Total Maximum Daily Loads for Organics and Metals in the Anacostia River Watershed

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To

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This document is a TMDL report submitted by the District of Columbia, Washington D.C. It addresses organochlorine pesticides (i.e., chlordane, dichlorodiphenyltrichloroethane (DDT) and its metabolites, dieldrin, heptachlor epoxide), polycyclic aromatic hydrocarbons (PAHs), and metals (arsenic, copper, zinc) impairments in the Anacostia River, its tributaries, and Kingman Lake.

The document was prepared by the District Department of Energy and Environment (DOEE) with technical support from Tetra Tech and the U.S. Environmental Protection Agency (EPA).

DOEE would like to acknowledge Tetra Tech's technical support, which included collecting additional water quality data for toxic pollutants, collating and using other available data, developing the Anacostia Toxics Model, and calculating TMDLs for toxic pollutants. This effort is discussed further in the Anacostia River Toxic Constituents TMDL Modeling Report (Tetra Tech, 2023b).

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EXECUTIVE SUMMARY

This document, upon approval by the U.S. Environmental Protection Agency (EPA), establishes total maximum daily loads (TMDLs) for three metals- arsenic, copper, and zinc; four pesticides- chlordane, dieldrin, heptachlor epoxide, and dichlorodiphenyltrichloroethane (DDT) and its metabolites; and three polycyclic aromatic hydrocarbon (PAH) groups- PAH 1, PAH 2, and PAH 3 (hereafter, referred to as the ten toxic pollutants) for all 13 impaired waterbody segments in the Anacostia River watershed in the District of Columbia. This results in a total of 61 TMDLs established for impaired waterbody-pollutant combinations. The remaining 69 waterbody-pollutant combinations are provided informational TMDLs[1] in Appendix A as these waterbody-pollutant combinations are not listed as impaired on DOEE's Integrated Report. Section 303(d) of the Clean Water Act (CWA) and EPA's implementing regulations direct each state or jurisdiction to identify and list waters, known as water quality limited segments (WQLS), in which current required controls of a specified substance are inadequate to achieve water quality standards (WQS). For each WQLS, the state or jurisdiction is required to either establish a TMDL for the specified substance that the waterbody can receive without violating WQS or demonstrate that WQS are being met (40 C.F.R. § 130.7). Section 303(d)(3) also allows states to develop informational TMDLs where a waterbody is not identified as a WQLS.

The District of Columbia (District) has listed, in two defined segments, all of the tidal Anacostia River mainstem within the District's boundaries as impaired for the ten toxic pollutants. In addition, the District has listed nine tributaries to the Anacostia River and Kingman Lake as impaired for some of the ten toxic pollutants. These WQLS are designated for the Class C (protection and propagation or fish, shellfish, and wildlife) and Class D (protection of human health related to consumption of fish and shellfish) beneficial uses, which are currently not supported due to elevated levels of toxic pollutants, and were initially listed on the District's 303(d) list in 1998. Toxic pollutant TMDLs were established for the Anacostia River and its tributaries (DOH, 2003a) and Kingman Lake (DOH, 2003b) by the District in 2003. The TMDLs established in this report will, when approved by EPA, supersede both the 2003 Organic and Metals TMDLs for the Anacostia River and its tributaries and the 2003 Organics and Metals TMDLs for Kingman Lake.

The objective of the toxic pollutant TMDLs established in this document is to ensure that the "protection and propagation of aquatic life" and "fish consumption" uses are protected in each of the impaired waterbodies. This objective was accomplished by identifying maximum allowable toxic pollutant loads that would meet the applicable water quality criteria (WQC) through:

- The identification of toxic pollutant sources and loads using existing data and literature, which were used to estimate baseline conditions;
- The configuration and calibration of a linked watershed/receiving water model;
- The selection of a representative TMDL endpoint protective of water quality standards for each of the ten toxic pollutants from the District's applicable WQC;

[1] Section 303(d)(3) of the CWA and 40 C.F.R. 130.7(e) authorize States to develop informational TMDLs as resources allow when water quality standards are currently being met. 33 U.S.C. 1313(d)(3). The intent is to develop information and identify levels that will protect the waterbody. For purposes of implementation, 40 C.F.R. 122.44(d)(1)(vii)(B) does not distinguish between TMDLs developed and wasteload allocations developed pursuant to CWA Sections 303(d)(1)(C) and those developed pursuant to CWA Section 303(d)(3).

- The execution of the linked watershed/receiving water model to assess the impact of flow/rainfall conditions and the major source categories on toxic pollutant loads, an iterative series of model runs with adjustments to input loads until a set of loads (the TMDL scenario) that met the TMDL endpoints in all model segments was achieved, the calculation of TMDLs (Table E-1) and annual allocations, and an analysis to determine the impact of natural attenuation on toxic pollutant loads;
- An analysis of the impact of future climatic conditions (precipitation quantity and intensity, air temperature, and sea level rise) as a result of climate change on the loads of toxic pollutants to the system and the impact to the estimated timeframes until TMDL endpoints would be attained; and
- The application of conservative assumptions to the TMDL scenario methods to provide an implicit margin of safety (MOS).

Table E-1 Anacostia River TMDLs

Pollutant	WLA (g/day)	LA (g/day)	Cumulative[2] TMDL (g/day)
Arsenic	2122.91	51.31	2174.21
Copper	462803.53	5553.37	468356.90
Zinc	456466.42	8319.65	464786.07
Chlordane	7.22	0.12	7.33
DDT	0.37	0.02	0.39
Dieldrin	0.00	0.00	0.00
Heptachlor epoxide	0.98	0.02	1.00
PAH 1	4940.12	27.19	4967.31
PAH 2	1.12	0.01	1.14
PAH 3	0.12	0.00	0.12

[1]The MOS is implicit.

[2]Cumulative annual load allocations from the downstream most segment of the Anacostia River (Anacostia #1).

EPA's regulations require TMDLs to account for seasonality and critical conditions related to stream flow, loading, and water quality parameters (40 C.F.R. § 130.7(c)(1)). Seasonality and critical conditions were considered in these TMDLs through the use of a dynamic model and analysis of all flow conditions (i.e., under both low flow and high flow scenarios) in the watershed over a 4-year simulation period. The linkage of the tidal Anacostia River to a dynamic watershed loading model ensures that nonpoint and stormwater point source loads from the watershed delivered at times other than the critical period were also considered in the analysis. Critical conditions for toxic parameter loads were incorporated by determining wasteload allocations (WLAs) based on maximum flows from dischargers set by design flows specified in National Pollutant Discharge Elimination System (NPDES) permits for each facility. Model simulation of multiple complete years accounted for seasonal variations. Continuous simulation (modeling over a period of several years that captured precipitation extremes) inherently considers seasonal hydrologic and source loading variability.

The CWA and EPA regulations require reasonable assurance that TMDL load allocations (LAs) will be implemented. Progress toward achieving the Anacostia River toxic pollutant TMDLs described in this report will require substantial reductions from point and nonpoint sources of toxic pollutants to the watershed. The District intends to proceed with an adaptive implementation approach concurrent with activities (e.g., on-going monitoring and best management practices (BMPs)) to reduce toxic pollutant loadings. Toxic pollutant regulatory activities will include the incorporation of WLAs in NPDES permits after the TMDL has been approved. In the District, several monitoring, restoration, and regulatory programs are already in place that are and will continue to reduce toxic pollutant loads from both point and nonpoint sources. These programs include storm water runoff controls, erosion control measures to reduce sediments and nutrients, identification of additional toxic pollutant sources and contaminated sites, and remediation of contaminated sites. While not part of TMDL development, instream remediation efforts, such as dredging and capping river bottom sediment in certain toxic pollutant hotspots, may be undertaken in connection with the Anacostia River Sediment Project (ARSP) to address PCB (and coincident pollutant) contamination. No aspect of these TMDLs is inconsistent with these remediation efforts, and in fact, it is anticipated that instream remediation efforts will aid implementation of these TMDLs and decrease the amount of time it takes for water quality to approach the TMDL endpoints. Follow-up monitoring of water, sediment, and fish tissue will be conducted as a component of the District's implementation strategy.

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ABBREVIATIONS

ARSP	Anacostia River Sediment Project
As	Arsenic
ATSDR	Agency for Toxics Substances and Disease Registry
AWRP	Anacostia Watershed Restoration Partnership
BARC	Beltsville Agricultural Research Center
BMP	Best management practice
CBP	Chesapeake Bay Program
CBT	Chesapeake Bay Trust
CCC	Criteria continuous concentration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIP	Consolidated implementation plan
CMC	Criteria maximum concentration
CSO	Combined sewer overflow
CSS	Combined sewer system
Cu	Copper
CWA	Clean Water Act
DC	District of Columbia
DCMR	District of Columbia Municipal Regulations
DDD	4,4’-dichlorodiphenyldichloroethane
DDE	4,4’-dichlorodiphenyldichloroethylene
DDT	4,4’-dichlorodiphenyltrichloroethane
DMR	Discharge monitoring report
DOEE	District of Columbia Department of Energy and Environment
EFDC	Environmental Fluid Dynamics Code
EPA	U.S. Environmental Protection Agency
FS	Feasibility study
g/year	Gram per year
HE	Heptachlor epoxide
HH	Human health

JBAB	Joint Base Anacostia-Bolling
LA	Load allocation
LSPC	Loading Simulation Program in C++
LTCP	Long term control plan
MD	Maryland
MOS	Margin of safety
MS4	Municipal separate storm sewer system
MSGP	Multi-Sector General Permit
MWCOG	Metropolitan Washington Council of Governments
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PECS	Potential environmental cleanup sites
PEPCO	Potomac Electric Power Company
PPB	Parts per billion
ROD	Record of decision
RI	Remedial investigation
TEQ	Toxic equivalent
TMDL	Total maximum daily loads
TSS	Total suspended solids
USGS	U.S. Geological Survey
WLA	Wasteload allocation
WNY	Washington Navy Yard
WQC	Water quality criteria
WQLS	Water quality limited segments
WQS	Water quality standards
WWTP	Wastewater treatment plant
Zn	Zinc
µg/L	Microgram per liter

1 INTRODUCTION

Section 303(d) of the Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations require states and jurisdictions to identify and list waterbodies, or water quality limited segments (WQLS), in which required technology-based controls of a specified substance are inadequate to achieve water quality standards (WQS). For each WQLS, the state or jurisdiction is required to either establish a total maximum daily load (TMDL) of the specified substance that the waterbody can receive without violating WQS or demonstrate that WQS are being met (40 C.F.R. § 130.7). The TMDL must account for seasonal variations, critical conditions, and a protective margin of safety (MOS) to account for uncertainty.

A TMDL establishes the maximum loading of an impairing substance that a waterbody can receive and still meet WQS. WQS are the combination of a designated use for a particular body of water, the water quality criteria (WQC) designed to protect that use, and antidegradation requirements. Designated uses include activities such as swimming, protection of fish and shellfish, and the protection of human health related to consumption of fish. WQC consist of narrative statements and numeric values designed to protect the designated uses. WQC may differ in waters with different designated uses.

As part of TMDL development, and following public comment on the initial proposed revised TMDL in 2021 as described in Section 1.1.1, an effort was made to understand the effects of climate change on toxic pollutants in the Anacostia River watershed. Several analyses were completed to estimate the effects of climate change on attainment of the TMDL endpoints and to estimate timeframes associated with such attainment. These analyses provide insight on the ability to achieve water quality goals in the future and are discussed in detail in Section 7.

1.1 History of Impairment

1.1.1 District of Columbia

In 1998, the District of Columbia (District) characterized the Anacostia River and its tributaries as impaired for metals and organic pollutants on its 303(d) list of WQLS. To address these impairments, TMDLs were developed for arsenic, copper, lead, mercury, chlordane, 4,4'-dichlorodiphenyldichloroethane (DDD), 4,4'-dichlorodiphenyldichloroethylene (DDE), 4,4'-dichlorodiphenyltrichloroethane (DDT), dieldrin, heptachlor epoxide, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). The TMDLs in the report, "District of Columbia Final Total Maximum Daily Loads for Organics and Metals in the Anacostia River, Fort Chaplin Tributary, Fort Davis Tributary, Fort Dupont Creek, Fort Stanton Tributary, Hickey Run, Nash Run, Popes Branch, Texas Avenue Tributary and Watts Branch," were approved by EPA on August 29, 2003 with amended approval on October 16, 2003. The TMDLs in the report "District of Columbia Final Total Maximum Daily Loads for Organics and Metals in Kingman Lake" were approved by EPA on October 31, 2003.

In 2006, Friends of the Earth successfully challenged EPA's approval of several District TMDLs because they did not include a daily load expression (*Friends of the Earth vs. the Environmental Protection Agency,* 446 F.3d 140, 144 (D.C. Cir. 2006)). The court ruled that "daily means daily". Following that litigation, Anacostia Riverkeepers, Friends of the Earth, and Potomac Riverkeepers filed a complaint (Case No.: 1:09-cv-00098-JDB) on January 15, 2009, because numerous other EPA-approved District

TMDLs did not have daily load expressions. In that case, the court ordered that EPA's approval of all the TMDLs challenged, including those for toxic pollutants, be vacated, but stayed vacatur to allow EPA and Department of Energy and Environment (DOEE) time to develop daily loads. EPA's approval of the 2003 Kingman Lake TMDLs was not challenged in that case. The toxic pollutant TMDLs established herein for the Anacostia River and its tributaries represent the last of the TMDLs that were the subject of the 2009 lawsuit that still require revision. A draft TMDL report was released for a 30-day public comment period on July 9, 2021. The comment period was extended by one week at the request of a stakeholder organization, so it ultimately closed on August 13, 2021. In addition, a public meeting was held on July 22, 2021, to provide an overview of the draft TMDLs. Numerous comments were submitted by several stakeholders during the comment period. After several requests from EPA for extension of the stay of vacatur since the original court ruling, the stay was most recently extended until April 1, 2024 to allow additional time to consider and respond to the public's comments.

The TMDLs presented in this report will, when approved by EPA, supersede the 2003 Anacostia River and tributaries Organics and Metals TMDLs and the 2003 Kingman Lake Organics and Metals TMDLs.

Most of the original toxic pollutant impairments identified in the 1998 303(d) list were based on very limited data, including macroinvertebrate data and some fish tissue data collected from the mainstem Potomac and Anacostia Rivers but not from specific tributaries. Consequently, to develop these TMDLs, DOEE reviewed available monitoring data for the existing impairments and collected additional data between 2013 and 2019 to clarify and identify the current impairment status for each of the tributaries as part of a larger effort to confirm the identified impairments for toxic pollutants across the District. The samples were analyzed for metals, pesticides, and PAHs, among other pollutants. As part of its 2020 Integrated Report, DOEE again assembled and evaluated the available water quality data for toxics to clarify and identify the current impairment status for the Anacostia River and its tributaries. The remaining impairment listings for toxics in the Anacostia River and its tributaries in the District are based on water column exceedances of the applicable criteria. There are additional listings for dieldrin in fish tissue and PCBs in fish tissue in the two Anacostia mainstem segments (Anacostia #2 and Anacostia #1) based on exceedances of DOEE's fish tissue threshold. Table 1-1 shows the remaining toxic pollutant impairments that are addressed through these TMDLs.

TMDLs are presented for waterbody-pollutant combinations that exceeded numeric WQC. In addition, informational TMDLs are presented in Appendix A for other waterbody-pollutant combinations that do not exceed any numeric WQC and therefore are not listed as impaired on DOEE's Integrated Report.

In 2007, EPA approved the "Total Maximum Daily Loads of Polychlorinated Biphenyls (PCBs) for Tidal Portions of the Potomac and Anacostia Rivers in the District of Columbia, Maryland, and Virginia" which adequately addressed PCB impairments in direct tributaries to the Potomac and Anacostia Rivers. These TMDLs included daily load expressions, therefore no additional PCB TMDLs are required for the Anacostia River watershed.

For each tributary where the data reviewed shows that a pollutant is exceeding a numeric WQC, a revised TMDL has been developed, including a daily load expression. The majority of these waterbody-pollutant combinations remained in Category 4a (waterbody is impaired and a TMDL has been developed) in the District's 2020 Integrated Report (DOEE, 2020). Rather than simply revising the existing TMDLs to establish a daily load for the toxic pollutants that were detected, DOEE elected to develop new TMDLs for these pollutants due to the following:

- Since the original TMDLs had been established in 2003, the numeric WQC for these toxic pollutants were revised. These changes are described in more detail in Section 1.3.1.
- Additional monitoring data was collected in the Anacostia River watershed to comply with requirements of the District's municipal separate storm sewer system (MS4) permit and for other District projects that could be used for modeling purposes.
- DOEE has undertaken considerable effort to develop a model for the Anacostia River as part of the Anacostia River Sediment Project (ARSP) Remedial Investigation (RI) and Feasibility Study (FS). DOEE thought that the TMDLs would benefit from the availability of this more up-to-date and sophisticated modeling framework.

Table 1-1 Toxic Pollutant[a] Impairments Being Addressed by the TMDLs. Impairments were determined as described in the District's Integrated Report (2020)

Segment	Uses supporting[b]	Uses not supporting[b]	Arsenic	Copper	Zinc	4,4 DDD	4,4 DDE	4,4 DDT	Chlordane	Dieldrin	Heptachlor epoxide	PAHs
Anacostia #1	E	A, B, C, D	D	D	D	D	D	D	D	D[c]	D	D
Anacostia #2	E	A, B, C, D	D	D	D	D	D	D	D	D[c]	D	D
Kingman Lake	E	A, B, C, D	D					D	D			D
Nash Run		A, B, C, D	D						D	D	D	D
Popes Branch		A, B, C, D					D		D		D	D
Watts Branch		A, B, C, D							D	D		
Hickey Run		A, B, C, D					D		D			D
Fort Dupont Creek		A, B, C, D	D									
Fort Chaplin Run		A, B, C, D	D									
Fort Davis Tributary		A, B, C, D	D									
Fort Stanton Tributary		A, B, C, D	D									D
Texas Avenue Tributary		A, B, C, D	D			D	D	D	D	D	D	D

Abbreviations: DDD = dichlorodiphenyldichloroethane; DDE = dichlorodiphenyldichloroethylene; DDT = dichlorodiphenyltrichloroethane

[a] Header shading color indicates type of toxic pollutant: medium blue = metals; yellow = organochlorine pesticides; green = PAHs.

[b] Uses: A = Primary contact recreation; B = secondary contact recreation and aesthetic enjoyment; C = protection and propagation of fish, shellfish, and wildlife; D = protection of human health related to consumption of fish and shellfish; E = navigation.

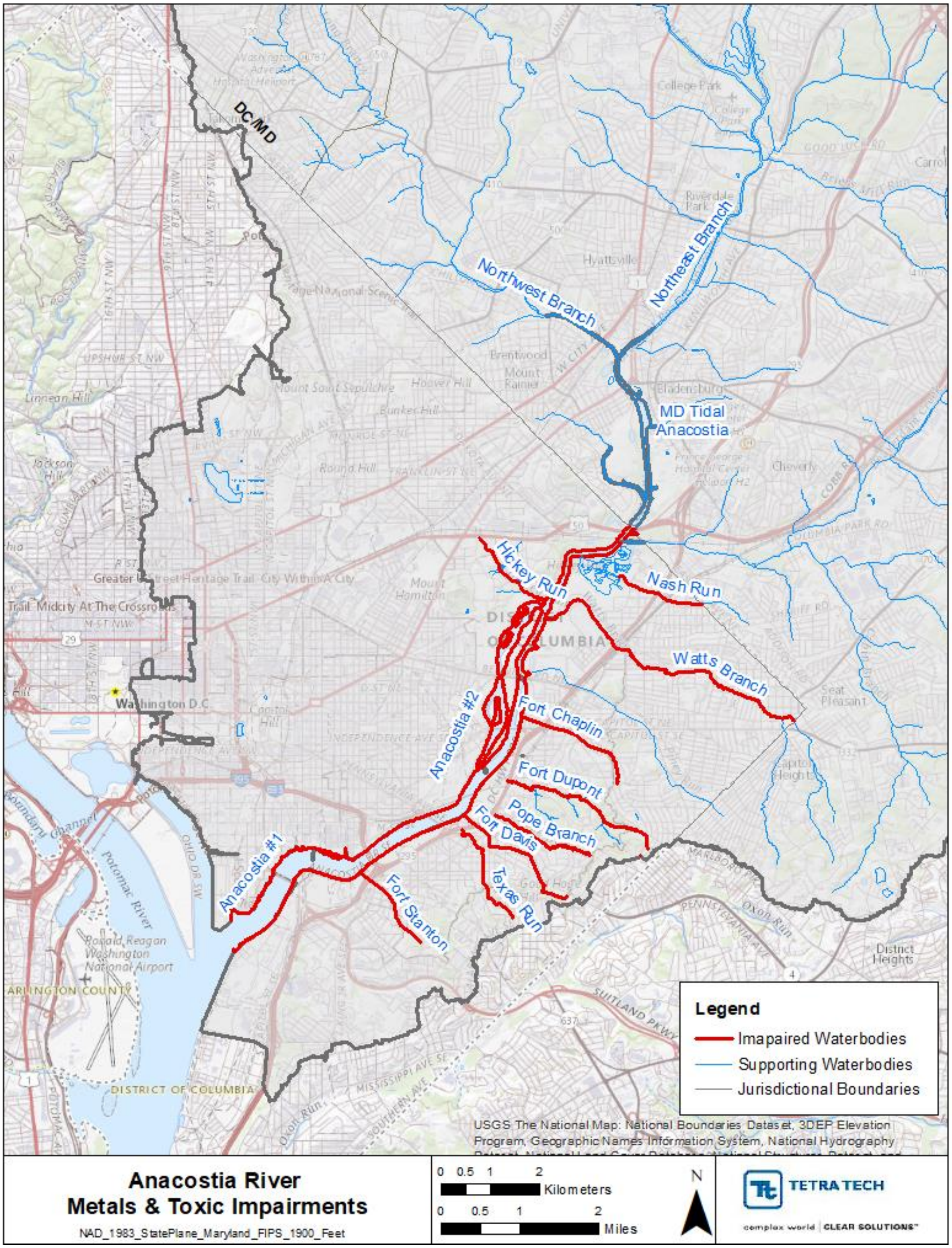

Figure 1-1 Waterbodies Impaired for Toxic Pollutants in the Anacostia River Watershed

1.2 Water Quality Model Background

The Anacostia River is a complex, tidally influenced waterbody with a drainage area that transitions from the suburban, mixed land use headwaters in Maryland to the highly urbanized District metropolitan area along its mainstem. The wide range of land cover and management conditions throughout the watershed, including legacy soil and sediment contamination, benefit from a robust modeling framework to properly simulate the hydrology, hydrodynamics, sediment, and toxics fate and transport of the system. A linked watershed/receiving water model is best suited to capture the critical system components of the Anacostia River. Such an integrated modeling system, after calibration, can appropriately represent the linkage between the sources in the watershed and legacy sources in the riverbed, as well as the impact of possible sources from the Potomac River, hence supporting the development of a comprehensive TMDL scenario.

The modeling approach selected is a linked watershed/receiving water modeling system that can describe and simulate hydrology, hydrodynamics, and pollutant loading in the Anacostia River watershed. The Loading Simulation Program in C++ (LSPC) model version 5.0 (U.S. EPA, 2009) was selected for watershed simulation and Environmental Fluid Dynamics Code (EFDC) was selected as the receiving water model for this project (Tetra Tech, 2023b). This linked watershed/receiving water modeling system was used extensively in the development of the ARSP RI and FS.

Climate change was incorporated into the linked watershed/receiving water model by developing model simulations using climate projections to simulate watershed loading, hydrodynamics, and fate and transport of toxic pollutants in the watershed for two future time horizons (Tetra Tech, 2023a). Climate change projections for rain quantity and intensity, air temperature, and sea level rise based on modeling and output data generated by the Chesapeake Bay Program Office Modeling Workgroup were used to simulate future climactic conditions. See Chapter 7 for further details.

1.3 Toxic Pollutants

1.3.1 Metals

Metals (e.g., copper and zinc) and metalloids (e.g., arsenic) are elements that have a relatively high density compared to water. The density or heaviness of a metal is often correlated with toxicity, meaning that some metals can be toxic at a low level of exposure (ATSDR, 2004; ATSDR, 2007a). Although metals occur naturally in the environment, contamination of the environment results from metals that enter the environment through anthropogenic activities at levels that pose a risk to human health. Major sources include mining and smelting, industrial production and use, and domestic and agricultural use. Minor sources include corrosion, leaching, atmospheric deposition, and natural phenomena such as volcanic eruptions and weathering (ATSDR, 2004; ATSDR, 2007a).

Metals or metallic compounds can enter aquatic systems through a variety of mechanisms but the most common include stormwater runoff and industrial or domestic waste discharge. Metals can be found at elevated concentrations in the environment due to natural background conditions or contamination at hazardous waste sites. Most of the metals that reach aquatic environments will collect in the sediment of lakes, rivers, and estuaries, though a percentage can be suspended in water and can be transported through the system or into groundwater. Metals can accumulate in aquatic plants and animals, particularly fish and filter feeders (e.g., freshwater mussels). These metals can be acutely toxic at a range of concentrations.

