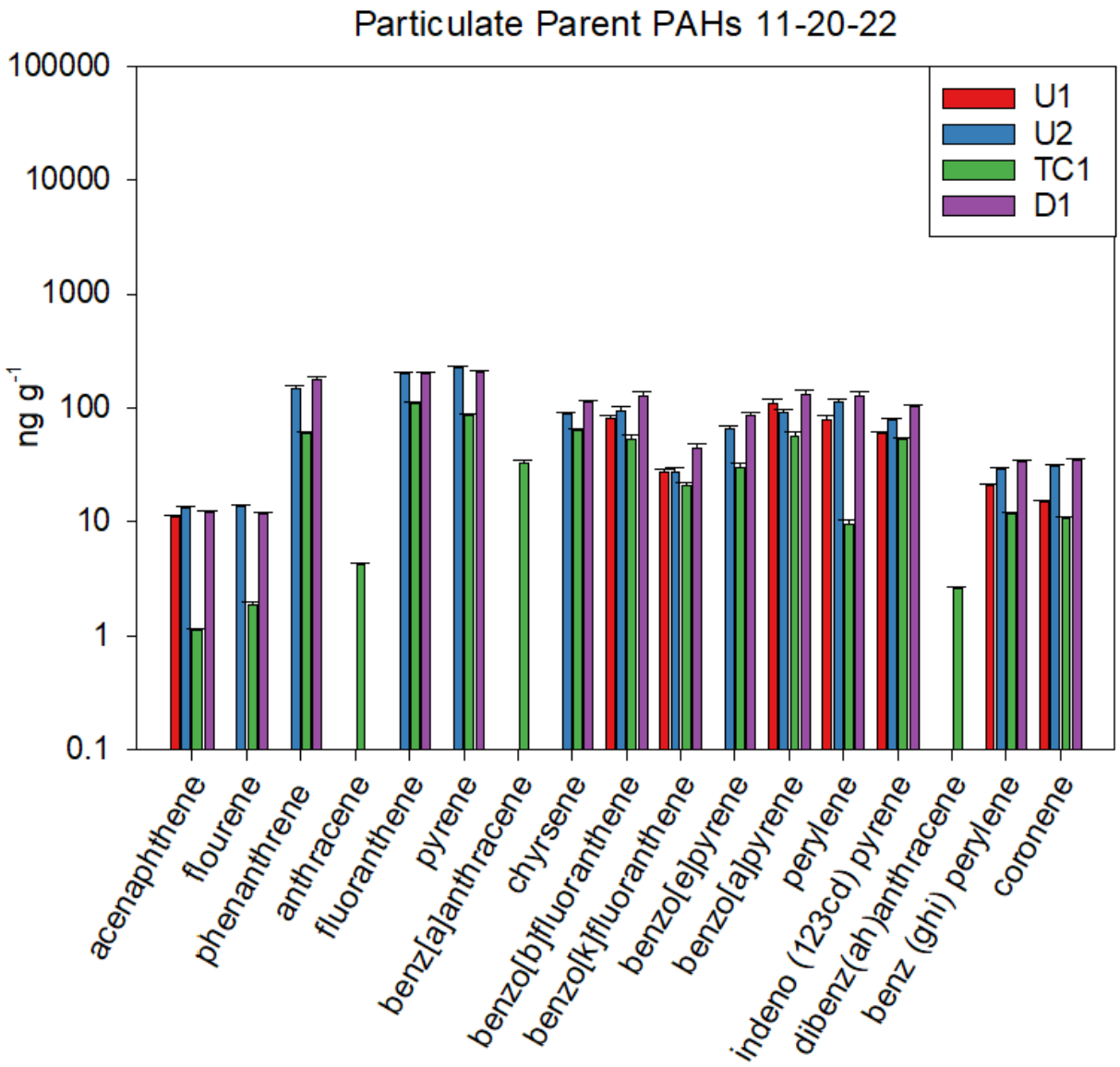

Fig. 3.11: Particulate PAH concentration by group for each site during the sampling event 11-20-22. Nonpresent bars indicate nonquantifiable compounds.

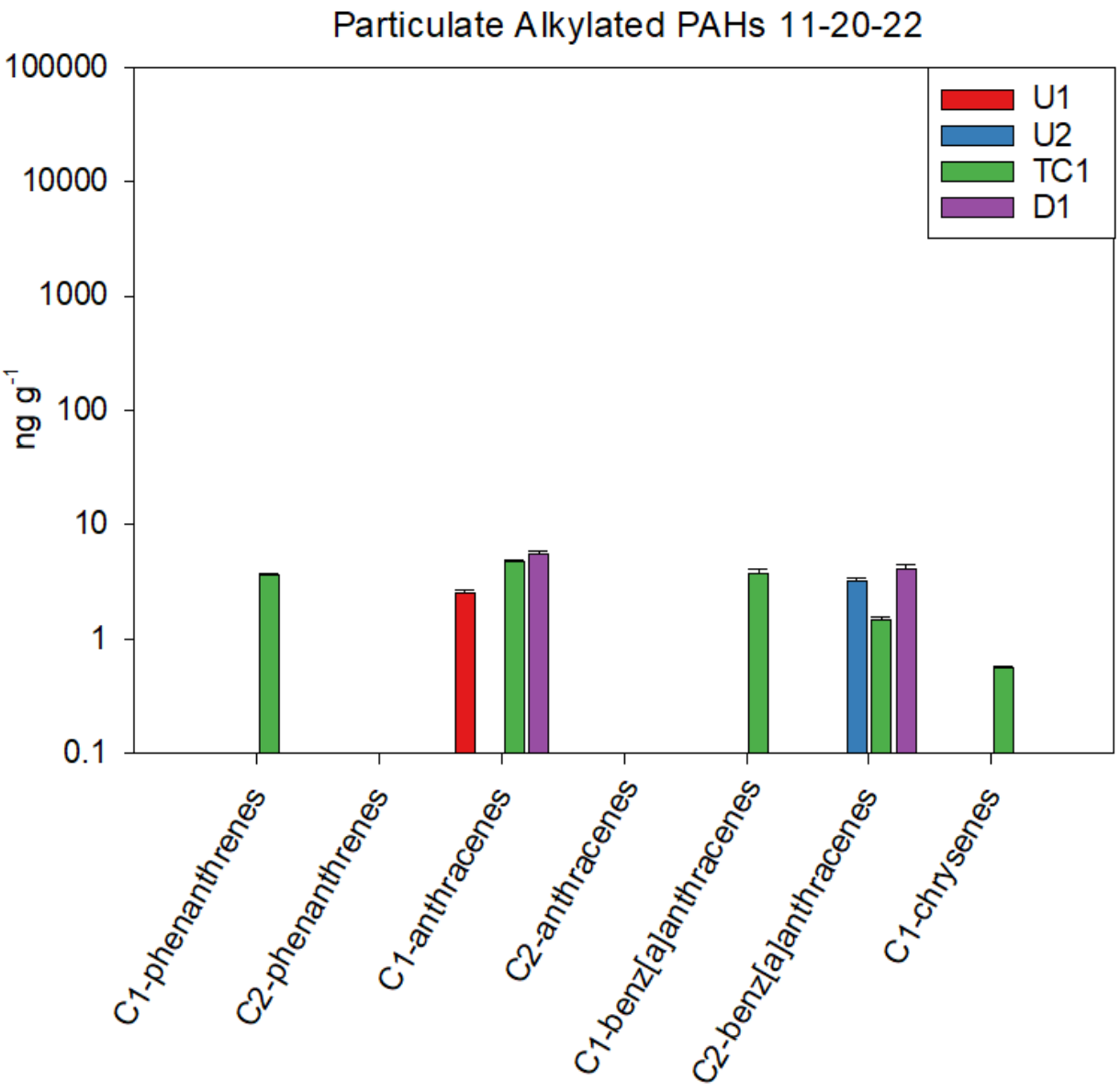

Fig. 3.12: Alkylated C_P-PAH homologs for each site during the sampling event 11-20-22. The absence of bars indicates nonquantifiable compounds.

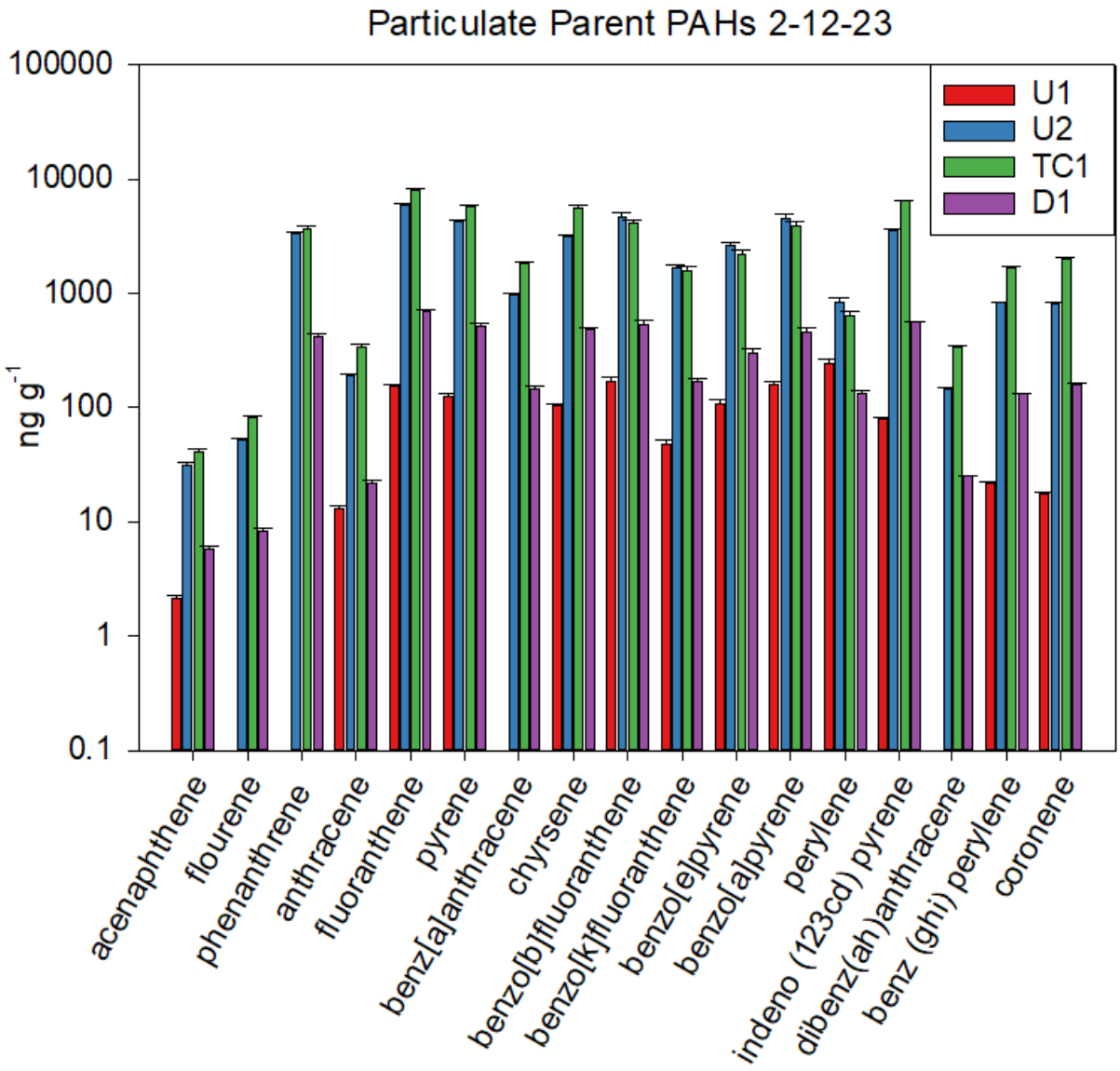

Fig. 3.13: C_P-PAH parent homologs for each site during the sampling event 2-12-23. Nonpresent bars indicate nonquantifiable compounds.

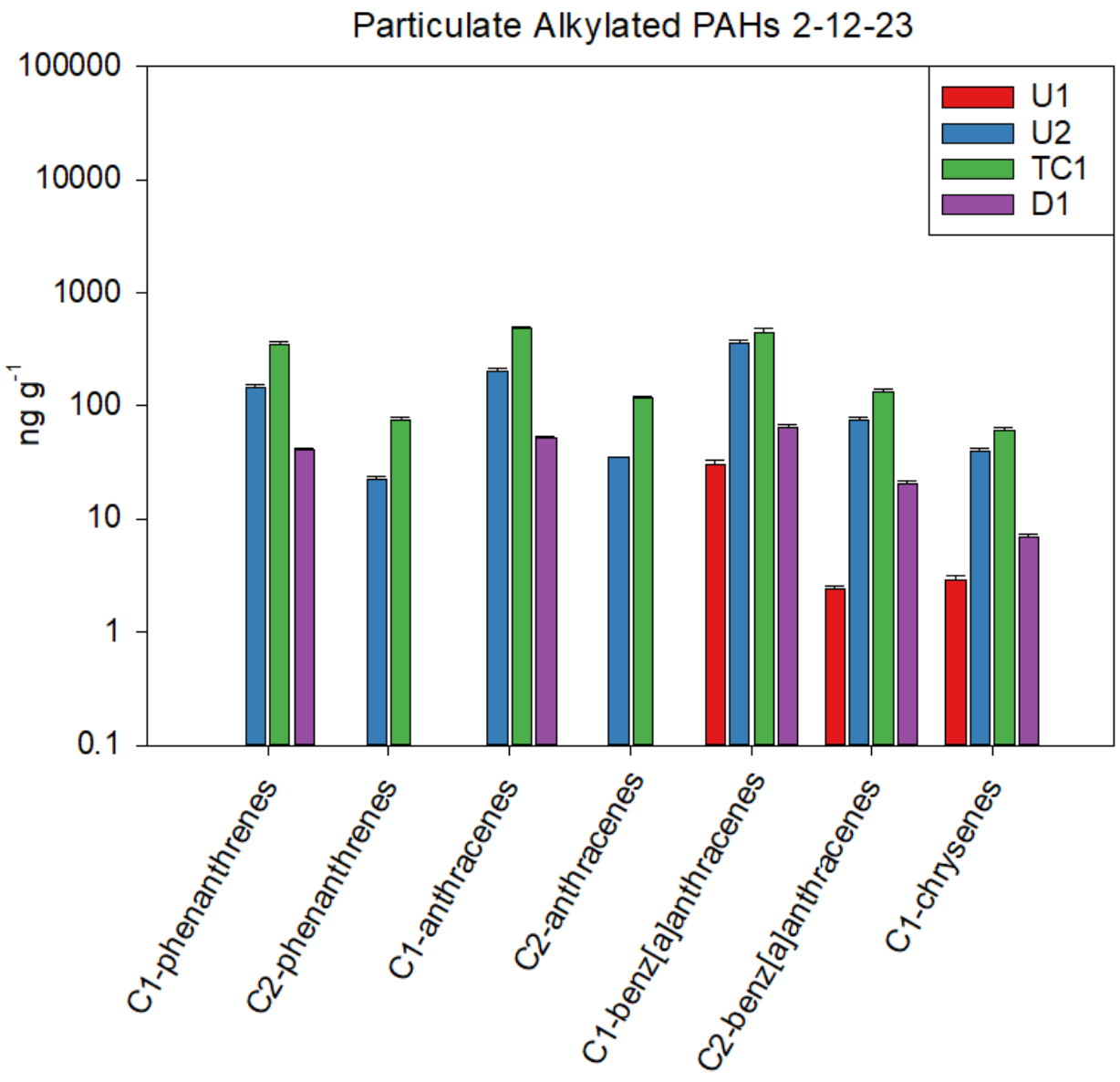

Fig. 3.14: Alkylated homologs of C_P-PAH for each site during the sampling event 2-12-23. Missing bars indicate Non-detectable compounds.

At the Town Creek sites, parent and alkylated homolog concentrations were highest at site TC3, seen in Fig. 3.15 and 3.16. In contrast, PAH homolog concentrations were lowest at site TC6. More alkylated PAH homologs were present at site TC3 compared to the other TC sites.

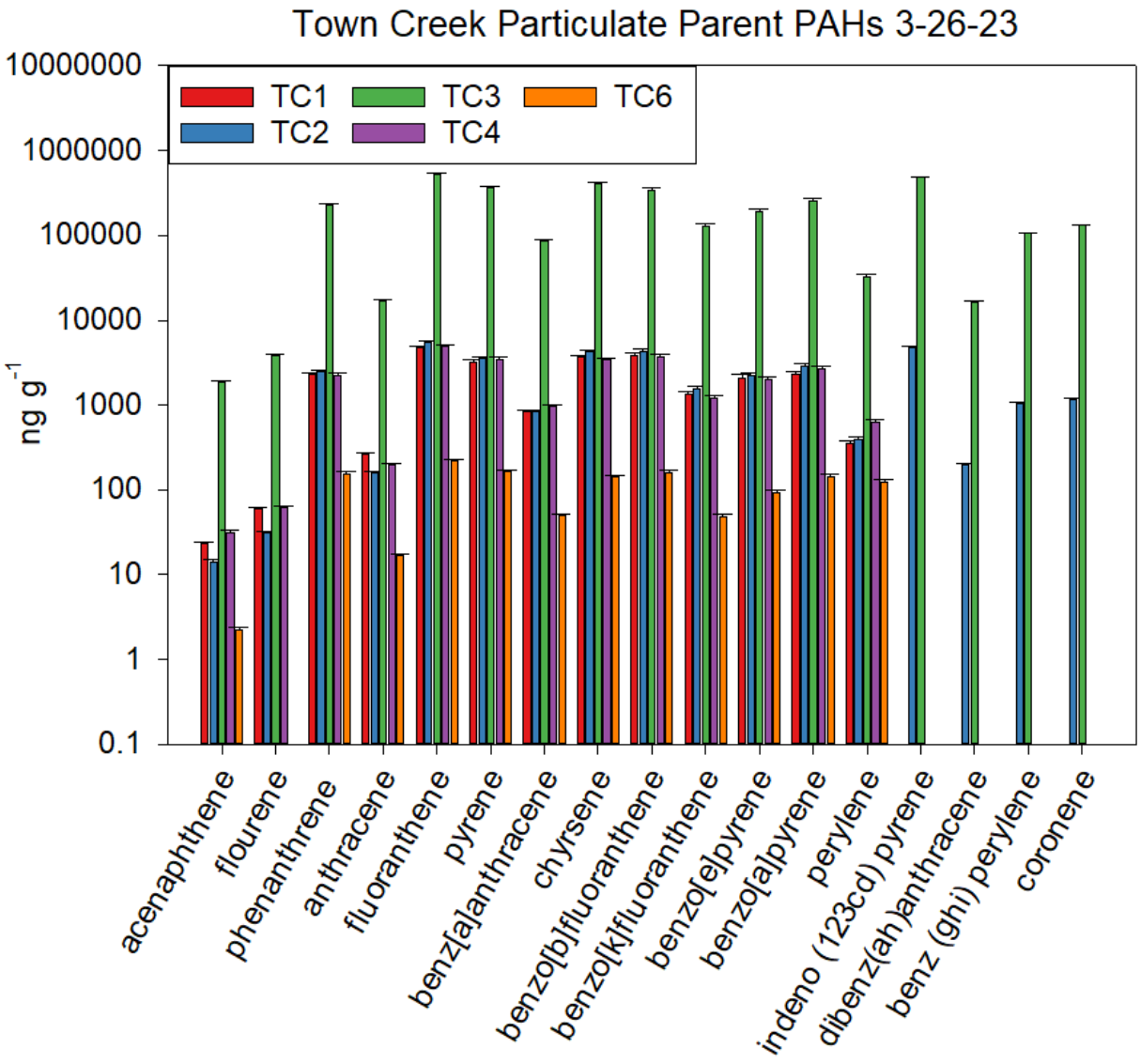

Fig. 3.15: Parent Cp-PAH for each Town Creek cross-river sampling during the sampling event 3-26-23. Missing bars indicate Non-detectable compounds.