1.3.2 Organochlorine Pesticides

Chlordane, DDT and metabolites, dieldrin, and heptachlor epoxide are all organochlorine pesticides or pesticide degradation products. Chlordane was marketed as a mixture of compounds, including heptachlor. Technical chlordane (Chemical Abstracts Service (CAS) Registry no. 12789-03-6) can contain over 120 different compounds. In this report, chlordane refers to CAS no. 57-74-9, which is a mixture containing approximately 95% cis- and trans-chlordane isomers. These isomers are also known as α- and γ-chlordane respectively (U.S. EPA, 1997). DDT is an insecticide that degrades in the environment via microorganism action into DDD and DDE. DDD also had a limited use as a pesticide itself. Dieldrin, while an insecticide, is also a degradation product of aldrin; heptachlor epoxide is the degradation product of the pesticide heptachlor.

Organochlorine pesticides can have a wide variety of harmful acute and chronic effects on aquatic organisms, including neurological damage and endocrine disorders, and on humans, including causing illness and cancer (Nowell et al., 1999; ATSDR, 2002; ATSDR, 2007b; ATSDR, 2018; ATSDR, 2019). As a result, aside from a handful of specialized uses, all uses of chlordane, DDT, dieldrin, and heptachlor epoxide are banned by EPA or have been voluntarily withdrawn from the market by their manufacturers in the U.S. Therefore, these pesticides are no longer actively used in the District. Some of these pesticides still enter the environment during manufacturing and application in other parts of the world and may enter the U.S. via atmospheric transport. These pollutants are on the CWA's Priority Pollutant List and EPA recommends the adoption of WQC for these chemicals to protect aquatic life and human health.

Smith et al. (1998) note that organochlorine pesticides share a range of physical and chemical properties including:

- Slow degradation rates in soils and sediments;
- Very limited solubility in water;
- Strong adherence to soils or sediments;
- Dissolve readily in non-polar organic solvents and fats;
- Limited volatility (except for DDT); and
- Strong tendency to bioaccumulate in fish, plants, and animals.

These properties explain the persistence of organochlorine pesticides in the environment even though their use in the U.S. has been banned for decades. Their limited solubility in water prevents them from being rapidly flushed from a watershed and their resistance to physical or biological degradation prevents them from diminishing quickly *in situ*. For example, chlordane can persist in soils for longer than 20 years after it is applied (ATSDR, 2018). Nevertheless, concentrations of organochloride pesticides are decreasing in sediments and in fish tissue over time due to natural attenuation (Gilliom et al., 2006; Van Metre et al., 1997; Van Metre and Mahler, 2005).

1.3.3 PAHs

Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals that are formed during the incomplete combustion of gas, oil, coal, wood, trash, or other organic substances. There are over 100 documented PAHs and these often exist in the environment in complex mixtures. Important sources of PAHs in surface waters include atmospheric deposition, municipal wastewater discharge, urban stormwater runoff, and runoff and effluent from other industries and oil spills (ATSDR, 1995). In addition to occurring naturally, more simple PAHs can be manufactured as individual compounds. ATSDR (1995) identified 17 PAHs based on amount of available information, incidence in the environment, and supposed level of harmfulness. These 17 PAHs are:

- acenaphthene
- acenaphthylene
- anthracene
- benz[a]anthracene
- benzo[a]pyrene
- benzo[e]pyrene
- benzo[b]fluoranthene
- benzo[g,h,i]perylene
- benzo[j]fluoranthene
- benzo[k]fluoranthene
- chrysene
- dibenz[a,h]anthracene
- fluoranthene
- fluorene
- indeno[1,2,3-c,d]pyrene
- phenanthrene
- pyrene

There are 13 PAHs that are assigned numeric criteria in the District's WQS. All of those PAHs were selected for inclusion in these TMDLs (Table 1-3).

PAHs can have a wide variety of negative effects on aquatic life and systemic, immunological, neurological, developmental, reproductive, and carcinogenic effects on human health. For these reasons, EPA has promulgated regulations to protect people from contact with or inhalation and ingestion of PAHs. These pollutants are on the CWA's Priority Pollutant List and EPA recommends the adoption of WQC for these chemicals to protect aquatic life and human health.

PAHs share many physical and chemical characteristics (Smith et al. (1998), including:

- Slow biodegradation rates once sorbed to sediment;
- Relatively low solubility and vapor pressure;
- Strong tendency to partition from water into biota and particulate and dissolved organic matter;
- Strong adherence to soils and sediments; and
- Accumulation in lipid stores of aquatic organisms.

In aquatic systems, PAHs generally do not dissolve in water but rather sorb to sediment particles, settling to the river or stream bottom. Often, the PAH content of aquatic plants and animals is higher than that of the surrounding water. PAHs in the water or sediment can be broken down into more stable products by the actions of microorganisms. Additionally, studies of animals have found that PAHs that enter the body are often excreted shortly after inhalation, ingestion, or dermal exposure (ATSDR, 1995). PAHs can be persistent in soils and sediment particles found in surface waters and are ubiquitous in the environment as a result of continuous releases from combustion and contaminated soils.

1.4 Designated Uses and Applicable Water Quality Standards

TMDLs are established to determine the allowable pollutant loadings required to achieve and maintain WQS. WQS are comprised of a designated use for a particular body of water, the WQC designed to protect that use, and antidegradation requirements. Designated uses include activities such as swimming, drinking water supply, protection of aquatic life, and fish and shellfish protection and propagation. WQC consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ between waters with different designated uses. Below is specific information on the District's WQS.

1.4.1 District of Columbia

Categories of District surface water designated uses are contained in the District of Columbia Water Quality Standards, Title 21 of District of Columbia Municipal Regulations, Chapter 11 (DCMR, Effective May 22, 2020). Use classes are:

Class A – primary contact recreation;
Class B – secondary contact recreation and aesthetic enjoyment;
Class C – protection and propagation of fish, shellfish, and wildlife;
Class D – protection of human health related to consumption of fish and shellfish; and
Class E – navigation.

The categories of use classes for the Anacostia River and its tributaries are listed in Table 1-2.

Table 1-2 Classification of the District's Waters

	Use Classes	
Surface Waters of the District	**Current Use**	**Designated Use**
Anacostia River	B, C, D, E	A, B, C, D, E
Anacostia River tributaries (except as listed below)	B, C, D	A, B, C, D
Hickey Run	B, C, D	A, B, C, D
Watts Branch	B, C, D	A, B, C, D

The District's WQS include both narrative and numeric criteria that protect its surface waters. 21 DCMR §1104.1 establishes the following narrative water quality criteria:

> The surface waters of the District shall be free from substances attributable to point or nonpoint sources discharged in amounts that do any one of the following:
>
> (a) Settle to form objectionable deposits;
> (b) Float as debris, scum, oil, or other matter to create a nuisance;
> (c) Produce objectionable odor, color, taste, or turbidity;

(d) Cause injury to, are toxic to, or produce adverse physiological or behavioral changes in humans, plants, or animals;
(e) Produce undesirable or nuisance aquatic life or result in the dominance of nuisance species; or
(f) Impair the biological community that naturally occurs in the waters or depends upon the waters for its survival and propagation.

The District's numeric WQC include a criteria maximum concentration (CMC) and a criteria continuous concentration (CCC) to protect acute and chronic exposure of aquatic life (Class C waters), respectively. The CMC is the highest concentration of a pollutant to which aquatic life can be exposed for a short period (one-hour average) without deleterious effects at a frequency that does not exceed more than once every three years. The CCC is the highest concentration of a pollutant to which aquatic life can be exposed for an extended period (four-day average) without deleterious effects at a frequency that does not exceed more than once every three years.

Another numeric criterion is the 30-day average concentration that is applied for the protection of human health related to the consumption of fish and shellfish (Class D waters). For the organochlorine pesticides and some PAHs, it represents the maximum 30-day average water column concentration of a pollutant that would result in a fish tissue pollutant concentration that would not raise an individual's lifetime risk of contracting cancer from the consumption of fish by more than one in one million (Table 1-3, footnote b). For the metals and remaining PAHs, the 30-day average concentration is not associated with carcinogenicity, but rather is based on reference doses. The 30-day average is based on average body weight, fish consumption rates, and bioaccumulation rates of the pollutant in the food chain (U.S. EPA, 2014).

Since the original TMDLs were developed, numeric WQC for toxic pollutants were updated in the District's WQS based on EPA's nationally recommended Human Health Ambient Water Quality Criteria (U.S. EPA, 2015). The updated WQC include the latest scientific information and EPA policies that include updated exposure factors (body weight, drinking water consumption, and fish consumption rate), bioaccumulation factors, health toxicity values, and relative source contributions. For example, in updating its human health criteria, EPA updated the fish consumption rate to 22 grams per day (U.S. EPA, 2015). These human health ambient WQC updates in the District's WQS were approved by EPA on August 5, 2020. The updated criteria established in 21 DCMR §1104.8 for the TMDLs established herein are noted in Table 1-3. Further, the most stringent metal and toxic pollutant numeric WQC across both aquatic life and human health designated uses are used as TMDL endpoints. For instance, if the aquatic life WQC for a particular pollutant was more stringent than the WQC for human health for that same pollutant, the aquatic life WQC was selected as the TMDL endpoint (See Table 1-6). As required by CWA §303(d)(1)(c) and EPA's regulations at 40 C.F.R. §130.7(c)(1) the TMDLs attain and maintain all applicable WQS. Numeric WQC are particularly important where the toxicity cause is known and/or where pollutants have the potential to bioaccumulate (U.S. EPA, 2014).

In addition to the numeric criteria, TMDLs must attain and maintain the applicable narrative criteria. Narrative criteria, which supplement numeric criteria, are statements that describe the desired water quality goal (U.S. EPA, 2014). Narrative criteria are used to express a parameter in a qualitative form as opposed to the quantitative form of numeric criteria. The applicable narrative criteria in the District's WQS are those established at 21 DCMR §1104.1(d), noted above, which prohibit substances attributable to discharges in amounts that "[c]ause injury to, are toxic to, or produce adverse physiological or behavioral changes in humans, plants, or animals". EPA's Human Health Ambient WQC, which have been adopted into the District's WQS, represent the latest scientific information and policies that consider the amounts at which pollutants "are toxic to" humans using updated exposure inputs, bioaccumulation factors, and updated toxicity values (EPA, 2015). Because the TMDLs herein were developed to attain the most stringent WQC in the District's WQS regulations, attainment of these criteria will prevent injury to, toxicity to, and adverse physiological or behavioral changes in humans, plants, and animals. As a result, the TMDLs are set at levels necessary to attain and maintain the applicable narrative criteria in the District's WQS regulations.

Table 1-3 Numeric Water Quality Criteria for District Waters

Pollutant Group (where applicable)	Pollutant	Criteria for Classes (µg/L)		
		C		D
		CCC 4-Day Average	CMC 1-Hour Average	30-Day Average
--	Arsenic	150	340	0.14
--	Copper	8.96[a]	13.44[a]	--
--	Zinc	118.14[a]	117.18[a]	26000
--	Chlordane	0.0043	2.4	0.00032,[b]
--	Dieldrin	0.056	0.24	0.0000012,[b]
DDT	4,4'-DDD	0.001	1.1	0.00012,[b]
	4,4'-DDE	0.001	1.1	0.000018,[b]
	4,4'-DDT	0.001	1.1	0.000030,[b]
--	Heptachlor Epoxide	0.0038	0.52	0.000032,[b]
PAH 1 (2+3 ring)	Acenaphthene	50	--	90
	Anthracene	--	--	400
	Naphthalene	600	--	--
	Fluorene	--	--	70
PAH 2 (4 ring)	Benzo[a]anthracene	--	--	0.0013,[b]
	Chrysene	--	--	0.13,[b]
	Fluoranthene	400	--	20
	Pyrene	--	--	30
PAH 3 (5 + 6 ring)	Benzo[a]pyrene	--	--	0.00013,[b]
	Benzo[b]fluoranthene	--	--	0.0013,[b]
	Benzo[k]fluoranthene	--	--	0.013,[b]

	Dibenzo[a,h]anthracene	--	--	0.00013,[b]
	Indeno[1,2,3-c,d]pyrene	--	--	0.0013,[b]

[a] Criterion is equation based, as described in the District's WQS. All values reported in this table are based on a hardness value of 100 mg/L $CaCO_3$.
[b] Denotes a Class D Human Health Criteria numeric value that is based on carcinogenicity of 10^{-6} risk level.

1.5 TMDL Endpoints

TMDL development generally uses applicable numeric WQC as TMDL endpoints for impaired waterbodies. WQC are available for all current impairment listings in the Anacostia River watershed, thus the applicable WQC will be applied as TMDL endpoints. The draft TMDLs presented herein are protective of all applicable WQS.

Certain pollutants were grouped within the model to align with the modeling platform, minimize unnecessary modeling complexity, and maintain consistency with the original TMDLs. These groupings are included in Table 1-3. DDD, DDE, and DDT were grouped together, and the most stringent criterion of the three was used as the TMDL endpoint. Additionally, PAHs were divided into three groups based on benzene ring structure and the most stringent criterion in each group was used as the TMDL endpoint. The PAH 1 group represents PAHs with two and three rings, the PAH 2 group represents PAHs with four rings, and the PAH 3 group represents PAHs with five and six rings.

The TMDL endpoints are presented in Tables 1-4 through 1-6. The most stringent applicable criteria are **bold** and highlighted yellow and represent criteria that were used as TMDL endpoints on which TMDL allocations were based. All applicable criteria were evaluated to ensure they were met under the TMDL modeling scenario, which was designed using the TMDL endpoints.

Table 1-4 TMDL Endpoints for Metals

Metal	CMC (1-hour average) (µg/L)	CCC (4-day average) (µg/L)	Human Health (30-day average) (µg/L)
Arsenic (dissolved)	340	150	**0.14**
Copper (dissolved)	13.44[1]	**8.96[1]**	
Zinc (dissolved)	**117.18[1]**	118.14[1]	26000

[1] Criterion is equation based, as described in the District's WQS. All calculated criteria values are based on a hardness value of 100 mg/L $CaCO_3$.

Table 1-5 TMDL Endpoints for Organochlorine Pesticides

Organochlorine Pesticide	Groupings	CMC (1-hour average) (µg/L)	CCC (4-day average) (µg/L)	Human Health (30-day average, risk level of 10-6) (µg/L)
4,4, DDD	DDT	1.1	0.001	0.00012
4,4, DDE		1.1	0.001	**0.000018**
4,4, DDT		1.1	0.001	0.000030
Chlordane		2.4	0.0043	**0.00032**
Dieldrin		0.24	0.056	**0.0000012**
Heptachlor Epoxide		0.52	0.0038	**0.000032**

Table 1-6 TMDL Endpoints for PAHs

PAHs	PAH Groupings	CCC (4-day average) (µg/L)	Human Health (30-day average, risk level of 10-6) (µg/L)
Acenaphthene	PAH 1 (2 + 3 ring)	**50**	90
Acenapthylene			
Anthracene			400
Fluorene			70
Naphthalene		600	
Benzo[a]anthracene	PAH 2 (4 ring)		**0.0013**
Chrysene			0.13
Fluoranthene		400	20
Pyrene			30
Benzo[a]pyrene	PAH 3 (5 + 6 ring)		**0.00013**
Benzo[b]fluoranthene			0.0013
Benzo[k]fluoranthene			0.013
Dibenzo[a,h]anthracene			0.00013
Indeno[1,2,3-c,d]pyrene			0.0013

1.5.1 Confirmation that TMDL Endpoints Address Fish-Tissue Based Impairment Listings

While the majority of the remaining impaired waterbody-pollutant combinations addressed by the TMDLs herein are based on water column criteria exceedances, there are three "Dieldrin in Fish Tissue" listings in the Upper and Lower Anacostia mainstem segments and Kingman Lake that are based on exceedances of DOEE's fish tissue listing threshold of 2.5 parts per billion (ppb). Using the bioaccumulation factors on which the District's water column WQC are based (EPA, 2016), translation of those WQC (and therefore, the TMDL endpoint for dieldrin) into fish tissue equivalents results in a value that is lower (i.e., more stringent) than DOEE's fish tissue listing threshold. Therefore, the dieldrin TMDLs herein adequately address both the water column-based and fish tissue-based impairments.

2 WATERSHED CHARACTERIZATION

The Anacostia River, with its headwaters in Montgomery and Prince George's Counties, Maryland, drains more than 170 square miles. The watershed terminates at the Anacostia River's confluence with the Potomac River in the District of Columbia. Approximately 80 percent of the watershed is in Maryland and 20 percent is in the District. The main subwatersheds include the Northwest Branch, Paint Branch, Little Paint Branch, Indian Creek, Upper and Lower Beaverdam Creeks, the Northeast Branch, Still Creek, Brier Ditch, Fort Dupont, Popes Branch, Watts Branch, Hickey Run, and Sligo Creek watersheds. The upper tributaries are nontidal freshwater, while the mainstem of the Anacostia River is tidally influenced. Figure 2-1 depicts the subwatersheds of the Anacostia River watershed.

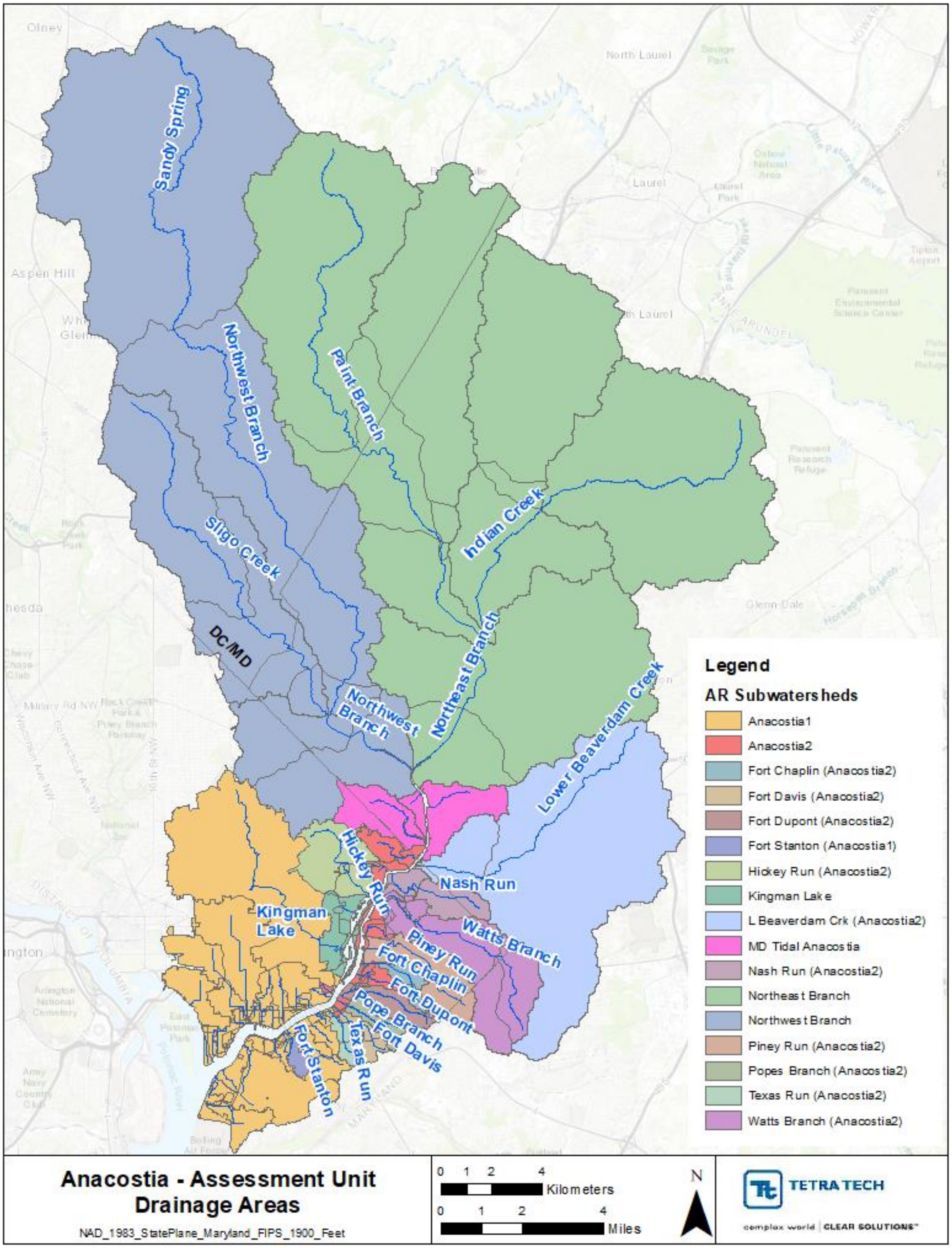

Figure 2-1 Anacostia River Watershed Assessment Unit Drainage Areas

The population residing in the Anacostia River watershed exceeds 850,000 people in the District of Columbia and Maryland. The upper portions of the watershed are in the Piedmont Plateau, which is characterized by gently rolling hills. The remainder of the watershed is in the Coastal Plain, which is somewhat flatter, but can also contain gently rolling hills. Elevations in the watershed range from sea level to about 400 feet above sea level.

The Anacostia River watershed is highly urbanized. According to the Anacostia Watershed Restoration Partnership (AWRP), established by Metropolitan Washington Council of Governments (MWCOG), about 45 percent of the watershed is residential, the dominant land use in the watershed. Undeveloped land covers just under 30 percent of the watershed. That undeveloped land is primarily comprised of forests and parks. Commercial and institutional land uses comprise more than 15 percent of the watershed. Agriculture land use makes up 4.5 percent of the watershed. Industrial land use makes up less than 4 percent of the watershed. Water and wetlands cover an additional 1 percent (ARWP, 2010).

According to the AWRP, the overall imperviousness of the watershed is 22.5 percent, although that is variable among subwatersheds. The Upper Beaverdam Creek subwatershed has the lowest level of imperviousness at 6 percent, largely because of the presence of the U.S. Department of Agriculture, Beltsville Agricultural Research Center (BARC), which occupies most of the subwatershed (AWRP, 2010). The highest levels of imperviousness are in the Hickey Run (41 percent) and the Northeast Branch (37 percent) subwatersheds (AWRP, 2010). Land use in Hickey Run is 30 percent industrial and 29 percent residential, while land use in the Northeast Branch is 51 percent residential and 10 percent commercial (AWRP, 2010). Some areas of the tidal mainstem of the Anacostia in the District, such as the northwest bank, have significantly higher levels of imperviousness (48 percent) (DDOE, 2012).

3 SOURCE ASSESSMENT

3.1 Nonpoint Sources

Probable nonpoint sources of the ten toxic pollutants are contaminated sites in the District and upstream sources originating in Maryland. Further, other processes contribute to the accumulation of toxic pollutants that can be considered part of the pollutant pathway, such as atmospheric deposition (both wet and dry deposition) of pollutants on the surrounding watershed and resuspension of toxic pollutants from the river or tributary bed sediment to the overlying water column.

3.1.1 Maryland Upstream Loads

The Maryland portion of the Anacostia River watershed comprising the Northeast and Northwest Branches drains to the Maryland portion of the tidal Anacostia River, which flows into the District portion of the tidal Anacostia River (Anacostia #2 tidal segment) (See Figure 2-2). In addition, several tributaries to the Anacostia River (e.g., Lower Beaverdam Creek, Watts Branch, and Nash Run) originate in Maryland and flow into the District portions of these waters, which then flow directly into the District portion of the tidal Anacostia River (Anacostia #2 tidal segment) (See Figure 2-1).

This TMDL report presents this upstream loading from Maryland for all ten toxic pollutants. These upstream loads are presented as a single value, representing the total load from the upstream subwatershed; however, it could include both point and nonpoint sources. For the purposes of this analysis, the load is treated as a single nonpoint source load (See Section 3.3.5 of the TMDL Modeling Report for more information) (Tetra Tech, 2023b).

3.1.2 Contaminated Sites

Nonpoint sources contributing toxic pollutant loads to the Anacostia River and its tributaries include losses from historically contaminated sites and current industrial operation areas that are not regulated by National Pollutant Discharge Elimination System (NPDES) permits.

A list of contaminated sites and industrial operation areas and their brief history can be found in Table 3-1. The location of each site can be found in Figure 3-1. The sites listed in Table 3-1 are identified as Potential Environmental Cleanup Sites (PECS) for purposes of the ARSP. A PECS is as an area along the river where current or historical activities include the storage, handling, use, or potential release of hazardous substances or petroleum products (DOEE, 2020). The ARSP RI Report summarizes contaminant data for each PECS (Tetra Tech, 2019a). In addition, contaminant source assessments were completed for over 70 chemicals in water and sediment to identify active sources of contaminants (Tetra Tech, 2019b). The results of the assessments suggest that PECS are potential sources based on elevated factor scores for metals, PAHs, and PCBs. In addition, contaminant releases from PECS may contribute to pollutant discharges in the ARSP study area, and investigations of the nature and extent of contaminated sediment associated with these sites are being or have been conducted, in some instances by Potentially Responsible Parties (PRPs) who may be liable for the costs of cleanup and natural resource damages associated with the releases from the PECS (DOEE, 2022).

For this TMDL, representative loads for these sources were developed from monitoring data in available literature and simulated rainfall-runoff and pollutant loading relationships for the watershed land areas.

Table 3-1 List of Historic Contaminated Sites along the Anacostia River

Site	Description
Firth Sterling Steel	The Firth Sterling Steel Co., built in 1906 and 1907, made steel casings for artillery shells. The casting plant closed in the 1920s. Joint Base Anacostia-Bolling currently occupies the site.
Former Hess Petroleum Terminal	This site is located in southeast Washington, D.C., just south of Nationals Park and north of the Anacostia River. Hess operated a bulk petroleum storage facility from 1968 until approximately 1983, and from 1984 to 1985.
Former Steuart Petroleum	Located on M Street SE along the western bank of the Anacostia River, this site was a bulk fuel storage and distribution facility by Steuart Petroleum company from 1948 to 1996.
Fort McNair	Fort McNair is a United States Army post located on the tip of Buzzard Point, at the confluence of the Anacostia and Potomac Rivers. Originally named Washington Arsenal, the fort has been an army post for more than 200 years.
Joint Base Anacostia-Bolling	Joint Base Anacostia-Bolling (JBAB) is a 966-acre military installation, located in southeast Washington, D.C., situated between the Potomac and Anacostia Rivers. JBAB was

	established in 2010 under U.S. Navy lead. In 2020, the Base's lead service authority was transferred to the U.S. Air Force.
Kenilworth Park Landfill	The Kenilworth Park Landfill Site is located within Anacostia Park, a unit of National Capital Parks – East, on the eastern bank of the Anacostia River. From 1942 until 1970, as permitted by the Federal Government (War Department), the District used the site for municipal solid waste disposal. Municipal waste incineration, incinerator ash disposal, and landfilling of municipal solid waste occurred at the site. By the 1970s, the entire landfill had ceased operations, was covered with soil, revegetated, and reclaimed for recreational purposes.
Poplar Point	The Poplar Point site is located in Anacostia Park in southeast Washington, D.C., approximately one mile upstream of the confluence of the Anacostia and Potomac Rivers. The Poplar Point area has undergone a variety of land use changes including nursery and greenhouse operations and naval operations. The site is home to Headquarters for National Capital Parks – East, U.S. Park Police Anacostia Operations Facility, and U.S. Park Police Aviation Unit facilities, and includes various storage buildings, wetlands, and managed meadows.
Southeast Federal Center	The Southeast Federal Center is a site in the southeast quadrant of the District along the Anacostia River. The site had previously been used for shipbuilding (1800s) and was later heavily industrialized by ordinance manufacturing through WWII.
Washington Gas	Washington Gas – East Station Site is located in southeast Washington, D.C. along the western bank of the Anacostia River, south of M Street and east of 11th Street. The site includes areas impacted by the residuals of gas manufacturing from a former manufactured gas plant that once operated on an adjacent parcel of land to the north.
CSX Benning Yard	CSX Benning Yard located at 225 33rd Street, SE, Washington, D.C. is an active railroad switching yard. Historically, a portion of Benning Yard was used to store and dispense diesel fuel to locomotives. In 2004, a new office building and parking facility were constructed in the area where fueling operations had previously been conducted.

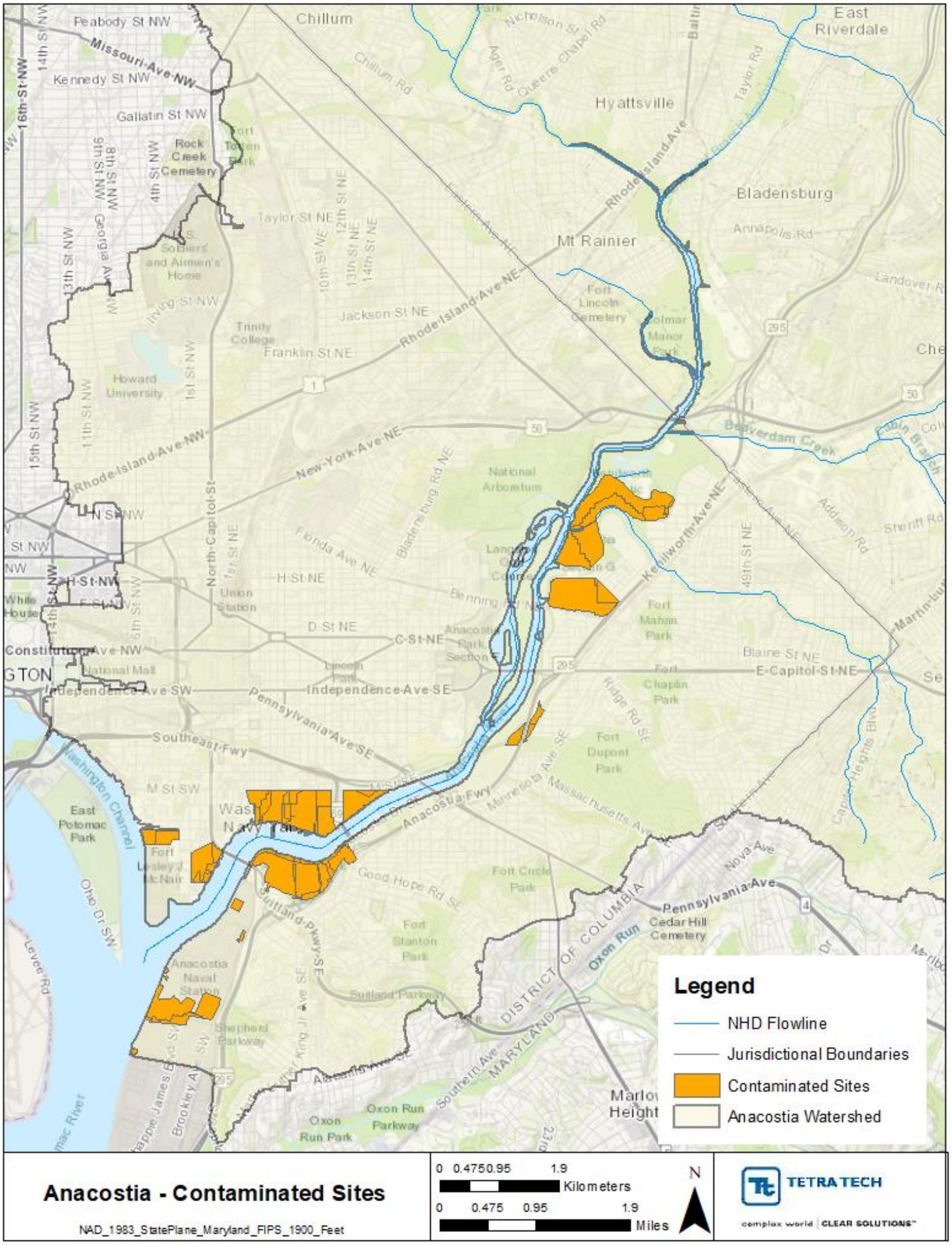

Figure 3-1 Location of Potential Contaminated Sites in the Anacostia River Watershed

3.1.3 Other Pollutant Pathways

Atmospheric Deposition

Atmospheric deposition may transport heavy metals and persistent organic pollutants to the Anacostia River watershed, although other pollutant pathways, such as groundwater and interflow pollutant pathways and stormwater/surface runoff pollutant loading, transport a greater quantity of toxic pollutants to the system. Additionally, atmospheric deposition of these toxic pollutants is expected to decrease over time since the production and use of many of the toxic pollutants are now banned. Atmospheric deposition was included as a pollutant loading pathway to surface and groundwater simulated in the watershed model. The watershed model included two atmospheric loading rates to account for both dry and wet deposition. Data used to inform these loading rates came from the ATSDR toxicological profiles for each pollutant. In some cases, loading rates for certain pollutants were negligible and were not included as a pathway (e.g., PAHs in dry deposition due to their hydrophobic nature). Atmospheric deposition was not assigned a baseline load or TMDL allocation because the loads associated with this pathway were incorporated into the loads from watershed runoff to surface waters and groundwater.

Resuspension and Diffusion from Bottom Sediments

The transport of toxic pollutants from bottom sediments to the water column through resuspension and diffusion can be a major pathway of toxic pollutants to the Anacostia River, particularly in the tidal segments. However, bottom sediments were not assigned a baseline load or TMDL allocation under the framework of these TMDLs because resuspension and diffusion from the bottom sediments to the water column is not considered a nonpoint source requiring a reduction. The linked watershed-receiving water model developed for these TMDLs simulates conditions within the water column and sediment as a single system. Therefore, exchanges between the sediment and water column are considered an internal pathway. Furthermore, modeling both media as part of one internal system is appropriate because elevated levels of toxic pollutants in fish tissue are a function of both water column and bottom sediment concentrations.

Many of these toxic pollutants, particularly the persistent organic pollutants, preferentially sorb to the organic carbon fraction of suspended sediment in the water column and settle on the river bottom, accumulating in the bottom sediments, with the bottom sediments functioning as a pollutant sink. Over time, this accumulation of pollutants within the bottom sediment can also become a pathway for contaminants to reach the water column via the disturbance and resuspension of sediments. Additionally, dissolved pollutant concentrations in sediment pore water can diffuse into the water column depending on the concentration gradient between the overlying water and the underlying bottom sediments. Please see Sections 5.4 and 7.6 for more information on how toxic pollutant concentrations in the bottom sediment were addressed in these TMDLs.

3.2 Point Sources

For this TMDL, point sources include individually permitted facilities, stormwater discharges (i.e., MS4 and entities covered under the Multi-Sector General Permit (MSGP)), and discharges from the combined sewer system (CSS).

3.2.1 Individually Permitted Facilities

The individually permitted facilities included as potential sources of these toxic pollutants are the Washington Navy Yard, PEPCO Environment Management Services, Super Concrete Corporation, and District of Columbia Water and Sewer Authority (DC Water). A map of the permitted facilities is included in Figure 3-2 and associated facility information and EPA NPDES Permit number can be found in Table 3-2.

For existing conditions, discharge monitoring reports for each facility were used to characterize flow and toxic pollutant concentrations. Typically, discharge monitoring report (DMR) data included flow, but not toxic pollutant concentrations. There was, however, some metal (copper and zinc) concentration data available for PEPCO. For facilities that did not have data enumerating toxic pollutant concentrations, the WQC for toxic pollutants (e.g., DDT, chlordane, dieldrin) in the District's WQS were used.

The Naval District Washington, also known as the Washington Navy Yard (WNY), occupies about 80 acres on the banks of the Lower Anacostia River and borders the eastern boundary of the Southeast Federal Center. It served as a major shipbuilding facility and gun factory during 19th century. In 1961, gun production ceased and the facility was converted to administrative and supply use. To calculate toxic pollutant loads, WNY was delineated as a subbasin and is simulated based on associated runoff and toxic pollutant loading characteristics.

PEPCO at the Benning Service Station is authorized to discharge to the Anacostia River. To calculate toxic pollutant loads, discharge monitoring data for flow and metals were used. Since there was no DMR data for the other toxic pollutants, the WQC concentrations for toxic pollutants (e.g., DDT, chlordane, dieldrin) in the District's WQS were used.

Both PEPCO and WNY were included in the model as dual sources. This means that toxic pollutant loads associated with the individual NPDES permits and their status as contaminated sites were used in calculating TMDL allocations. See Section 5.6 for more detail.

Super Concrete is authorized to discharge from outfall 004 to a tributary that contributes water to the Northwest Branch of the Anacostia River. Since there was no DMR data for toxic pollutant concentrations, the WQC concentrations for toxic pollutants (e.g., DDT, chlordane, dieldrin) in the District's WQS were used.

DC Water's Blue Plains Advanced Wastewater Treatment Plant (WWTP) covers 150 acres and has a design capacity of 384 MGD. For this TMDL, outfall 019, which used to discharge to the Anacostia River, was included as a source. The TMDL model simulation period was from 2014 through 2017; therefore, it does not account for the on-the-ground changes due to the operation of the Anacostia tunnel system since March 2018.

Table 3-2 Individual NPDES permits represented in the Anacostia Toxic Pollutants Model

NPDES Permit No.	Facility Name	Type	Outfall Number	Latitude	Longitude
DC0000094	PEPCO Environment Management Services	Industrial	013, 101	38.9000	-76.9583
DC0000141[1]	Washington Navy Yard	Industrial	001,005, 006, 007, 008, 009, 013,	38.87194	-76.991389

			014, CSO-14F, CSO-15G, CSO-15H, MS4-01E		
DC0000175	Super Concrete Corporation	Industrial	004	38.9486	-77.0058
DC0021199	D.C. Water (Blue Plains WWTP)	Publicly Owned Treatment Works	019	38.8725	-77.0025

[1]Included in the allocation tables as a WLA for the Washington Navy Yard; representative latitude/longitude is for outfall 001.

3.2.2 Stormwater

For stormwater discharges, the toxic pollutant loads were determined for both the District's MS4 and the permitted sites that receive coverage from the MSGP for Industrial Activities. The MS4 is located along the outer edges of the city and surrounds the CSS that serves the inner portions of the city (Figure 3-2). Watershed simulations for the contributing areas were used to estimate toxics pollutant loads from the MS4.

The contributing toxic pollutant loading from sites under the MSGP were estimated using a GIS overlay of site boundaries, land cover data, and unit area runoff data. The GIS overlay included parcel areas for 16 permitted stormwater commercial and industrial facilities. The GIS overlay was also used to identify the assessment unit in which each of the MSGP facilities was located. The allocations for MSGP facilities were calculated based on the proportion of the area of the facility located in each of the assessment units. These MSGP areas were used to tabulate annual average and maximum daily WLAs for each facility based on the proportion of the facility's parcel area compared to the total MSGP parcel area and multiplied by the total MSGP WLA of the assessment unit. Aggregate annual average and daily allocations assigned to the MSGP were refined to assign an annual average and maximum daily WLA to each individual facility covered under the MSGP in the District. Providing individual annual average and maximum daily WLAs to facilities covered under the MSGP in the District represents a revision from the earlier draft of the TMDLs that was released for public notice and comment in 2021. Individual WLAs for facilities covered under the MSGP in the District are not based on site specific or discharge specific data. In the event that site specific data reveals that a particular facility is not discharging the pollutants of concern at levels that have a reasonable potential to cause or contribute to an exceedance of water quality criteria, the permittee's compliance with the general permit would be consistent with the assumptions and requirements of these TMDLs. In the event that the number of facilities in the District covered under the MSGP increases with a future general permit reissuance, any new facilities may not discharge at concentrations greater than the applicable water quality criteria at the end of the discharge pipe.

Toxic pollutant loads were also estimated for the CSS using the watershed model. A map of areas covered by the CSS can be found in Figure 3-2. Overflow relationships were developed to determine combined sewer overflow (CSO) during substantial rainfall events. Toxic pollutant concentrations were then assigned to overflows based on simulated in-stream concentrations. The TMDL model simulation period was from 2014 through 2017 and, therefore, it does not account for the on-the-ground changes due to the operation of the Anacostia tunnel system since March 2018.

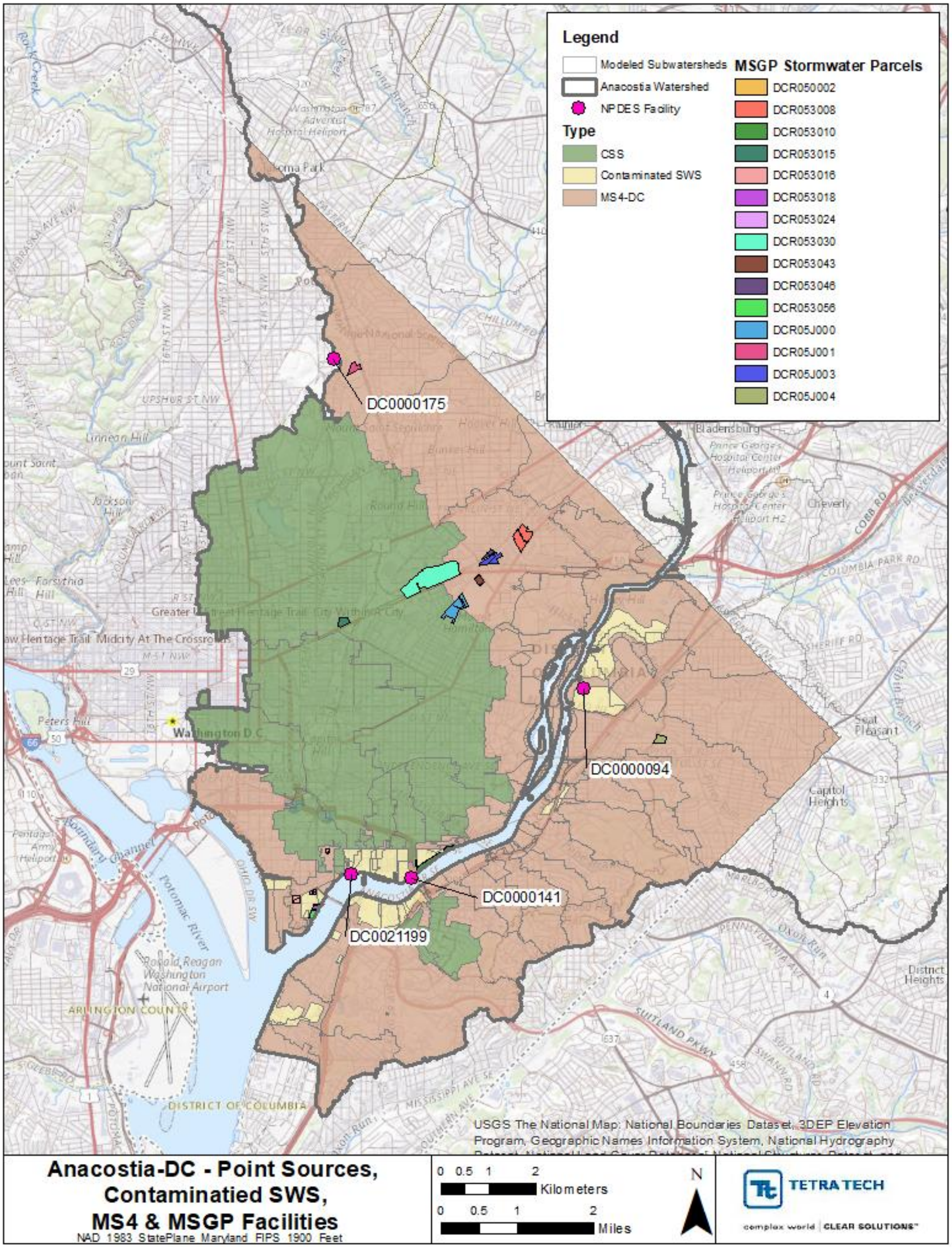

Figure 3-2 Locations of MS4, CSS, MSGP, and Contaminated Site Subwatersheds in the District

3.3 Source Assessment Summary

All identified nonpoint and point sources of metals (arsenic, copper, zinc), organochlorine pesticides (chlordane, DDT and its metabolites, dieldrin, heptachlor epoxide), and PAHs in the District's portion of the Anacostia River, its tributaries, and Kingman Lake have been characterized. The source assessment for the District captures point and nonpoint sources within the District's boundaries and also incorporates the upstream loads from Maryland. As the Anacostia River is an interjurisdictional water, it is important to capture the loads from each jurisdiction. For each pollutant in the District, the upstream Maryland segments (Northeast Branch, Northwest Branch, MD Tidal Anacostia) and the tributaries to the Anacostia River that originate in Maryland (Nash Run, Watts Branch, and Lower Beaverdam Creek) are included as upstream loads to the District. The only nonpoint source of toxic pollutants in the District is stormwater runoff from historically contaminated sites (Table 3-1). These contaminated sites are assigned baseline loads and load allocations.

Stormwater runoff is a major source of toxic pollutants to the Anacostia River watershed. The majority of stormwater runoff in the District is captured by the MS4 or the CSS. The MS4 and CSS are the sources within the District that contribute the largest loads of toxic pollutants to the river system. Other sources that capture and convey stormwater include other point sources that are regulated under NPDES (e.g., sites that have coverage under the MSGP and individually permitted facilities). These permitted facilities include both stormwater and process water discharges to the Anacostia River and are listed in Table 3-4. Facilities with individual NPDES permits that are not expected to discharge significant quantities of these toxic pollutants are provided a baseline load and allocation, but no percent reduction. This applies to both the DC Water Blue Plains WWTP and Super Concrete Corporation. They were included in the model to accurately represent all potential sources of toxic pollutants in the Anacostia River watershed in the District. A summary of the baseline loads for the impaired District segments can be found in the allocation tables in Section 5.6.3.

4 MODELING APPROACH

A linked watershed/receiving water model is best suited to capture the critical system components of the Anacostia River. An integrated modeling system, after calibration, appropriately represents the linkage between the sources in the watershed and legacy contamination in the riverbed, as well as the impact of possible contaminant flux from the Potomac River, hence supporting the development of a comprehensive TMDL scenario. This system can describe and simulate hydrology, hydrodynamics, and pollutant loading in the Anacostia River watershed.

A watershed model is a series of algorithms applied to watershed characteristics and meteorological data to simulate land-based processes over a selected period, including rainfall-runoff, interflow, groundwater flow, flow routing, water temperature, and pollutant loadings. Watershed models often use build-up and wash-off representations of pollutants on land surfaces and can accommodate other processes including pollutant-soil/sediment association, subsurface pollutant transport, and atmospheric deposition of pollutants.

Receiving water models are composed of a series of algorithms to simulate water circulation, water temperature, suspended sediment transport, fate and transport of contaminants, and kinetics and transport of conventional water quality constituents of the waterbody. External forces are applied including meteorological data, flow and pollutant loadings from point and nonpoint sources, and other boundary conditions. The models are used to represent physical, chemical, and biological aspects of a lake, river, or estuary. These models vary from simple one-dimensional box models to complex three-dimensional models capable of simulating water movement, salinity, temperature, sediment transport, pollutant transport, and bio-chemical interactions occurring in the water column.

Watershed models can provide flow and pollutant loading (boundary conditions) to a receiving water model and can also simulate water quality processes within streams and lakes with relatively simple algorithms. Receiving water models can simulate detailed processes in rivers, lakes, and estuaries. More specifics on the model domains and their configuration used in these TMDLs are discussed below.

The rest of Section 4 and Sections 5.2 through 5.4 describe only a few key aspects of the linked watershed/receiving water model for the Anacostia River watershed. These pertinent sections are included to aid in the understanding of how the TMDL allocations were developed. A complete description of the modeling framework, its configuration, and calibration are included in the separate TMDL modeling report (Tetra Tech, 2023b).

4.1 Loading Simulation Program in C++ (LSPC) Configuration

The Loading Simulation Program in C++ (LSPC) model version 5.0 (U.S. EPA, 2009) is the platform selected for watershed simulation and toxic pollutants TMDL development for the Anacostia River, its tributaries, and Kingman Lake because it meets the above criteria. A calibrated watershed model was used to characterize loadings from the Anacostia River watershed beginning at the headwaters in Maryland, ensuring that all major watershed sources and pathways are represented, including catchments adjacent to the tidal reaches of the Anacostia River. The watershed model estimated the relative pollutant contributions from multiple sources and connected these contributions to the spatial distribution of contamination over time. For TMDL development, the applied model possessed the following capabilities, making it a scientifically sound representation of the watershed loading and transport system and an advantageous management tool:

- Simulated hydrologic variations due to time variable weather patterns and the related transient saturation or unsaturated condition of the land surface/subsurface.
- Simulated time variable chemical loadings from various sources in the watershed, including the sediment associated pollutants (metals, organochlorine pesticides, and PAHs) that are the target of TMDL development.
- Simulated interactions within a stream channel.
- Provided model results with a broad range of spatial and temporal scales.
- Evaluated source loading abatement scenarios for water quality control/management design.

4.2 Environmental Fluid Dynamics Code (EFDC) Configuration

A receiving water model was used given the complex flow dynamics in the tidal Anacostia River, coupled with the variable hydrologic inputs from the surrounding watershed. Environmental Fluid Dynamics Code (EFDC) was selected as the receiving water model for this project (Tetra Tech, 2023b). Previous receiving water studies completed in the Anacostia River provide a strong basis for using an EFDC framework for the tidal Anacostia River (Tetra Tech, 2019a). The EFDC model has been applied worldwide for both hydrodynamic and water quality applications and can be easily linked to the LSPC watershed model, which was used to represent watershed source loadings.

EFDC is a general-purpose modeling package for simulating one- or multi-dimensional flow, transport, and bio-geochemical processes in surface water systems including rivers, lakes, estuaries, reservoirs, wetlands, and coastal regions. The EFDC model (Hamrick, 1992) was originally developed at the Virginia Institute of Marine Science for estuarine and coastal applications and is considered public domain software. This model is EPA-supported and is used extensively to support receiving water modeling studies and TMDLs throughout the world.

Modeling the Anacostia River to develop these TMDLs requires evaluating source-response linkages and estimating existing loadings. As part of the linked modeling system, the EFDC model provides a dynamic representation of hydrodynamic conditions, conventional water quality conditions, sediment transport, and toxic pollutant concentrations in the tidal Anacostia River. Flows, suspended sediment, and pollutant loads from the catchments adjacent to the tidal Anacostia River are described using the LSPC model.

In tidal systems such as the tidal Anacostia River, the transport of particulate and dissolved materials is a process governed by the interaction between freshwater inflows, ocean tidal oscillations, and windshear over the water surface. During periods of high tributary inflows, estuary processes are mostly driven by advective transport and have a higher flushing capacity. During periods of low tributary inflows, conversely, the estuary processes are more influenced by dispersive transport largely driven by tidal dynamics.

5 TMDL DEVELOPMENT

5.1 Overview

The purpose of a TMDL is to allocate allowable loads among different pollutant sources to achieve WQS (U.S. EPA, 1991). This TMDL considers all significant sources contributing metals, organochlorine pesticides, and PAHs to the impaired waters. The sources can be separated into point and nonpoint sources.