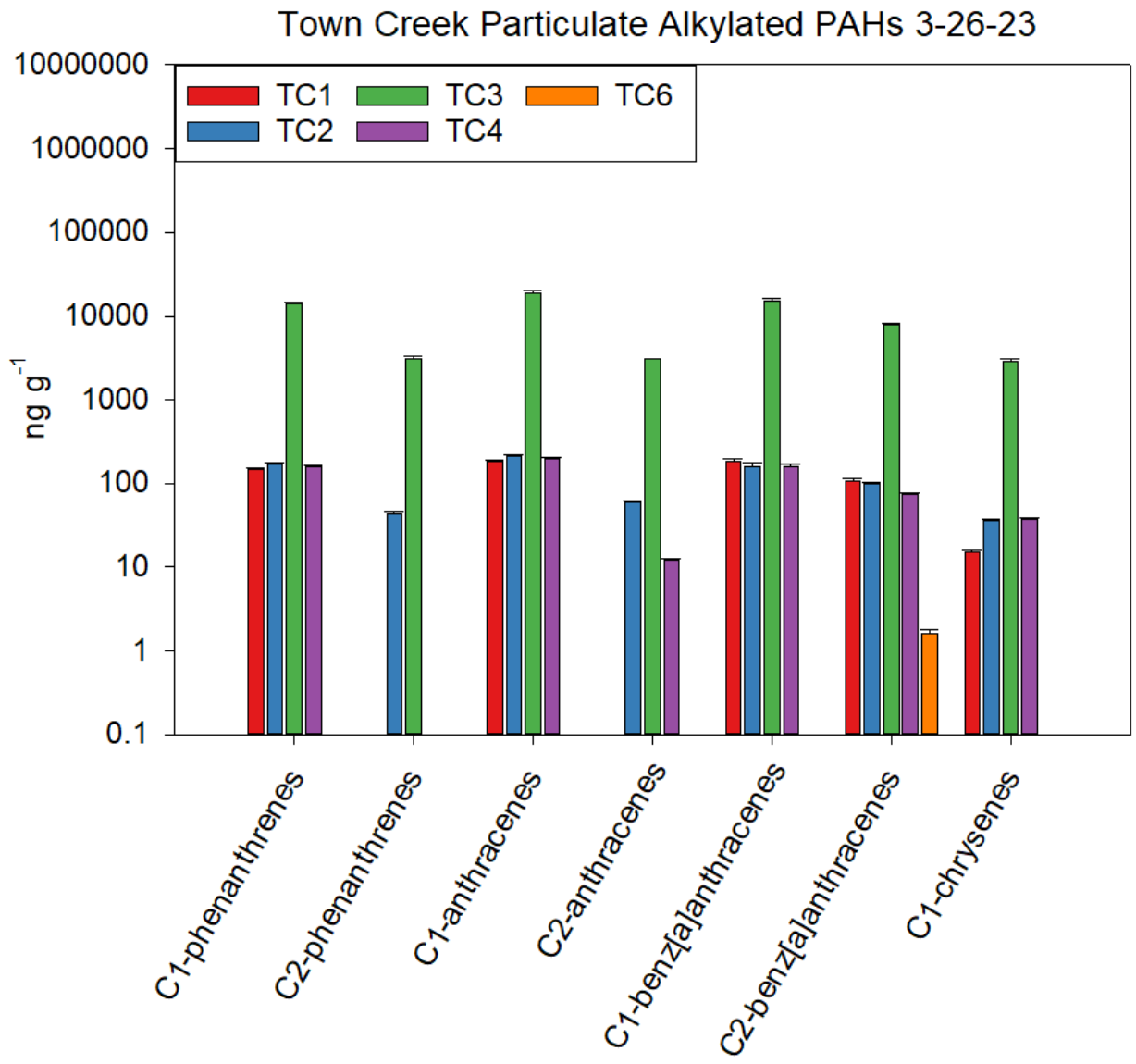

Fig. 3.16: Particulate PAH concentration by group for each Town Creek site during the sampling event 3-26-23. Missing bars indicate Non-detectable compounds.

The dissolved homolog concentrations for the sampling events 11-20-22 and 2-12-23 can be seen in Figs. 3.17 to 3.20, respectively. Primarily low molecular weight parent PAH homologs were present during the 11-20-22 sampling event. In contrast, higher molecular weight parent PAH homologs were present during the 2-12-23 sampling event for each site. Low molecular weight alkylated PAH homologs were the primary homologs present during the 11-20-22 sampling event. In contrast, the 2-12-23 had both low and high molecular weight alkylated PAH homologs present. The concentrations of parent PAH homologs were lower than that of the

alkylated homologs during the 11-20-22 sampling event, whereas the parent PAH homologs were higher in concentration than the alkylated homologs during the 2-12-23 sampling event.

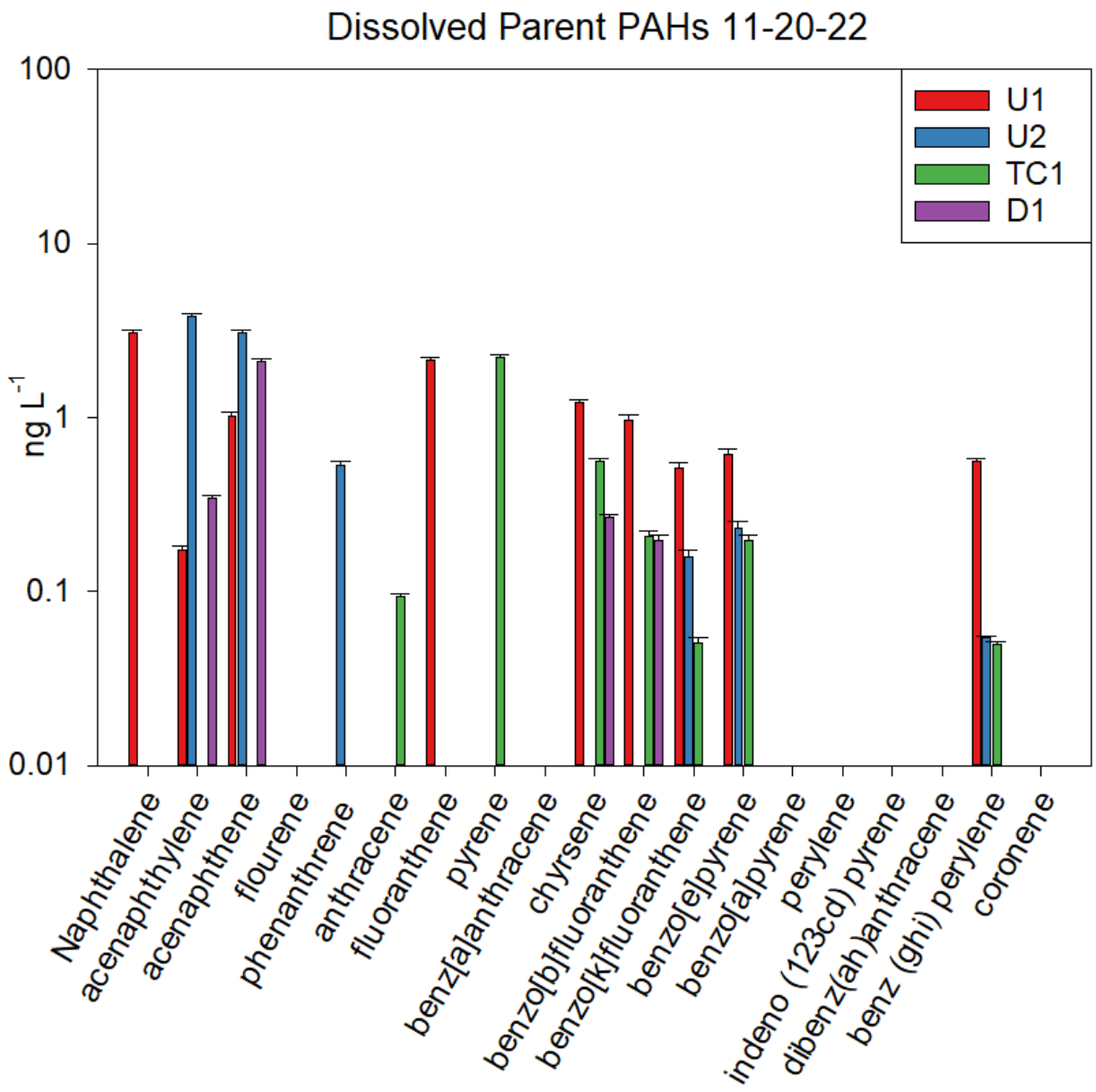

Fig. 3.17: Dissolved PAH concentration by group for each site during the sampling event 11-20-22. Missing bars indicate Non-detectable compounds.

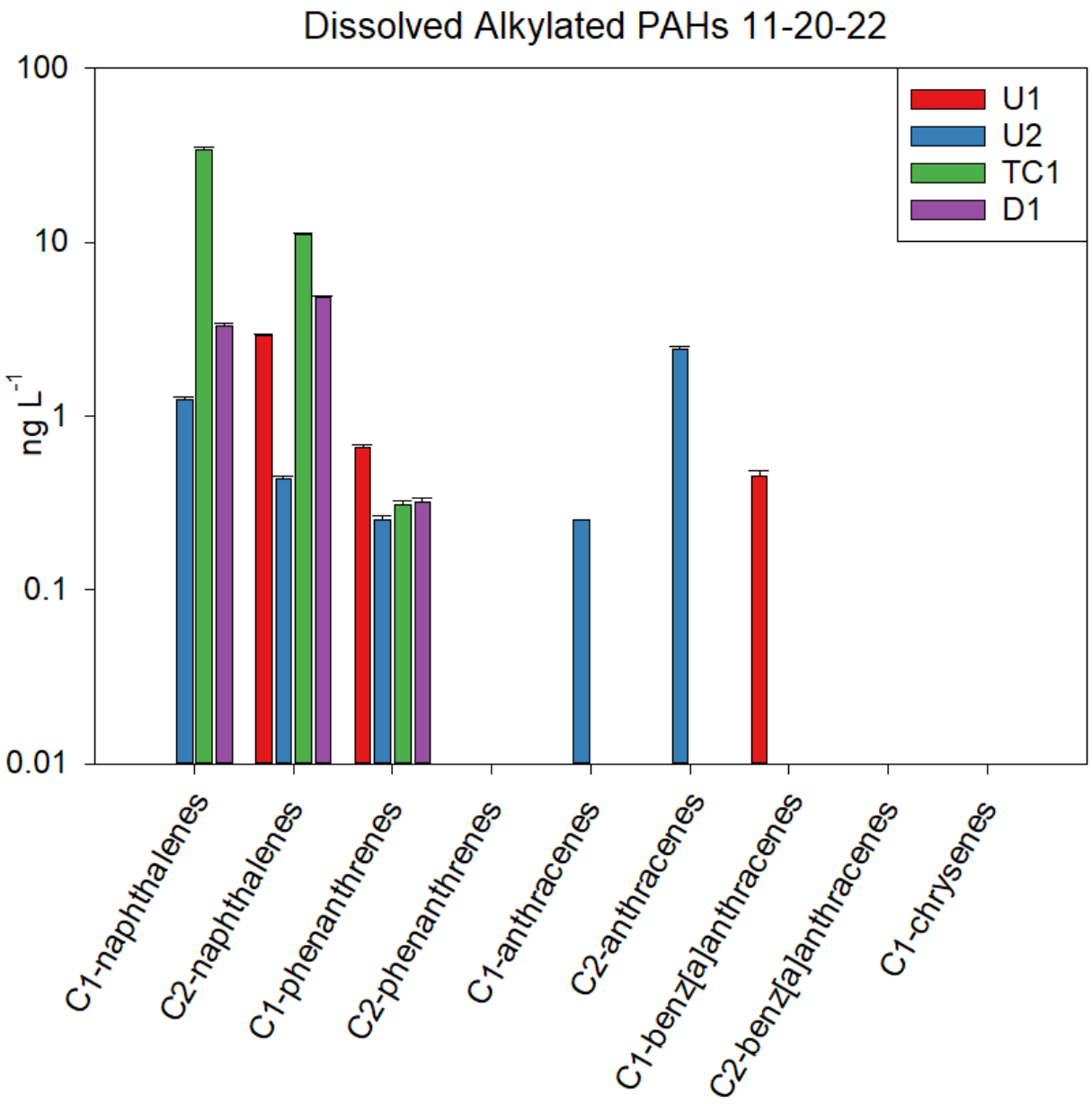

Fig. 3.18: Dissolved PAH concentration by group for each site during the sampling event 11-20-22. Missing bars indicate Non-detectable compounds.

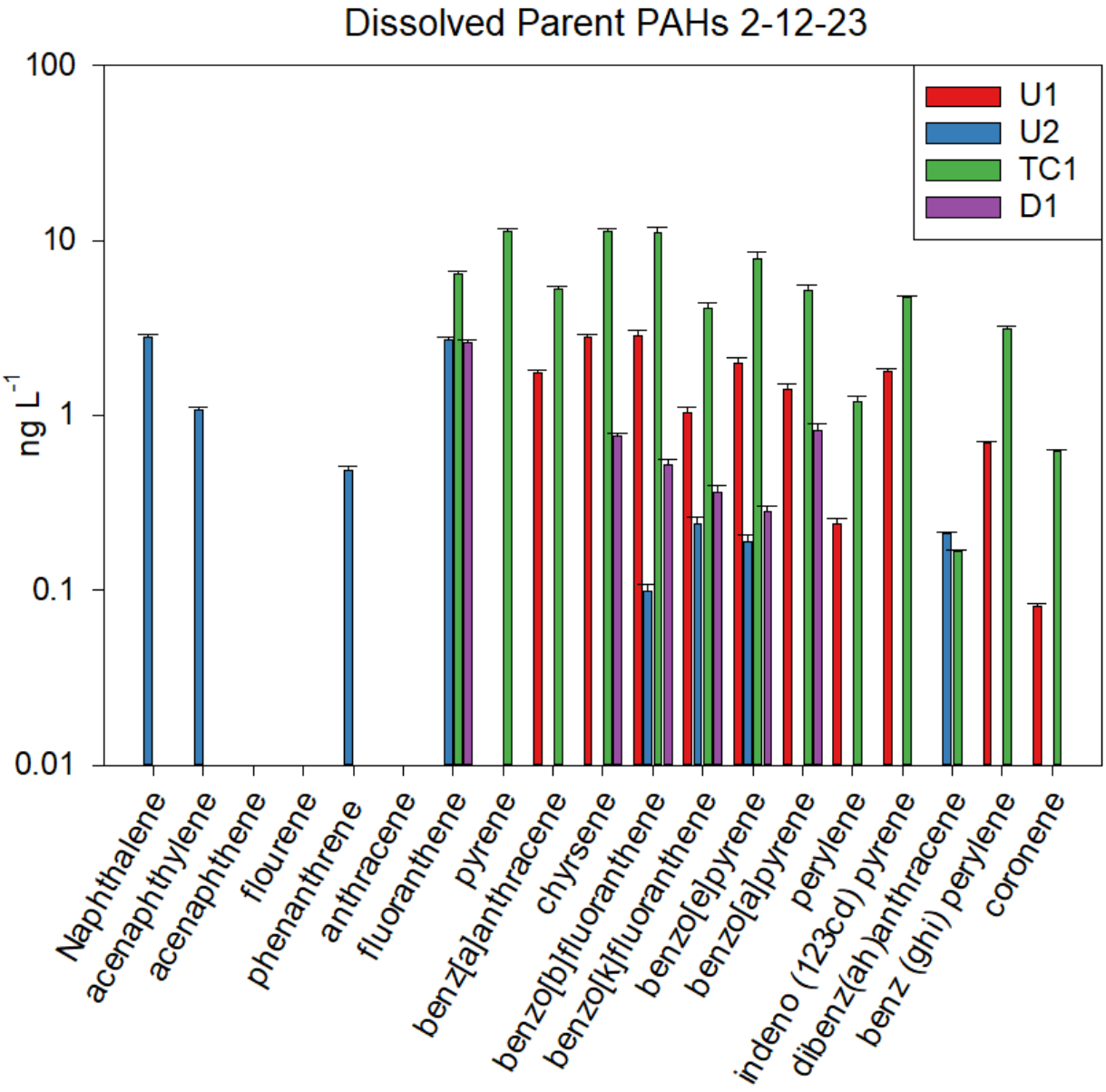

Fig. 3.19: Dissolved PAH concentration by group for each site during the sampling event 2-12-23. Missing bars indicate Non-detectable compounds.

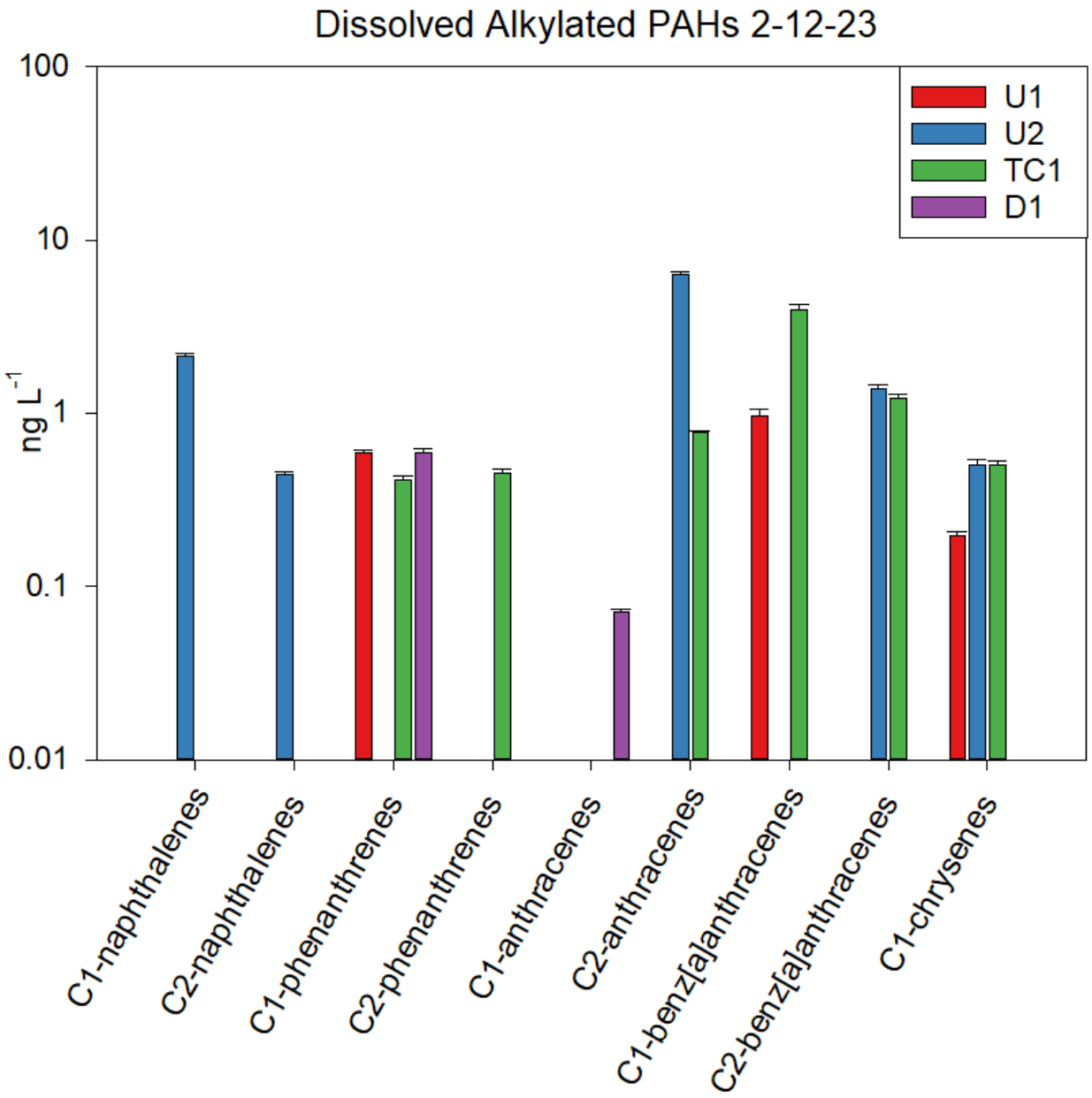

Fig. 3.20: Dissolved PAH concentration by group for each site during the sampling event 2-12-23. Missing bars indicate Non-detectable compounds.

At the Town Creek sites, parent and alkylated homolog concentrations were highest at site TC3, seen in Fig. 3.21 and 3.22. Both low and high-molecular-weight parent PAH homologs were present at each site. This is similarly true for the alkylated homologs, although the concentrations of the low molecular weight homologs are higher than that of the high molecular

weight homologs. The alkylated homolog concentrations are higher than the parent homolog concentrations at sites TC3 and 4, the opposite is true for each other Town Creek site.