The TMDL was calculated using the following equation:

TMDL = WLA + LA + MOS

Where, WLA = sum of the wasteload (regulated or point source) allocations

LA = sum of load (nonpoint source) allocations; and

MOS = margin of safety

This report addresses 13 WQLS and ten impairing toxic pollutants (Table 1-1). This translates to a total of 61 TMDLs established for impaired waterbody-pollutant combinations in the Anacostia River, its tributaries, and Kingman Lake. The remaining 69 waterbody-pollutant combinations are provided informational TMDLs in Appendix A as these waterbody-pollutant combinations are not listed as impaired on DOEE’s Integrated Report. The LAs and WLAs are provided in Section 5.6 for each of the impaired waterbody-pollutant combinations. Although a TMDL allocation is provided for each impairment, it is important to recognize the inter-connectedness of the impaired waterbodies. Many tributaries to the Anacostia River begin in Maryland (e.g., Lower Beaverdam Creek, Watts Branch, Nash Run), cross jurisdictional lines into the District, and meet the Anacostia River mainstem at their confluences within the District. Additionally, upstream segments of the mainstem Anacostia River in Maryland (i.e., Northeast and Northwest Branches, MD Tidal Anacostia) flow directly into downstream segments in the District (i.e., Anacostia #2 and #1). These tidal waters move toxics pollutant loads between the WQLS. Therefore, the TMDLs for the Anacostia River can be viewed as a package of allocations.

5.2 Baseline Scenario

The existing conditions of pollutant concentrations were determined from available monitoring data. Sources of pollutants that were considered included urban, agricultural, and other runoff, point source discharges, and spills and/or leaks (i.e., contaminated sites and industrial operation areas contributing contaminant loads). Other pollutant pathways and processes that were considered included atmospheric deposition, legacy contaminants in bed sediments of the Anacostia River, and groundwater contributions to both the Anacostia River and its tributaries. Sources of existing data considered can be grouped into three general categories: toxic pollutant monitoring data (e.g., agency monitoring, NPDES DMRs, the ARSP), general watershed characteristic data (e.g., land use, meteorological, USGS gages), and other data from a large body of literature (e.g., pollutant toxicological profiles). Relevant, existing data were used as inputs to the linked watershed (LSPC) and receiving water models (EFDC). Specifics on the data sources used can be found in the TMDL Modeling Report (Tetra Tech, 2023b). Additional details on source considerations can be found in Section 3 of this TMDL report.

The linked models were simulated over a four-year period from 2014-2017 to capture a representative period of existing conditions in the Anacostia River system. Initially, baseline conditions were simulated for each identified source for each of the ten pollutants in every subwatershed. A calibration process was completed using the large dataset compiled on existing data and simulated data. Daily, monthly, seasonal, and total modeled flow volumes were compared to observed data, and error statistics were calculated. Model results were also visually compared to observed data using time series plots, and additional graphical and tabular monthly comparisons were performed. Once it was determined that the model simulation appropriately captured existing conditions when compared to observed data, the calibration was deemed acceptable and the process of developing a TMDL scenario was begun. When considering the acceptability of the calibration, focus was placed on the accurate representation of the trends, relationships, and magnitudes and, thus, the underlying physics and kinetics. A more in-depth description of model calibration can be found in Sections 5 and 6 of the TMDL Modeling Report (Tetra Tech, 2023b).

5.3 TMDL Scenario

The development of a TMDL scenario is the process of reducing pollutant loads to achieve the applicable TMDL endpoints, which are the most stringent WQC for each specific pollutant or pollutant group. The TMDL scenario was developed through an iterative process of first implementing watershed reductions until the endpoints were met in the tributaries and then evaluating whether those reductions were sufficient to meet the endpoints in the tidal segments of the Anacostia River. Initial reductions were applied throughout the watershed in LSPC as follows:

1. Individual point source discharges were, in most cases, set to criteria concentrations (see Section 3.2.1 for more information on point sources).

2. Watershed loading was reduced using a top-down approach targeting the farthest upstream subwatersheds first. Once instream water quality targets were met in those watersheds, the subwatersheds directly downstream were then reduced until targets were met in all subwatersheds.
3. Instream water quality concentrations were compared against the endpoints at the model reach pour point.
4. Watershed loadings were reduced on a land use basis. In each subbasin, all urban land uses were assigned equal percent load reductions up to a threshold of 99.9%. If this was not sufficient to meet the endpoint, then all agricultural land uses in the subbasin were reduced equally until the water quality target was met.
5. After the above subbasin watershed reductions were implemented in the model, if there were still areas not meeting the endpoints, then bed sediment toxic pollutant concentrations were reduced universally for the tidal mainstem to estimate the post-TMDL bed sediment toxic pollutant concentrations.

Initial watershed reductions in EFDC showed water quality meeting the endpoints in the tidal segments of the Anacostia for two of the ten toxic pollutants: zinc and PAH 1. All other toxic pollutants exceeded the TMDL endpoints in most tidal segments of the river.

Further analysis of flow and rainfall conditions associated with model results showed that simulated water column concentrations in the tidal segments exceeded the endpoints during both wet and dry conditions. Further, these analyses demonstrated that upstream watershed loads were driving non-compliance during wet, high flow periods, whereas pollutant fluxes from the bed sediments to the water column and decreased flushing were driving non-compliance during dry, low flow conditions. Therefore, additional reductions were required to meet the TMDL endpoints. A methodology was developed and implemented to achieve additional watershed reductions to ensure the endpoints in the tidal segments were met during wet, high flow periods and simulated reductions to bed sediment in the tidal segments were made to ensure the endpoints were achieved during dry, low flow periods. This methodology for additional watershed reductions in LSPC was implemented as follows:

1. Load reductions from individually NPDES-permitted process water facilities were kept at the same level as previously determined in the initial round of reductions (i.e., no further reductions to these sources).
2. The same land uses, which had loads reduced during round one, were then targeted for additional load reductions. Additional reductions were applied based on available capacity remaining after the first round of reductions. For example, if the load reduction to a land use was 85% in the first round and an additional 50% load reduction was required on the remaining load to meet the WQC in the tidal portion of the Anacostia during wet periods, then the new reduction applied was 92.5% (0.85 + (1-0.85) * 0.50 = 0.925).
3. First, the urban land use load reductions were maximized by applying the additional reductions equally to all the urban land uses targeted in the first round.
4. If maximizing urban land use load reductions was not sufficient, then agricultural land uses targeted for reduction in the first round were further reduced. Dieldrin, PAH 2, and PAH 3 required further agricultural land use reductions. Dieldrin reductions also required that additional agricultural areas not targeted in the previous round be targeted.
5. The reduced LSPC loads were evaluated in the EFDC model to ensure endpoint attainment during wet conditions.

Once the watershed reductions were sufficient to achieve the TMDL endpoints in the tidal segments during all periods of high flow, a complementary exercise was completed to identify bed sediment concentrations which would result in achievement of the TMDL endpoints in tidal segments during dry, low flow conditions. Bed sediments contain elevated concentrations of toxic pollutants addressed in this TMDL, and they act as a pathway of pollutants to the overlying water column during dry periods. To address this, estimated reductions to bed sediment concentrations of pollutants that did not meet the TMDL endpoints with watershed reductions alone were calculated.

Once the watershed and estimated bed sediment load reductions were sufficient to achieve the TMDL endpoints throughout the entire system, a final analysis was completed to estimate the time needed for the prescribed watershed load reductions (and other instream processes) to result in future bed sediment conditions that achieve the TMDL endpoints via natural attenuation. See Section 5.4 for additional information on natural attenuation estimates.

To confirm that the TMDL scenario would result in attaining the TMDL endpoints, the models were run with the TMDL scenario as the starting condition and the model outputs were checked at 15 locations throughout the watershed, comprising the pour point of each subwatershed in the non-tidal areas and representative cell clusters in the tidal areas. These 15 areas are referred to as verification units. Figure 5.1 illustrates the location of each verification unit throughout the watershed. The results of the verification analysis indicated that the TMDL endpoint for each of the toxic pollutants was achieved at each of the 15 verification units in the TMDL scenario. The TMDL Modeling Report (Tetra Tech, 2023b) provides figures which illustrate the results graphically.

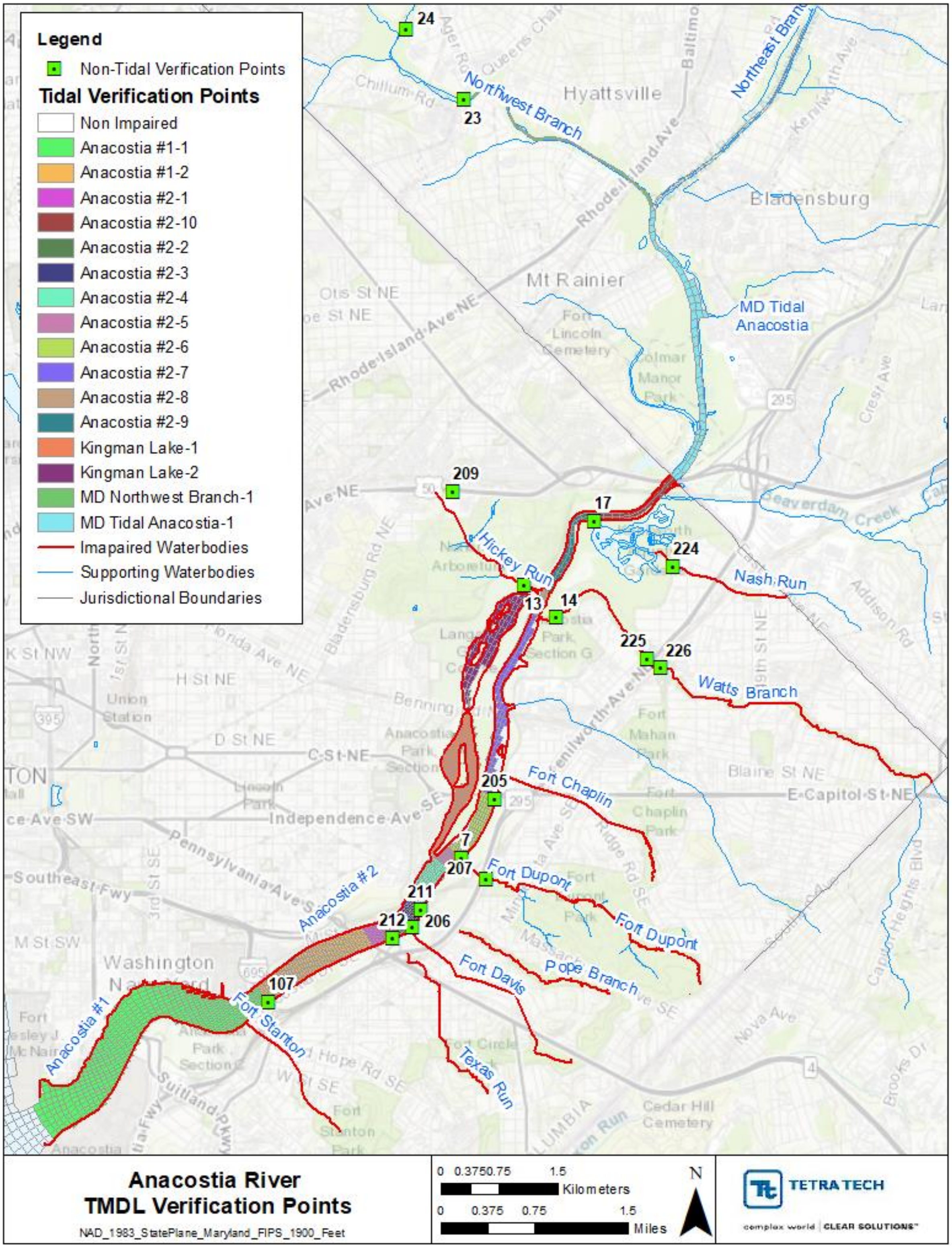

Figure 5-1 Anacostia River TMDL Verification Units

5.4 Natural Attenuation Estimates

Given that these TMDLs call for significant pollutant reductions from a number of toxic sources within the watershed and because a number of these legacy pollutants such as chlordane, dieldrin, DDT and its metabolites, and heptachlor epoxide are banned and therefore are no longer actively applied within the watershed legally, it is reasonable to expect that the concentrations of the TMDL pollutants will decline in the environment over time through natural attenuation. A decline in soil concentrations over time will lead to lower water concentrations (dissolved and particulate fractions) in waterbodies. Instream processes such as burial of contaminated sediments with newer, less contaminated material, scour and export of sediments during periods of high stream flow, and natural degradation will also contribute to the decline of these pollutants over time. These processes occur naturally within the environment. However, natural attenuation often requires decades before a significant improvement is observable.

As introduced above, natural attenuation was incorporated in the TMDL scenario as a TMDL assumption. As load reductions to nonpoint and point sources in the watershed are implemented, the net decrease in toxic pollutants in runoff and other discharges to the Anacostia River will result in the decrease of toxic pollutant concentrations in the water column and sediment, allowing the process of natural attenuation to occur. Due to the effects of contaminant flux from bed sediments to the overlying water column in the TMDL scenario, it is expected that, over time, clean sediments from the watershed following source reduction will cover the contaminated sediment and eliminate the contaminant flux. Therefore, allowing for the attainment of TMDL endpoints in the water column. A methodology was developed to use changes in bed sediment concentrations during the 4-year model simulation period to extrapolate and predict bed sediment concentrations over time and identify the length of time that it will take, after the load reductions are implemented, for natural attenuation to result in the attainment of the TMDL endpoints. Table 5.1 provides the estimated timelines for natural attenuation to result in attainment of the TMDL endpoints after the TMDL scenario is implemented. The estimated timelines for natural attenuation vary based on location in the watershed and pollutant. Generally, the analysis suggests that natural attenuation occurs quickest at the Anacostia #2-8 verification unit. In addition, natural attenuation is estimated to occur more quickly at the upstream most Anacostia mainstem verification units and slowest in the lower segment of Kingman Lake. Some factors that explain this variation include existing bed sediment pollutant concentrations (i.e., levels of contamination) and other physical factors that impact flushing (e.g., river morphology, discharge, water velocity, etc.). This analysis demonstrated that the load reductions expressed in the TMDL will ultimately result in reduction of contaminant flux from the bottom sediment and attainment of TMDL endpoints.

In addition to the process of natural attenuation, remediation of contaminated sediments (i.e., dredging, capping, carbon amendments) can reduce the concentrations of these legacy pollutants in the water column resulting from resuspension and diffusion of contaminants in the bed sediments. Nothing in these TMDLs precludes the use of dredging or other remediation efforts as a tools to achieve TMDL endpoints; consequently, these TMDLs are not inconsistent with sediment remediation efforts of the ARSP. In fact, it is reasonable to expect instream remediation efforts will decrease the amount of time it takes for water quality to approach the TMDL endpoints. While sediment removal is not an assumption or requirement of the TMDLs, the TMDLs provide further support for the need for the ARSP. This TMDL effort is unique in that a separate yet concurrent process to remediate contaminated sediment in the tidal Anacostia River is ongoing under the ARSP (see Section 9.2). The ARSP will initially implement sediment remediation efforts in certain toxic pollutant hotspots. These efforts will aid TMDL implementation and make progress towards achieving and maintaining applicable WQS.

Table 5-1 Attenuation Timeline Estimates for Each Pollutant and Tidal Verification Unit

	Attenuation years									
Verification unit	**Heptachlor epoxide**	**Chlordane**	**Dieldrin**	**DDT**	**Arsenic**	**Copper**	**Zinc[1]**	**PAH1[1]**	**PAH2**	**PAH3**
Anacostia #1-1	36	49	73	77	82	61	N/A	N/A	78	74
Anacostia #1-2	23	34	38	57	46	36	N/A	N/A	49	50
Anacostia #2-1	42	62	59	67	66	50	N/A	N/A	68	69
Anacostia #2-2	21	25	45	40	53	48	N/A	N/A	46	44
Anacostia #2-3	15	21	20	25	31	23	N/A	N/A	32	32
Anacostia #2-4	15	28	41	37	34	32	N/A	N/A	34	32
Anacostia #2-5	13	25	29	25	27	22	N/A	N/A	31	30
Anacostia #2-6	17	22	20	29	34	21	N/A	N/A	26	27
Anacostia #2-7	6	15	12	17	16	15	N/A	N/A	17	17
Anacostia #2-8	5	9	10	8	9	8	N/A	N/A	9	9
Anacostia #2-9	7	13	9	14	12	0	N/A	N/A	14	15
Anacostia #2-10	4	10	11	17	12	7	N/A	N/A	12	12
Kingman Lake-1	111	117	151	175	206	184	N/A	N/A	199	210
Kingman Lake-2	7	17	19	17	25	25	N/A	N/A	23	24

[1] Zinc and PAH 1 TMDL endpoints will be attained once the TMDL allocations are implemented and attainment is not reliant on the process of natural attenuation.

5.5 Daily Load Methodology

In November 2006, EPA released the memorandum *Establishing TMDL Daily Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et. al., No. 05-5015 (April 25, 2006) and Implications for NPDES permits*, which recommends that all TMDLs and associated LAs and WLAs include a daily time increment in conjunction with other appropriate temporal expressions that might be necessary to implement the relevant WQS. Therefore, this report presents daily load expressions (i.e., TMDLs) in addition to annual load allocations for the Anacostia River, its tributaries, and Kingman Lake.

Daily loads were developed in a manner consistent with Section 303(d) of the CWA, EPA's implementing regulations at 40 C.F.R. § 130.7, and the 2006 Daily Loads Memorandum (U.S. EPA, 2006). Daily loads were calculated using the LSPC model's reach output, which contains a time series for each of the watersheds that drain into the impaired segments. Specifically, daily flow and concentration time series data from the most downstream pour point of the impaired segments were extracted for each of the ten toxic pollutants. The loading of the toxic pollutant from the reach is subject to various transformation processes after it reaches the water from the watershed. Please refer to the TMDL Modeling Report (Tetra Tech, 2023b) for more information. For each of the impaired segments, a total daily load was calculated for each day of the TMDL allocation scenario across the four-year simulation period, and then the highest daily load was selected as the maximum daily load for that impaired segment.

Ratios of the annual average aggregate LAs and aggregate WLAs were used to parse the maximum daily load into aggregate LAs and aggregate WLAs for each impaired segment. The maximum daily aggregate LAs and aggregate WLAs for each impaired segment were then further divided to provide individual daily LAs and WLAs for each source in each impaired segment. The ratio of the individual annual average load for each of the various source categories was calculated and then multiplied by the maximum daily load to further parse the load for each impaired segment. For example, the ratio of the annual average LA for CSX and the total annual average LA for the system was calculated and multiplied by the maximum daily LA to derive the maximum daily LA for CSX. Providing individual daily WLAs to sources is a revision from the earlier draft of the TMDLs that was released for public notice and comment in 2021.

6 ALLOCATIONS

The TMDLs for the Anacostia River, its tributaries, and Kingman Lake cover 13 impaired waterbody segments and up to ten impairing toxic pollutants for each waterbody segment. This results in a total of 61 TMDLs established for impaired waterbody-pollutant combinations in the Anacostia River, its tributaries, and Kingman Lake. The remaining 69 waterbody-pollutant combinations are provided informational TMDLs in Appendix A as these waterbody-pollutant combinations are not listed as impaired on DOEE's IR. Table 6-1 summarizes the Anacostia River WLAs, LAs, and TMDLs for the ten toxic pollutants for the Anacostia River. Table 6-2 summarizes the cumulative annual baseline load, load reduction, annual WLAs, annual LAs, and annual loads for the ten toxic pollutants for the Anacostia River.

Table 6-1 Anacostia River TMDLs[1]

Pollutant	WLA (g/day)	LA (g/day)	Cumulative[2] TMDL (g/day)
Arsenic	2122.91	51.31	2174.21
Copper	462803.53	5553.37	468356.90
Zinc	456466.42	8319.65	464786.07
Chlordane	7.22	0.12	7.33
DDT	0.37	0.02	0.39
Dieldrin	0.00	0.00	0.00
Heptachlor epoxide	0.98	0.02	1.00
PAH 1	4940.12	27.19	4967.31
PAH 2	1.12	0.01	1.14
PAH 3	0.12	0.00	0.12

[1]The MOS is implicit.

[2]Cumulative annual load allocations from the downstream most segment of the Anacostia River (Anacostia #1).

Table 6-2 Summary of Annual Baseline Load, Load Reduction, and Anacostia River Annual Loads[1]

Pollutant	Baseline load (g/year)	Load Reduction (%)	WLA (g/year)	LA (g/year)	Cumulative[2] Annual Load Allocation (g/year)
Arsenic	230,080	96.63	536.61	7222.32	7758.93
Copper	1,77,265	5.48	113156.21	1545845.92	1659002.13
Zinc	2,847,024	1.65	365170.44	2434982.44	2800152.88
Chlordane	1,597	98.28	1.69	25.82	27.51
DDT	135	98.89	0.09	1.41	1.5
Dieldrin	313	100	0.002	0.005	0.01
Heptachlor epoxide	285	97.5	0.20	6.91	7.12
PAH 1	20,696	0	86958.97	50217.66	137176.63
PAH 2	49,746	99.98	2.22	5.89	8.11
PAH 3	41	100	0.22	0.62	0.85

[1]The MOS is implicit.

[2]Cumulative annual load allocations from the downstream most segment of the Anacostia River (Anacostia #1).

TMDL load allocations are expressed in three ways for each toxic pollutant. The tables that follow in Sections 6.3, 6.4, 6.5, 6.6, and Appendix A include the same information, structure, and organization for each of the toxic pollutants.

- In Section 6.3, Tables 6-3 through 6-12 show total maximum daily load allocations.
- In Section 6.4, Tables 6-13 through 6-22 show annual load allocations for each impaired waterbody-pollutant combination. In the annual and TMDL allocation tables, the Contaminated Site LA and the MSGP WLA are collapsed into one row for simplicity.
- In Section 6.5, the Contaminated Site LA is expanded to provide individual LAs for each of the 12 contaminated sites. Similarly, in Section 6.6, the MSGP WLA is expanded to provide individual WLAs for each of the 16 MSGP facilities.
- Finally, Appendix A includes a set of tables that provide informational TMDLs for the unimpaired waterbody-pollutant combinations. Appendix A includes informational total maximum daily load allocations, annual load allocations, individual contaminated site LAs, and individual MSGP WLAs for unimpaired waterbody-pollutant combinations.

These allocations may be revised among different sources if necessary to achieve WQS for the Anacostia River.

6.1 Wasteload Allocation

The wasteload allocation (WLA) portion of the TMDL includes permitted point sources. This includes the CSS, MS4, facilities covered under the MSGP for stormwater, and four individual NPDES permitted facilities: Blue Plains WWTP (DC0021199), Super Concrete (DC0000175), WNY (DC0000141), and PEPCO (DC0000094). Aside from having individual NPDES permits, WNY and PEPCO are also considered contaminated sites with completed or ongoing clean-up investigations for legacy contamination, and so their loads include both the land-based loads attributed to the contaminated land and the loads attributed to their NPDES-regulated discharges. Like the other individual NPDES permitted facilities, the WLAs for their NPDES discharges are set at criteria concentrations and do not require reductions. However, their land based loads do require reductions as part of the nonpoint source load allocation.

6.2 Load Allocation

The load allocation (LA) portion of the TMDL is representative of nonpoint sources of contaminants. In the District, the LA includes a group of known contaminated sites: CSX, Firth Sterling Steel, Former Hess Petroleum Terminal, Former Steuart Petroleum, Fort McNair, Joint Base Anacostia-Bolling (JBAB), JBAB AOC 1, JBAB Site 2, JBAB Site 3, Kenilworth Park Landfill North, Kenilworth Park Landfill South, Poplar Point, Southeast Federal Center, and Washington Gas. Within the District, an LA is also included for the upstream loads of toxic pollutants originating in Maryland. Non-regulated stormwater runoff is not included as a nonpoint source in DC as all other watershed runoff is incorporated into the stormwater loads associated with the MS4, CSS, or MSGP.

6.3 Total Maximum Daily Load Tables

Table 6-3 TMDLs for Arsenic

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	3.73
	Contaminated Sites	0.24
	Nonpoint Sources/LAs	**3.96**
	MS4	6.86
	Point Sources/WLAs	**6.86**
	Total Nash Run	**10.82**
Kingman Lake[2]	MS4	14.16
	Point Sources/WLAs	**14.16**
	Total Kingman Lake	**14.16**
Fort Chaplin Run[2]	MS4	6.17
	Point Sources/WLAs	**6.17**
	Total Fort Chaplin Run	**6.17**
Fort Dupont Creek	Contaminated Sites	0.18
	Nonpoint Sources/LAs	**0.18**
	MS4	12.19
	Point Sources/WLAs	**12.19**
	Total Fort Dupont Creek	**12.37**
Fort Davis Tributary[2]	MS4	4.90
	Point Sources/WLAs	**4.90**
	Total Fort Davis Tributary	**4.90**
Texas Avenue Tributary[2]	MS4	5.17
	Point Sources/WLAs	**5.17**
	Total Texas Avenue Tributary	**5.17**
Anacostia #2[3]	Upstream Loads	

Anacostia #2[3] **(continued)**	MD Upstream Load[4]	5053.08
	Cumulative Load from Tributaries	74.19
	Load from Kingman Lake	14.16
	Cumulative Upstream Load	**5141.42**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	366.45
	Nonpoint Sources/LAs	**366.45**
	Anacostia #2 Direct Drainage	
	MS4	568.24
	MSGP	10.18
	Pepco (DC0000094)[5]	10.26
	Point Sources/WLAs	**588.68**
	Total Anacostia #2	**6096.56**
Fort Stanton Tributary[2]	MS4	3.39
	Point Sources/WLAs	**3.39**
	Total Fort Stanton Tributary	**3.39**
Anacostia #1[6]	Upstream Loads	
	Cumulative Load from Anacostia #2	6096.56
	Cumulative Load from Tributaries	3.39
	Cumulative Upstream Load	**6099.95**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	51.31
	Nonpoint Sources/LAs	**51.31**
	Anacostia #1 Direct Drainage	
	CSS	361.01
	MS4	817.90
	MSGP	19.01
	Blue Plains WWTP (DC0021199)	912.39
	Washington Navy Yard (DC0000141)[5]	12.59
	Point Sources/WLAs	**2122.91**
	Total Anacostia #1	**8274.16**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is established for these segments because all stormwater runoff is captured by the MS4.

[3]Loads established for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from the Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run that drain directly to District waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads established for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-4 TMDLs for Copper

Segment	Source	TMDL (g/day)
Anacostia #2[1]	Upstream Loads	
	MD Upstream Load[2]	1.04E+06
	Cumulative Load from Tributaries	2.09E+04
	Load from Kingman Lake	3241.45
	Cumulative Upstream Load	**1.06E+06**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	572.64
	Nonpoint Sources/LAs	**572.64**
	Anacostia #2 Direct Drainage	
	MS4	1.43E+05
	MSGP	3129.14
	Pepco (DC0000094)[3]	774.33
	Point Sources/WLAs	**1.47E+05**
	Total Anacostia #2	**1.21E+06**
Anacostia #1[4]	Upstream Loads	
	Cumulative Load from Anacostia #2	1.21E+06
	Cumulative Load from Tributaries	850.50
	Cumulative Upstream Load	**1.21E+06**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	5553.37
	Nonpoint Sources/LAs	**5553.37**
	Anacostia #1 Direct Drainage	
	CSS	1.37E+05
	MS4	2.54E+05
	MSGP	8884.99
	Blue Plains WWTP (DC0021199)	5.93E+04
	Washington Navy Yard (DC0000141)[3]	3483.29
	Point Sources/WLAs	**4.63E+05**
	Total Anacostia #1	**1.68E+06**

[1]Loads established for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[2]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[3]The loads for this individual discharger include both the land-based load attributed to the contaminated land and the load attributed to their discharges.

[4]Loads established for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-5 TMDLs for Zinc

Segment	Source	TMDL (g/day)
Anacostia #2[1]	Upstream Loads	
	MD Upstream Load[2]	9.84E+05
	Cumulative Load from Tributaries	2.23E+04
	Load from Kingman Lake	3.04E+03
	Cumulative Upstream Load	**1.01E+06**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	1716.86
	Nonpoint Sources/LAs	**1716.86**
	Anacostia #2 Direct Drainage	
	MS4	1.32E+05
	MSGP	3238.74
	Pepco (DC0000094)[3]	1.07E+04
	Point Sources/WLAs	**1.46E+05**
	Total Anacostia #2	**1.16E+06**
Anacostia #1[4]	Upstream Loads	
	Cumulative Load from Anacostia #2	1.16E+06
	Cumulative Load from Tributaries	852.92
	Cumulative Upstream Load	**1.16E+06**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	8.32E+03
	Nonpoint Sources/LAs	**8.32E+03**
	Anacostia #1 Direct Drainage	
	CSS	6.95E+04
	MS4	1.26E+05

Anacostia #1[4] (continued)	MSGP	4868.17
	Blue Plains WWTP (DC0021199)	2.44E+05
	Washington Navy Yard (DC0000141)[3]	1.22E+04
	Point Sources/WLAs	**4.56E+05**
	Total Anacostia #1	**1.62E+06**

[1]Loads established for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[2]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[3]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[4]Loads established for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-6 TMDLs for Chlordane

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	0.009
	Contaminated Sites	0.001
	Nonpoint Sources/LAs	**0.010**
	MS4	0.021
	Point Sources/WLAs	**0.021**
	Total Nash Run	**0.031**
Hickey Run[2]	MS4	0.043
	MSGP	0.004
	Point Sources/WLAs	**0.047**
	Total Hickey Run	**0.047**
Watts Branch[3]	MD Upstream Load[4]	0.047
	Contaminated Sites	0.001
	Nonpoint Sources/LAs	**0.049**
	MS4	0.049
	Pepco (DC0000094)[5]	0.001
	Point Sources/WLAs	**0.050**
	Total Watts Branch	**0.098**
Kingman Lake[2]	MS4	0.023
	Point Sources/WLAs	**0.023**

Kingman Lake[2] (continued)	***Total Kingman Lake***	**0.023**
Popes Branch[2]	DC MS4	0.010
	Point Sources/WLAs	**0.010**
	Total Popes Branch	**0.010**
Texas Avenue Tributary[2]	MS4	0.010
	Point Sources/WLAs	**0.010**
	Total Texas Avenue Tributary	**0.010**
Anacostia #2[6]	Upstream Loads	
	MD Upstream Load[7]	17.673
	Cumulative Load from Tributaries	0.181
	Load from Kingman Lake	0.023
	Cumulative Upstream Load	**17.877**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	0.030
	Nonpoint Sources/LAs	**0.030**
	Anacostia #2 Direct Drainage	
	MS4	2.322
	MSGP	0.043
	Pepco (DC0000094)[5]	0.065
	Point Sources/WLAs	**2.430**
	Total Anacostia #2	**20.336**
Anacostia #1[8]	Upstream Loads	
	Cumulative Load from Anacostia #2	20.336
	Cumulative Load from Tributaries	0.005
	Cumulative Upstream Load	**20.342**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	0.116
	Nonpoint Sources/LAs	**0.116**
	Anacostia #1 Direct Drainage	
	CSS	1.6224
	MS4	3.137
	MSGP	0.110
	Blue Plains WWTP (DC0021199)	2.227
	Washington Navy Yard (DC0000141)[5]	0.122
	Point Sources/WLAs	**7.2183**
	Total Anacostia #1	**27.6761**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is established for these segments because all stormwater runoff is captured by the MS4.

[3]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[4]Upstream loads from the Maryland portion of the Watts Branch watershed.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads established for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[7]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[8]Loads established for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-7 TMDLs for DDT and its Metabolites

Segment	Source	TMDL (g/day)
Hickey Run[1]	MS4	0.0033
	MSGP	0.0002
	Point Sources/WLAs	**0.0035**
	Total Hickey Run	**0.0035**
Kingman Lake[1]	MS4	2.00E-03
	Point Sources/WLAs	**2.00E-03**
	Total Kingman Lake	**2.00E-03**
Popes Branch[1]	MS4	7.87E-04
	Point Sources/WLAs	**7.87E-04**
	Total Popes Branch	**7.87E-04**
Texas Avenue Tributary[1]	MS4	7.44E-04
	Point Sources/WLAs	**7.44E-04**
	Total Texas Avenue Tributary	**7.44E-04**
Anacostia #2[2]	Upstream Loads	
	MD Upstream Load[3]	0.8526
	Cumulative Load from Tributaries	0.0180
	Load from Kingman Lake	0.0020
	Cumulative Upstream Load	**0.8727**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	0.0064
	Nonpoint Sources/LAs	**0.0064**
	Anacostia #2 Direct Drainage	
	MS4	0.1247

Anacostia #2[2] **(continued)**	MSGP	0.0017
	Pepco (DC0000094)[4]	0.0080
	Point Sources/WLAs	**0.1345**
	Total Anacostia #2	**1.0135**
Anacostia #1[5]	Upstream Loads	
	Cumulative Load from Anacostia #2	1.0135
	Cumulative Load from Tributaries	4.12E-04
	Cumulative Upstream Load	**1.0139**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	0.0161
	Nonpoint Sources/LAs	**0.0161**
	Anacostia #1 Direct Drainage	
	CSS	0.0686
	MS4	0.1431
	MSGP	0.0037
	Blue Plains WWTP (DC0021199)	0.1266
	Washington Navy Yard (DC0000141)[4]	0.0309
	Point Sources/WLAs	**0.3729**
	Total Anacostia #1	**1.4030**

[1]No LA is established for these segments because all stormwater runoff is captured by the MS4.

[2]Loads established for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[3]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[5]Loads established for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-8 TMDLs for Dieldrin

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	0
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**

Nash Run (continued)	MS4	0
	Point Sources/WLAs	**0**
	Total Nash Run	**0**
Watts Branch[2]	MD Upstream Load[3]	0.0001
	Contaminated Sites	0
	Nonpoint Sources/LAs	**5.04E-05**
	MS4	0
	Pepco (DC0000094)[4]	0
	Point Sources/WLAs	**0**
	Total Watts Branch	**0**
Texas Avenue Tributary[5]	MS4	0
	Point Sources/WLAs	**0**
	Total Texas Avenue Tributary	**0**
Anacostia #2[6]	Upstream Loads	
	MD Upstream Load[7]	1.00E-02
	Cumulative Load from Tributaries	0
	Load from Kingman Lake	0
	Cumulative Upstream Load	**1.00E-02**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	Anacostia #2 Direct Drainage	
	MS4	0
	MSGP	0
	Pepco (DC0000094)[4]	0
	Point Sources/WLAs	**0**
	Total Anacostia #2	**1.00E-02**
Anacostia #1[8]	Upstream Loads	
	Cumulative Load from Anacostia #2	1.00E-02
	Cumulative Load from Tributaries	0
	Cumulative Upstream Load	**1.00E-02**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	Anacostia #1 Direct Drainage	
	CSS	0
	MS4	0
	MSGP	0
	Blue Plains WWTP (DC0021199)	3.50E-03
	Washington Navy Yard (DC0000141)[4]	0

Anacostia #1[8] (continued)	***Point Sources/WLAs***	**3.50E-03**
	Total Anacostia #1	**1.35E-02**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[3]Upstream loads from the Maryland portion of the Watts Branch watershed.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[5]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[6]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[7]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[8]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-9 TMDLs for Heptachlor Epoxide

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	1.82E-03
	Contaminated Sites	0.0003
	Nonpoint Sources/LAs	**2.08E-03**
	MS4	0.0034
	Point Sources/WLAs	**0.0034**
	Total Nash Run	**5.51E-03**
Popes Branch[2]	MS4	2.16E-03
	Point Sources/WLAs	**2.16E-03**
	Total Popes Branch	**2.16E-03**
Texas Avenue Tributary[2]	MS4	2.08E-03
	Point Sources/WLAs	**2.08E-03**
	Total Texas Avenue Tributary	**2.08E-03**
Anacostia #2[3]	Upstream Loads	
	MD Upstream Load[4]	2.21E+00
	Cumulative Load from Tributaries	3.34E-02
	Load from Kingman Lake	4.53E-03

Anacostia #2[3] (continued)	***Cumulative Upstream Load***	**2.25E+00**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	4.07E-03
	Nonpoint Sources/LAs	**4.07E-03**
	Anacostia #2 Direct Drainage	
	MS4	3.01E-01
	MSGP	6.14E-03
	Pepco (DC0000094)[5]	7.89E-03
	Point Sources/WLAs	**3.15E-01**
	Total Anacostia #2	**2.57E+00**
Anacostia #1[6]	Upstream Loads	
	Cumulative Load from Anacostia #2	2.57E+00
	Cumulative Load from Tributaries	1.46E-03
	Cumulative Upstream Load	**2.57E+00**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	1.59E-02
	Nonpoint Sources/LAs	**1.59E-02**
	Anacostia #1 Direct Drainage	
	CSS	0.2170
	MS4	4.77E-01
	MSGP	1.20E-02
	Blue Plains WWTP (DC0021199)	2.53E-01
	Washington Navy Yard (DC0000141)[5]	2.08E-02
	Point Sources/WLAs	**0.9799**
	Total Anacostia #1	**3.5661**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from the Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to Distrcit waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-10 TMDLs for the PAH 1 Group

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	9.54
	Contaminated Sites	6.17
	Nonpoint Sources/LAs	**15.71**
	MS4	17.71
	Point Sources/WLAs	**17.71**
	Total Nash Run	**33.42**
Hickey Run[2]	MS4	36.50
	MSGP	4.36
	Point Sources/WLAs	**40.87**
	Total Hickey Run	**40.87**
Kingman Lake[2]	MS4	18.31
	Point Sources/WLAs	**18.31**
	Total Kingman Lake	**18.31**
Popes Branch[2]	MS4	9.21
	Point Sources/WLAs	**9.21**
	Total Popes Branch	**9.21**
Texas Avenue Tributary[2]	MS4	8.30
	Point Sources/WLAs	**8.30**
	Total Texas Avenue Tributary	**8.30**
Anacostia #2[3]	Upstream Loads	
	MD Upstream Load[4]	6719.59
	Cumulative Load from Tributaries	164.24
	Load from Kingman Lake	18.31
	Cumulative Upstream Load	**6902.15**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	12.00
	Nonpoint Sources/LAs	**12.00**
	Anacostia #2 Direct Drainage	
	MS4	795.03
	MSGP	20.25
	Pepco (DC0000094)[5]	583.54
	Point Sources/WLAs	**1398.81**
	Total Anacostia #2	**8312.96**
Fort Stanton Tributary[2]	MS4	5.63
	Point Sources/WLAs	**5.63**
	Total Fort Stanton Tributary	**5.63**
Anacostia #1[6]	Upstream Loads	
	Cumulative Load from Anacostia #2	8312.96

Anacostia #1[6] (continued)	Cumulative Load from Tributaries	5.63
	Cumulative Upstream Load	**8318.59**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	27.19
	Nonpoint Sources/LAs	**27.19**
	Anacostia #1 Direct Drainage	
	CSS	27.36
	MS4	49.27
	MSGP	2.02
	Blue Plains WWTP (DC0021199)	4852.40
	Washington Navy Yard (DC0000141)[5]	9.07
	Point Sources/WLAs	**4940.12**
	Total Anacostia #1	**13285.90**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

*Due to the endpoint selected to represent the PAH 1 group, in some cases a negative percent reduction is called for but are presented as zero because the PAHs in the PAH 1 group do not need to be reduced from those sources.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-11 TMDLs for the PAH 2 Group

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	0
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	MS4	0
	Point Sources/WLAs	**0**
	Total Nash Run	**0**
Hickey Run[2]	MS4	0

Hickey Run[2] (continued)	MSGP	0
	Point Sources/WLAs	**0**
	Total Hickey Run	**0**
Kingman Lake[2]	MS4	0
	Point Sources/WLAs	**0**
	Total Kingman Lake	**0**
Popes Branch[2]	DC MS4	0
	Point Sources/WLAs	**0**
	Total Popes Branch	**0**
Texas Avenue Tributary[2]	MS4	0
	Point Sources/WLAs	**0**
	Total Texas Avenue Tributary	**0**
Anacostia #2[3]	Upstream Loads	
	MD Upstream Load[4]	2.84
	Cumulative Load from Tributaries	0
	Load from Kingman Lake	0
	Cumulative Upstream Load	**2.84**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	Anacostia #2 Direct Drainage	
	MS4	0
	MSGP	0
	Pepco (DC0000094)[5]	0.28
	Point Sources/WLAs	**0.28**
	Total Anacostia #2	**3.13**
Fort Stanton Tributary[2]	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Stanton Tributary	**0**
Anacostia #1[6]	Upstream Loads	
	Cumulative Load from Anacostia #2	3.13
	Cumulative Load from Tributaries	0
	Cumulative Upstream Load	**3.13**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	Anacostia #1 Direct Drainage	
	CSS	0
	MS4	0
	MSGP	0
	Blue Plains WWTP (DC0021199)	1.12
	Washington Navy Yard (DC0000141)[5]	0

Anacostia #1[6] (continued)	***Point Sources/WLAs***	**1.12**
	Total Anacostia #1	**4.25**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is given for these segments because all stormwater runoff is captured by the MS4.

[3]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-12 TMDLs for the PAH 3 Group

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	0
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	MS4	0
	Point Sources/WLAs	**0**
	Total Nash Run	**0**
Hickey Run[2]	MS4	0
	MSGP	0
	Point Sources/WLAs	**0**
	Total Hickey Run	**0**
Kingman Lake[2]	MS4	0
	Point Sources/WLAs	**0**
	Total Kingman Lake	**0**
Popes Branch[2]	MS4	0
	Point Sources/WLAs	**0**
	Total Popes Branch	**0**
Texas Avenue Tributary[2]	MS4	0
	Point Sources/WLAs	**0**
	Total Texas Avenue Tributary	**0**
Anacostia #2[3]	Upstream Loads	

Anacostia #2[3] (continued)	MD Upstream Load[4]	0.292
	Cumulative Load from Tributaries	0
	Load from Kingman Lake	0
	Cumulative Upstream Load	**0.292**
	Anacostia #2 Direct Drainage	
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	Anacostia #2 Direct Drainage	
	MS4	0
	MSGP	0
	Pepco (DC0000094)[5]	0.030
	Point Sources/WLAs	**0**
	Total Anacostia #2	**0.322**
Fort Stanton Tributary[2]	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Stanton Tributary	**0**
Anacostia #1[6]	Upstream Loads	
	Cumulative Load from Anacostia #2	0.322
	Cumulative Load from Tributaries	0
	Cumulative Upstream Load	**0.322**
	Anacostia #1 Direct Drainage	
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	Anacostia #1 Direct Drainage	
	CSS	0
	MS4	0
	MSGP	0
	Blue Plains WWTP (DC0021199)	0.115
	Washington Navy Yard (DC0000141)[5]	0
	Point Sources/WLAs	**0.115**
	Total Anacostia #1	**0.437**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

6Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

6.4 Annual Load Tables

Table 6-13 Annual Loads for Arsenic

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Nash Run	MD Upstream Load[1]	542.44	19.07	12.44	97.71
	Contaminated Sites	1171.48	41.18	0.79	99.93
	Nonpoint Sources/LAs	**1713.92**	**60.26**	**13.23**	**99.23**
	MS4	1130.53	39.74	22.92	97.97
	Point Sources/WLAs	**1130.53**	**39.74**	**22.92**	**97.97**
	Total Nash Run	**2844.45**	**100**	**36.15**	**98.73**
Kingman Lake[2]	MS4	1292.84	100	33.40	97.42
	Point Sources/WLAs	**1292.84**	**100**	**33.40**	**97.42**
	Total Kingman Lake	**1292.84**	**100**	**33.40**	**97.42**
Fort Chaplin Run[2]	MS4	699.53	100	18.04	97.42
	Point Sources/WLAs	**699.53**	**100**	**18.04**	**97.42**
	Total Fort Chaplin Run	**699.53**	**100**	**18.04**	**97.42**
Fort Dupont Creek	Contaminated Sites	186.31	19.14	0.32	99.83
	Nonpoint Sources/LAs	**186.31**	**19.14**	**0.32**	**99.83**
	MS4	787.14	80.86	21.73	97.24
	Point Sources/WLAs	**787.14**	**80.86**	**21.73**	**97.24**
	Total Fort Dupont Creek	**973.45**	**100**	**22.05**	**97.74**
Fort Davis Tributary[2]	MS4	530.38	100	15.87	97.01
	Point Sources/WLAs	**530.38**	**100**	**15.87**	**97.01**
	Total Fort Davis Tributary	**530.38**	**100**	**15.87**	**97.01**
Texas Avenue Tributary[2]	MS4	579.50	100	14.85	97.44
	Point Sources/WLAs	**579.50**	**100**	**14.85**	**97.44**
	Total Texas Avenue Tributary	**579.50**	**100**	**14.85**	**97.44**
Anacostia #2[3]	Upstream Loads				
	MD Upstream Load[4]	150468.97	76.06	5920.27	96.07
	Cumulative Load from Tributaries	39739.48	20.09	1131.92	97.15
	Load from Kingman Lake	1292.84	0.65	33.40	97.42
	Cumulative Upstream Load	**191501.29**	**96.80**	**7085.59**	**96.30**
	Anacostia #2 Direct Drainage				
	Contaminated Sites	674.08	0.34	0.41	99.94

Anacostia #2[3] (continued)	***Nonpoint Sources/LAs***	**674.08**	**0.34**	**0.41**	**99.94**
	Anacostia #2 Direct Drainage				
	MS4	4343.06	2.20	102.65	97.64
	MSGP	13.21	0.01	0.30	97.71
	Pepco (DC0000094)[5]	1307.34	0.66	5.62	99.57
	Point Sources/WLAs	**5663.61**	**2.86**	**108.57**	**98.08**
	Total Anacostia #2	**197838.98**	**100**	**7194.57**	**96.36**
Fort Stanton Tributary[2]	MS4	833.28	100	19.86	97.62
	Point Sources/WLAs	**833.28**	**100**	**19.86**	**97.62**
	Total Fort Stanton Tributary	**833.28**	**100**	**19.86**	**97.62**
Anacostia #1[6]	Upstream Loads				
	Cumulative Load from Anacostia #2	197838.98	85.99	7194.57	96.36
	Cumulative Load from Tributaries	833.28	0.36	19.86	97.62
	Cumulative Upstream Load	**198672.26**	**86.35**	**7214.43**	**96.37**
	Anacostia #1 Direct Drainage				
	Contaminated Sites	10837.56	4.71	7.89	99.93
	Nonpoint Sources/LAs	**10837.56**	**4.71**	**7.89**	**99.93**
	Anacostia #1 Direct Drainage				
	CSS	4335.35	1.88	94.63	97.82
	MS4	13177.13	5.73	194.53	98.52
	MSGP	228.44	0.10	4.98	97.82
	Blue Plains WWTP (DC0021199)	239.16	0.10	239.16	0
	Washington Navy Yard (DC0000141)[5]	2590.60	1.13	3.30	99.87
	Point Sources/WLAs	**20570.69**	**8.94**	**536.61**	**97.39**
	Total Anacostia #1	**230080.51**	**100**	**7758.93**	**96.63**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-14 Annual Loads for Copper

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Anacostia #2[1]	Upstream Loads				
	MD Upstream Load[2]	1196772.01	76.26	1196772.01	0
	Cumulative Load from Tributaries	313745.53	19.99	298677.56	4.80
	Load from Kingman Lake	9083.76	0.58	8745.12	3.73
	Cumulative Upstream Load	**1519601.30**	**96.83**	**1504194.69**	**1.01**
	Anacostia #2 Direct Drainage				
	Contaminated Sites	3363.69	0.21	100.91	97.00
	Nonpoint Sources/LAs	**3363.69**	**0.21**	**100.91**	**97.00**
	Anacostia #2 Direct Drainage				
	MS4	32930.72	2.10	32437.95	1.50
	MSGP	103.34	0.01	103.34	0
	Pepco (DC0000094)[3]	13418.82	0.86	532.43	96.03
	Point Sources/WLAs	**46452.88**	**2.96**	**33073.72**	**28.80**
	Total Anacostia #2	**1569417.87**	**100**	**1537369.32**	**2.04**
Anacostia #1[4]	Upstream Loads				
	Cumulative Load from Anacostia #2	1569417.87	89.41	1537369.32	2.04
	Cumulative Load from Tributaries	6302.04	0.36	6302.04	0
	Cumulative Upstream Load	**1575719.91**	**89.77**	**1543671.36**	**2.03**
	Anacostia #1 Direct Drainage				
	Contaminated Sites	53838.23	3.07	2174.56	95.96
	Nonpoint Sources/LAs	**53838.23**	**3.07**	**2174.56**	**95.96**
	Anacostia #1 Direct Drainage				
	CSS	35424.57	2.02	35424.57	0
	MS4	59356.69	3.38	59232.80	0.21
	MSGP	2293.44	0.13	2293.38	0
	Blue Plains WWTP (DC0021199)	15306.35	0.87	15306.35	0
	Washington Navy Yard (DC0000141)[3]	13326.39	0.76	899.10	93.25
	Point Sources/WLAs	**125707.45**	**7.16**	**113156.21**	**9.98**
	Total Anacostia #1	**1755265.58**	**100**	**1659002.13**	**5.48**

[1]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.
[2]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.
[3]The loads for this individual discharger include both the land-based load attributed to the contaminated land and the load attributed to their discharges.