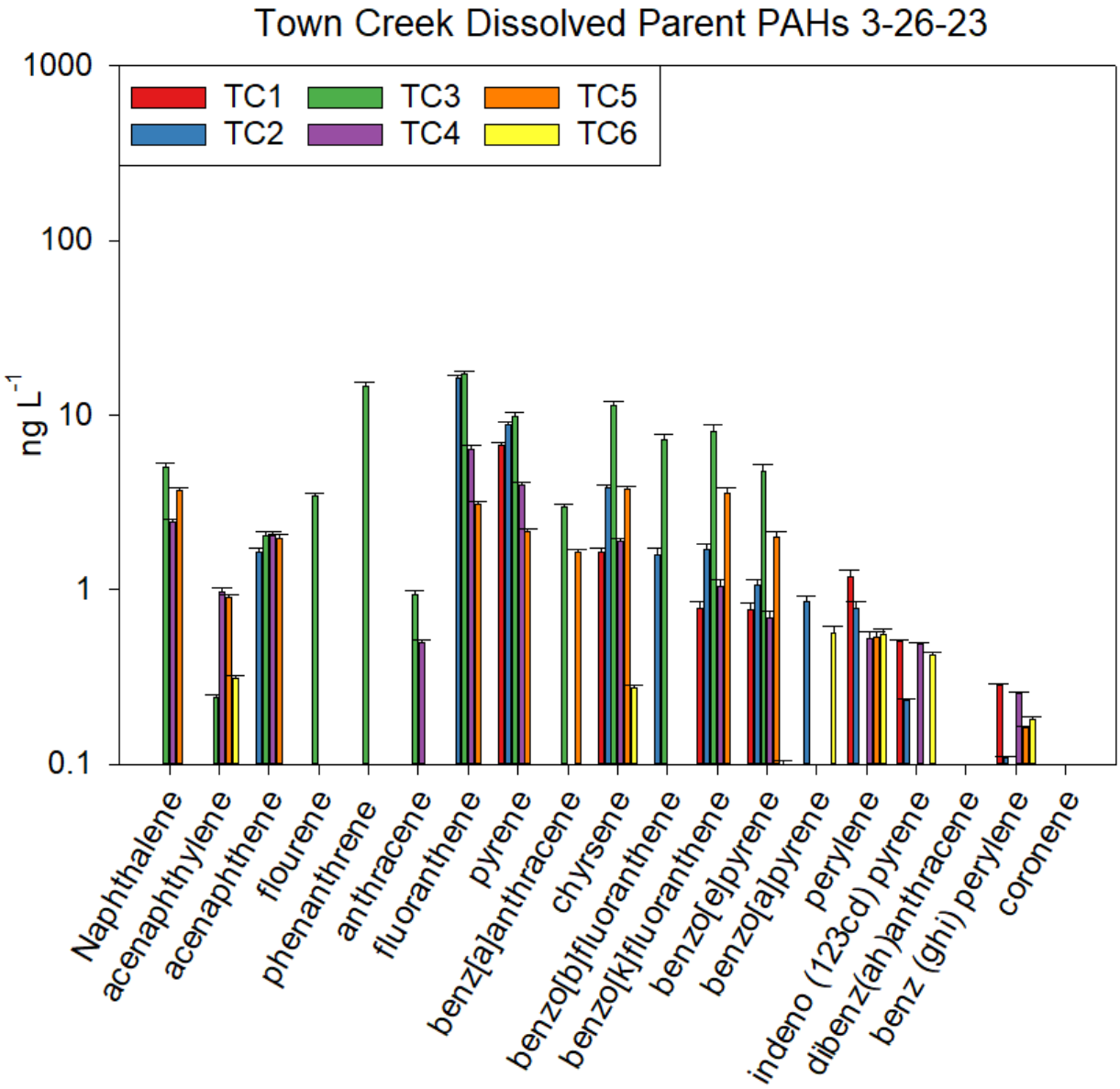

Fig. 3.21: Dissolved PAH concentration by group for each Town Creek site during the sampling event 3-26-23. Missing bars indicate Non-detectable compounds.

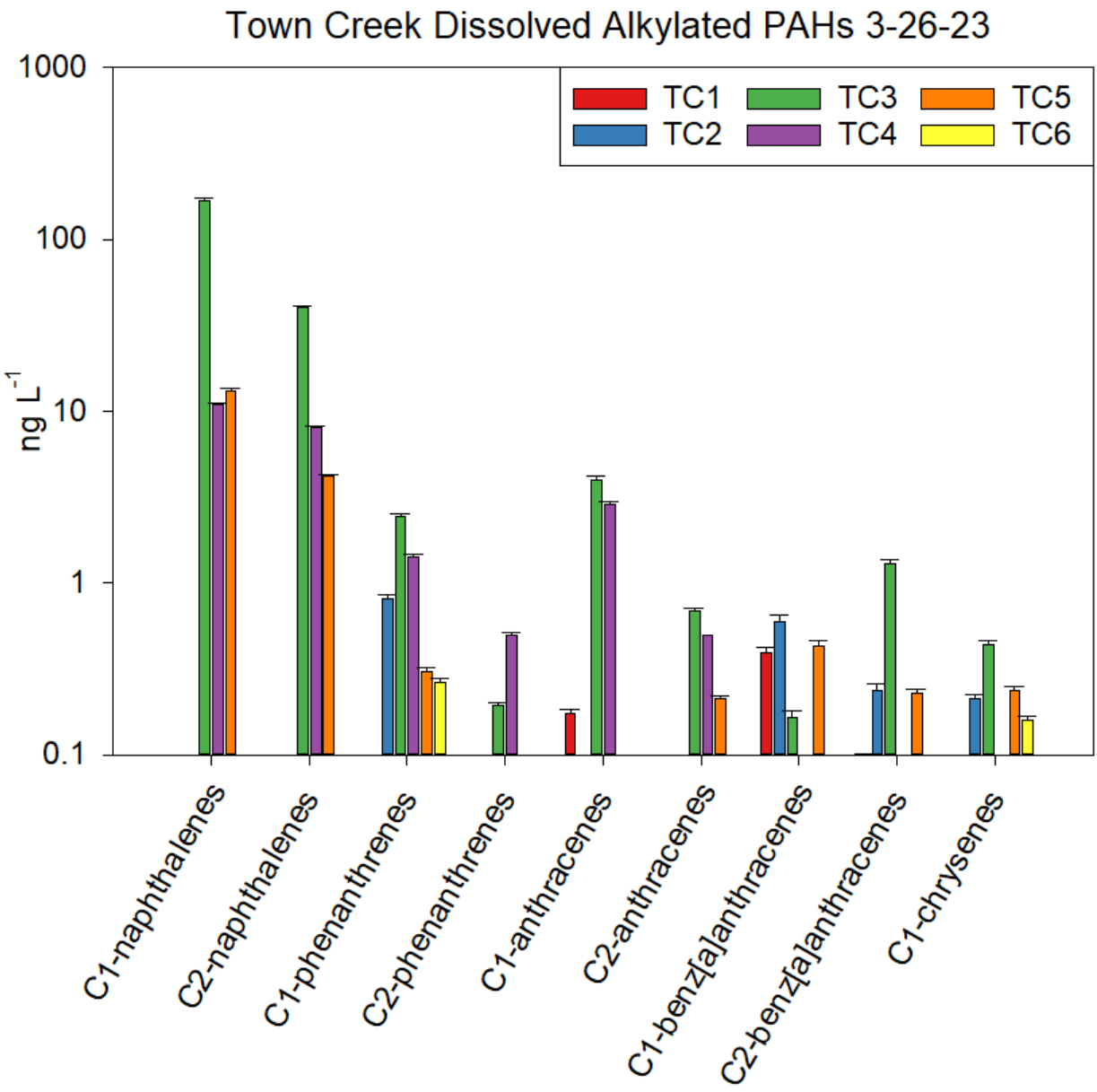

Fig. 3.22: Dissolved PAH concentration by group for each Town Creek site during the sampling event 3-26-23. Missing bars indicate Non-detectable compounds.

4.0 Discussion

4.1 PAH Abundances

Total PAH concentrations (C_P and C_W) varied at each site throughout the study period. However, this variance in total concentration did not correlate with either gauge height of the river, or the DOC at each of the sites sampled (fig.7.1 to 7.4 in the appendix). This suggests that the PAH levels entering the Tar in Greenville were not primarily driven by river hydrology or association with DOC. The DOC does differ between the main sites, U1, U2, TC1, and D1, with TC1 DOC being lower during each sampling event except for 3-26-23 and 4-14-23. This suggests that the source of natural organic matter entering Town Creek is distinct from that of the mainstem of the Tar River. TDN concentrations were less variable across sites ranging between 0.27 mg L^{-1} – 0.74 mg L^{-1}. This lack of variation could indicate that the sources of biological matter are similar between the sampled sites. One potential source of contamination for the Tar River that could introduce PAHs regardless of gauge height is discharge from wastewater treatment plants, other urban areas, and other leaking storage tanks upgradient of the sampled sites. Although wastewater treatment plants do not produce PAHs, except in the case of sludge incineration, they can act to concentrate PAHs that are brought in by regional wastewater.[31] Alternatively urban runoff could be a primary contributor to PAH contamination present in the Tar River. Sources such as these could be the cause of variation in the total PAH concentrations in the Tar River.

The total C_P-PAHs quantified at the four primary sites have similar concentrations during the 11-20-22 and 1-15-23 sampling events. However, this similarity does not persist during the 2-12-23 sampling event with higher total PAH concentrations being higher at U2 and TC1, 38916 ng g^{-1} 50517.79 ng g^{-1} respectively, than at U1 and D1, 1327.96 ng g^{-1} and 5085.57 ng g^{-1}

respectively. Additionally during the 3-26-23 sampling event TC1 had a similarly high total concentration to that of 2-12-23. This variance in C_P-PAHs could be caused by the biofilm present at the site, as this biofilm was not present during the 2-12-23, 3-26-23, and 4-14-23 sampling events. This study presents two potential reasons for the heightened concentrations when the biofilm was not present. Bacterial communities found within biofilms, such as the genus *sphingomonas,* have been shown to breakdown PAHs such as phenanthrene and pyrene.[26, 32] There is evidence of this genus of bacteria based on a previous study by Brooks 2020 on the biofilm present at Town Creek.[10] Thus the biofilm present at Town Creek may be actively remediating the PAHs present at the site. Alternatively, the biofilm present may be diluting the C_P-PAHs present. Thus, when the biofilm is not present, the C_P-PAHs are not being diluted leading to a higher total concentration. The 4-14-23 sampling event was the higher flow event sampled with a gauge height of 13.7 ft. The water level of the river could have diluted the PAHs present at the site explaining why there was not an increased concentration despite the biofilm not being present.

The trends in total C_W-PAHs values and compound relative abundances differed from that of the C_P-PAHs. The TC1 site had the highest total concentrations during each event except the 9-25-22 event. However, the highest concentration event for the total C_W-PAHs was during the 10-2-22 sampling event. The total C_W-PAHs showed no correlation with the gauge height of the Tar River or the DOC of the sample. Thus, neither gauge height nor DOC can predict the total PAH concentration of the sites. The Town Creek concentrations may not correlate with gauge height due to differences in flow from that of the Tar River. Like the C_P-PAHs the concentrations of C_W-PAHs may be affected instead by wastewater treatment plant discharge or urban runoff. Unlike the C_P-PAHs however, there were two sampling events with alkylated PAH

ratios that indicate a petrogenic source, one of which coincided with the highest total C_W-PAHs measured at the main sites.

When compared to other studies of contaminated sites, the total PAHs of the Tar River indicate that Town Creek is not affecting the overall PAH levels. In other studies addressing contaminated sites, the total PAHs of the system increase downriver of the contamination source (Table 4.1).[3, 11, 33] This trend is not seen in the sites sampled in this study, although PAH levels may be higher, the potential contamination from the seep entering Town Creek is not having an effect on the total PAHs similar to that of other contamination sources. This could be due to the previous remediation of the contamination in the area, although studies such as Sower et al. 2008 show that even after remediation PAH levels can remain elevated.[11] Additionally this could be due to the differences in flow of Town Creek and the Tar River, with the Tar River having a higher flow which would dilute input from Town Creek.

Table 4.1: A comparison of total dissolved and particulate PAHs upriver, at the potential seep site at Town Creek, and downriver compared to other upriver, contamination, and downriver sites of other studies.[3, 11, 33]

Source	Units	Upriver	Contamination Site	Down River
11-20-22 Particulate fuel contamination	ng g^{-1}	1288.39 ± 21	635.87 ± 10	1484.1 ± 25
2-12-23 Particulate fuel contamination	ng g^{-1}	38916.56 ± 700	50517.79 ± 732	5085.57 ± 81
Archambault Et Al. 2018 Neuse River Road Runoff	ng g^{-1}	2309	--	3542
11-20-22 Dissolved fuel contamination	ng L^{-1}	12.54 ± 0.26	48.95 ± 1.3	11.49 ± 0.22
2-12-23 Dissolved fuel contamination	ng L^{-1}	24.07 ± 0.39	81.48 ± 1.4	6.8 0.15
Sower and Anderson 2008 Willamette River Tar contamination	ng L^{-1}	62	1170	269
Minick and Anderson 2017 Willamette River sediment capped contamination	ng L^{-1}	7.90 ± 0.43	27.50 ± 1.5	10.48 ± 0.58

The total C_W-PAHs of the Town Creek site when sampled radially outward show that the PAH contamination differs moving along the creek. The concentrations are higher at TC3 than that of any other TC site sampled. This suggests that additional PAHs are entering the creek, proceeding down gradient. The lower total C_W-PAHs at TC1, when compared to TC3, could be due to additional groundwater entering Town Creek along the entire creek instead of only near the TC1 sampling site.

4.2 PAH Sources

The sources of PAHs entering a system influence the ratio of parent or alkylated PAHs compared to that of the total concentration of PAHs. Combustion-derived sources typically have higher concentrations of parent PAHs.[14] A study done by Goto et al. 2021 determined the concentration of parent and alkylated PAHs in fuels and lubricants. Each oil and lubricant studied had similar or higher concentrations of alkylated PAHs present when compared with the parent PAHs.[34] Thus when comparing the ratio of parent PAHs and alkylated PAHs to the total PAH concentration at sampling sites, a majority parent PAH ratio indicates primarily combustion-derived sources of PAHs, whereas a majority of alkylated compounds indicate petroleum-derived sources.[14, 34, 35]

Concentrations of particulate phase PAHs during each sampling event were dominated by parent compounds relative to their alkylated homologs. This indicates that the sources of these C_P-PAHs are likely pyrogenic. This trend was also seen at Town Creek at each site sampled with the total PAH concentration was comprised primarily of parent PAHs (Figs. 4.1 and 4.2). Due to the parent PAHs comprising a greater relative abundance of total PAHs compared to alkylated compounds, it can be surmised that the potential lingering contamination from a historic petrogenic source (expected to have a higher relative abundance of alkylated PAHs), is not

contributing particulate phase PAHs to Town Creek.[34, 35] This is further supported by the isomer ratios of phenanthrene and anthracene, and fluoranthene and pyrene. The phenanthrene to anthracene ratio varied between 0.57 – 0.96 in the particulate phase. Ratios above 0.9 could indicate that there are petrogenic sources entering the Tar River. None of the fluoranthene pyrene ratios measured were lower than 0.4, ranging between 0.47 – 0.60. A fluoranthene to pyrene ratio of above 0.4 indicates a pyrogenic source, thus this ratio suggests primarily pyrogenic sources of PAHs entering the Tar River (Fig. 4.3).

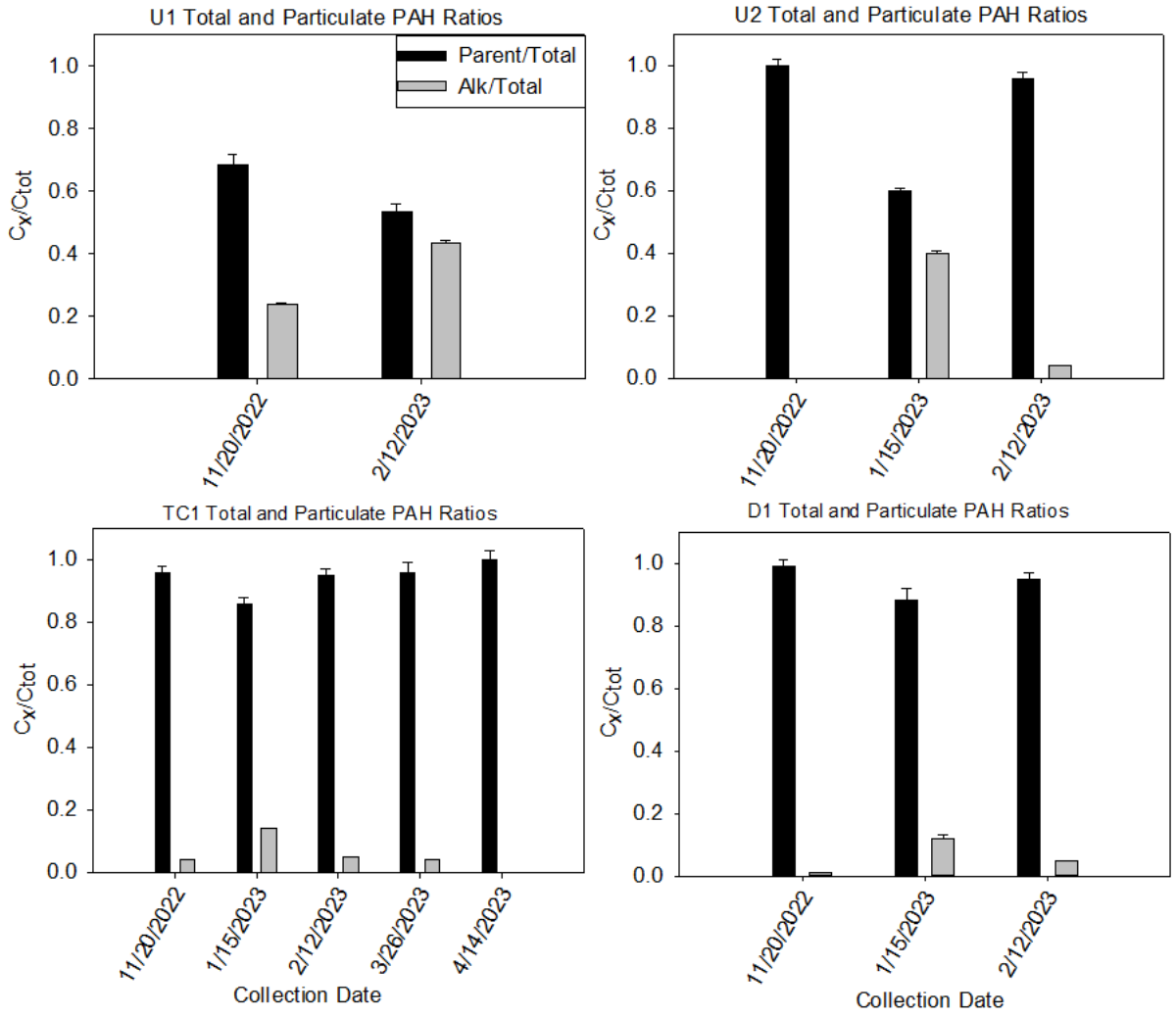

Fig. 4.1: Ratios of the parent PAHs to the total concentration and alkylated PAHs to the total concentration in the particulate phase.