[4]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-15 Annual Loads for Zinc

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Anacostia #2[1]	Upstream Loads				
	MD Upstream Load[2]	1.86E+06	76.78	1.86E+06	0
	Cumulative Load from Tributaries	4.80E+05	19.85	4.72E+05	1.69
	Load from Kingman Lake	1.25E+04	0.52	1.25E+04	0
	Cumulative Upstream Load	**2.35E+06**	**97.15**	**2.34E+06**	**0.34**
	Anacostia #2 Direct Drainage				
	Contaminated Sites	2625.83	0.11	778.48	70.35
	Nonpoint Sources/LAs	**2625.83**	**0.11**	**778.48**	**70.35**
	Anacostia #2 Direct Drainage				
	MS4	5.06E+04	2.09	5.06E+04	0
	MSGP	183.70	0.01	183.70	0
	Pepco (DC0000094)[3]	1.56E+04	0.65	1.20E+04	23.50
	Point Sources/WLAs	**6.64E+04**	**2.75**	**6.27E+04**	**5.54**
	Total Anacostia #2	**2.42E+06**	**100**	**2.40E+06**	**0.56**
Anacostia #1[4]	Upstream Loads				
	Cumulative Load from Anacostia #2	2.42E+06	84.90	2.40E+06	0.56
	Cumulative Load from Tributaries	9627.02	0.34	9627.02	0
	Cumulative Upstream Load	**2.43E+06**	**85.24**	**2.41E+06**	**0.56**
	Anacostia #1 Direct Drainage				
	Contaminated Sites	5.03E+04	1.77	2.18E+04	56.64
	Nonpoint Sources/LAs	**5.03E+04**	**1.77**	**2.18E+04**	**56.64**
	Anacostia #1 Direct Drainage				
	CSS	5.70E+04	2.00	5.70E+04	0
	MS4	9.39E+04	3.30	9.39E+04	0
	MSGP	3997.18	0.14	3997.18	0
	Blue Plains WWTP (DC0021199)	2.00E+05	7.03	2.00E+05	0
	Washington Navy Yard (DC0000141)[3]	1.48E+04	0.52	1.00E+04	32.22
	Point Sources/WLAs	**3.70E+05**	**12.99**	**3.65E+05**	**1.29**
	Total Anacostia #1	**2.85E+06**	**100**	**2.80E+06**	**1.65**

[1]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[2]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[3]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[4]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-16 Annual Loads for Chlordane

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Nash Run	MD Upstream Load[1]	4.278	29.69	0.049	98.86
	Contaminated Sites	1.864	12.94	0.007	99.62
	Nonpoint Sources/LAs	**6.142**	**42.63**	**0.056**	**99.09**
	MS4	8.267	57.37	0.119	98.56
	Point Sources/WLAs	**8.267**	**57.37**	**0.119**	**98.56**
	Total Nash Run	**14.409**	**100**	**0.175**	**98.79**
Hickey Run[2]	MS4	21.502	90.41	0.276	98.71
	MSGP	2.281	9.59	0.026	98.86
	Point Sources/WLAs	**23.783**	**100**	**0.302**	**98.73**
	Total Hickey Run	**23.783**	**100**	**0.302**	**98.73**
Watts Branch[3]	MD Upstream Load[4]	20.164	42.85	0.329	98.37
	Contaminated Sites	2.179	4.63	0.008	99.62
	Nonpoint Sources/LAs	**22.343**	**47.48**	**0.337**	**98.49**
	MS4	23.442	49.82	0.339	98.55
	Pepco (DC0000094)[5]	1.273	2.70	0.005	99.62
	Point Sources/WLAs	**24.715**	**52.52**	**0.344**	**98.61**
	Total Watts Branch	**47.058**	**100**	**0.681**	**98.55**
Kingman Lake[2]	MS4	8.640	100	0.108	98.75
	Point Sources/WLAs	**8.640**	**100**	**0.108**	**98.75**
	Total Kingman Lake	**8.640**	**100**	**0.108**	**98.75**
Popes Branch[2]	DC MS4	4.553	100	0.052	98.86
	Point Sources/WLAs	**4.553**	**100**	**0.052**	**98.86**
	Total Popes Branch	**4.553**	**100**	**0.052**	**98.86**
Texas Avenue Tributary[2]	MS4	4.470	100	0.058	98.71
	Point Sources/WLAs	**4.470**	**100**	**0.058**	**98.71**
	Total Texas Avenue Tributary	**4.470**	**100**	**0.058**	**98.71**
Anacostia #2[6]	Upstream Loads				
	MD Upstream Load[7]	1114.183	76.18	21.146	98.10
	Cumulative Load from Tributaries	297.608	20.35	3.963	98.67
	Load from Kingman Lake	8.640	0.59	0.108	98.75

Anacostia #2[6] (continued)	***Cumulative Upstream Load***	**1420.430**	**97.12**	**25.217**	**98.22**
	Anacostia #2 Direct Drainage				
	Contaminated Sites	1.230	0.08	0.005	99.63
	Nonpoint Sources/LAs	**1.230**	**0.08**	**0.005**	**99.63**
	Anacostia #2 Direct Drainage				
	MS4	32.785	2.24	0.392	98.80
	MSGP	0.116	0.01	0.001	98.88
	Pepco (DC0000094)[5]	8.028	0.55	0.036	99.56
	Point Sources/WLAs	**40.928**	**2.80**	**0.429**	**98.95**
	Total Anacostia #2	**1462.588**	**100**	**25.650**	**98.25**
Anacostia #1[8]	Upstream Loads				
	Cumulative Load from Anacostia #2	1462.588	91.55	25.650	98.25
	Cumulative Load from Tributaries	6.138	0.38	0.081	98.67
	Cumulative Upstream Load	**1468.726**	**91.94**	**25.732**	**98.25**
	Anacostia #1 Direct Drainage				
	Contaminated Sites	23.1768	1.45	0.0834	99.64
	Nonpoint Sources/LAs	**23.1768**	**1.45**	**0.0834**	**99.64**
	Anacostia #1 Direct Drainage				
	CSS	35.0448	2.19	0.3983	98.86
	MS4	59.7903	3.74	0.6888	98.85
	MSGP	2.3743	0.15	0.027	98.86
	Blue Plains WWTP (DC0021199)	0.5467	0.03	0.5467	0
	Washington Navy Yard (DC0000141)[5]	7.9088	0.50	0.0299	99.62
	Point Sources/WLAs	**105.6649**	**6.61**	**1.6907**	**98.40**
	Total Anacostia #1	**1597.5674**	**100**	**27.5057**	**98.28**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[4]Upstream loads from the Maryland portion of the Watts Branch watershed.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[7]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[8]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-17 Annual Loads for DDT and its Metabolites

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Hickey Run[1]	MS4	1.4741	92.34	0.0130	99.12
	MSGP	0.1222	7.66	0.0009	99.26
	Point Sources/WLAs	**1.5963**	**100**	**0.0139**	**99.13**
	Total Hickey Run	**1.5963**	**100**	**0.0139**	**99.13**
Kingman Lake[1]	MS4	0.7384	100	0.0061	99.17
	Point Sources/WLAs	**0.7384**	**100**	**0.0061**	**99.17**
	Total Kingman Lake	**0.7384**	**100**	**0.0061**	**99.17**
Popes Branch[1]	MS4	0.3623	100	0.0027	99.25
	Point Sources/WLAs	**0.3623**	**100**	**0.0027**	**99.25**
	Total Popes Branch	**0.3623**	**100**	**0.0027**	**99.25**
Texas Avenue Tributary[1]	MS4	0.3331	100	0.0028	99.16
	Point Sources/WLAs	**0.3331**	**100**	**0.0028**	**99.16**
	Total Texas Avenue Tributary	**0.3331**	**100**	**0.0028**	**99.16**
Anacostia #2[2]	Upstream Loads				
	MD Upstream Load[3]	83.3871	74.03	1.1602	98.61
	Cumulative Load from Tributaries	23.8418	21.17	0.1882	99.21
	Load from Kingman Lake	0.7384	0.66	0.0061	99.17
	Cumulative Upstream Load	**107.9673**	**95.86**	**1.3545**	**98.75**
	Anacostia #2 Direct Drainage				
	Contaminated Sites	0.8256	0.73	0.0020	99.76
	Nonpoint Sources/LAs	**0.8256**	**0.73**	**0.0020**	**99.76**
	Anacostia #2 Direct Drainage				
	MS4	2.3646	2.10	0.0187	99.21
	MSGP	0.0072	0.01	0.0001	98.61
	Pepco (DC0000094)[4]	1.4705	1.31	0.0040	99.73
	Point Sources/WLAs	**3.8423**	**3.41**	**0.0228**	**99.41**
	Total Anacostia #2	**112.6352**	**100**	**1.3793**	**98.78**
Anacostia #1[5]	Upstream Loads				
	Cumulative Load from Anacostia #2	112.6352	83.02	1.3793	98.78
	Cumulative Load from Tributaries	0.4449	0.33	0.0038	99.15
	Cumulative Upstream Load	**113.0801**	**83.35**	**1.3831**	**98.78**
	Anacostia #1 Direct Drainage				
	Contaminated Sites	13.0264	9.60	0.0312	99.76
	Nonpoint Sources/LAs	**13.0264**	**9.60**	**0.0312**	**99.76**
	Anacostia #1 Direct Drainage				
	CSS	2.2479	1.66	0.0166	99.26
	MS4	4.1054	3.03	0.0309	99.25

Anacostia #1[5] **(continued)**	MSGP	0.1173	0.09	0.0009	99.23
	Blue Plains WWTP (DC0021199)	0.0307	0.02	0.0307	0
	Washington Navy Yard (DC0000141)[4]	3.0598	2.26	0.0075	99.75
	Point Sources/WLAs	**9.5611**	**7.05**	**0.0866**	**99.09**
	Total Anacostia #1	**135.6676**	**100**	**1.5009**	**98.89**

[1]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[2]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[3]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[5]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-18 Annual Loads for Dieldrin

Segment	**Source**	**Baseline Load (g/year)**	**Baseline Load (%)**	**TMDL (g/year)**	**Load Reduction (%)**
Nash Run	MD Upstream Load[1]	0.8465	26.33	0	100
	Contaminated Sites	0.8106	25.22	0	100
	Nonpoint Sources/LAs	**1.6571**	**51.55**	**0**	**100**
	MS4	1.5574	48.45	0	100
	Point Sources/WLAs	**1.5574**	**48.45**	**0**	**100**
	Total Nash Run	**3.2145**	**100**	**0**	**100**
Watts Branch[2]	MD Upstream Load[3]	3.7154	37.04	0.0001	100
	Contaminated Sites	1.0276	10.24	0	100
	Nonpoint Sources/LAs	**4.7430**	**47.28**	**0.0001**	**100**
	MS4	4.5506	45.37	0	100
	Pepco (DC0000094)[4]	0.7373	7.35	0	100
	Point Sources/WLAs	**5.2879**	**52.72**	**0**	**100**
	Total Watts Branch	**10.03**	**100**	**0**	**100**
Texas Avenue Tributary[5]	MS4	0.8062	100	0	100
	Point Sources/WLAs	**0.8062**	**100**	**0**	**100**
	Total Texas Avenue Tributary	**0.8062**	**100**	**0**	**100**
Anacostia #2[6]	Upstream Loads				
	MD Upstream Load[7]	199.8386	73.28	0.0047	100
	Cumulative Load from Tributaries	59.8845	21.96	0.0002	100
	Load from Kingman Lake	1.4418	0.53	0	100

Anacostia #2[6] (continued)	***Cumulative Upstream Load***	**261.1649**	**95.76**	**0.0049**	**100**
	Anacostia #2 Direct Drainage				
	Contaminated Sites	0.6279	0.23	0	100
	Nonpoint Sources/LAs	**0.6279**	**0.23**	**0**	**100**
	Anacostia #2 Direct Drainage				
	MS4	6.2627	2.30	0	100
	MSGP	0.0238	0.01	0	100
	Pepco (DC0000094)[4]	4.6445	1.70	0	100
	Point Sources/WLAs	**10.9310**	**4.01**	**0**	**100**
	Total Anacostia #2	**272.7238**	**100**	**0.0049**	**100**
Anacostia #1[8]	Upstream Loads				
	Cumulative Load from Anacostia #2	272.7238	87.13	0.0049	100
	Cumulative Load from Tributaries	1.2066	0.39	0	100
	Cumulative Upstream Load	**273.9304**	**87.52**	**0.0049**	**100**
	Anacostia #1 Direct Drainage				
	Contaminated Sites	14.3807	4.59	0	100
	Nonpoint Sources/LAs	**14.3807**	**4.59**	**0**	**100**
	Anacostia #1 Direct Drainage				
	CSS	7.4047	2.37	0	100
	MS4	11.8655	3.79	0	100
	MSGP	0.5428	0.17	0	100
	Blue Plains WWTP (DC0021199)	0.0020	0	0.0020	0
	Washington Navy Yard (DC0000141)[4]	4.8805	1.56	0	100
	Point Sources/WLAs	**24.6955**	**7.89**	**0.0020**	**99.99**
	Total Anacostia #1	**313.0066**	**100**	**0.0069**	**100.00**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[3]Upstream loads from the Maryland portion of the Watts Branch watershed.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[5]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[6]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[7]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[8]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-19 Annual Loads for Heptachlor Epoxide

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Nash Run	MD Upstream Load[1]	0.7099	18.26	0.0069	99.03
	Contaminated Sites	1.7446	44.88	0.0010	99.94
	Nonpoint Sources/LAs	**2.4545**	**63.15**	**0.0079**	**99.68**
	MS4	1.4324	36.85	0.0130	99.09
	Point Sources/WLAs	**1.4324**	**36.85**	**0.0130**	**99.09**
	Total Nash Run	**3.8869**	**100**	**0.0209**	**99.46**
Popes Branch[2]	MS4	0.7833	100	0.0066	99.16
	Point Sources/WLAs	**0.7833**	**100**	**0.0066**	**99.16**
	Total Popes Branch	**0.7833**	**100**	**0.0066**	**99.16**
Texas Avenue Tributary[2]	MS4	0.7833	100	0.0066	99.16
	Point Sources/WLAs	**0.7833**	**100**	**0.0066**	**99.16**
	Total Texas Avenue Tributary	**0.7833**	**100**	**0.0066**	**99.16**
Anacostia #2[3]	Upstream Loads				
	MD Upstream Load[4]	186.8092	75.10	2.1736	98.84
	Cumulative Load from Tributaries	1.5733	0.63	0.0132	99.16
	Load from Kingman Lake	52.4165	21.07	4.6551	91.12
	Cumulative Upstream Load	**240.7990**	**96.80**	**6.8419**	**97.16**
	Anacostia #2 Direct Drainage				
	Contaminated Sites	0.991	0.40	0.0006	99.94
	Nonpoint Sources/LAs	**0.9910**	**0.40**	**0.0006**	**99.94**
	Anacostia #2 Direct Drainage				
	MS4	5.5304	2.22	0.0481	99.13
	MSGP	0.0181	0.01	0.0002	98.90
	Pepco (DC0000094)[5]	1.4183	0.57	0.0041	99.71
	Point Sources/WLAs	**6.9668**	**2.80**	**0.0524**	**99.25**
	Total Anacostia #2	**248.7568**	**100**	**6.8949**	**97.23**
Anacostia #1[6]	Upstream Loads				
	Cumulative Load from Anacostia #2	248.7568	87.25	6.8949	97.23
	Cumulative Load from Tributaries	1.0621	0.37	0.0097	99.09
	Cumulative Upstream Load	**249.8189**	**87.63**	**6.9046**	**97.24**
	Anacostia #1 Direct Drainage				
	Contaminated Sites	15.6629	5.49	0.0102	99.93
	Nonpoint Sources/LAs	**15.6629**	**5.49**	**0.0102**	**99.93**
	Anacostia #1 Direct Drainage				
	CSS	5.7618	2.02	0.0469	99.19
	MS4	9.9230	3.48	0.0934	99.06
	MSGP	0.3409	0.12	0.0026	99.24

Anacostia #1[6] (continued)	Blue Plains WWTP (DC0021199)	0.0547	0.02	0.0547	0
	Washington Navy Yard (DC0000141)[5]	3.5339	1.24	0.0045	99.87
	Point Sources/WLAs	**19.6143**	**6.88**	**0.2021**	**98.97**
	Total Anacostia #1	**285.0961**	**100**	**7.1169**	**97.50**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-20 Annual Loads for the PAH 1 Group

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Nash Run	MD Upstream Load[1]	56.34	28.56	56.34	0
	Contaminated Sites	36.42	18.46	36.42	0
	Nonpoint Sources/LAs	**92.76**	**47.01**	**92.76**	**0**
	MS4	104.55	52.99	104.55	0
	Point Sources/WLAs	**104.55**	**52.99**	**104.55**	**0**
	Total Nash Run	**197.31**	**100**	**197.31**	**0**
Hickey Run[2]	MS4	283.93	89.33	283.93	0
	MSGP	33.93	10.67	33.93	0
	Point Sources/WLAs	**317.85**	**100**	**317.85**	**0**
	Total Hickey Run	**317.85**	**100**	**317.85**	**0**
Kingman Lake[2]	MS4	100.12	100	100.12	0
	Point Sources/WLAs	**100.12**	**100**	**100.12**	**0**
	Total Kingman Lake	**100.12**	**100**	**100.12**	**0**
Popes Branch[2]	MS4	54.44	100	54.44	0
	Point Sources/WLAs	**54.44**	**100**	**54.44**	**0**
	Total Popes Branch	**54.44**	**100**	**54.44**	**0**
Texas Avenue Tributary[2]	MS4	55.55	100	55.55	0
	Point Sources/WLAs	**55.55**	**100**	**55.55**	**0**
	Total Texas Avenue Tributary	**55.55**	**100**	**55.55**	**0**

Anacostia #2[3]	Upstream Loads				
	MD Upstream Load[4]	13813.01	74.69	44163.19	0*
	Cumulative Load from Tributaries	3964.15	21.43	3964.15	0
	Load from Kingman Lake	100.12	0.54	100.12	0
	Cumulative Upstream Load	**17877.28**	**96.66**	**48227.46**	**0***
	Anacostia #2 Direct Drainage				
	Contaminated Sites	24.63	0.13	24.63	0
	Nonpoint Sources/LAs	**24.63**	**0.13**	**24.63**	**0**
	Anacostia #2 Direct Drainage				
	MS4	420.72	2.27	420.72	0
	MSGP	1.57	0.01	1.57	0
	Pepco (DC0000094)[5]	170.49	0.92	996.34	0*
	Point Sources/WLAs	**592.78**	**3.21**	**1418.63**	**0***
	Total Anacostia #2	**18494.69**	**100**	**49670.72**	**0***
Fort Stanton Tributary[2]	MS4	79.42	100	79.4213	0
	Point Sources/WLAs	**79.42**	**100**	**79.42**	**0**
	Total Fort Stanton Tributary	**79.42**	**100**	**79.42**	**0**
Anacostia #1[6]	Upstream Loads				
	Cumulative Load from Anacostia #2	18494.69	89.36	49670.72	0*
	Cumulative Load from Tributaries	79.42	0.38	79.4213	0
	Cumulative Upstream Load	**18574.11**	**89.74**	**49750.14**	**0***
	Anacostia #1 Direct Drainage				
	Contaminated Sites	467.52	2.26	467.52	0
	Nonpoint Sources/LAs	**467.52**	**2.26**	**467.52**	**0**
	Anacostia #1 Direct Drainage				
	CSS	481.59	2.33	481.59	0
	MS4	867.25	4.19	867.25	0
	MSGP	35.50	0.17	35.50	0
	Blue Plains WWTP (DC0021199)	111.04	0.54	85414.92	0*
	Washington Navy Yard (DC0000141)[5]	159.72	0.77	159.72	0
	Point Sources/WLAs	**1655.09**	**8.00**	**86958.97**	**0***
	Total Anacostia #1	**20696.72**	**100**	**137176.63**	**0***

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

*Due to the endpoint selected to represent the PAH 1 group, in some cases a negative percent reduction is called for but are presented as zero because the PAHs in the PAH 1 group do not need to be reduced from those sources.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-21 Annual Loads for the PAH 2 Group

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Nash Run	MD Upstream Load[1]	133.48	27.83	0	100
	Contaminated Sites	99.33	20.71	0	100
	Nonpoint Sources/LAs	**232.81**	**48.54**	**0**	**100**
	MS4	246.81	51.46	0	100
	Point Sources/WLAs	**246.81**	**51.46**	**0**	**100**
	Total Nash Run	**479.62**	**100**	**0**	**100**
Hickey Run[2]	MS4	666.17	89.23	0	100
	MSGP	80.37	10.77	0	100
	Point Sources/WLAs	**746.54**	**100**	**0**	**100**
	Total Hickey Run	**746.54**	**100**	**0**	**100**
Kingman Lake[2]	MS4	234.58	100	0	100
	Point Sources/WLAs	**234.58**	**100**	**0**	**100**
	Total Kingman Lake	**234.58**	**100**	**0**	**100**
Popes Branch[2]	DC MS4	127.78	100	0	100
	Point Sources/WLAs	**127.78**	**100**	**0**	**100**
	Total Popes Branch	**127.78**	**100**	**0**	**100**
Texas Avenue Tributary[2]	MS4	130.92	100	0	100
	Point Sources/WLAs	**130.92**	**100**	**0**	**100**
	Total Texas Avenue Tributary	**130.92**	**100**	**0**	**100**
Anacostia #2[3]	Upstream Loads				
	MD Upstream Load[4]	32392.79	73.81	5.81	99.98
	Cumulative Load from Tributaries	9445.68	21.52	0.06	100
	Load from Kingman Lake	234.58	0.53	0	100
	Cumulative Upstream Load	**42073.05**	**95.87**	**5.87**	**99.99**
	Anacostia #2 Direct Drainage				
	Contaminated Sites	81.08	0.18	0	100
	Nonpoint Sources/LAs	**81.08**	**0.18**	**0**	**100**
	Anacostia #2 Direct Drainage				
	MS4	994.83	2.27	0	100
	MSGP	3.75	0.01	0	100

Anacostia #2[3] **(continued)**	Pepco (DC0000094)[5]	735.08	1.67	0.02	100
	Point Sources/WLAs	**1733.67**	**3.95**	**0.02**	**100**
	Total Anacostia #2	**43887.80**	**100**	**5.89**	**99.99**
Fort Stanton Tributary[2]	MS4	188.52	100	0	100
	Point Sources/WLAs	**188.52**	**100**	**0**	**100**
	Total Fort Stanton Tributary	**188.52**	**100**	**0**	**100**
Anacostia #1[6]	Upstream Loads				
	Cumulative Load from Anacostia #2	43887.80	88.22	5.89	99.99
	Cumulative Load from Tributaries	188.52	0.38	0	100
	Cumulative Upstream Load	**44076.31**	**88.60**	**5.89**	**99.99**
	Anacostia #1 Direct Drainage				
	Contaminated Sites	1883.21	3.79	0	100
	Nonpoint Sources/LAs	**1883.21**	**3.79**	**0**	**100**
	Anacostia #1 Direct Drainage				
	CSS	1145.92	2.30	0	100
	MS4	1868.80	3.76	0	100
	MSGP	84.43	0.17	0	100
	Blue Plains WWTP (DC0021199)	2.22	0	2.22	0
	Washington Navy Yard (DC0000141)[5]	685.23	1.38	0	100
	Point Sources/WLAs	**3786.60**	**7.61**	**2.22**	**99.94**
	Total Anacostia #1	**49746.12**	**100**	**8.11**	**99.98**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is given for these segments because all stormwater runoff is captured by the MS4.

[3]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table 6-22 Annual Loads for the PAH 3 Group

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Nash Run	MD Upstream Load[1]	109.544	27.52	0	100
	Contaminated Sites	85.432	21.46	0	100
	Nonpoint Sources/LAs	**194.976**	**48.98**	**0**	**100**

Nash Run	MS4	203.136	51.02	0	100
	Point Sources/WLAs	**203.136**	**51.02**	**0**	**100**
	Total Nash Run	**398.112**	**100**	**0**	**100**
Hickey Run[2]	MS4	548.047	89.33	0	100
	MSGP	65.433	10.67	0	100
	Point Sources/WLAs	**613.480**	**100**	**0**	**100**
	Total Hickey Run	**613.480**	**100**	**0**	**100**
Kingman Lake[2]	MS4	194.646	100	0	100
	Point Sources/WLAs	**194.646**	**100**	**0**	**100**
	Total Kingman Lake	**194.646**	**100**	**0**	**100**
Popes Branch[2]	MS4	105.882	100	0	100
	Point Sources/WLAs	**105.882**	**100**	**0**	**100**
	Total Popes Branch	**105.882**	**100**	**0**	**100**
Texas Avenue Tributary[2]	MS4	108.108	100	0	100
	Point Sources/WLAs	**108.108**	**100**	**0**	**100**
	Total Texas Avenue Tributary	**108.108**	**100**	**0**	**100**
Anacostia #2[3]	Upstream Loads				
	MD Upstream Load[4]	26746.870	73.91	0.616	100
	Cumulative Load from Tributaries	7768.875	21.47	0.006	100
	Load from Kingman Lake	194.646	0.54	0	100
	Cumulative Upstream Load	**34710.390**	**95.91**	**0.622**	**100**
	Anacostia #2 Direct Drainage				
	Contaminated Sites	67.567	0.19	0	100
	Nonpoint Sources/LAs	**67.567**	**0.19**	**0**	**100**
	Anacostia #2 Direct Drainage				
	MS4	818.190	2.26	0	100
	MSGP	3.075	0.01	0	100
	Pepco (DC0000094)[5]	590.125	1.63	0.002	100
	Point Sources/WLAs	**1411.390**	**3.90**	**0**	**100**
	Total Anacostia #2	**36189.346**	**100**	**0.624**	**100**
Fort Stanton Tributary[2]	MS4	154.676	100	0	100
	Point Sources/WLAs	**154.676**	**100**	**0**	**100**
	Total Fort Stanton Tributary	**154.676**	**100**	**0**	**100**
Anacostia #1[6]	Upstream Loads				
	Cumulative Load from Anacostia #2	36189.346	88.31	0.624	100
	Cumulative Load from Tributaries	154.676	0.38	0	100
	Cumulative Upstream Load	**36344.022**	**88.68**	**0.624**	**100**
	Anacostia #1 Direct Drainage				
	Contaminated Sites	1540.955	3.76	0	100
	Nonpoint Sources/LAs	**1540.955**	**3.76**	**0**	**100**
	Anacostia #1 Direct Drainage				
	CSS	936.299	2.28	0	100

Anacostia #1[6] (continued)	MS4	1533.128	3.74	0	100
	MSGP	68.740	0.17	0	100
	Blue Plains WWTP (DC0021199)	0.222	0	0.222	0
	Washington Navy Yard (DC0000141)[5]	558.308	1.36	0	100
	Point Sources/WLAs	**3096.698**	**7.56**	**0.222**	**100**
	Total Anacostia #1	**40981.675**	**100**	**0.846**	**100**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]Loads presented for the Anacostia #2 segment are cumulative. The loads for Anacostia #2 include loads from Maryland Anacostia Tidal Segment, Kingman Lake, tributaries to Anacostia #2, and direct drainage.