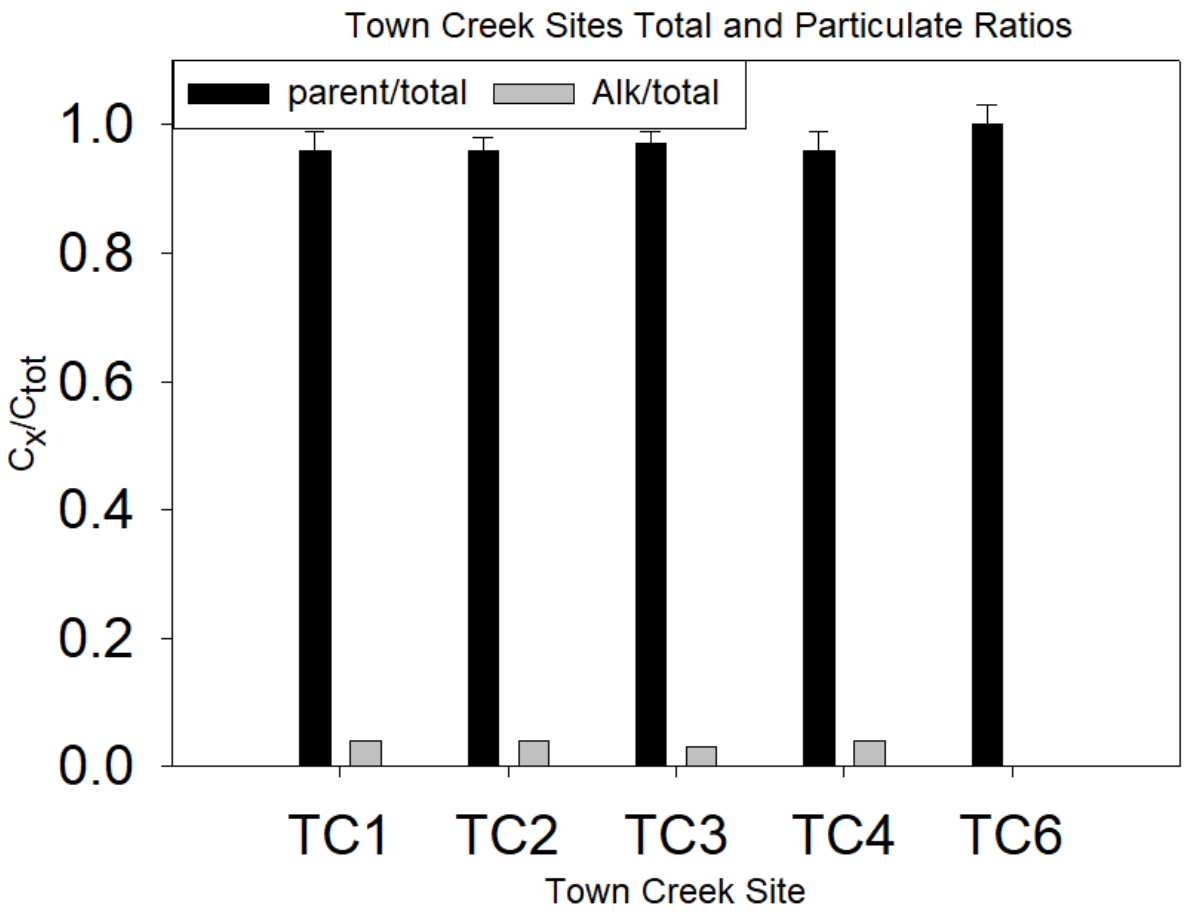

Fig. 4.2: Total particulate PAH ratios for the Town Creek sites during the 3-26-23 sampling event.

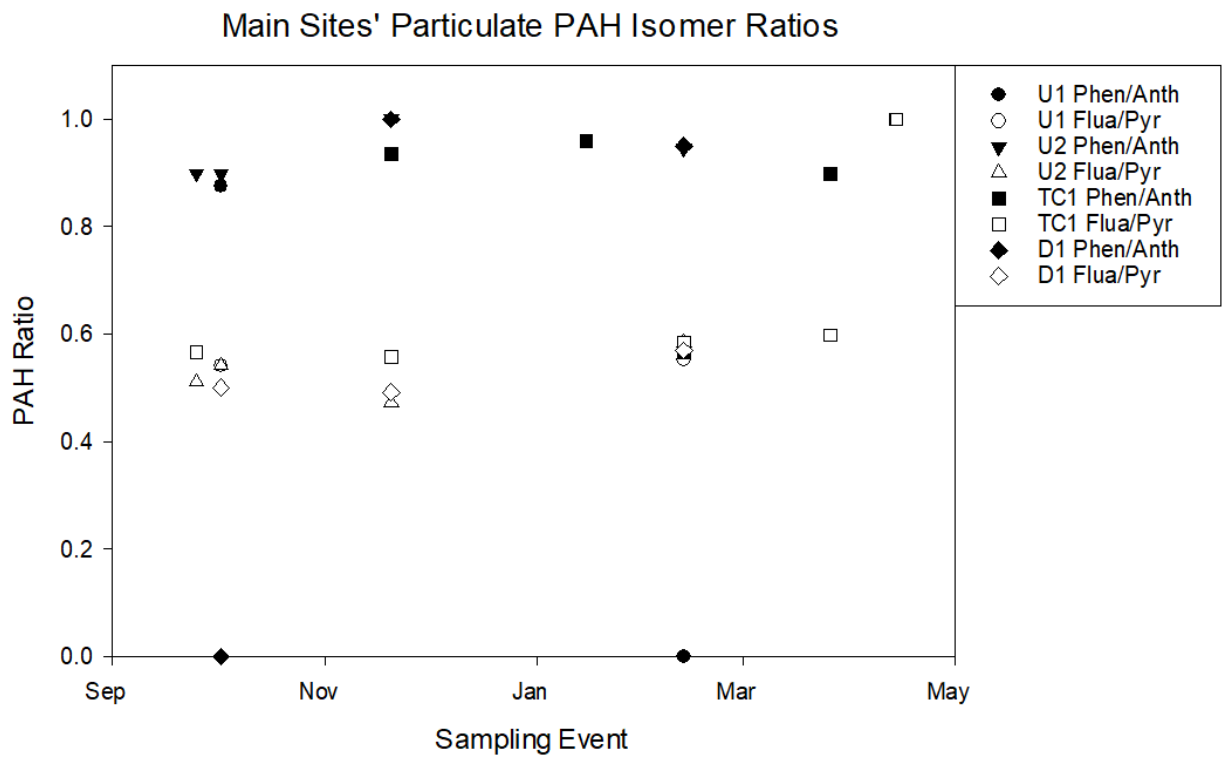

Fig. 4.3: Particulate isomer ratios of each main site throughout the sampling period. A Phen/Anth of <0.9 indicates a pyrogenic source. A Flua/Pyr of <0.4 indicates a petrogenic source.[14]

Ratios of alkylated homologs to parent PAHs differ in total C_W-PAHs differ from those of the C_P-PAHs in that there were events where alkylated compounds were relatively more abundant than parent compounds. Parent:alkylated homolog ratios at sites U1 and U2 had a greater relative abundance of parent compounds indicating pyrogenic sources, parent to total ratio of >0.5, of PAHs. However, there were sampling events where alkylated compounds composed more of the total than parent compounds at sites TC1 and D1. Two events at Site TC1 were primarily alkylated compounds, 10-2-22 and 11-20-22, whereas site D1 was only primarily alkylated compounds during 11-20-22 (Fig. 4.4). During these sampling events the PAH ratios are more indicative of petrogenic sources than pyrogenic.[34, 35] The PAH isomers, however, indicate a different source for these sampling events as neither the phenanthrene and anthracene

or fluoranthene and pyrene ratio suggest a petrogenic source (Fig. 4.6). In contrast, the fluoranthene and pyrene ratio of the TC1 site indicated a petrogenic source while the parent and alkylated ratios indicated a pyrogenic source. This suggests that Town Creek is being affected by multiple sources of PAHs. The sampling event 11-20-22 had an average gauge height of 2.6775 ft while the event 10-2-22 had a gauge height of 6.03. This may indicate that during low flow periods in the Tar River, the TC site has a greater influence on the PAH composition downriver of it. Additionally, the PAH ratio at Town Creek was not indicative of pyrogenic sources during each sampling event showing that there are periods where the seep is not the primary contributor of PAHs to the site. This variance in PAH ratio does not correlate with the DOC or the gauge height of the river and instead may be driven by flow from Town Creek itself.

The PAH ratios at various points of Town Creek show that the alkylated ratio overtakes that of the particulate phase at TC3. At sites TC1, 2, 5, and 6 the ratio of parent to total PAHs is suggestive of pyrogenic sources, whereas at sites TC3 and 4 the ratio is suggestive of petrogenic sources.[34, 35] This could indicate that the seep is having a greater effect on Town Creek at TC3 vs TC1 or 2 (Fig. 4.5). This could also indicate that subsurface groundwater inputs may be higher at downstream sites of Town Creek. The DOC concentrations were similar for each site along Town Creek; thus, the DOC of the sites did not predict the difference in PAH ratio.

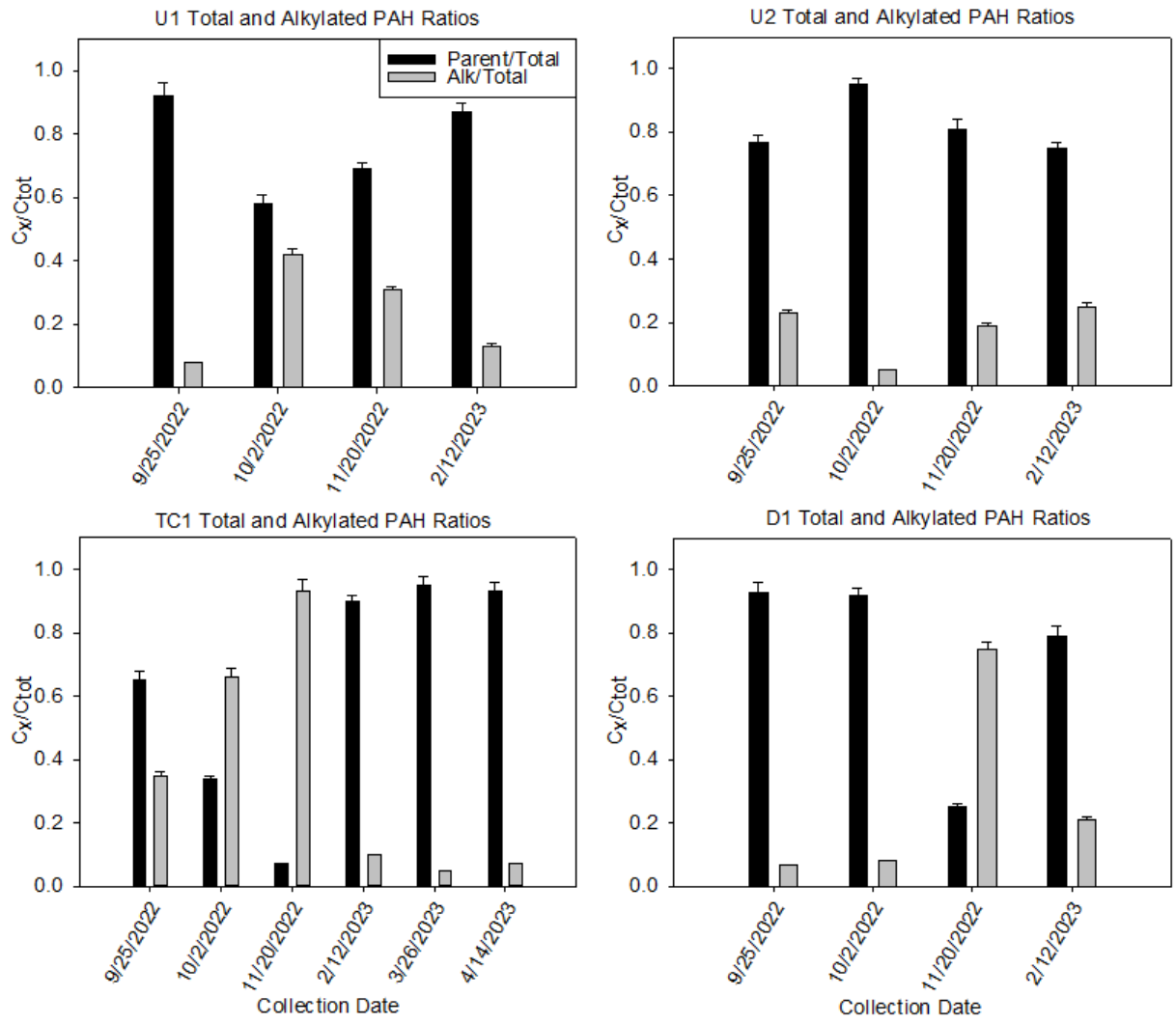

Fig. 4.4: Ratios of the parent PAHs to the total concentration and alkylated PAHs to the total concentration in the dissolved phase.

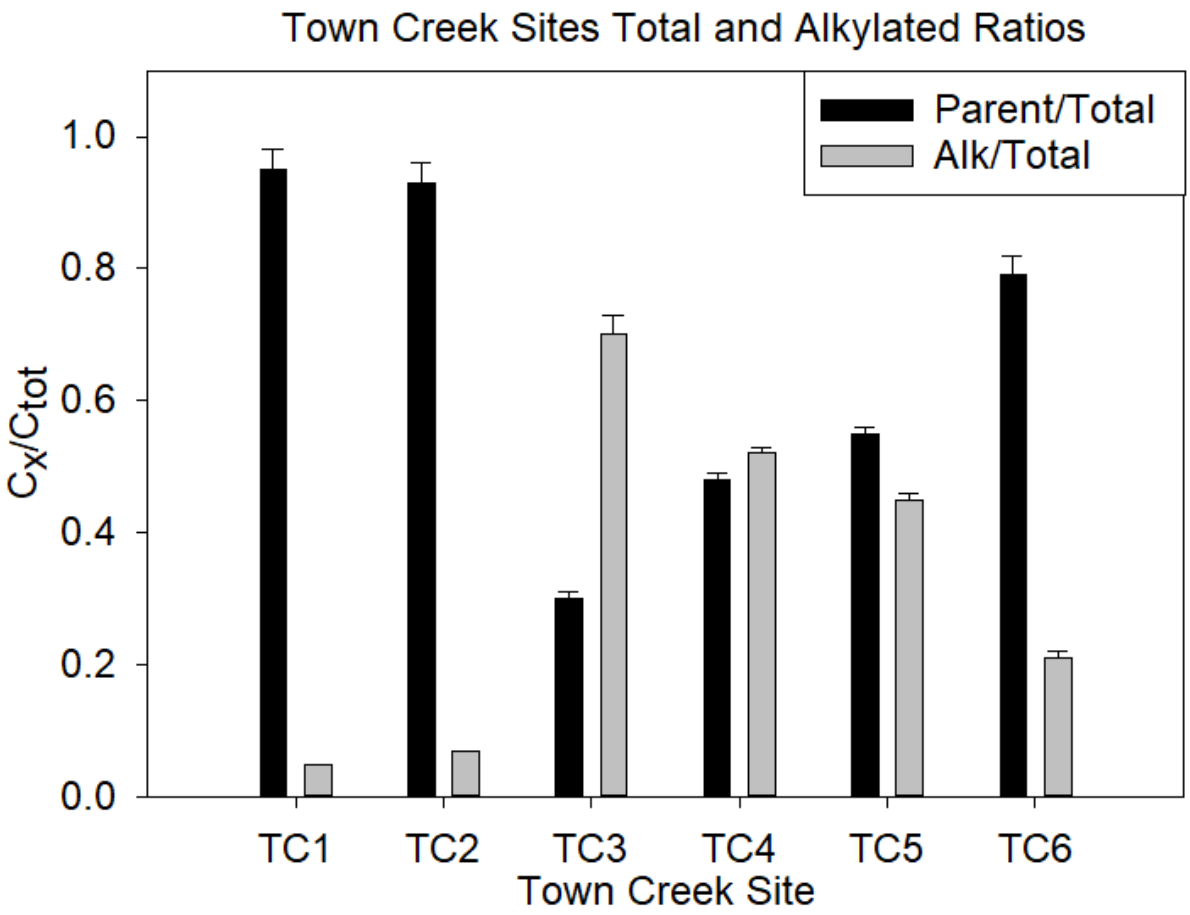

Fig. 4.5. Total dissolved PAH ratios for the Town Creek sites during the 3-26-23 sampling event.

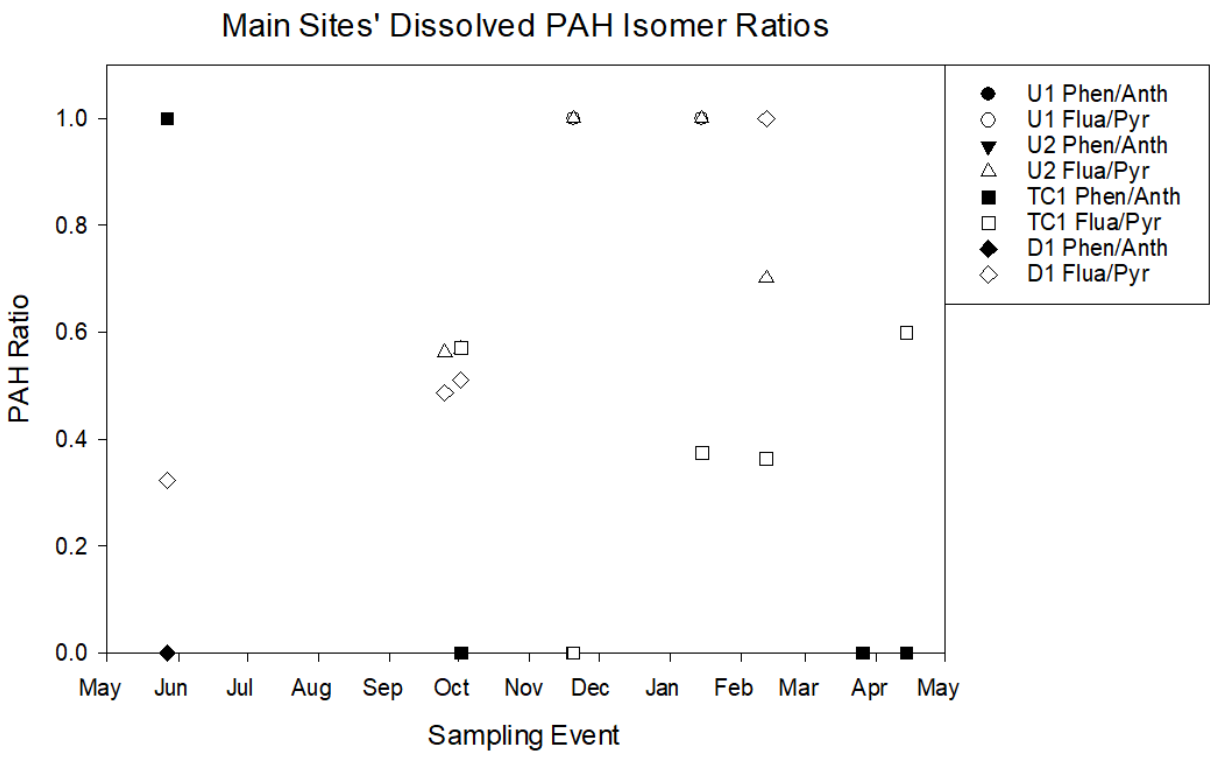

Fig. 4.6: Dissolved isomer ratios of each main site throughout the sampling period. A Phen/Anth of <0.9 indicates a pyrogenic source. A Flua/Pyr of <0.4 indicates a petrogenic source.[14]

4.3 Log K_D vs Log K_{ow}

In a two-phase aqueous system at equilibrium, the concentration of a chemical in the freely dissolved phase (C_W) relative to that in a particulate phase (C_S), may be described by a linear equation: $K_D = C_S/C_W$, where K_D (l/kg) is the particulate/dissolved distribution coefficient. As noted above, high molecular weight PAHs were detectable in the aqueous phase of some samples. For example, benzo(ghi)perylene was detected at a concentration of 3.14 ug L^{-1} in the dissolved phase at TC1 during the 2-12-23 sampling event (see Fig 3.19). In order to better understand the predominant phase distribution of PAHs in these sampling sites, values for K_D were calculated an compared to each PAH's octanol-water coefficient (K_{OW}). As values of K_{OW} for PAHs increase, the relative abundance of that PAHs in the particulate phase (K_D) should

ideally increase. During the 2-12-23, sampling event, K_D increase as a function of K_{OW} (Figs. 4.7 and 4.8) . However, the relationship between K_D and K_{OW} varies sites U2 and TC1 during this sampling event. Site U2 has a correlation coefficient of 0.89 indicating that the log K_D and K_{OW} are related. Although K_D does increase with increasing K_{OW} at site TC1, the correlation is low at site TC1 (0.16), compared to the correlation between the two variables as depicted in U2.

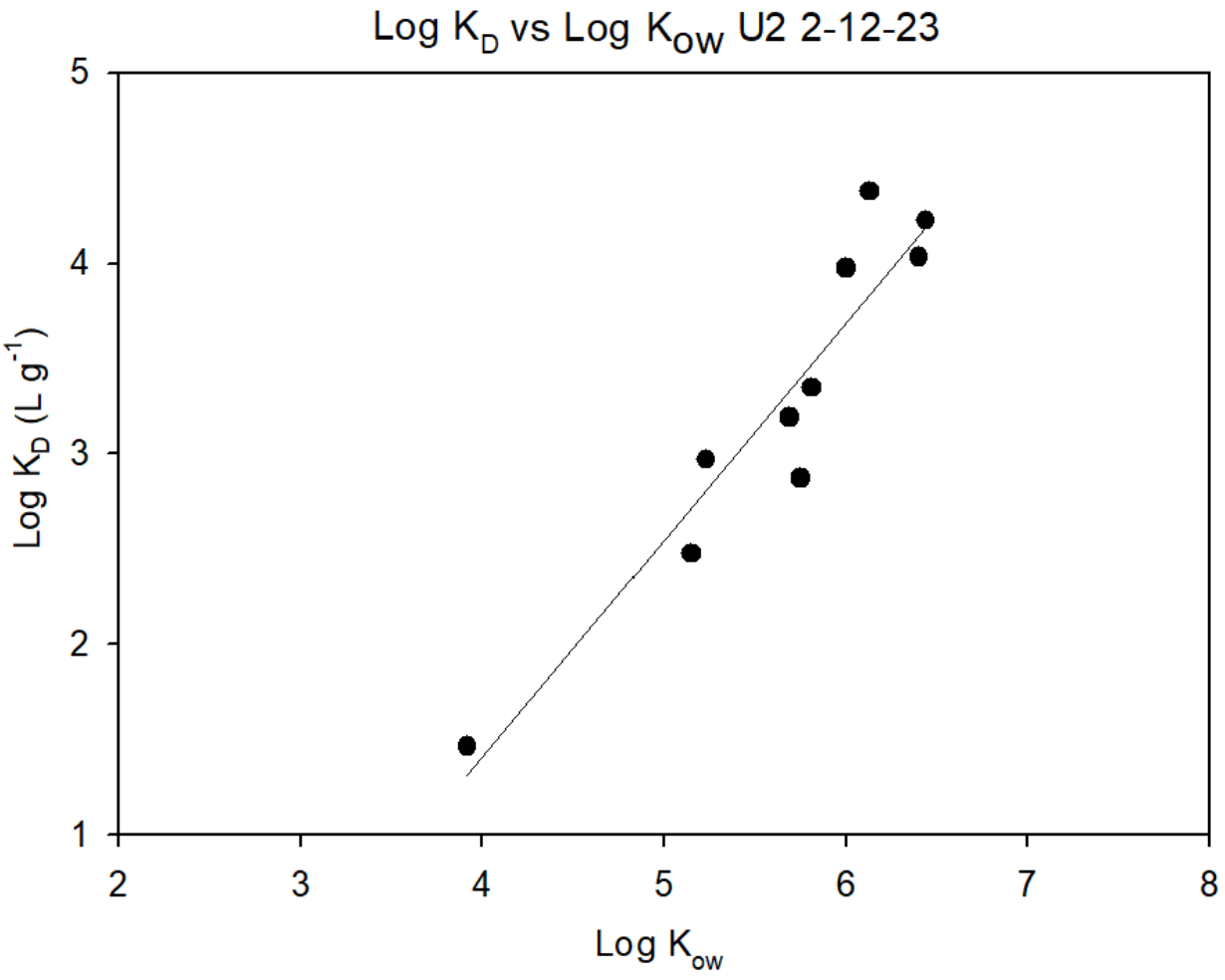

Fig. 4.7: LogK_D vs LogK_{ow} graph for site U2 during the sampling event 2-12-23.[24, 36]

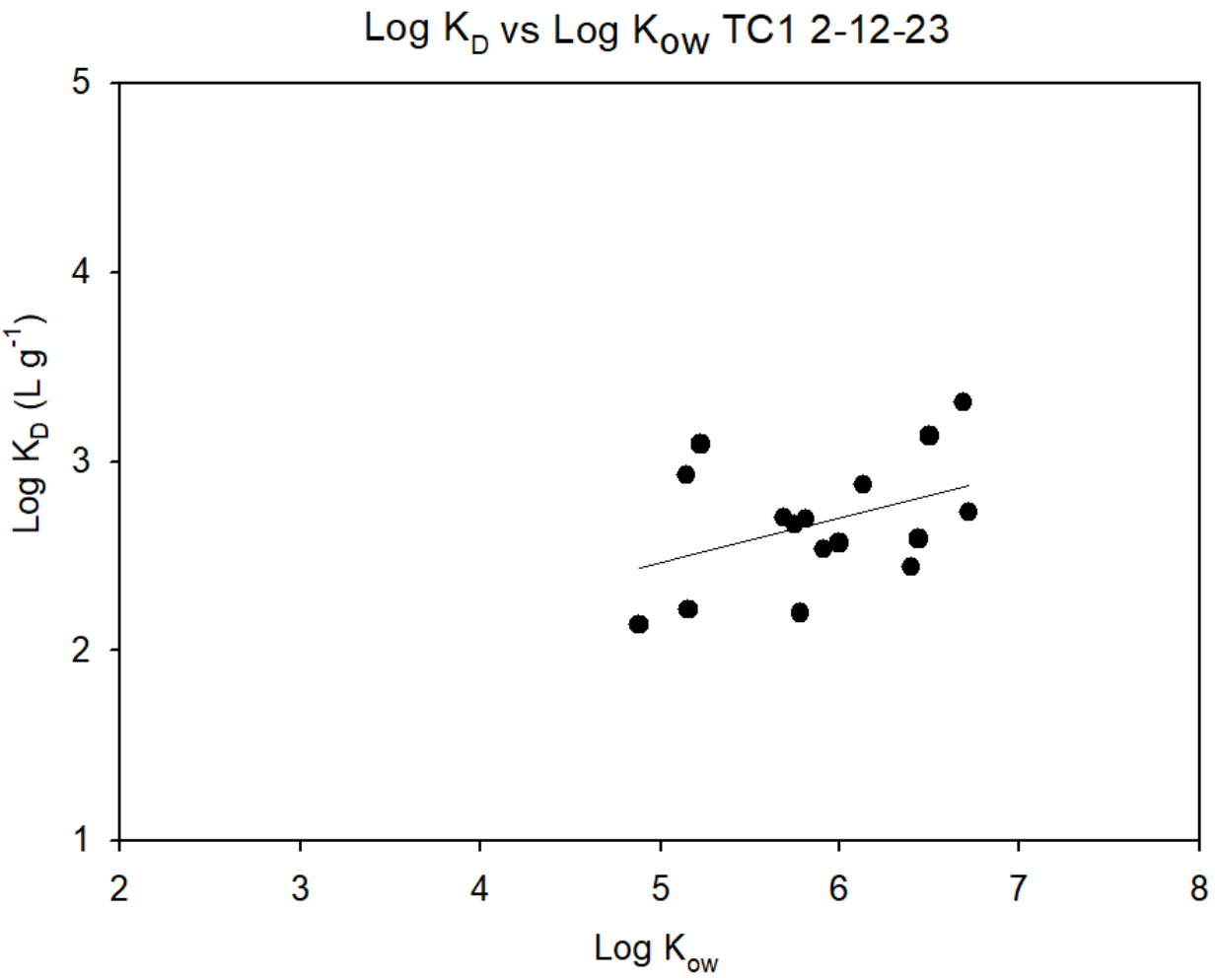

Fig. 4.8: Log K_D vs Log K_{ow} graph for site TC1 during the sampling event 2-12-2.[24, 36]

5. Conclusions and Future Work

Town Creek has been contaminated by a fuel seep in the past. This study suggests that the PAHs in this area are petrogenic and unique, compared to sites sampled in the mainstem of the Tar River. Moreover, based on alkylated homologs and parent PAHs quantified, PAHs in the particulate phase in Town Creek do not appear to have originated from the same source(s) as the PAHs in the dissolved phase. This could be due to the fuel contamination not producing particulate phase PAHs, thus the particulate matter at Town Creek shows no signs of this contamination. However, the relative abundance of alkylated compounds in the dissolved phase during the 10-2-22 and 11-20-22 sampling events indicates that there may still be fuel contamination entering the creek.

The Tar River had an increased relative abundance of alkylated compounds during the lowest flow event sampled, this points towards Town Creek having a greater effect on the Tar River during low flow periods. However, during high-flow periods this relatively higher abundance of alkylated compounds was not present, thus Town Creek's effects are likely smaller during high-flow periods. This disproves the hypothesis that contamination from Town Creek would affect the PAH fingerprint of the downriver site during high and low flow periods. More research could be done on the relationship between the discharge of Town Creek and dilution from the Tar River. Additionally, research could be done on contaminant input directly after rainfall to determine how the contaminant input changes after sediment agitation.

Three events sampled at Town Creek lacked the biofilm present during all other sampling events. Two of these events showed higher contamination levels compared to sampling events where the biofilm was present. This could be due to the biofilm breaking down PAHs in the creek when present, but when absent the contamination from the area is broken down more

slowly and thus can reach higher concentrations.[10, 26, 32] Alternatively this may be due to dilution of the particulate phase PAHs by the biofilm.

Future research should focus more specifically on Town Creek during periods with and without the biofilm present. Although there is evidence that the biofilm may be remediating PAHs, there were only three events without the biofilm present. Thus, future studies could more specifically compare times when it is present and absent. In addition, water inoculated with biofilm could be tested for the ability to remediate PAHs. This research would give additional information on biofilms' use in the remediation of PAH-contaminated sites in a real-world environment. Despite this study finding no hazardous levels of PAHs, the Town Creek site still could act as a case study for biofilms effects on a site with PAH contamination.

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7. Appendix

Table 7.1: DOC and TDN for each sampling sate during each sampling date in mg L^{-1}.

Sample Period	Sample Station	Mean Conc. DOC mg L^{-1}	STDEV DOC mg L^{-1}	Mean Conc. TDN mg L^{-1}	STDEV TDN mg L^{-1}
5/27/2022	U-1	5.84	0.09085	0.5416	0.09292
5/27/2022	D-1	5.156	0.06187	0.6557	0.00645
5/27/2022	C-1	2.031	0.3514	0.306	0.1296
9/25/2022	U-1	5.279	0.07858	0.5082	0.00458
9/25/2022	U-2	10.02	0.05527	0.3771	0.0105
9/25/2022	D-1	5.294	0.04849	0.3227	0.00994
9/25/2022	C-1	3.188	0.02335	0.5679	0.00679
10/2/2022	U-1	9.253	0.8468	0.4552	0.00923
10/2/2022	U-2	7.33	0.02595	0.5141	0.00532
10/2/2022	D-1	13.4	0.2648	0.4363	0.00793
10/2/2022	C-1	3.246	0.04713	0.2795	0.00748
11/20/2022	U-1	8.186	0.1385	0.6214	0.00932
11/20/2022	U-2	7.907	0.1051	0.5936	0.01187
11/20/2022	D-1	7.427	0.07866	0.5882	0.00459
11/20/2022	C-1	2.062	0.02796	0.4555	0.00403
12/11/2022	U-1	8.277	0.1334	0.6532	0.01166
12/11/2022	U-2	8.377	0.05657	0.6397	0.00877
12/11/2022	D-1	7.508	0.08428	0.7364	0.0046
12/11/2022	C-1	2.773	0.01671	0.7046	0.01085
1/15/2023	U-1	6.39	0.0647	0.4275	0.01082
1/15/2023	U-2	6.422	0.08855	0.4384	0.00382
1/15/2023	D-1	6.331	0.07874	0.4521	0.00797
1/15/2023	C-1	2.344	0.00995	0.2714	0.00275
2/12/2023	U-1	6.942	0.03659	0.5052	0.0122
2/12/2023	U-2	6.069	0.0298	0.4848	0.00486
2/12/2023	D-1	6.575	0.0717	0.5358	0.00715
2/12/2023	C-1	2.161	0.00633	0.2225	0.00469
3/26/2023	C-1	6.514	0.02989	0.6113	0.1589
3/26/2023	C-2	7.664	0.1251	0.7387	0.01267
3/26/2023	C-3	7.351	0.0504	0.6962	0.01548
3/26/2023	C-4	6.66	0.05452	0.4776	0.01361
3/26/2023	C-5	6.475	0.09647	0.449	0.00723
3/26/2023	C-6	6.455	0.081	0.4712	0.01273
4/14/2023	C-1	29.33	1.542	0.6489	0.00996

Table 7.2: TSS, Temp, and gauge height for each sampling site during each sampling event.

Sample Period	Sample Station	TSS mg L^{-1}	Temp C	Gauge Heigh ft.	Gauge Height Avg ft.	Gauge Height STDEV ft.
5/27/2022	U-1	7.68	23.50	4.50	4.52	0.02
5/27/2022	D-1	2.00	23.70	4.52		
5/27/2022	C-1	625.00		4.53		
9/25/2022	U-1	2.14	20.10	3.87	3.77	0.08
9/25/2022	U-2	5.00	22.30	3.80		
9/25/2022	D-1	1.85	22.60	3.70		
9/25/2022	C-1	25.70	20.80	3.70		
10/2/2022	U-1	17.60	18.70	5.92	6.03	0.08
10/2/2022	U-2	18.30	19.00	6.02		
10/2/2022	D-1	6.40	19.30	6.09		
10/2/2022	C-1	28.50	20.50	6.09		
11/20/2022	U-1	3.00	11.60	2.73	2.68	0.04
11/20/2022	U-2	3.56	9.60	2.68		
11/20/2022	D-1	3.15	9.60	2.65		
11/20/2022	C-1	71.00	15.10	2.65		
12/11/2022	U-1	7.26	11.10	4.32	4.27	0.04
12/11/2022	U-2	8.00	11.20	4.28		
12/11/2022	D-1	4.31	12.30	4.24		
12/11/2022	C-1	38.90	17.10	4.24		
1/15/2023	U-1	NQ		4.24	4.41	0.12
1/15/2023	U-2	6.70	7.40	4.45		
1/15/2023	D-1	7.33	7.50	4.47		
1/15/2023	C-1	278.70	12.50	4.49		
2/12/2023	U-1	8.29	11.20	6.08	6.10	0.01
2/12/2023	U-2	9.16	10.20	6.11		
2/12/2023	D-1	8.71	11.00	6.11		
2/12/2023	C-1	12.47	9.80	6.10		
3/26/2023	C-1	1.5	18.50	4.18	4.40	0.25
3/26/2023	C-2	2.84	17.90	4.18		
3/26/2023	C-3	0.4285	19.00	4.62		
3/26/2023	C-4	1.9		4.62		
3/26/2023	C-5	3	18.90	4.62		
3/26/2023	C-6	8.2		4.62		
4/14/2023	C-1	3.3	21.30	13.71	-	-

Table 7.3: Each compound within a mass window, red names indicate a compound that was used in the surrogate or internal standard, "" indicates a high priority PAH by the EPA.*[20]

Window 1	Window 2	Window 3	Window 4	Window 5
D8-Napthalene	Acenaphthene*	Fluoranthene*	7-Methylbenz[a]anthracene	D12-Indeno[1,2,3-cd]pyrene
Naphthalene*	Fluorene*	2,3-Dimethylanthracene	6-Methylchrysene	Indeno[1,2,3-cd]pyrene*
2-Methylnaphthalene	D10-Phenanthrene	Pyrene*	4-Methylchrysene	D12-Benzo[ghi]perylene
1-Methylnaphthalene	Phenanthrene*	9,10-Dimethylanthracene	6,8-Dimethylbenz[a]anthracene	Dibenz[a,h]anthracene*
2,6-Dimethylnaphthalene	D10-Anthracene	2-Methylfluoranthene	3,9-Dimethylbenz[a]anthracene	Benzo[g,h,i]perylene*
2,7-Dimethylnaphthalene	Anthracene*	Retene	Benzo[b]fluoranthene*	Coronene
1,3-Dimethylnaphthalene	2-Methylanthracene	9-Phenylanthracene	Benzo[k]fluoranthene*	
1,6-Dimethylnaphthalene	1-Methylanthracene	Benz[a]anthracene*	Benzo[e]pyrene	
1,4-Dimethylnaphthalene	1-Methylphenanthrene	D12-benz[a]anthracene	D12-Benzo[a]pyrene	
1,5-Dimethylnaphthalene	9-Methylanthracene	D12-Chrysene	Benzo[a]pyrene*	
D8-Acenaphthylene	2-Phenylnapthalene	Chrysene*	D12-Perylene	
Acenaphthylene*	3,6-Dimethylphenanthrene		Perylene	
1,2-Dimethylnaphthalene				
1,8-Dimethylnaphthalene				

Table 7.4: Average and standard deviation of % recoveries for each mass window and sample type.

Window	Avg. % recovery Particulate	% recovery Standard Deviation	Avg. % recovery Dissolved	% recovery Standard Deviation
1	49.50	16.27	57.54	10.21
2	76.81	20.76	89.39	14.53
3	83.34	18.86	91.63	14.51
4	69.63	21.47	75.33	15.32
5	55.42	11.38	71.66	11.68

Table 7.5: Minimum detectable quantities (MDQ) for each compound analyzed.

PAH Compounds	MDQ
	ug
D8-Napthalene	5.61E-07
Napthalene	3.84E-07
2-Methylnaphthalene	9.53E-07
1-Methylnaphthalene	1.52E-06
2,6-Dimethylnaphthalene	9.51E-07
2,7-Dimethylnaphthalene	9.44E-07
1,3-Dimethylnaphthalene	4.61E-06
1,6-Dimethylnaphthalene	4.65E-06
1,4-Dimethylnaphthalene	4.69E-06
1,5-Dimethylnaphthalene	4.79E-06
D8-Acenaphthylene	1.17E-06
Acenaphthylene	1E-06
1,2-Dimethylnaphthalene	9.93E-07
1,8-Dimethlnaphthalene	4.67E-06
Acenaphthene	4.8E-06
Fluorene	5.55E-06
D10-Phenanthrene	1.15E-05
Phenanthrene	1.13E-05
D10-Anthracene	1.15E-05
Anthracene	1.11E-05
2-Methylanthracene	1.95E-05
1-Methylanthracene	5E-06
1-Methylphenanthrene	4.79E-06
9-Methylanthracene	9.08E-06
2-Phenylnapthalene	1.02E-05
3,6-Dimethylphenanthrene	1.09E-05
Fluoranthene	9.2E-06
2,3-Dimethylanthracene	2.08E-05
Pyrene	9.36E-06
9,10-Dimethylanthracene	2.13E-05
2-Methylfluoranthene	1.18E-05
Retene	1.44E-05
9-Phenylanthracene	6.61E-06
Benz[a]anthracene	1.03E-05
D12-benz[a]anthracene	1.28E-05
D12-Chrysene	1.45E-05
Chrysene	9.23E-06
7-Methylbenz[a]anthracene	1.78E-05

6-Methylchrysene	9.81E-06
4-Methylchrysene	1.04E-05
6,8-Dimethylbenz[a]anthracene	1.27E-05
3,9-Dimethylbenz[a]anthracene	2.39E-05
Benzo[b]fluoranthene	2.2E-05
Benzo[k]fluoranthene	1.54E-05
Benzo[e]pyrene	9.07E-06
D12-Benzo[a]pyrene	2.63E-05
Benzo[a]pyrene	6.03E-05
D12-Perylene	2.88E-05
Perylene	2.44E-05
D12-Indeno[1,2,3-cd]pyrene	3.95E-05
Indeno[1,2,3-cd]pyrene	3.25E-05
D12-Benzo[ghi]perylene	2.99E-05
Dibenz[a,h]anthracene	5.84E-05
Benzo[g,h,i]perylene	1.68E-05
Coronene	1.39E-05

Table 7.6: Lab mean concentrations compared to SRM 1944 New York Bay Sediments certificate concentrations.