[4]Upstream loads from Maryland include loads from the Maryland Anacostia Tidal Segment watershed comprising the Northeast Branch, Northwest Branch, and direct drainage to the Maryland Anacostia Tidal Segment, as well as upstream loads from the Maryland portion of the Lower Beaverdam Creek, Watts Branch, and Nash Run which drain directly to District waters.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[6]Loads presented for the Anacostia #1 segment are cumulative. The loads for Anacostia #1 include cumulative loads from Anacostia #2, tributaries to Anacostia #1, and direct drainage.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

6.5 Contaminated Site LAs

In Tables 6-3 through 6-22, the loads associated with the contaminated sites are consolidated into one row. Tables 6-23 through 6-42 expand on that consolidated row and provide individual LAs for each contaminated site. Tables 6-23 through 6-32 provide daily LAs for each contaminated site for each pollutant. Tables 6-33 through 6-42 provide annual LAs for each contaminated site for each pollutant.

6.5.1 Daily LAs

Table 6-23 Contaminated Site Daily LAs for Arsenic

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	0.24
Fort Dupont Creek	CSX	0.18
Anacostia #2	CSX	1.34
	Kenilworth Park Landfill North	4.77
	Kenilworth Park Landfill South	0.67
Anacostia #1	Firth Sterling Steel	0.16
	Former Hess Petroleum Terminal	10.54
	Former Steuart Petroleum	0.40
	Fort McNair	2.61
	JBAB AOC 1	0.20
	JBAB Site 1	0.35

Anacostia #1 (continued)	JBAB Site 2	13.47
	JBAB Site 3	0.64
	Joint Base Anacostia-Bolling (JBAB)	0.06
	Poplar Point	11.73
	Southeast Federal Center	6.55
	Washington Gas	4.59

Table 6-24 Contaminated Site Daily LAs for Copper

Segment	Contaminated Site	LA (g/day)
Anacostia #2	CSX	85.69
	Kenilworth Park Landfill North	399.5
	Kenilworth Park Landfill South	87.45
Anacostia #1	Firth Sterling Steel	17.31
	Former Hess Petroleum Terminal	922
	Former Steuart Petroleum	50.05
	Fort McNair	274.15
	JBAB AOC 1	20.31
	JBAB Site 1	53.85
	JBAB Site 2	1719.75
	JBAB Site 3	70.07
	Joint Base Anacostia-Bolling (JBAB)	6.1
	Poplar Point	1107.53
	Southeast Federal Center	749.9
	Washington Gas	562.35

Table 6-25 Contaminated Site Daily LAs for Zinc

Segment	Contaminated Site	LA (g/day)
Anacostia #2	CSX	570.23
	Kenilworth Park Landfill North	948.47
	Kenilworth Park Landfill South	198.16
Anacostia #1	Firth Sterling Steel	13.04
	Former Hess Petroleum Terminal	1839.54
	Former Steuart Petroleum	40.53
	Fort McNair	232.26
	JBAB AOC 1	25.33
	JBAB Site 1	82.03
	JBAB Site 2	2371.23
	JBAB Site 3	54.06

Anacostia #1 (continued)	Joint Base Anacostia-Bolling (JBAB)	11.88
	Poplar Point	966.95
	Southeast Federal Center	2177.94
	Washington Gas	504.85

Table 6-26 Contaminated Site Daily LAs for Chlordane

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	1.28E-03
Watts Branch	Kenilworth Park Landfill North	1.18E-03
Anacostia #2	CSX	5.70E-03
	Kenilworth Park Landfill North	1.98E-02
	Kenilworth Park Landfill South	4.02E-03
Anacostia #1	Firth Sterling Steel	2.79E-04
	Former Hess Petroleum Terminal	2.05E-02
	Former Steuart Petroleum	8.36E-04
	Fort McNair	5.43E-03
	JBAB AOC 1	4.18E-04
	JBAB Site 1	9.75E-04
	JBAB Site 2	3.08E-02
	JBAB Site 3	1.25E-03
	Joint Base Anacostia-Bolling (JBAB)	1.39E-04
	Poplar Point	2.62E-02
	Southeast Federal Center	2.02E-02
	Washington Gas	9.19E-03

Table 6-27 Contaminated Site Daily LAs for DDT and its Metabolites

Segment	Contaminated Site	LA (g/day)
Anacostia #2	CSX	4.82E-04
	Kenilworth Park Landfill North	4.88E-03
	Kenilworth Park Landfill South	1.02E-03
Anacostia #1	Firth Sterling Steel	5.18E-05
	Former Hess Petroleum Terminal	1.91E-03
	Former Steuart Petroleum	1.55E-04
	Fort McNair	1.09E-03
	JBAB AOC 1	5.18E-05
	JBAB Site 1	1.04E-04
	JBAB Site 2	3.42E-03
	JBAB Site 3	2.07E-04
	Joint Base Anacostia-Bolling (JBAB)	0

Anacostia #1 (continued)	Poplar Point	5.90E-03
	Southeast Federal Center	1.97E-03
	Washington Gas	1.29E-03

Table 6-28 Contaminated Site Daily LAs for Dieldrin

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	0
Watts Branch	Kenilworth Park Landfill North	0
Anacostia #2	CSX	0
	Kenilworth Park Landfill North	0
	Kenilworth Park Landfill South	0
Anacostia #1	Firth Sterling Steel	0
	Former Hess Petroleum Terminal	0
	Former Steuart Petroleum	0
	Fort McNair	0
	JBAB AOC 1	0
	JBAB Site 1	0
	JBAB Site 2	0
	JBAB Site 3	0
	Joint Base Anacostia-Bolling (JBAB)	0
	Poplar Point	0
	Southeast Federal Center	0
	Washington Gas	0

Table 6-29 Contaminated Site Daily LAs for Heptachlor Epoxide

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	2.64E-04
Anacostia #2	CSX	7.26E-04
	Kenilworth Park Landfill North	2.76E-03
	Kenilworth Park Landfill South	5.81E-04
Anacostia #1	Firth Sterling Steel	0
	Former Hess Petroleum Terminal	2.96E-03
	Former Steuart Petroleum	1.56E-04
	Fort McNair	7.80E-04
	JBAB AOC 1	0
	JBAB Site 1	1.56E-04
	JBAB Site 2	4.37E-03
	JBAB Site 3	1.56E-04
	Joint Base Anacostia-Bolling (JBAB)	0

Anacostia #1 (continued)	Poplar Point	4.05E-03
	Southeast Federal Center	2.18E-03
	Washington Gas	1.09E-03

Table 6-30 Contaminated Site Daily LAs for the PAH 1 Group

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	6.17
Anacostia #2	CSX	2.42
	Kenilworth Park Landfill North	7.94
	Kenilworth Park Landfill South	1.64
Anacostia #1	Firth Sterling Steel	0.07
	Former Hess Petroleum Terminal	4.62
	Former Steuart Petroleum	0.19
	Fort McNair	1.21
	JBAB AOC 1	0.09
	JBAB Site 1	0.21
	JBAB Site 2	6.81
	JBAB Site 3	0.29
	Joint Base Anacostia-Bolling (JBAB)	0.03
	Poplar Point	5.76
	Southeast Federal Center	5.86
	Washington Gas	2.05

Table 6-31 Contaminated Site Daily LAs for the PAH 2 Group

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	0
Anacostia #2	CSX	0
	Kenilworth Park Landfill North	0
	Kenilworth Park Landfill South	0
Anacostia #1	Firth Sterling Steel	0
	Former Hess Petroleum Terminal	0
	Former Steuart Petroleum	0
	Fort McNair	0
	JBAB AOC 1	0
	JBAB Site 1	0
	JBAB Site 2	0
	JBAB Site 3	0
	Joint Base Anacostia-Bolling (JBAB)	0
	Poplar Point	0

Anacostia #1 (continued)	Southeast Federal Center	0
	Washington Gas	0

Table 6-32 Contaminated Site Daily LAs for the PAH 3 Group

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	0
Anacostia #2	CSX	0
	Kenilworth Park Landfill North	0
	Kenilworth Park Landfill South	0
Anacostia #1	Firth Sterling Steel	0
	Former Hess Petroleum Terminal	0
	Former Steuart Petroleum	0
	Fort McNair	0
	JBAB AOC 1	0
	JBAB Site 1	0
	JBAB Site 2	0
	JBAB Site 3	0
	Joint Base Anacostia-Bolling (JBAB)	0
	Poplar Point	0
	Southeast Federal Center	0
	Washington Gas	0

6.5.2 Annual LAs

Table 6-33 Contaminated Site Annual LAs for Arsenic

Segment	Contaminated Site	LA (g/year)
Nash Run	Kenilworth Park Landfill North	0.79
Fort Dupont Creek	CSX	0.32
Anacostia #2	CSX	0.49
	Kenilworth Park Landfill North	1.73
	Kenilworth Park Landfill South	0.24
Anacostia #1	Firth Sterling Steel	0.02
	Former Hess Petroleum Terminal	1.62
	Former Steuart Petroleum	0.06
	Fort McNair	0.40
	JBAB AOC 1	0.03
	JBAB Site 1	0.05
	JBAB Site 2	2.07
	JBAB Site 3	0.10

Anacostia #1 (continued)	Joint Base Anacostia-Bolling (JBAB)	0.01
	Poplar Point	1.81
	Southeast Federal Center	1.01
	Washington Gas	0.71

Table 6-34 Contaminated Site Annual LAs for Copper

Segment	Contaminated Site	LA (g/year)
Anacostia #2	CSX	77.26
	Kenilworth Park Landfill North	360.1836
	Kenilworth Park Landfill South	78.85
Anacostia #1	Firth Sterling Steel	6.78
	Former Hess Petroleum Terminal	361.03
	Former Steuart Petroleum	19.6
	Fort McNair	107.35
	JBAB AOC 1	7.95
	JBAB Site 1	21.09
	JBAB Site 2	673.41
	JBAB Site 3	27.44
	Joint Base Anacostia-Bolling (JBAB)	2.39
	Poplar Point	433.68
	Southeast Federal Center	293.64
	Washington Gas	220.2

Table 6-35 Contaminated Site Annual LAs for Zinc

Segment	Contaminated Site	LA (g/year)
Anacostia #2	CSX	1127.603
	Kenilworth Park Landfill North	1875.541
	Kenilworth Park Landfill South	391.8396
Anacostia #1	Firth Sterling Steel	34.19
	Former Hess Petroleum Terminal	4821.88
	Former Steuart Petroleum	106.23
	Fort McNair	608.82
	JBAB AOC 1	66.40
	JBAB Site 1	215.03
	JBAB Site 2	6215.57
	JBAB Site 3	141.70
	Joint Base Anacostia-Bolling (JBAB)	31.15
	Poplar Point	2534.62
	Southeast Federal Center	5708.90
	Washington Gas	1323.34

Table 6-36 Contaminated Site Annual LAs for Chlordane

Segment	Contaminated Site	LA (g/year)
Nash Run	Kenilworth Park Landfill North	7.10E-03
Watts Branch	Kenilworth Park Landfill North	8.20E-03
Anacostia #2	CSX	4.40E-03
	Kenilworth Park Landfill North	1.53E-02
	Kenilworth Park Landfill South	3.10E-03
Anacostia #1	Firth Sterling Steel	2.00E-04
	Former Hess Petroleum Terminal	1.47E-02
	Former Steuart Petroleum	6.00E-04
	Fort McNair	3.90E-03
	JBAB AOC 1	3.00E-04
	JBAB Site 1	7.00E-04
	JBAB Site 2	2.21E-02
	JBAB Site 3	9.00E-04
	Joint Base Anacostia-Bolling (JBAB)	1.00E-04
	Poplar Point	1.88E-02
	Southeast Federal Center	1.45E-02
	Washington Gas	6.60E-03

Table 6-37 Contaminated Site Annual LAs for DDT and its Metabolites

Segment	Contaminated Site	LA (g/year)
Anacostia #2	CSX	8.00E-04
	Kenilworth Park Landfill North	8.10E-03
	Kenilworth Park Landfill South	1.70E-03
Anacostia #1	Firth Sterling Steel	1.00E-04
	Former Hess Petroleum Terminal	3.70E-03
	Former Steuart Petroleum	3.00E-04
	Fort McNair	2.10E-03
	JBAB AOC 1	1.00E-04
	JBAB Site 1	2.00E-04
	JBAB Site 2	6.60E-03
	JBAB Site 3	4.00E-04
	Joint Base Anacostia-Bolling (JBAB)	0
	Poplar Point	1.14E-02
	Southeast Federal Center	3.80E-03
	Washington Gas	2.50E-03

Table 6-38 Contaminated Site Annual LAs for Dieldrin

Segment	Contaminated Site	LA (g/year)
Nash Run	Kenilworth Park Landfill North	0
Watts Branch	Kenilworth Park Landfill North	0
Anacostia #2	CSX	0
	Kenilworth Park Landfill North	0
	Kenilworth Park Landfill South	0
Anacostia #1	Firth Sterling Steel	0
	Former Hess Petroleum Terminal	0
	Former Steuart Petroleum	0
	Fort McNair	0
	JBAB AOC 1	0
	JBAB Site 1	0
	JBAB Site 2	0
	JBAB Site 3	0
	Joint Base Anacostia-Bolling (JBAB)	0
	Poplar Point	0
	Southeast Federal Center	0
	Washington Gas	0

Table 6-39 Contaminated Site Annual LAs for Heptachlor Epoxide

Segment	Contaminated Site	LA (g/year)
Nash Run	Kenilworth Park Landfill North	1.00E-03
Anacostia #2	CSX	5.00E-04
	Kenilworth Park Landfill North	1.90E-03
	Kenilworth Park Landfill South	4.00E-04
Anacostia #1	Firth Sterling Steel	0
	Former Hess Petroleum Terminal	1.90E-03
	Former Steuart Petroleum	1.00E-04
	Fort McNair	5.00E-04
	JBAB AOC 1	0
	JBAB Site 1	1.00E-04
	JBAB Site 2	2.80E-03
	JBAB Site 3	1.00E-04
	Joint Base Anacostia-Bolling (JBAB)	0
	Poplar Point	2.60E-03
	Southeast Federal Center	1.40E-03
	Washington Gas	7.00E-04

Table 6-40 Contaminated Site Annual LAs for the PAH 1 Group

Segment	Contaminated Site	LA (g/year)
Nash Run	Kenilworth Park Landfill North	36.42
Anacostia #2	CSX	24.13
	Kenilworth Park Landfill North	79.13
	Kenilworth Park Landfill South	16.31
Anacostia #1	Firth Sterling Steel	1.20
	Former Hess Petroleum Terminal	79.49
	Former Steuart Petroleum	3.29
	Fort McNair	20.82
	JBAB AOC 1	1.55
	JBAB Site 1	3.55
	JBAB Site 2	117.07
	JBAB Site 3	5.01
	Joint Base Anacostia-Bolling (JBAB)	0.48
	Poplar Point	98.97
	Southeast Federal Center	100.77
	Washington Gas	35.32

Table 6-41 Contaminated Site Annual LAs for the PAH 2 Group

Segment	Contaminated Site	LA (g/year)
Nash Run	Kenilworth Park Landfill North	0
Anacostia #2	CSX	0
	Kenilworth Park Landfill North	0
	Kenilworth Park Landfill South	0
Anacostia #1	Firth Sterling Steel	0
	Former Hess Petroleum Terminal	0
	Former Steuart Petroleum	0
	Fort McNair	0
	JBAB AOC 1	0
	JBAB Site 1	0
	JBAB Site 2	0
	JBAB Site 3	0
	Joint Base Anacostia-Bolling (JBAB)	0
	Poplar Point	0
	Southeast Federal Center	0
	Washington Gas	0

Table 6-42 Contaminated Site Annual LAs for the PAH 3 Group

Segment	Contaminated Site	LA (g/year)
Nash Run	Kenilworth Park Landfill North	0
Anacostia #2	CSX	0
	Kenilworth Park Landfill North	0
	Kenilworth Park Landfill South	0
Anacostia #1	Firth Sterling Steel	0
	Former Hess Petroleum Terminal	0
	Former Steuart Petroleum	0
	Fort McNair	0
	JBAB AOC 1	0
	JBAB Site 1	0
	JBAB Site 2	0
	JBAB Site 3	0
	Joint Base Anacostia-Bolling (JBAB)	0
	Poplar Point	0
	Southeast Federal Center	0
	Washington Gas	0

6.6 MSGP WLAs

In Tables 6-3 through 6-22, the loads associated with the MSGP are consolidated into one row. Tables 6-43 and 6-44 expand on that consolidated row and provide individual WLAs for individual MSGP facilities. Table 6-43 provides daily WLAs for individual MSGP facilities for each pollutant. Tables 6-44 provides annual WLAs for individual MSGP facilities for each pollutant.

6.6.1 Daily WLAs

Table 6-43 Daily WLAs for Individual MSGP Facilities

Segment	Facility	Drains To	Arsenic (g/day)	Copper (g/day)	Zinc (g/day)	Chlordane (g/day)	DDT (g/day)	Dieldrin (g/day)	Heptachlor Epoxide (g/day)	PAH 1 (g/day)	PAH 2 (g/day)	PAH 3 (g/day)
Hickey Run	DCR053008	MS4	-	-	-	1.22E-03	6.83E-05	-	-	1.31	0	0
	DCR053030	MS4	-	-	-	1.27E-03	7.07E-05	-	-	1.36	0	0
	DCR053043	MS4	-	-	-	2.63E-04	1.47E-05	-	-	0.28	0	0
	DCR053046	MS4	-	-	-	2.08E-04	1.16E-05	-	-	0.22	0	0
	DCR05J000	MS4	-	-	-	5.01E-04	2.80E-05	-	-	0.54	0	0
	DCR05J003	MS4	-	-	-	5.97E-04	3.34E-05	-	-	0.64	0	0
Anacostia #2	DCR05J004	MS4	10.18	3129.14	3238.74	4.35E-02	1.74E-03	0	6.14E-03	20.25	0	0
Anacostia #1	DCR050002	MS4	0.21	96.17	52.69	1.19E-03	4.02E-05	0	1.30E-04	0.02	0	0
	DCR053010	Anacostia River	2.05	959.78	525.87	1.19E-02	4.01E-04	0	1.30E-03	0.22	0	0
	DCR053015	CSS	1.23	577.08	316.19	7.14E-03	2.41E-04	0	7.81E-04	0.13	0	0
	DCR053016	MS4	0.88	410.40	224.86	5.08E-03	1.71E-04	0	5.56E-04	0.09	0	0
	DCR053018	Anacostia River	0.52	242.47	132.85	3.00E-03	1.01E-04	0	3.28E-04	0.06	0	0
	DCR053024	MS4	0.36	169.51	92.87	2.10E-03	7.08E-05	0	2.29E-04	0.04	0	0
	DCR053030	CSS	10.20	4767.82	2612.33	5.90E-02	1.99E-03	0	6.45E-03	1.08	0	0
	DCR053056	Anacostia River	0.61	283.30	155.22	3.51E-03	1.18E-04	0	3.84E-04	0.06	0	0
	DCR05J000	CSS	2.95	1378.47	755.28	1.71E-02	5.76E-04	0	1.87E-03	0.31	0	0

Note: Hickey Run is not listed as impaired for arsenic, copper, zinc, dieldrin, and heptachlor epoxide but WLAs for each MSGP facility for those pollutants are in a separate table in Appendix A.

6.6.2 Annual WLAs

Table 6-44 Annual WLAs for Individual MSGP Facilities

Segment	Facility	Drains To	Arsenic (g/year)	Copper (g/year)	Zinc (g/year)	Chlordane (g/year)	DDT (g/year)	Dieldrin (g/year)	Heptachlor Epoxide (g/year)	PAH 1 (g/year)	PAH 2 (g/year)	PAH 3 (g/year)
Hickey Run	DCR053008	MS4	-	-	-	7.80E-03	2.71E-04	-	-	10.22	0	0
	DCR053030	MS4	-	-	-	8.08E-03	2.81E-04	-	-	10.58	0	0
	DCR053043	MS4	-	-	-	1.68E-03	5.84E-05	-	-	2.20	0	0
	DCR053046	MS4	-	-	-	1.32E-03	4.60E-05	-	-	1.74	0	0
	DCR05J000	MS4	-	-	-	3.20E-03	1.11E-04	-	-	4.19	0	0
	DCR05J003	MS4	-	-	-	3.81E-03	1.32E-04	-	-	4.99	0	0
Anacostia #2	DCR05J004	MS4	6.08	2560.22	4415.59	2.92E-02	1.10E-03	0	3.60E-03	38.02	0	0
Anacostia #1	DCR050002	MS4	0.12	52.54	91.06	6.08E-04	2.16E-05	0	6.71E-05	0.80	0	0
	DCR053010	Anacostia River	1.19	524.30	908.77	6.07E-03	2.16E-04	0	6.70E-04	7.94	0	0
	DCR053015	CSS	0.72	315.24	546.41	3.65E-03	1.30E-04	0	4.03E-04	4.77	0	0
	DCR053016	MS4	0.51	224.19	388.59	2.60E-03	9.24E-05	0	2.86E-04	3.40	0	0
	DCR053018	Anacostia River	0.30	132.45	229.58	1.53E-03	5.46E-05	0	1.69E-04	2.01	0	0
	DCR053024	MS4	0.21	92.60	160.50	1.07E-03	3.82E-05	0	1.18E-04	1.40	0	0
	DCR053030	CSS	5.94	2604.52	4514.42	3.02E-02	1.07E-03	0	3.33E-03	39.45	0	0
	DCR053056	Anacostia River	0.35	154.76	268.25	1.79E-03	6.38E-05	0	1.98E-04	2.34	0	0
	DCR05J000	CSS	1.72	753.02	1305.20	8.72E-03	3.10E-04	0	9.62E-04	11.41	0	0

Note: Hickey Run is not listed as impaired for arsenic, copper, zinc, dieldrin, and heptachlor epoxide but WLAs for each MSGP facility for those pollutants are in a separate table in Appendix A.

6.7 Margin of Safety

Under the CWA, a TMDL must provide a "margin of safety (MOS) which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality." 33 U.S.C. 1313(d)(1)(C). The MOS can account for uncertainty in the load estimates and the simulation process affecting pollutant fate and transport. There are two ways to incorporate the MOS: (1) implicitly by using conservative model assumptions to develop allocations or (2) explicitly by specifying a portion of the TMDL as the MOS and using the remainder for allocations. (U.S. EPA, 1991). *Anacostia Riverkeeper v. Jackson,* 798 F. Supp. 2d 210 (D.D.C., 2011).

The modeling framework applied to develop these TMDLs was calibrated against monitoring data collected throughout the watershed and from impaired waterbodies. Although these monitoring data represented actual conditions, they were not of a continuous time series and might not have captured the full range of in-stream conditions that occurred during the simulation period. Capturing the full range of in-stream conditions was difficult for some of these toxic pollutants since the method detection limit is above WQC, and confidence in model predictions below the method detection limit was difficult to discern. An implicit MOS was selected to account for those cases when monitoring might not have captured the full range of in-stream conditions.

There is an implicit margin of safety achieved through the adoption of conservative analyses and modeling assumptions. Conservative assumptions include the following:

- Regulated WWTPs' WLAs are represented at the maximum allowable permitted concentration as opposed to actual discharges from the WWTP.
- DC Water's Blue Plains Advanced Wastewater Treatment Plant (WWTP) at outfall 019 is represented as an active individual point source and is assigned a wasteload allocation even though it no longer discharges.
- Modeled total DDT and used the most stringent of the metabolite criteria (DDE) as the TMDL endpoint for allocations. Using the most stringent of the applicable criteria for the three parameters as the endpoint ensures that the criterion for that individual, most stringent metabolite is met. Further, doing so is more protective than required for the other DDT metabolites that have less stringent criteria. The TMDL ensures that the sum of all metabolites of DDT will not exceed the criteria associated with the most stringent metabolite, meaning that the metabolites individually will be below their criteria threshold, especially those metabolites with less stringent criteria.
- The 13 PAHs were placed into three groups based on ring structure, using the most stringent criterion within each group as the TMDL endpoint for allocations. Using the most stringent criterion to represent an entire PAH group as the TMDL endpoint ensures that the criterion for that individual most stringent PAH is met. Further, it is more protective than required for the other individual PAHs within that group that have less stringent criteria. Similar to above, the TMDL ensures that the sum of all PAHs within each group will not exceed the criterion associated with the most stringent PAH, meaning that each PAH individually will be below their criteria threshold, especially those with criteria that are less stringent than the most stringent PAH in that group.

- TMDLs were developed based on the entire simulated period of 2014-2017 to incorporate the widest range in environmental conditions rather than a shorter period of time, which may not include relatively wet or dry periods. A review of the associated weather data showed that the 2014-2017 simulation period captured a wide range of conditions and included high and low river flow periods.
- For non-stormwater NPDES facilities that had no DMR monitoring data for use in setting existing conditions, all pollutant concentrations were represented at criteria except for PAH 1[2].
- When water quality monitoring data recorded a non-detect, concentrations were applied at approximately half the detection limit during model setup and calibration. This overestimates baseline concentrations when toxicant values fell below half the detection limit.

6.8 Critical Conditions and Seasonal Variations

EPA regulations [40 C.F.R. 130.7(c)(1)] require TMDLs to account for critical conditions for stream flow, loading, and water quality parameters to ensure that the water quality and designated uses of the waterbodies are protected during periods when they are most vulnerable. Critical conditions include combinations of environmental factors that result in attaining and maintaining the endpoints and have an acceptably low frequency of occurrence (U.S. EPA, 2001). Critical conditions for stream flow, loading, and water quality parameters are captured in the modeling framework for these TMDLs.