Compound	Certificate Concentration	Lab mean	Lab stdev
	microgram/gdw		
Napthalene*	1.28	1.06	0.57
2-Methylnaphthalene	0.74	0.89	0.45
1-Methylnaphthalene	0.47	0.57	0.16
Acenaphthene*	0.39	0.38	0.18
Fluorene	0.48	0.57	0.29
Phenanthrene*	5.27	13.51	6.61
Anthracene*	1.13	2.07	0.64
2-Methylanthracene	0.58	0.25	0.43
1-Methylphenanthrene	1.7	3.52	1.56
Fluoranthene*	8.92	6.70	5.69
Pyrene*	9.7	8.55	1.91
Benz[a]anthracene*	4.72	4.06	0.42
Chrysene*	4.86	6.48	1.73
Benzo[b]fluoranthene*	3.87	12.44	6.83
Benzo[k]fluoranthene*	2.3	4.81	2.64
Benzo[e]pyrene	3.28	7.83	4.32

Benzo[a]pyrene*	4.3	2.80	0.85
Perylene	1.17	0.75	0.14
Indeno[1,2,3-cd]pyrene*	2.78	3.76	0.66
Dibenz[a,h]anthracene	0.424	0.86	0.16
Benzo[g,h,i]perylene	2.84	1.98	0.22
Coronene	0.53	1.11	0.18

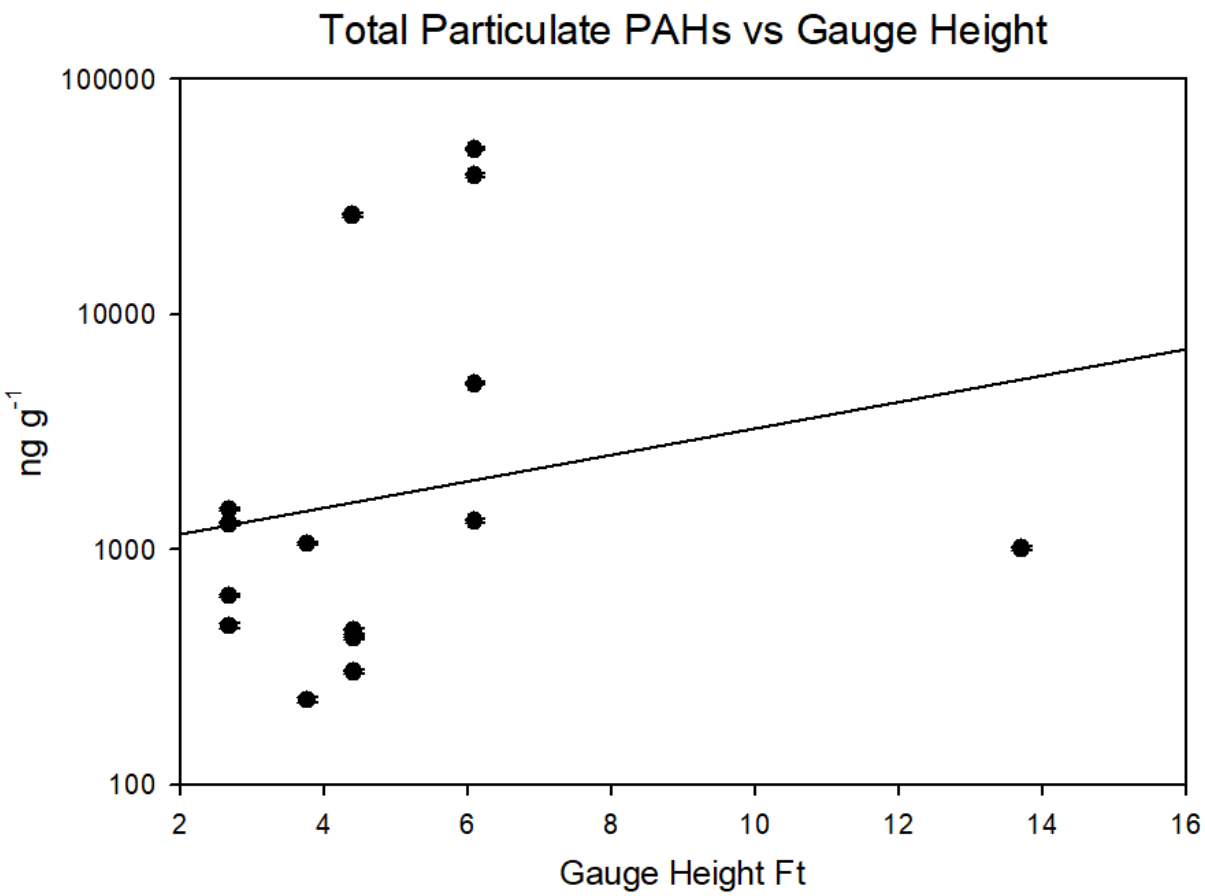

Fig 7.1: Total particulate PAHs ng g^{-1} vs Gauge Height ft for each main site. The correlation coefficient of the regression line is 0.04.

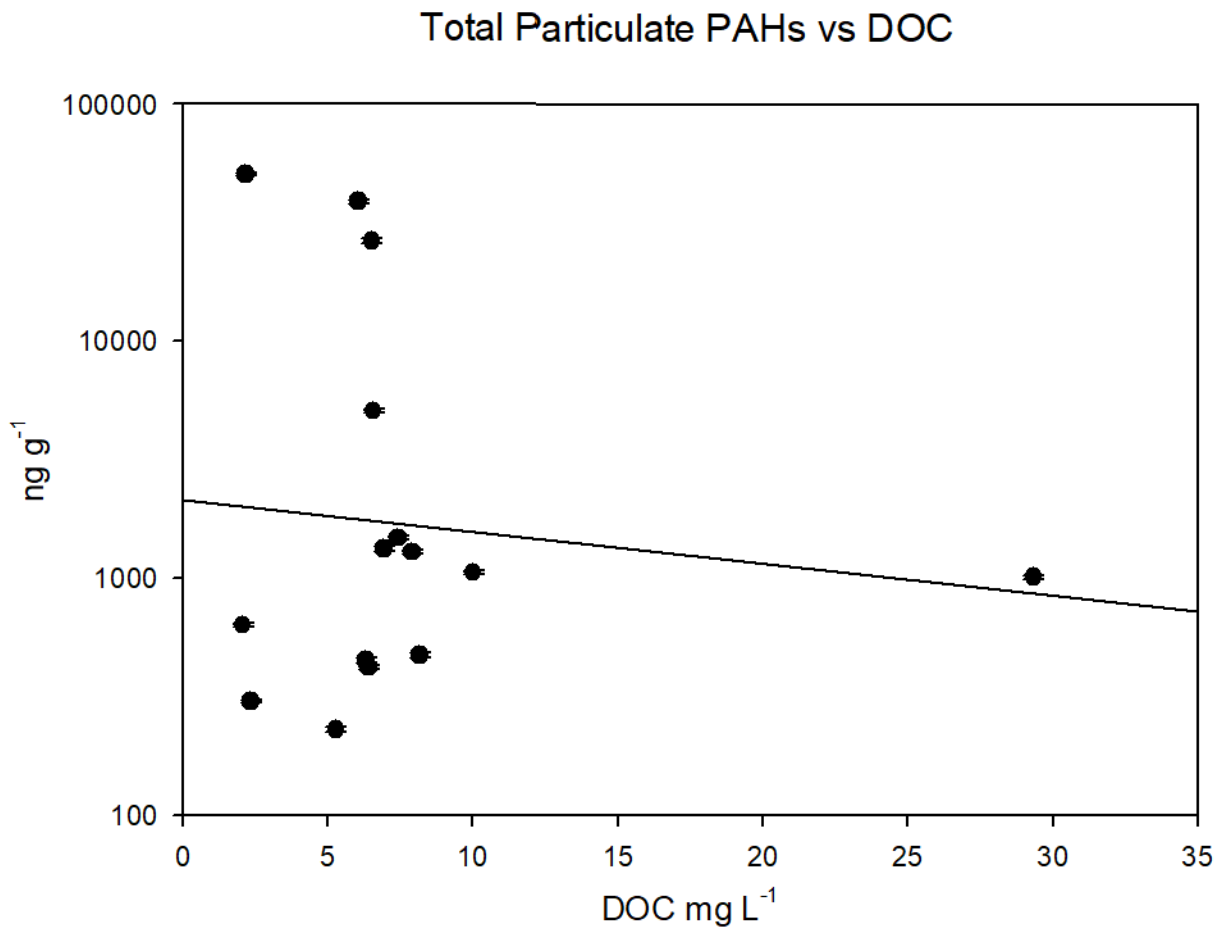

Fig 7.2: Total particulate PAHs ng g^{-1} vs DOC mg L^{-1} for each main site. The correlation coefficient of the regression line is 0.01.

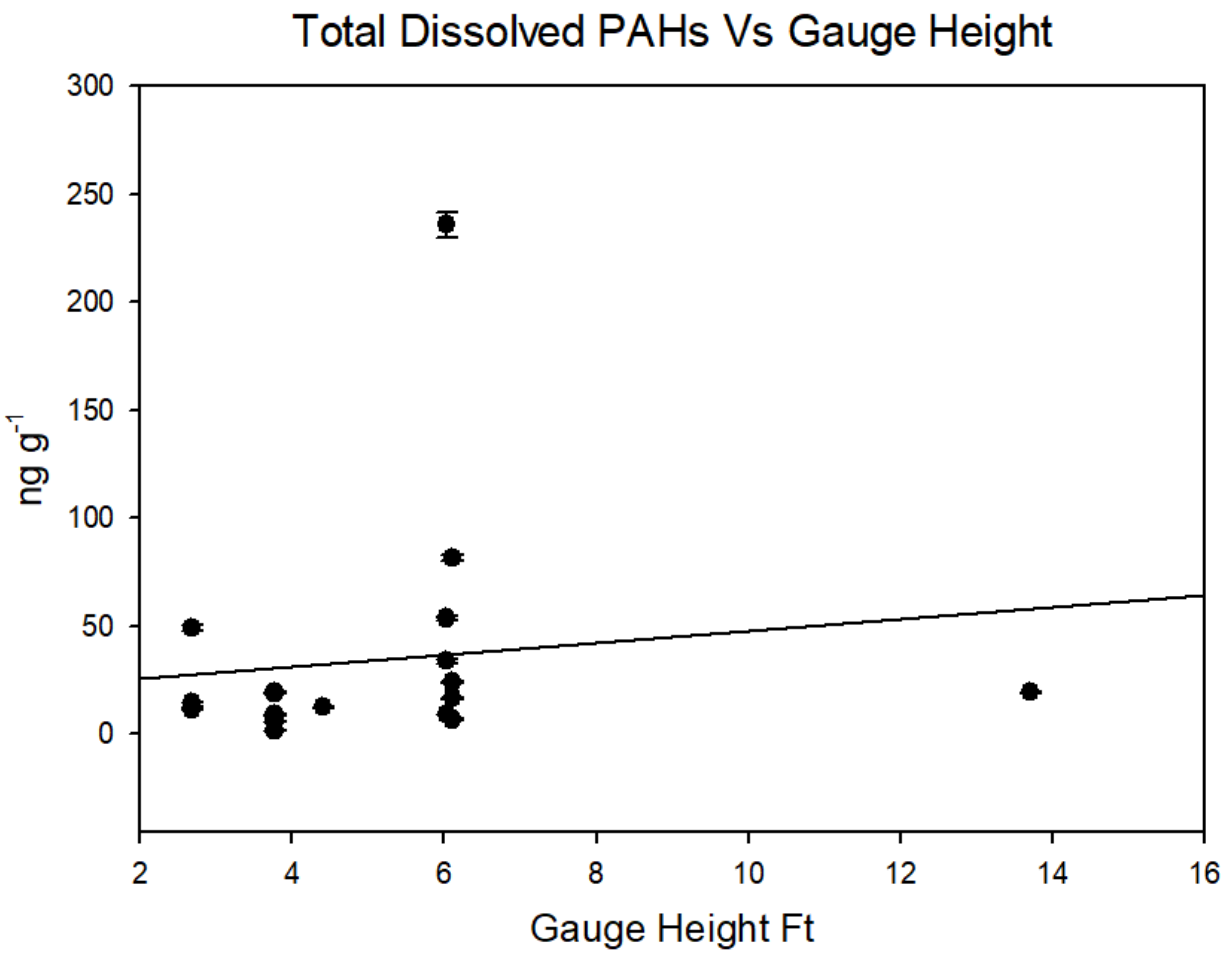

Fig 7.3: Total dissolved PAHs ng L^{-1} vs Gauge Height ft for each main site. The correlation coefficient of the regression line is 0.02.

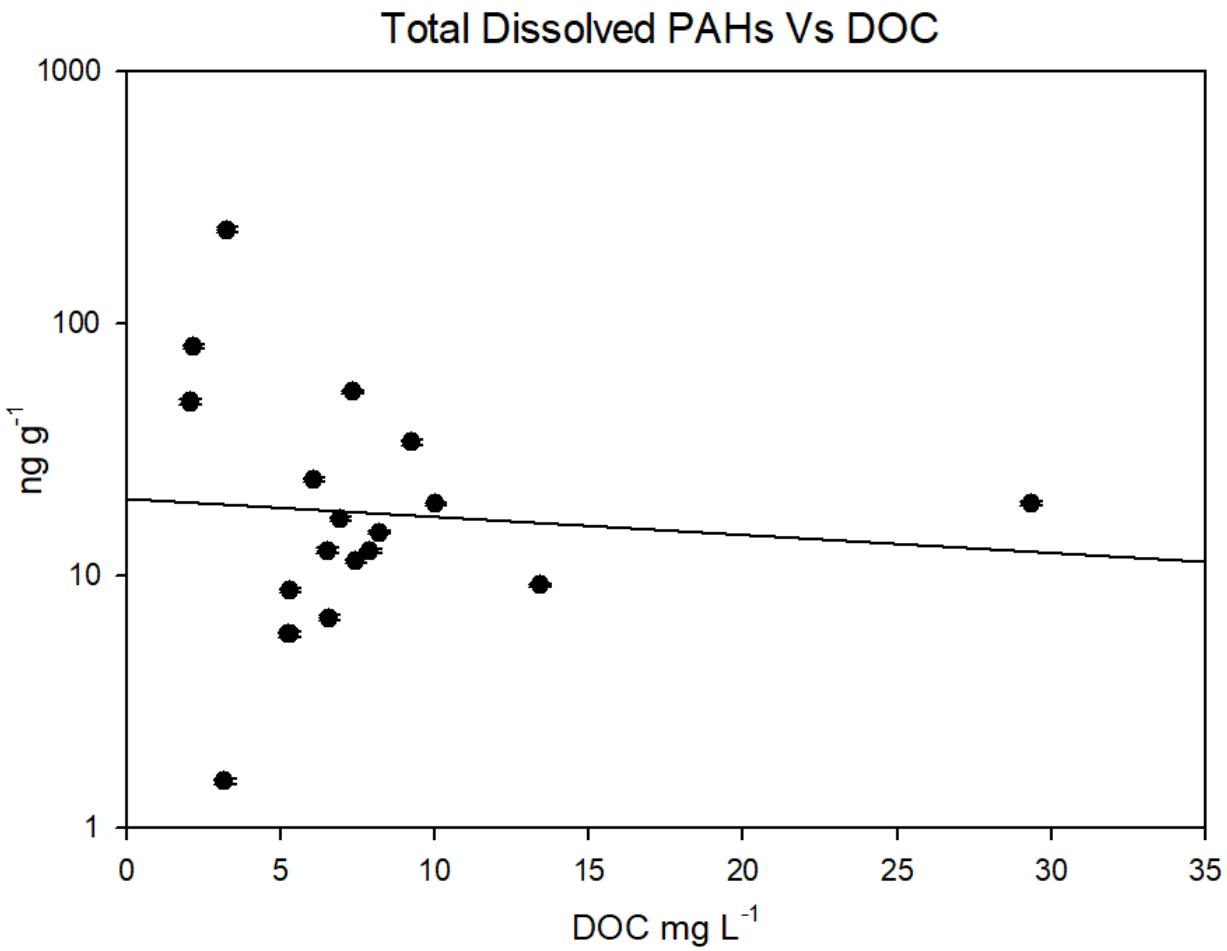

Fig 7.4: Total particulate PAHs ng L^{-1} vs DOC mg L^{-1} for each main site. The correlation coefficient of the regression line is 0.007.

Table 7.7: PAH concentrations and standard deviations in ng g^{-1} for the particulate samples during each sampling event with each primary site.

	5/27/2022							
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}	
naphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	0.18	0.01	ND	ND
1-Methylnaphthelene	ND	ND	ND	ND	0.20	0.01	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	0.25	0.01	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	0.32	0.01	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	0.39	0.02	ND	ND
acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND

1,2- Dimethylnaphthalene	ND	ND	ND	ND	0.03	0.00	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
9-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
3,6-Dimethylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
2,3-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
pyrene	ND	ND	ND	ND	ND	ND	ND	ND
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Retene	ND	ND	ND	ND	ND	ND	ND	ND
9-phenylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	ND	ND	ND	ND	ND	ND	ND	ND
chrysene	ND	ND	ND	ND	ND	ND	ND	ND
7-methylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
4-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (b) fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
benz (k) fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
benz (e) pyrene	ND	ND	ND	ND	ND	ND	ND	ND
benz [a] pyrene	ND	ND	ND	ND	ND	ND	ND	ND
perylene	ND	ND	ND	ND	ND	ND	ND	ND
indeno (123) cd pyrene	ND	ND	ND	ND	ND	ND	ND	ND
dibenz ah anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (ghi) perylene	ND	ND	ND	ND	ND	ND	ND	ND
coronene	ND	ND	ND	ND	ND	ND	ND	ND
				9/25/2022				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}	
naphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND

1-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	20.66	0.97	22.07	1.04	ND	ND	20.66	0.97
Fluorene	40.35	1.90	23.19	1.09	ND	ND	40.35	1.90
Phenanthrene	ND	ND	146.22	6.87	ND	ND	ND	ND
Anthracene	ND	ND	16.44	0.77	ND	ND	ND	ND
2-Methylanthracene	6.73	0.32	ND	ND	ND	ND	6.73	0.32
1-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
9-Methylanthracene	ND	ND	2.45	0.12	ND	ND	ND	ND
2- phenylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
3,6-Dimethylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
fluoranthene	ND	ND	147.86	5.91	538.78	21.55	ND	ND
2,3-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
pyrene	ND	ND	141.48	5.66	412.77	16.51	ND	ND
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	ND	ND	13.45	0.54	ND	ND
Retene	80.63	3.23	68.10	2.72	6.71	0.27	80.63	3.23
9-phenylanthracene	2.76	0.11	ND	ND	ND	ND	2.76	0.11
benzo[a]anthracene	ND	ND	ND	ND	158.65	6.35	ND	ND
chrysene	ND	ND	80.82	3.23	372.89	14.92	ND	ND
7-methylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
4-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	3.80	0.31	ND	ND	ND	ND
benz (b) fluoranthene	ND	ND	97.12	7.92	ND	ND	ND	ND
benz (k) fluoranthene	ND	ND	28.01	2.28	ND	ND	ND	ND
benz (e) pyrene	ND	ND	61.22	4.99	ND	ND	ND	ND
benz [a] pyrene	ND	ND	86.00	7.01	ND	ND	ND	ND
perylene	62.80	5.12	135.94	11.08	ND	ND	62.80	5.12
indeno (123) cd pyrene	ND	ND	ND	ND	ND	ND	ND	ND
dibenz ah anthracene	4.03	0.10	ND	ND	ND	ND	4.03	0.10

benz (ghi) perylene	ND	ND	ND	ND	ND	ND	ND	ND
coronene	11.48	0.29	ND	ND	ND	ND	11.48	0.29
				10/2/2022				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}	
naphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	2.74	0.13
acenaphthene	1.53	0.07	3.68	0.17	ND	ND	4.64	0.22
Fluorene	ND	ND	4.91	0.23	ND	ND	6.65	0.31
Phenanthrene	42.62	2.00	70.53	3.31	ND	ND	ND	ND
Anthracene	6.07	0.29	8.07	0.38	ND	ND	10.44	0.49
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	8.87	0.42	ND	ND	ND	ND
1-methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
9-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	ND	ND	6.49	0.31	ND	ND	ND	ND
3,6-Dimethylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
fluoranthene	62.76	2.51	123.29	4.93	ND	ND	105.58	4.22
2,3-Dimethylanthracene	ND	ND	1.81	0.07	ND	ND	ND	ND
pyrene	53.12	2.12	104.31	4.17	ND	ND	105.21	4.21
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	7.21	0.29	ND	ND	ND	ND
Retene	25.22	1.01	63.10	2.52	ND	ND	56.84	2.27
9-phenylanthracene	0.60	0.02	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	23.74	0.95	46.42	1.86	ND	ND	ND	ND
chrysene	40.32	1.61	83.60	3.34	ND	ND	62.88	2.52
7-methylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
4-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND

3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (b) fluoranthene	ND	ND	ND	ND	ND	ND	66.12	5.39
benz (k) fluoranthene	ND	ND	ND	ND	ND	ND	20.79	1.69
benz (e) pyrene	ND	ND	ND	ND	ND	ND	43.38	3.54
benz [a] pyrene	ND	ND	ND	ND	ND	ND	65.21	5.31
perylene	ND	ND	ND	ND	ND	ND	105.66	8.61
indeno (123) cd pyrene	ND	ND	ND	ND	ND	ND	ND	ND
dibenz ah anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (ghi) perylene	ND	ND	ND	ND	ND	ND	ND	ND
coronene	ND	ND	ND	ND	ND	ND	ND	ND
				11/20/2022				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}	
naphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	10.97	0.52	13.18	0.62	1.12	0.05	11.97	0.56
Fluorene	ND	ND	13.55	0.64	1.90	0.09	11.69	0.55
Phenanthrene	ND	ND	150.65	7.08	60.09	2.82	180.76	8.50
Anthracene	ND	ND	ND	ND	4.19	0.20	ND	ND
2-Methylanthracene	2.57	0.12	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	ND	ND	4.73	0.22	ND	ND
1-methylphenanthrene	ND	ND	ND	ND	3.62	0.17	ND	ND
9-Methylanthracene	ND	ND	ND	ND	ND	ND	5.59	0.26
2- phenylnaphthalene	ND	ND	ND	ND	4.72	0.22	ND	ND
3,6-Dimethylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
fluoranthene	ND	ND	201.30	8.05	108.77	4.35	199.13	7.97
2,3-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
pyrene	ND	ND	225.03	9.00	86.14	3.45	205.67	8.23
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	ND	ND	5.54	0.22	ND	ND

Retene	62.36	2.49	62.22	2.49	2.54	0.10	62.76	2.51
9-phenylanthracene	4.17	0.17	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	ND	ND	ND	ND	33.37	1.33	ND	ND
chrysene	ND	ND	89.31	3.57	63.83	2.55	112.53	4.50
7-methylbenz(a)anthracene	ND	ND	ND	ND	3.75	0.31	ND	ND
4-methylchrysene	ND	ND	ND	ND	0.27	0.02	ND	ND
6-methylchrysene	ND	ND	ND	ND	0.28	0.02	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	3.21	0.26	0.75	0.06	4.13	0.34
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	0.74	0.06	ND	ND
benz (b) fluoranthene	80.29	6.54	94.76	7.72	53.45	4.36	127.58	10.40
benz (k) fluoranthene	27.28	2.22	27.40	2.23	20.79	1.69	44.31	3.61
benz (e) pyrene	ND	ND	65.02	5.30	29.98	2.44	86.06	7.01
benz [a] pyrene	110.20	8.98	90.25	7.36	56.55	4.61	131.77	10.74
perylene	79.94	6.52	112.39	9.16	9.56	0.78	127.63	10.40
indeno (123) cd pyrene	60.18	1.54	80.04	2.05	53.76	1.38	103.47	2.65
dibenz ah anthracene	ND	ND	ND	ND	2.63	0.07	ND	ND
benz (ghi) perylene	21.08	0.54	28.89	0.74	11.95	0.31	33.91	0.87
coronene	15.23	0.39	31.20	0.80	10.83	0.28	35.12	0.90
				12/11/2022				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}	
naphthalene	81.69	3.80	76.93	3.58	ND	ND	653.00	30.36
2-Methylnaphthelene	42.33	1.97	35.60	1.66	ND	ND	59.48	2.77
1-Methylnaphthelene	32.22	1.50	28.15	1.31	ND	ND	80.08	3.72
2,6- Dimethylnaphthalene	5.55	0.26	4.82	0.22	ND	ND	874.80	40.68
2,7- Dimethylnaphthalene	5.51	0.26	4.97	0.23	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	11.32	0.53	ND	ND	198.21	9.22
1,6- Dimethylnaphthalene	8.85	0.41	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	5.85	0.27	ND	ND	17.28	0.80
1,5- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	5.91	0.27	6.69	0.31	ND	ND	22.49	1.05
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	2.63	0.12	ND	ND	ND	ND	190.05	8.84
acenaphthene	3.42	0.16	4.59	0.22	ND	ND	ND	ND
Fluorene	ND	ND	7.16	0.34	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND

9-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
3,6-Dimethylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
2,3-Dimethylanthracene	6.72	0.27	91.44	3.66	ND	ND	ND	ND
pyrene	ND	ND	ND	ND	ND	ND	ND	ND
9,10-Dimethylanthracene	24.77	0.99	30.56	1.22	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Retene	27.55	1.10	103.59	4.14	ND	ND	ND	ND
9-phenylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	ND	ND	ND	ND	ND	ND	ND	ND
chrysene	ND	ND	ND	ND	ND	ND	ND	ND
7-methylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
4-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	3.13	0.26	ND	ND	ND	ND
benz (b) fluoranthene	ND	ND	47.39	3.86	ND	ND	ND	ND
benz (k) fluoranthene	ND	ND	14.76	1.20	ND	ND	ND	ND
benz (e) pyrene	ND	ND	32.05	2.61	ND	ND	ND	ND
benz [a] pyrene	ND	ND	44.22	3.60	ND	ND	ND	ND
perylene	101.89	8.30	ND	ND	ND	ND	ND	ND
indeno (123) cd pyrene	29.68	0.76	33.09	0.85	ND	ND	196.47	5.03
dibenz ah anthracene	2.45	0.06	2.90	0.07	ND	ND	23.83	0.61
benz (ghi) perylene	14.44	0.37	17.22	0.44	ND	ND	114.19	2.92
coronene	7.35	0.19	9.12	0.23	ND	ND	52.22	1.34
				1/15/2023				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}	
naphthalene	ND	ND	100.93	4.69	5.78	0.27	65.47	3.04
2-Methylnaphthelene	ND	ND	53.32	2.48	2.95	0.14	31.04	1.44
1-Methylnaphthelene	ND	ND	35.41	1.65	10.83	0.50	21.46	1.00
2,6- Dimethylnaphthalene	ND	ND	7.91	0.37	1.27	0.06	ND	ND
2,7- Dimethylnaphthalene	ND	ND	7.78	0.36	1.25	0.06	ND	ND
1,3- Dimethylnaphthalene	ND	ND	15.37	0.71	3.40	0.16	ND	ND
1,6- Dimethylnaphthalene	ND	ND	17.04	0.79	2.04	0.09	ND	ND
1,4- Dimethylnaphthalene	ND	ND	9.40	0.44	1.52	0.07	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	2.58	0.12	ND	ND
acenaphthylene	ND	ND	5.15	0.24	0.86	0.04	ND	ND
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	1.42	0.07

1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	1.94	0.09
acenaphthene	ND	ND	7.73	0.36	1.24	0.06	2.97	0.14
Fluorene	ND	ND	12.08	0.57	3.32	0.16	ND	ND
Phenanthrene	ND	ND	ND	ND	53.78	2.53	ND	ND
Anthracene	ND	ND	ND	ND	2.25	0.11	ND	ND
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	22.10	1.04	4.44	0.21	ND	ND
1-methylphenanthrene	ND	ND	ND	ND	2.87	0.14	ND	ND
9-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	ND	ND	ND	ND	5.68	0.27	ND	ND
3,6-Dimethylphenanthrene	ND	ND	ND	ND	0.82	0.04	ND	ND
fluoranthene	ND	ND	ND	ND	74.48	2.98	ND	ND
2,3-Dimethylanthracene	ND	ND	ND	ND	0.27	0.01	ND	ND
pyrene	ND	ND	ND	ND	57.18	2.29	ND	ND
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	ND	ND	1.55	0.06	ND	ND
Retene	ND	ND	43.67	1.75	0.78	0.03	20.49	0.82
9-phenylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	ND	ND	ND	ND	13.19	0.53	ND	ND
chrysene	ND	ND	ND	ND	25.99	1.04	ND	ND
7-methylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
4-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	0.31	0.03
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (b) fluoranthene	ND	ND	ND	ND	ND	ND	56.45	4.60
benz (k) fluoranthene	ND	ND	ND	ND	ND	ND	17.80	1.45
benz (e) pyrene	ND	ND	ND	ND	ND	ND	37.10	3.02
benz [a] pyrene	ND	ND	ND	ND	ND	ND	43.74	3.57
perylene	ND	ND	ND	ND	ND	ND	113.46	9.25
indeno (123) cd pyrene	ND	ND	46.22	1.18	12.59	0.32	20.67	0.53
dibenz ah anthracene	ND	ND	ND	ND	1.00	0.03	ND	ND
benz (ghi) perylene	ND	ND	24.27	0.62	5.97	0.15	10.69	0.27
coronene	ND	ND	12.31	0.32	1.89	0.05	5.51	0.14
				2/12/2023				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}	
naphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND

2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	2.14	0.10	31.33	1.47	41.58	1.95	5.84	0.27
Fluorene	ND	ND	52.06	2.45	81.86	3.85	8.39	0.39
Phenanthrene	ND	ND	3318.87	155.99	3658.75	171.96	419.62	19.72
Anthracene	13.20	0.62	187.61	8.82	342.08	16.08	21.81	1.02
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	204.71	9.62	470.52	22.11	51.85	2.44
1-methylphenanthrene	ND	ND	146.50	6.89	350.36	16.47	40.77	1.92
9-Methylanthracene	ND	ND	ND	ND	9.22	0.43	ND	ND
2- phenylnaphthalene	ND	ND	301.03	14.15	524.87	24.67	63.10	2.97
3,6-Dimethylphenanthrene	ND	ND	22.51	1.06	74.91	3.52	ND	ND
fluoranthene	154.77	6.19	5897.58	235.90	7961.62	318.46	691.65	27.67
2,3-Dimethylanthracene	ND	ND	12.57	0.50	44.04	1.76	ND	ND
pyrene	125.91	5.04	4192.18	167.69	5684.19	227.37	521.93	20.88
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	272.22	10.89	272.27	10.89	23.40	0.94
Retene	44.19	1.77	54.32	2.17	81.93	3.28	36.02	1.44
9-phenylanthracene	ND	ND	ND	ND	2.11	0.08	1.21	0.05
benzo[a]anthracene	ND	ND	958.79	38.35	1816.93	72.68	146.37	5.85
chrysene	104.59	4.18	3119.70	124.79	5629.27	225.17	484.28	19.37
7-methylbenz(a)anthracene	30.39	2.48	355.66	28.99	444.55	36.23	64.25	5.24
4-methylchrysene	2.90	0.24	20.34	1.66	29.87	2.43	3.59	0.29
6-methylchrysene	ND	ND	19.67	1.60	31.07	2.53	3.27	0.27
6,8-Dimethylbenz(a)anthracene	2.40	0.20	46.74	3.81	81.33	6.63	12.90	1.05
3,9-Dimethylbenz(a)anthracene	ND	ND	28.53	2.33	50.82	4.14	7.79	0.64
benz (b) fluoranthene	170.14	13.87	4722.44	384.88	4069.10	331.63	537.30	43.79
benz (k) fluoranthene	47.68	3.89	1661.77	135.43	1588.91	129.50	168.25	13.71
benz (e) pyrene	108.01	8.80	2591.34	211.19	2184.40	178.03	303.74	24.75
benz [a] pyrene	158.58	12.92	4567.44	372.25	3917.45	319.27	462.21	37.67
perylene	244.34	19.91	835.30	68.08	640.77	52.22	131.61	10.73
indeno (123) cd pyrene	78.98	2.02	3522.01	90.16	6388.27	163.54	557.30	14.27
dibenz ah anthracene	ND	ND	146.90	3.76	339.35	8.69	24.94	0.64
benz (ghi) perylene	21.83	0.56	821.25	21.02	1678.40	42.97	131.11	3.36

coronene	17.90	0.46	805.17	20.61	2027.00	51.89	161.08	4.12

Table 7.7 cont: PAH concentrations and standard deviations in ng g^{-1} for the particulate samples during the 3-26-23 sampling event.

	3/26/2023											
Compounds	TC1	stdev	TC2	stdev	TC3	stdev	TC4	stdev	TC5	stdev	TC6	stdev
	ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}		ng g^{-1}	
naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	22.91	1.08	14.18	0.67	1851.51	87.02	31.63	1.49	ND	ND	2.26	0.11
Fluorene	60.06	2.82	31.36	1.47	3813.69	179.24	62.40	2.93	ND	ND	ND	ND
Phenanthrene	2330.91	109.55	2476.10	116.38	226411.08	10641.32	2250.59	105.78	ND	ND	155.55	7.31
Anthracene	264.24	12.42	160.53	7.54	16857.93	792.32	197.16	9.27	ND	ND	16.93	0.80
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	183.81	8.64	209.51	9.85	18551.09	871.90	197.51	9.28	ND	ND	ND	ND
1-methylphenanthrene	146.17	6.87	171.80	8.07	14037.69	659.77	157.58	7.41	ND	ND	ND	ND
9-Methylanthracene	ND	ND	2.66	0.13	564.48	26.53	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	283.63	13.33	316.07	14.86	28354.49	1332.66	277.63	13.05	ND	ND	ND	ND
3,6-Dimethylphenanthrene	ND	ND	43.54	2.05	3126.13	146.93	ND	ND	ND	ND	ND	ND
fluoranthene	4826.92	193.08	5588.25	223.53	533051.05	21322.04	4923.37	196.93	ND	ND	219.60	8.78
2,3-Dimethylanthracene	ND	ND	16.73	0.67	ND	ND	12.16	0.49	ND	ND	ND	ND
pyrene	3249.31	129.97	3512.52	140.50	364565.53	14582.62	3507.37	140.29	ND	ND	165.57	6.62

9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	249.22	9.97	302.59	12.10	17726.73	709.07	249.16	9.97	ND	ND	ND	ND
Retene	112.11	4.48	99.67	3.99	9304.94	372.20	124.52	4.98	ND	ND	40.44	1.62
9-phenylanthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	826.65	33.07	845.98	33.84	85203.86	3408.15	983.94	39.36	ND	ND	50.24	2.01
chrysene	3702.44	148.10	4284.02	171.36	412864.72	16514.59	3439.49	137.58	ND	ND	140.43	5.62
7-methylbenz(a)anthracene	182.19	14.85	161.81	13.19	15053.94	1226.90	160.04	13.04	ND	ND	ND	ND
4-methylchrysene	15.08	1.23	18.14	1.48	1532.49	124.90	17.49	1.43	ND	ND	ND	ND
6-methylchrysene	ND	ND	17.24	1.41	1356.56	110.56	19.23	1.57	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	67.84	5.53	55.35	4.51	4345.27	354.14	44.83	3.65	ND	ND	1.63	0.13
3,9-Dimethylbenz(a)anthracene	40.04	3.26	42.87	3.49	3439.72	280.34	28.62	2.33	ND	ND	ND	ND
benz (b) fluoranthene	3836.15	312.65	4219.21	343.87	335876.62	27373.94	3700.31	301.57	ND	ND	160.26	13.06
benz (k) fluoranthene	1353.77	110.33	1554.20	126.67	127370.44	10380.69	1210.56	98.66	ND	ND	48.47	3.95
benz (e) pyrene	2102.24	171.33	2215.74	180.58	189021.67	15405.27	2019.17	164.56	ND	ND	91.98	7.50
benz [a] pyrene	2302.32	187.64	2834.96	231.05	252958.34	20616.10	2657.23	216.56	ND	ND	140.51	11.45
perylene	349.63	28.49	396.27	32.30	32196.72	2624.03	635.93	51.83	ND	ND	122.82	10.01
indeno (123) cd pyrene	ND	ND	4790.47	122.64	482021.59	12339.75	ND	ND	ND	ND	ND	ND
dibenz ah anthracene	ND	ND	199.39	5.10	16517.59	422.85	ND	ND	ND	ND	ND	ND
benz (ghi) perylene	ND	ND	1050.38	26.89	105839.87	2709.50	ND	ND	ND	ND	ND	ND
coronene	ND	ND	1176.32	30.11	130930.40	3351.82	ND	ND	ND	ND	ND	ND

Table 7.7 cont: PAH concentrations and standard deviations in ng g^{-1} for the dissolved samples during the 4-14-23 sampling event.

	4/14/2023	
Compounds	TC1	stdev
	ng g^{-1}	
naphthalene	ND	ND
2-Methylnaphthelene	ND	ND
1-Methylnaphthelene	ND	ND
2,6- Dimethylnaphthalene	ND	ND
2,7- Dimethylnaphthalene	ND	ND
1,3- Dimethylnaphthalene	ND	ND
1,6- Dimethylnaphthalene	ND	ND
1,4- Dimethylnaphthalene	ND	ND
1,5- Dimethylnaphthalene	ND	ND
acenaphthylene	ND	ND
1,2- Dimethylnaphthalene	ND	ND
1,8- Dimethylnaphthalene	ND	ND
acenaphthene	9.19	0.43
Fluorene	14.26	0.67
Phenanthrene	213.60	10.04
Anthracene	ND	ND
2-Methylanthracene	ND	ND
1-Methylanthracene	ND	ND
1-methylphenanthrene	ND	ND
9-Methylanthracene	ND	ND
2- phenylnaphthalene	ND	ND
3,6-Dimethylphenanthrene	ND	ND
fluoranthene	201.43	8.06
2,3-Dimethylanthracene	ND	ND
pyrene	ND	ND
9,10-Dimethylanthracene	ND	ND
2-methylfluoranthene	ND	ND
Retene	ND	ND
9-phenylanthracene	ND	ND
benzo[a]anthracene	ND	ND
chrysene	118.66	4.75
7-methylbenz(a)anthracene	ND	ND
4-methylchrysene	ND	ND
6-methylchrysene	ND	ND
6,8-Dimethylbenz(a)anthracene	4.67	0.38
3,9-Dimethylbenz(a)anthracene	ND	ND

benz (b) fluoranthene	131.60	10.73
benz (k) fluoranthene	37.99	3.10
benz (e) pyrene	82.56	6.73
benz [a] pyrene	ND	ND
perylene	36.61	2.98
indeno (123) cd pyrene	97.58	2.50
dibenz ah anthracene	ND	ND
benz (ghi) perylene	31.28	0.80
coronene	29.75	0.76

Table 7.8: PAH concentrations and standard deviations in ng L^{-1} for the dissolved samples during each sampling event with each primary site.

	5/27/2022							
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}	
naphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	ND	ND	ND	ND	0.37	0.02	0.63	0.03
Fluorene	ND	ND	ND	ND	0.23	0.01	ND	ND
Phenanthrene	ND	ND	ND	ND	1.33	0.06	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	0.09	0.00
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	ND	ND	0.33	0.02	ND	ND
1-methylphenanthrene	ND	ND	ND	ND	0.19	0.01	0.28	0.01
9-Methylanthracene	ND	ND	ND	ND	0.29	0.01	ND	ND
2- phenylnaphthalene	ND	ND	ND	ND	ND	ND	0.35	0.02
3,6-Dimethylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
fluoranthene	ND	ND	ND	ND	ND	ND	2.03	0.08
2,3-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
pyrene	ND	ND	ND	ND	ND	ND	4.25	0.17
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	ND	ND	ND	ND	ND	ND

Retene	ND	ND	ND	ND	ND	ND	ND	ND
9-phenylanthracene	ND	ND	ND	ND	ND	ND	0.12	0.00
benzo[a]anthracene	ND	ND	ND	ND	ND	ND	ND	ND
chrysene	0.05	0.00	ND	ND	ND	ND	1.26	0.05
7-methylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
4-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (b) fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
benz (k) fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
benz (e) pyrene	ND	ND	ND	ND	ND	ND	ND	ND
benz [a] pyrene	ND	ND	ND	ND	ND	ND	ND	ND
perylene	ND	ND	ND	ND	ND	ND	ND	ND
indeno (123) cd pyrene	ND	ND	ND	ND	ND	ND	ND	ND
dibenz ah anthracene	0.02	0.00	ND	ND	ND	ND	0.02	0.00
benz (ghi) perylene	0.04	0.00	ND	ND	0.19	0.00	ND	ND
coronene	ND	ND	ND	ND	ND	ND	ND	ND
				9/25/2022				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}	
naphthalene	3.12	0.15	3.40	0.16	ND	ND	3.32	0.15
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthelene	ND	ND	2.49	0.12	ND	ND	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	0.26	0.01	ND	ND	0.19	0.01
1,5- Dimethylnaphthalene	ND	ND	0.51	0.02	ND	ND	ND	ND
acenaphthylene	ND	ND	0.56	0.03	ND	ND	0.38	0.02
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	0.22	0.01	ND	ND
acenaphthene	ND	ND	1.93	0.09	ND	ND	0.94	0.04
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylanthracene	0.07	0.00	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-methylphenanthrene	ND	ND	0.33	0.02	ND	ND	ND	ND
9-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	ND	ND	0.29	0.01	0.21	0.01	ND	ND
3,6-Dimethylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND

fluoranthene	ND	ND	2.76	0.11	ND	ND	1.65	0.07
2,3-Dimethylanthracene	ND	ND	ND	ND	ND	ND	0.44	0.02
pyrene	ND	ND	2.15	0.09	ND	ND	1.73	0.07
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Retene	ND	ND	0.53	0.02	ND	ND	ND	ND
9-phenylanthracene	ND	ND	0.09	0.00	0.10	0.00	ND	ND
benzo[a]anthracene	ND	ND	ND	ND	ND	ND	ND	ND
chrysene	0.14	0.01	1.52	0.06	0.73	0.03	0.10	0.00
7-methylbenz(a)anthracene	0.17	0.01	0.39	0.03	ND	ND	ND	ND
4-methylchrysene	0.11	0.01	ND	ND	ND	ND	ND	ND
6-methylchrysene	0.12	0.01	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (b) fluoranthene	ND	ND	1.09	0.09	ND	ND	ND	ND
benz (k) fluoranthene	ND	ND	0.18	0.01	ND	ND	0.05	0.00
benz (e) pyrene	0.21	0.02	0.67	0.05	0.27	0.02	ND	ND
benz [a] pyrene	ND	ND	ND	ND	ND	ND	ND	ND
perylene	1.12	0.09	ND	ND	ND	ND	ND	ND
indeno (123) cd pyrene	0.47	0.01	ND	ND	ND	ND	ND	ND
dibenz ah anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (ghi) perylene	0.33	0.01	0.10	0.00	ND	ND	ND	ND
coronene	ND	ND	ND	ND	ND	ND	ND	ND
				10/2/2022				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}	
naphthalene	19.42	0.90	10.12	0.47	48.59	2.26	ND	ND
2-Methylnaphthelene	5.48	0.25	ND	ND	9.43	0.44	ND	ND
1-Methylnaphthelene	7.40	0.34	ND	ND	107.46	5.00	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	14.81	0.69	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	3.97	0.18	ND	ND
1,4- Dimethylnaphthalene	0.43	0.02	ND	ND	9.72	0.45	ND	ND
1,5- Dimethylnaphthalene	0.50	0.02	1.13	0.05	5.82	0.27	ND	ND
acenaphthylene	ND	ND	ND	ND	0.99	0.05	ND	ND
1,2- Dimethylnaphthalene	0.19	0.01	0.19	0.01	3.56	0.17	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	ND	ND	2.03	0.10	5.27	0.25	0.83	0.04
Fluorene	ND	ND	ND	ND	5.77	0.27	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	0.75	0.04	ND	ND
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND

1-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
9-Methylanthracene	0.26	0.01	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	ND	ND	ND	ND	0.31	0.01	0.17	0.01
3,6-Dimethylphenanthrene	ND	ND	0.42	0.02	0.48	0.02	0.19	0.01
fluoranthene	ND	ND	5.71	0.23	8.76	0.35	2.03	0.08
2,3-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
pyrene	ND	ND	4.33	0.17	6.59	0.26	1.94	0.08
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	0.53	0.02	ND	ND	ND	ND
Retene	ND	ND	ND	ND	ND	ND	0.46	0.02
9-phenylanthracene	ND	ND	ND	ND	0.38	0.02	ND	ND
benzo[a]anthracene	ND	ND	10.71	0.43	ND	ND	0.57	0.02
chrysene	0.18	0.01	6.56	0.26	0.90	0.04	1.02	0.04
7-methylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	0.33	0.03
4-methylchrysene	ND	ND	ND	ND	0.06	0.00	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	0.40	0.03	ND	ND	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	0.06	0.00
benz (b) fluoranthene	ND	ND	4.06	0.33	0.47	0.04	0.67	0.05
benz (k) fluoranthene	ND	ND	2.69	0.22	0.26	0.02	0.25	0.02
benz (e) pyrene	ND	ND	ND	ND	ND	ND	0.54	0.04
benz [a] pyrene	ND	ND	ND	ND	1.29	0.11	ND	ND
perylene	ND	ND	ND	ND	ND	ND	ND	ND
indeno (123) cd pyrene	ND	ND	4.59	0.12	ND	ND	ND	ND
dibenz ah anthracene	ND	ND	0.29	0.01	ND	ND	0.08	0.00
benz (ghi) perylene	ND	ND	ND	ND	0.19	0.00	ND	ND
coronene	ND	ND	ND	ND	ND	ND	0.07	0.00
				11/20/2022				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}	
naphthalene	3.07	0.14	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	6.51	0.30	ND	ND
1-Methylnaphthelene	ND	ND	ND	ND	27.47	1.28	3.29	0.15
2,6- Dimethylnaphthalene	0.78	0.04	ND	ND	1.66	0.08	ND	ND
2,7- Dimethylnaphthalene	0.73	0.03	ND	ND	1.67	0.08	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	3.25	0.15	1.50	0.07
1,6- Dimethylnaphthalene	ND	ND	ND	ND	1.70	0.08	1.86	0.09
1,4- Dimethylnaphthalene	0.43	0.02	0.55	0.03	1.29	0.06	0.66	0.03
1,5- Dimethylnaphthalene	0.82	0.04	0.70	0.03	1.48	0.07	0.65	0.03
acenaphthylene	0.17	0.01	0.44	0.02	ND	ND	0.34	0.02
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	0.14	0.01	ND	ND	ND	ND	0.18	0.01

acenaphthene	1.02	0.05	3.81	0.18	ND	ND	2.09	0.10
Fluorene	ND	ND	3.06	0.14	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	0.09	0.00	ND	ND
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-methylphenanthrene	0.66	0.03	0.53	0.03	0.31	0.01	0.32	0.02
9-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	0.36	0.02	0.34	0.02	0.21	0.01	0.16	0.01
3,6-Dimethylphenanthrene	ND	ND	0.25	0.01	ND	ND	ND	ND
fluoranthene	2.15	0.09	2.43	0.10	ND	ND	ND	ND
2,3-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
pyrene	ND	ND	ND	ND	2.23	0.09	ND	ND
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	0.20	0.01	ND	ND	ND	ND	ND	ND
Retene	ND	ND	ND	ND	ND	ND	ND	ND
9-phenylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	ND	ND	ND	ND	ND	ND	ND	ND
chrysene	1.23	0.05	ND	ND	0.56	0.02	0.27	0.01
7-methylbenz(a)anthracene	0.45	0.04	ND	ND	ND	ND	ND	ND
4-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (b) fluoranthene	0.96	0.08	ND	ND	0.21	0.02	0.20	0.02
benz (k) fluoranthene	0.51	0.04	ND	ND	0.05	0.00	ND	ND
benz (e) pyrene	0.61	0.05	0.16	0.01	0.19	0.02	ND	ND
benz [a] pyrene	ND	ND	0.23	0.02	ND	ND	ND	ND
perylene	ND	ND	ND	ND	ND	ND	ND	ND
indeno (123) cd pyrene	ND	ND	ND	ND	ND	ND	ND	ND
dibenz ah anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (ghi) perylene	0.56	0.01	ND	ND	0.05	0.00	ND	ND
coronene	ND	ND	0.05	0.00	ND	ND	ND	ND
				12/11/2022				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}	
naphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND

1,4- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	ND	ND	2.51	0.12	ND	ND	0.97	0.05
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
9-Methylanthracene	ND	ND	ND	ND	ND	ND	0.06	0.00
2- phenylnaphthalene	0.08	0.00	ND	ND	0.05	0.00	0.17	0.01
3,6-Dimethylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
2,3-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
pyrene	ND	ND	ND	ND	ND	ND	ND	ND
9,10-Dimethylanthracene	0.48	0.02	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	0.47	0.02	0.12	0.00	ND	ND
Retene	ND	ND	ND	ND	ND	ND	ND	ND
9-phenylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	ND	ND	ND	ND	ND	ND	ND	ND
chrysene	0.37	0.01	0.12	0.00	0.31	0.01	0.40	0.02
7-methylbenz(a)anthracene	ND	ND	ND	ND	0.32	0.03	ND	ND
4-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (b) fluoranthene	ND	ND	ND	ND	0.66	0.05	ND	ND
benz (k) fluoranthene	ND	ND	ND	ND	0.82	0.07	ND	ND
benz (e) pyrene	ND	ND	ND	ND	0.39	0.03	ND	ND
benz [a] pyrene	ND	ND	ND	ND	ND	ND	ND	ND
perylene	ND	ND	ND	ND	ND	ND	ND	ND
indeno (123) cd pyrene	ND	ND	ND	ND	0.44	0.01	ND	ND
dibenz ah anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (ghi) perylene	0.30	0.01	0.28	0.01	0.31	0.01	0.26	0.01
coronene	ND	ND	0.12	0.00	ND	ND	ND	ND
				1/15/2023				
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}	
naphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND

1-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND
1,2- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	ND	ND	1.49	0.07	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylanthracene	ND	ND	ND	ND	0.13	0.01	ND	ND
1-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-methylphenanthrene	ND	ND	0.33	0.02	ND	ND	ND	ND
9-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	ND	ND	0.37	0.02	ND	ND	0.14	0.01
3,6-Dimethylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
fluoranthene	1.96	0.08	2.13	0.09	3.30	0.13	ND	ND
2,3-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
pyrene	ND	ND	ND	ND	5.51	0.22	ND	ND
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Retene	0.76	0.03	ND	ND	ND	ND	1.62	0.06
9-phenylanthracene	0.20	0.01	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	ND	ND	ND	ND	ND	ND	ND	ND
chrysene	0.46	0.02	ND	ND	2.99	0.12	0.58	0.02
7-methylbenz(a)anthracene	ND	ND	ND	ND	0.83	0.07	1.19	0.10
4-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6-methylchrysene	ND	ND	ND	ND	ND	ND	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
benz (b) fluoranthene	ND	ND	ND	ND	4.62	0.38	ND	ND
benz (k) fluoranthene	ND	ND	ND	ND	0.81	0.07	ND	ND
benz (e) pyrene	ND	ND	ND	ND	3.54	0.29	0.40	0.03
benz [a] pyrene	ND	ND	ND	ND	1.84	0.15	ND	ND
perylene	ND	ND	ND	ND	ND	ND	ND	ND
indeno (123) cd pyrene	ND	ND	ND	ND	0.27	0.01	ND	ND
dibenz ah anthracene	ND	ND	ND	ND	0.20	0.01	ND	ND
benz (ghi) perylene	ND	ND	ND	ND	0.88	0.02	0.05	0.00
coronene	ND	ND	ND	ND	ND	ND	ND	ND

	2/12/2023							
Compounds	U1	stdev	U2	stdev	TC1	stdev	D1	stdev
	ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}	
naphthalene	ND	ND	4.86	0.23	ND	ND	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthelene	ND	ND	2.79	0.13	ND	ND	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,6- Dimethylnaphthalene	ND	ND	1.23	0.06	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	0.32	0.02	ND	ND	ND	ND
1,5- Dimethylnaphthalene	ND	ND	0.39	0.02	ND	ND	ND	ND
acenaphthylene	ND	ND	0.44	0.02	ND	ND	ND	ND
1,2- Dimethylnaphthalene	ND	ND	0.22	0.01	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
acenaphthene	ND	ND	1.07	0.05	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylanthracene	ND	ND	ND	ND	ND	ND	0.07	0.00
1-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
1-methylphenanthrene	0.59	0.03	0.49	0.02	0.42	0.02	0.59	0.03
9-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
2- phenylnaphthalene	0.18	0.01	0.29	0.01	0.54	0.03	ND	ND
3,6-Dimethylphenanthrene	ND	ND	ND	ND	0.45	0.02	ND	ND
fluoranthene	ND	ND	6.29	0.25	6.44	0.26	2.61	0.10
2,3-Dimethylanthracene	ND	ND	ND	ND	0.32	0.01	ND	ND
pyrene	ND	ND	2.69	0.11	11.29	0.45	ND	ND
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	0.80	0.03
2-methylfluoranthene	0.23	0.01	0.36	0.01	0.59	0.02	ND	ND
Retene	ND	ND	ND	ND	1.16	0.05	ND	ND
9-phenylanthracene	ND	ND	ND	ND	ND	ND	ND	ND
benzo[a]anthracene	1.76	0.07	ND	ND	5.28	0.21	ND	ND
chrysene	2.81	0.11	1.40	0.06	11.33	0.45	0.76	0.03
7-methylbenz(a)anthracene	0.97	0.08	ND	ND	3.93	0.32	ND	ND
4-methylchrysene	0.10	0.01	ND	ND	0.26	0.02	ND	ND
6-methylchrysene	0.10	0.01	ND	ND	0.24	0.02	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	0.52	0.04	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND	ND	ND	0.71	0.06	ND	ND
benz (b) fluoranthene	2.84	0.23	0.50	0.04	11.01	0.90	0.52	0.04
benz (k) fluoranthene	1.03	0.08	0.10	0.01	4.07	0.33	0.37	0.03
benz (e) pyrene	1.98	0.16	0.24	0.02	7.91	0.64	0.28	0.02
benz [a] pyrene	1.41	0.12	0.19	0.02	5.19	0.42	0.83	0.07

perylene	0.24	0.02	ND	ND	1.19	0.10	ND	ND
indeno (123) cd pyrene	1.79	0.05	ND	ND	4.70	0.12	ND	ND
dibenz ah anthracene	ND	ND	ND	ND	0.17	0.00	ND	ND
benz (ghi) perylene	0.69	0.02	0.21	0.01	3.14	0.08	ND	ND
coronene	0.08	0.00	ND	ND	0.62	0.02	ND	ND

Table 7.8 cont: PAH concentrations and standard deviations in ng L^{-1} for the dissolved samples during the 3-26-23 sampling event.

	3/26/2023											
Compounds	TC1	stdev	TC2	stdev	TC3	stdev	TC4	stdev	TC5	stdev	TC6	stdev
	ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}		ng L^{-1}	
naphthalene	ND	ND	ND	ND	5.06	0.24	2.44	0.11	3.68	0.17	ND	ND
2-Methylnaphthelene	ND	ND	ND	ND	16.90	0.79	2.97	0.14	1.93	0.09	ND	ND
1-Methylnaphthelene	ND	ND	ND	ND	151.76	7.06	7.91	0.37	11.15	0.52	ND	ND
2,6- Dimethylnaphthalene	ND	ND	ND	ND	4.27	0.20	0.96	0.04	0.45	0.02	ND	ND
2,7- Dimethylnaphthalene	ND	ND	ND	ND	4.20	0.20	0.83	0.04	0.45	0.02	ND	ND
1,3- Dimethylnaphthalene	ND	ND	ND	ND	13.45	0.63	2.37	0.11	1.56	0.07	ND	ND
1,6- Dimethylnaphthalene	ND	ND	ND	ND	6.46	0.30	1.13	0.05	ND	ND	ND	ND
1,4- Dimethylnaphthalene	ND	ND	ND	ND	5.10	0.24	1.15	0.05	0.85	0.04	ND	ND
1,5- Dimethylnaphthalene	ND	ND	ND	ND	2.54	0.12	1.65	0.08	0.85	0.04	ND	ND
acenaphthylene	ND	ND	ND	ND	0.24	0.01	0.98	0.05	0.90	0.04	0.31	0.01
1,2- Dimethylnaphthalene	ND	ND	ND	ND	4.15	0.19	ND	ND	ND	ND	ND	ND
1,8- Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	0.05	0.00	ND	ND
acenaphthene	ND	ND	1.64	0.08	2.06	0.10	2.06	0.10	1.97	0.09	ND	ND
Fluorene	ND	ND	ND	ND	3.43	0.16	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	14.72	0.69	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	0.94	0.04	0.49	0.02	ND	ND	ND	ND
2-Methylanthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylanthracene	ND	ND	ND	ND	3.76	0.18	2.78	0.13	ND	ND	ND	ND
1-methylphenanthrene	ND	ND	0.82	0.04	2.43	0.11	1.41	0.07	0.31	0.01	0.27	0.01
9-Methylanthracene	0.18	0.01	ND	ND	0.24	0.01	0.09	0.00	ND	ND	ND	ND
2- phenylnaphthalene	ND	ND	0.72	0.03	1.54	0.07	0.80	0.04	0.23	0.01	0.20	0.01
3,6-Dimethylphenanthrene	ND	ND	ND	ND	0.19	0.01	0.50	0.02	ND	ND	ND	ND
fluoranthene	ND	ND	16.39	0.66	17.32	0.69	6.42	0.26	3.11	0.12	ND	ND
2,3-Dimethylanthracene	ND	ND	ND	ND	0.50	0.02	ND	ND	0.21	0.01	ND	ND
pyrene	6.73	0.27	8.78	0.35	9.91	0.40	3.98	0.16	2.15	0.09	ND	ND
9,10-Dimethylanthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-methylfluoranthene	ND	ND	ND	ND	0.29	0.01	0.12	0.00	ND	ND	ND	ND

Retene	ND	ND	ND	ND	7.38	0.30	1.03	0.04	0.50	0.02	ND	ND
9-phenylanthracene	ND	ND	ND	ND	ND	ND	ND	ND	0.43	0.02	ND	ND
benzo[a]anthracene	ND	ND	ND	ND	2.97	0.12	ND	ND	1.63	0.07	ND	ND
chrysene	1.65	0.07	3.86	0.15	11.49	0.46	1.89	0.08	3.77	0.15	0.27	0.01
7-methylbenz(a)anthracene	0.39	0.03	0.60	0.05	0.17	0.01	ND	ND	0.43	0.04	ND	ND
4-methylchrysene	ND	ND	0.10	0.01	0.21	0.02	ND	ND	0.11	0.01	0.08	0.01
6-methylchrysene	ND	ND	0.11	0.01	0.22	0.02	ND	ND	0.12	0.01	0.08	0.01
6,8-Dimethylbenz(a)anthracene	ND	ND	ND	ND	0.67	0.05	ND	ND	0.04	0.00	ND	ND
3,9-Dimethylbenz(a)anthracene	0.09	0.01	0.24	0.02	0.63	0.05	ND	ND	0.18	0.02	ND	ND
benz (b) fluoranthene	ND	ND	1.59	0.13	7.21	0.59	ND	ND	ND	ND	ND	ND
benz (k) fluoranthene	0.79	0.06	1.69	0.14	8.14	0.66	1.05	0.09	3.58	0.29	ND	ND
benz (e) pyrene	0.77	0.06	1.06	0.09	4.82	0.39	0.69	0.06	2.00	0.16	0.10	0.01
benz [a] pyrene	ND	ND	0.86	0.07	ND	ND	ND	ND	ND	ND	0.57	0.05
perylene	1.19	0.10	0.79	0.06	ND	ND	0.53	0.04	0.53	0.04	0.56	0.05
indeno (123) cd pyrene	0.50	0.01	0.23	0.01	ND	ND	0.49	0.01	ND	ND	0.43	0.01
dibenz ah anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benz (ghi) perylene	0.28	0.01	0.11	0.00	ND	ND	0.26	0.01	0.16	0.00	0.18	0.00
coronene	ND	ND	ND	ND	ND	ND	0.04	0.00	ND	ND	ND	ND

Table 7.8 cont: PAH concentrations and standard deviations in ng L^{-1} for the dissolved samples during the 4-14-23 sampling event.

	4/14/2023	
Compounds	TC1	stdev
	ng L^{-1}	
naphthalene	ND	ND
2-Methylnaphthelene	ND	ND
1-Methylnaphthelene	ND	ND
2,6- Dimethylnaphthalene	ND	ND
2,7- Dimethylnaphthalene	ND	ND
1,3- Dimethylnaphthalene	ND	ND
1,6- Dimethylnaphthalene	ND	ND
1,4- Dimethylnaphthalene	ND	ND
1,5- Dimethylnaphthalene	ND	ND
acenaphthylene	ND	ND
1,2- Dimethylnaphthalene	ND	ND
1,8- Dimethylnaphthalene	ND	ND
acenaphthene	ND	ND
Fluorene	ND	ND
Phenanthrene	ND	ND
Anthracene	0.07	0.00
2-Methylanthracene	ND	ND
1-Methylanthracene	ND	ND
1-methylphenanthrene	ND	ND
9-Methylanthracene	0.16	0.01
2- phenylnaphthalene	0.35	0.02
3,6-Dimethylphenanthrene	ND	ND
fluoranthene	5.02	0.20
2,3-Dimethylanthracene	ND	ND
pyrene	3.36	0.13
9,10-Dimethylanthracene	ND	ND
2-methylfluoranthene	ND	ND
Retene	ND	ND
9-phenylanthracene	ND	ND
benzo[a]anthracene	ND	ND
chrysene	2.00	0.08
7-methylbenz(a)anthracene	0.91	0.07
4-methylchrysene	ND	ND
6-methylchrysene	ND	ND
6,8-Dimethylbenz(a)anthracene	ND	ND
3,9-Dimethylbenz(a)anthracene	ND	ND
benz (b) fluoranthene	2.18	0.18
benz (k) fluoranthene	2.52	0.21

benz (e) pyrene	1.25	0.10
benz [a] pyrene	1.33	0.11
perylene	ND	ND
indeno (123) cd pyrene	ND	ND
dibenz ah anthracene	ND	ND
benz (ghi) perylene	0.11	0.00
coronene	0.16	0.00