Toxic pollutant TMDLs for the Anacostia River watershed adequately address critical conditions for flow by using a dynamic model and analysis of all flow conditions in the basin. Available water quality and flow data show that critical conditions for toxic parameters in the watershed occur under all conditions (i.e., under both low flow and high flow scenarios). For example, during wet periods with high flow, stormwater runoff results in water quality exceedances while during dry periods, flux from contaminated bed sediments result in water quality exceedances. Therefore, the use of a dynamic modeling application capable of representing conditions resulting from both low and high flow regimes is appropriate. In addition, the dynamic modeling platform simulates water quality on an hourly time step, ensuring that acute conditions, as well as long-term conditions, are considered.

The linkage of the tidal Anacostia River to a dynamic watershed loading model ensures that nonpoint and stormwater source loads from the watershed delivered at times other than the critical period were also considered in the analysis. The TMDLs are based on the entire modeled period of 2014 through 2017.

Critical conditions for toxic pollutant loads were also considered by determining WLAs based on maximum flows from dischargers set by design flows specified in non-stormwater NPDES permits for each facility. Use of design flows in in TMDL development provides additional assurance that, when design flows are reached, the water quality in the stream will meet the TMDL endpoints.

Model simulation of multiple complete years accounted for seasonal variations. Continuous simulation (modeling over a period of several years that captured precipitation extremes) inherently considers

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[2] Criteria for PAH 1 is sufficiently high (5 orders of magnitude higher than other parameters) that setting it to criteria had a disproportional effect on the model results. Consequently, facilities with no PAH 1 monitoring data were set to the maximum detection limit of 0.065 µg/L.

seasonal hydrologic and source loading variability. The pollutant concentrations were simulated on a sub-daily time step, capturing seasonal variation, and allowing for evaluation of critical conditions.

7 CLIMATE CHANGE

As a result of climate change, it is expected that the District will experience warmer average temperatures, more frequent and intense heavy rain events, and higher tides as a result of rising sea level. In fact, in the last 50 years, the District's average annual temperature increased by 2°F (DOEE, 2019). Specifically, within the national park boundaries of Rock Creek, the annual average temperatures increased 2°F from 1950 to 2013, with the greatest increase in summer (NPS, 2017). Average annual rainfall has not changed significantly; however, more rainfall is occurring in the fall and winter and less in the summer (DOEE, 2019). This seasonal increase in rainfall affects the volume and transport of runoff and associated pollutants.

7.1 Climate Change Scenario Methodology

To assess TMDL implications under future climate scenarios, the fate and transport of ten toxic pollutants (Table 1-3) was simulated under conditions of climate induced changes in precipitation quantity and intensity, air temperature, and sea level rise. The projected climate change effects and time horizons selected for this analysis were chosen to be consistent with the Chesapeake Bay Program's medium- to long-term planning outlook (Shenk, et al., 2021). This approach was adopted to align methodology and the future horizons to a larger regional (and widely accepted) modeling effort in the Chesapeake Bay. Details of this analysis can be found in Appendix B (Tetra Tech, 2023a).

A climate change analysis was performed for two time horizons: a near-term horizon around 2035 (2034-2037) and a long-term horizon around 2055 (2054-2057). For each time horizon, and for each of the ten toxic pollutants (Table 1-3 Numeric Water Quality Criteria for District Waters), two sets of model runs were conducted:

- The first scenario (Climate Change Scenario) was designed to assess change in water column concentrations for each pollutant group under future climate scenarios in tandem with the TMDL allocation scenario. The model setup used in the climate change analysis was unchanged from the model setup used in developing the TMDL allocation scenario except for the projected changes in the three climate factors (precipitation quantity and intensity, air temperature, and sea level rise).
- The second scenario (Natural Attenuation Scenario) was designed to estimate how long natural attenuation of toxic pollutants in bed sediment will take considering climate change impacts relative to the natural attenuation results documented in the TMDL.

The climate change analysis described herein represents a major revision from the earlier draft of the TMDLs that was released for public notice and comment in 2021.

7.2 Climate Change Scenario Results

7.2.1 Impacts of Climate Change on Tidal Anacostia River Water Quality

The results of the near-term (circa 2035) and long-term (circa 2055) climate change scenarios are shown in Table 7.1 and Table 7.2, respectively. These tables show the difference between the TMDL scenario, which is characterized by watershed TMDL allocations and bed sediment reductions that meet water quality targets under existing climate conditions during 2014-2017, and the climate change scenarios characterized by climate change. In simpler terms, Tables 7.1 and 7.2 present the comparison of water column concentrations between the TMDL scenario and the climate change scenarios (2035 and 2055) across all pollutants. Detailed results of this analysis can be found in Appendix B (Tetra Tech, 2023a).

Results of the LSPC simulations suggest that additional toxicant loads are generated under climate change conditions for both near-term and long-term scenarios due to increased precipitation and associated runoff. For instance, chlordane concentrations consistently increase under both climate change scenarios across all verification units. While some verification unit-pollutant combinations show an increase in predicted toxic water column concentrations under the climate change scenarios (e.g., heptachlor epoxide, DDT and its metabolites, and chlordane), most increase less than five percent.

On the other hand, the tidal Anacostia River receiving these loads shows improvement in some areas for some pollutant groups due to dilution from sea level rise and other hydrologic processes. For example, under both 2035 and 2055 scenarios (Tables 7.1 and 7.2, respectively), PAH concentrations improve consistently throughout all verification units (with exception of Anacostia #1-2 for PAH 1), as do metals (with few exceptions) and Dieldrin.

Although there are few increases in toxicant concentrations in these areas, only one toxicant exceeds the TMDL water column target in only one verification unit. The maximum 30-day average heptachlor epoxide concentrations exceed the TMDL target in the Anacostia 1-1 verification unit in the 2055 climate change scenario (Table 7.2). This is the only verification unit and contaminant that would exceed the water column TMDL target under near-term or long-term climate change conditions.

The organochlorine pesticides, on the other hand, tend to increase in concentration, except for dieldrin. In general, verification units downstream of Anacostia verification unit 2-7 (Figure 5-1) are negatively impacted by climate change, likely due to increased CSS contributions within this region. This is particularly evident in the 2055 scenario for which there is a greater intensification of precipitation. However, as noted previously in Section 3.2.2, the TMDL model does not account for the on-the-ground changes due to the operation of the Anacostia tunnel system; therefore, the simulated increase of pesticides due to increased CSS contributions may be prevented to a certain extent by the operation of the Anacostia tunnel system.

Table 7.1 Comparison of the TMDL and near-term 2035 scenario water column results (maximum 30-day average concentration) for the tidal Anacostia River by verification unit and toxicant.

2035 Climate Change Scenario	Pollutant:	Arsenic	Copper	Zinc	Heptachlor epoxide	Chlordane	Dieldrin	DDT	PAH 1	PAH 2	PAH 3	
	TMDL Endpoint (µg/l):	0.14	8.96	117.18	3.20E-05	3.20E-04	1.20E-06	1.80E-05	50.00	1.30E-03	1.30E-04	
	Verification Unit	Change in Maximum 30-day Average Concentration (%)										Average:
Upstream	Anacostia #2-10	-0.2%	-1.3%	-2.5%	3.7%	3.2%	-4.3%	2.8%	-4.8%	-2.3%	-1.9%	-0.7%
	Anacostia #2-9	-2.7%	-2.2%	-4.9%	3.7%	3.3%	-5.8%	2.9%	-6.5%	-4.6%	-4.4%	-2.1%
	Anacostia #2-8	-3.4%	-2.8%	-6.2%	3.7%	3.2%	-6.7%	2.8%	-4.0%	-5.9%	-5.6%	-2.5%
	Kingman Lake-2	-1.2%	-0.9%	-0.4%	3.6%	3.3%	-4.8%	3.0%	-10.1%	-1.6%	-1.8%	-1.1%
	Anacostia #2-7	-3.7%	-2.5%	-5.4%	4.0%	3.6%	-6.5%	3.2%	-6.3%	-5.6%	-5.3%	-2.4%
	Anacostia #2-6	-3.6%	-1.7%	-4.6%	1.0%	4.4%	-5.5%	4.0%	-10.4%	-4.9%	-4.3%	-2.6%
	Kingman Lake-1	-2.4%	-1.5%	-3.7%	4.6%	4.4%	-5.8%	4.0%	-12.1%	-4.1%	-3.9%	-2.1%
	Anacostia #2-5	-3.1%	-1.5%	-3.9%	0.1%	4.4%	-5.0%	4.1%	-16.3%	-4.3%	-3.5%	-2.9%
	Anacostia #2-4	-2.5%	-1.4%	-3.8%	0.1%	4.2%	-4.7%	3.8%	-18.2%	-3.5%	-3.2%	-2.9%
	Anacostia #2-3	-2.2%	-1.6%	-4.1%	-0.6%	4.3%	-4.4%	2.2%	-14.7%	-3.6%	-3.2%	-2.8%
	Anacostia #2-2	-2.0%	-1.6%	-4.2%	-1.2%	4.3%	-4.3%	1.0%	-13.5%	-3.4%	-3.1%	-2.8%
	Anacostia #2-1	-1.8%	-1.5%	-4.2%	-1.2%	4.3%	-4.2%	-0.5%	-12.3%	-3.3%	-3.0%	-2.8%
	Anacostia #1-2	-1.2%	-1.5%	-4.4%	-0.9%	4.1%	-3.8%	-0.4%	-8.5%	-2.9%	-2.6%	-2.2%
Downstream	Anacostia #1-1	-0.3%	-1.6%	-3.7%	3.9%	3.6%	-1.3%	-0.1%	0.3%	-1.4%	-1.2%	-0.2%
	Average:	-1.7%	-1.4%	-3.4%	1.9%	3.7%	-4.4%	2.3%	-8.7%	-3.3%	-3.0%	-1.8%

30-day avg concentration decrease ≥ 5%

Table 7.2 Comparison of the TMDL and near-term 2055 scenario water column results (maximum 30-day average concentration) for the tidal Anacostia River by verification unit and toxicant.

2055 Climate Change Scenario	Pollutant:	Arsenic	Copper	Zinc	Heptachlor epoxide	Chlordane	Dieldrin	DDT	PAH 1	PAH 2	PAH 3	
	TMDL Endpoint (µg/l):	0.14	8.96	117.18	3.20E-05	3.20E-04	1.20E-06	1.80E-05	50.00	1.30E-03	1.30E-04	
	Verification Unit	Change in Maximum 30-day Average Concentration (%)										Average:
Upstream	Anacostia #2-10	0.3%	-0.2%	-5.5%	4.6%	3.9%	-9.5%	3.3%	-10.5%	-5.5%	-5.0%	-2.4%
	Anacostia #2-9	-2.8%	-1.9%	-11.5%	4.6%	4.0%	-12.7%	3.4%	-11.4%	-10.7%	-10.2%	-4.9%
	Anacostia #2-8	-5.7%	-3.2%	-13.9%	4.3%	3.8%	-14.2%	3.3%	-6.3%	-13.1%	-12.6%	-5.8%
	Kingman Lake-2	-1.2%	1.7%	3.7%	4.7%	4.3%	-8.2%	3.9%	-27.1%	-0.3%	-1.5%	-2.0%
	Anacostia #2-7	-7.5%	-3.3%	-12.2%	5.6%	5.0%	-13.8%	4.4%	-11.2%	-12.6%	-12.2%	-5.8%
	Anacostia #2-6	-7.1%	-0.8%	-9.5%	3.2%	6.6%	-11.5%	5.9%	-17.8%	-10.5%	-9.4%	-5.1%
	Kingman Lake-1	-4.0%	-1.1%	-5.3%	6.7%	6.2%	-11.2%	5.7%	-26.3%	-6.7%	-6.7%	-4.3%
	Anacostia #2-5	-6.4%	-1.3%	-8.1%	2.2%	6.4%	-10.3%	5.8%	-18.4%	-8.7%	-7.5%	-4.6%
	Anacostia #2-4	-4.9%	-2.2%	-7.7%	1.9%	5.9%	-9.7%	5.3%	-12.8%	-7.3%	-6.8%	-3.8%
	Anacostia #2-3	-4.4%	-2.7%	-8.4%	1.0%	5.8%	-9.2%	3.6%	-11.3%	-7.5%	-6.8%	-4.0%
	Anacostia #2-2	-3.9%	-2.7%	-8.5%	0.4%	5.8%	-9.0%	2.3%	-9.9%	-7.3%	-6.6%	-3.9%
	Anacostia #2-1	-3.4%	-2.5%	-8.5%	-0.2%	5.9%	-8.7%	0.6%	-8.5%	-6.9%	-6.3%	-3.9%
	Anacostia #1-2	-2.1%	-2.4%	-8.8%	-0.8%	6.4%	-7.8%	-0.2%	-3.9%	-6.0%	-5.4%	-3.1%
Downstream	Anacostia #1-1	-0.4%	-2.1%	-6.3%	6.3%	6.3%	-1.9%	0.0%	7.0%	-2.7%	-2.4%	0.4%
	Average:	-2.9%	-1.1%	-6.5%	3.2%	5.2%	-8.9%	3.4%	-10.5%	-6.5%	-6.1%	-3.1%

30-day avg concentration decrease ≥ 5%

30-day avg concentration increase ≥ 5%

Exceeds TMDL Endpoint

7.2.2 Impacts of Climate Change on Natural Attenuation of Bed Sediments

The attenuation timeframes predicted under each of the two climate change scenarios are compared to the attenuation timeframes predicted under the 2014-2017 TMDL allocation scenario to see what the effects of climate change will be on the TMDL allocation scenario and predicted water quality attainment (Tables 6.3 and 6.4).

Across the toxicant groups, there is a negligible change in the duration of natural attenuation of bed sediments, except in the Kingman Lake and Anacostia 1-1 (at the confluence of Potomac River). In particular, pollutant concentrations in bed sediment in the lower verification unit of Kingman Lake (Kingman Lake-1) attenuate more rapidly in both 2035 and 2055 scenarios, whereas concentrations in the Anacostia 1-1 verification unit attenuate more slowly. Greater detail on this analysis can be found in Appendix B (Tetra Tech, 2023a).

Table 7.3 Change in Attenuation Period for the 2035 Climate Change Scenario (years; negative indicates faster attenuation vs. TMDL, positive indicates slower attenuation).

		2035 Climate Change Scenario: Change in Attenuation Period (years: negative indicates faster attenuation vs. TMDL, positive: indicates slower attenuation)									
	Verification Unit	Arsenic	Copper	Zinc*	Heptachlor epoxide	Chlordane	Dieldrin	DDT	PAH 1*	PAH 2	PAH 3
Upstream	Anacostia #2-10	0	0	N/A	0	-1	0	0	N/A	0	0
	Anacostia #2-9	0	0	N/A	0	-1	0	-1	N/A	0	-1
	Anacostia #2-8	1	0	N/A	1	0	0	1	N/A	1	1
	Kingman Lake-2	-2	-1	N/A	0	0	-2	-1	N/A	-1	-2
	Anacostia #2-7	0	0	N/A	-1	-1	-1	-1	N/A	0	0
	Anacostia #2-6	-3	-2	N/A	-1	-1	-3	-2	N/A	1	-3
	Kingman Lake-1	-22	-19	N/A	-19	-23	-3	-15	N/A	-20	-25
	Anacostia #2-5	-1	0	N/A	-1	-1	0	-1	N/A	-2	-1
	Anacostia #2-4	-1	1	N/A	0	-2	0	0	N/A	1	-1
	Anacostia #2-3	0	0	N/A	1	4	2	0	N/A	0	2
	Anacostia #2-2	-9	-5	N/A	0	-2	-1	-1	N/A	-1	-1
	Anacostia #2-1	-3	-4	N/A	-3	0	-2	-2	N/A	0	-4
	Anacostia #1-2	1	2	N/A	0	1	1	-1	N/A	3	1
Downstream	Anacostia #1-1	5	2	N/A	1	2	2	1	N/A	-5	1

* The TMDL does not require bed sediment reductions for zinc and the PAH 1 group

≥ 5 Additional years to achieve bed sediment target
≥ 5 Fewer years to achieve bed sediment target
≥ 10 Fewer years to achieve bed sediment target
≥ 20 Fewer years to achieve bed sediment target

Table 7.4 Change in Attenuation Period for the 2055 Climate Change Scenario (years; negative indicates faster attenuation vs. TMDL, positive indicates slower attenuation).

		2055 Climate Change Scenario: Change in Attenuation Period (years: negative indicates faster attenuation vs. TMDL, positive: indicates slower attenuation)									
	Verification Unit	Arsenic	Copper	Zinc*	Heptachlor epoxide	Chlordane	Dieldrin	DDT	PAH 1*	PAH 2	PAH 3
Upstream	Anacostia #2-10	0	0	N/A	0	-1	-1	-1	N/A	0	0
	Anacostia #2-9	-1	-1	N/A	0	-1	0	-2	N/A	-1	-1
	Anacostia #2-8	2	1	N/A	1	2	2	3	N/A	2	2
	Kingman Lake-2	-2	-2	N/A	-1	-1	2	-1	N/A	-2	-2
	Anacostia #2-7	-1	-1	N/A	-1	-1	-1	-1	N/A	-1	-1
	Anacostia #2-6	-5	-3	N/A	-2	-1	-3	-4	N/A	-3	-5
	Kingman Lake-1	-36	-31	N/A	-19	-16	-22	-22	N/A	-33	-31
	Anacostia #2-5	-1	0	N/A	0	-1	-1	-2	N/A	-3	-2
	Anacostia #2-4	2	2	N/A	1	4	2	4	N/A	1	1
	Anacostia #2-3	1	4	N/A	0	3	2	0	N/A	1	0
	Anacostia #2-2	-8	-5	N/A	0	2	1	0	N/A	0	0
	Anacostia #2-1	1	-3	N/A	-1	-1	0	2	N/A	8	-2
	Anacostia #1-2	5	5	N/A	2	4	4	3	N/A	6	8
Downstream	Anacostia #1-1	8	5	N/A	4	10	8	2	N/A	-1	5

* The TMDL does not require bed sediment reductions for zinc and the PAH 1 group

≥ 5 Additional years to achieve bed sediment target
≥ 5 Fewer years to achieve bed sediment target
≥ 10 Fewer years to achieve bed sediment target
≥ 20 Fewer years to achieve bed sediment target

7.3 Climate Change Scenario Discussion

After considering the impacts of climate change under the TMDL allocation scenario on predicted toxic water column concentrations within the Anacostia River and natural attenuation timeframes, DOEE has determined, based on the analyses undertaken, that climate change is not predicted to have a significant enough impact on water quality following achievement of the TMDL allocations to warrant revisions to those TMDL allocations. Notably, there is a significant amount of uncertainty associated with future water quality predictions due to climate change. Therefore, revising TMDL allocations to account for the uncertain, predicted increase in toxic water column concentrations of less than 10 percent in only a few verification unit/pollutant combinations is not warranted.

Regarding predicted toxic water column concentrations, most verification units-pollutant combinations show a decrease in predicted toxic water column concentrations under both climate change scenarios (Tables 7-1 and 7-2). While some verification unit-pollutant combinations show an increase in predicted toxic water column concentrations under the climate change scenarios (particularly for heptachlor epoxide, DDT and its metabolites, and chlordane), most increase less than 5 percent, with the greatest increase being 6.7 percent for those particular pollutants. Furthermore, Table 7-2 shows that only one verification unit-pollutant combination (in the Lower Anacostia for heptachlor epoxide in the 2055 climate change scenario) exceeded its TMDL endpoint under the TMDL allocation scenario. This verification unit exceedance does not necessitate revisions to the TMDL allocations because revising TMDL allocations to account for the uncertain, predicted increase in toxic water column concentrations of less than 10 percent, but above the TMDL endpoint, in only one verification unit/pollutant combination is not warranted.

Other reasons for not revising the TMDL allocations include:

1. The TMDL scenario does not account for the on-the-ground changes due to the operation of the Anacostia tunnel system (installed March 2018); therefore, the simulated increase of pesticides due to increased CSS contributions may be prevented to a certain extent by the operation of the Anacostia tunnel system;
2. The TMDL scenario does not account for in-stream remediation efforts at hotspots of toxic pollutant contamination in the Anacostia River mainstem due to the ARSP, and it is expected that in-stream remediation could result in decreases of these TMDL pollutants in the sediment that are concomitant with pollutants of concern for the ARSP;
3. The predicted increase in heptachlor epoxide water column concentrations due to climate change is only 6.3%; and
4. It is reasonable to expect that additional time for natural attenuation (i.e., more than what is already called for in that assessment unit's 2055 scenario (37 years)) will result in achievement of the TMDL endpoint in that verification unit.

Regarding predicted timeframes of natural attenuation of toxics in bed sediment under the climate change scenarios, while the 2055 climate change scenario led to some verification unit-pollutant combinations taking more time (up to 10 years longer) to achieve water quality targets after TMDL allocations were achieved, overall, it is expected that the timeframes for most verification unit-pollutant combinations to achieve water quality targets will not be significantly impacted by climate change (less than five-year difference from the TMDL allocation scenario). Many of these verification unit-pollutant combinations were predicted to achieve water quality targets in less time (up to 36 fewer years) under the climate change scenarios, particularly those in Kingman Lake, which called for the largest natural attenuation timelines under the TMDL allocation scenario.

In summary, although climate change is expected to result in a greater load of toxic pollutants to the Anacostia River due to increased precipitation and associated runoff, the dilution of these toxics due to sea level rise and other hydrologic functions counteracts the increased load and results in minimal impact from climate change under the TMDL scenario. As a result, DOEE has not proposed revisions to the TMDL allocations to account for the uncertain, predicted impacts of climate change.

8 PUBLIC PARTICIPATION

This section will be updated after the public comment period and prior to final submission to EPA.

The availability of draft TMDLs was advertised in the D.C. Register on _____, 2023. The electronic documents were also posted on DOEE's internet site at https://doee.dc.gov/service/total-maximum-daily-load-tmdl-documents. Interested parties were invited to submit comments during the public comment period, which began on ____, 2023, and will end on _____, 2023.

A previous public comment period was advertised in the D.C. Register beginning on July 9, 2021. The electronic documents were also posted on DOEE's internet site. Interested parties were invited to submit comments during the public comment period, which began on July 9, 2021 and ended on August 13, 2021. In addition to the formal public comment period, DOEE, EPA, and Tetra Tech held a public meeting with support from MWCOG on July 22, 2021, to provide an overview of the draft TMDLs to the public.

Furthermore, DOEE presented on TMDL development progress to the MWCOG's AWRP on September 25, 2018. Attendees included federal, state, and local government agencies as well as local non-profit environmental organizations. DOEE also provided brief updates on TMDL development at several AWRP Management Committee and Anacostia Toxic Source Workgroup meetings, on November 27, 2018, June 6, 2019, June 27, 2019, and March 8, 2021.

DOEE will respond to all written comments received during both public comment periods upon final submission to EPA. Responses to public comments will be included in Appendix C.

9 REASONABLE ASSURANCE FOR TMDL IMPLEMENTATION

Section 303(d) of the Clean Water Act (CWA) requires that a TMDL be "established at a level necessary to implement the applicable water quality standard". According to 40 C.F.R. § 130.2(i), "[i]f best management practices or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent". Providing reasonable assurance that nonpoint source control measures will achieve expected load reductions increases the probability that the pollution reduction levels specified in the TMDL will be achieved and, therefore, applicable WQS will be attained.

When a TMDL is developed for waters impaired by point sources, the issuance of a NPDES permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. § 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with "the assumptions and requirements of any available wasteload allocation" in an EPA-approved TMDL. For example, permit limits consistent with the assumptions and requirements of the WLAs assigned in this TMDL will be incorporated in reissued permits for the four individual NPDES permitted facilities: Blue Plains WWTP (DC0021199), Super Concrete (DC0000175), WNY (DC0000141), and PEPCO (DC0000094).

9.1 Point Source Reductions

9.1.1 MS4 Load Reductions

As part of the NPDES permit requirements, the District MS4 program is required to develop a TMDL implementation plan. In July 2016, the District submitted the DC Total Maximum Daily Load (TMDL) Consolidated Implementation Plan to EPA, hereinafter referred to as the DC TMDL-CIP. Because the original Anacostia River toxic pollutants TMDLs were approved by EPA in 2003, the DC TMDL-CIP incorporates the below activities, which work to address toxic contamination. The District updated its DC TMDL-CIP in 2022. The updated plan includes new information related to WLAs, achievement of existing programmatic milestones, and attainment strategies for future implementation (DOEE, 2022).

In both plans, there are several ongoing initiatives throughout the District to reduce stormwater runoff, which in turn, will reduce arsenic, chlordane, copper, DDT and its metabolites, dieldrin, heptachlor epoxide, PAH 1, PAH 2, PAH 3, and zinc in the Anacostia River. Because the toxic pollutants bind to sediment and are transported to the Anacostia River and its tributaries during rain events, reducing stormwater runoff represents an effective strategy for the DC MS4 to reduce toxic contamination. The centerpiece of these stormwater runoff initiatives is captured in the DC TMDL-CIP and includes through regulations the retention of 1.2" rain events from new development and redevelopment projects. The impact of these regulations will be amplified through the District's direct investment in green infrastructure and programs to promote voluntary retrofits of stormwater control measures, expansion of the urban tree canopy, and incorporation of green infrastructure features into the District capital projects, which are all programs that will all aid in reducing toxic contamination. For example, DOEE's 2022 plan cites 5-year numeric milestones in the District's MS4 permit that include 307 acres managed in the Anacostia watershed. Acres managed is the land treated by stormwater control measures to the applicable standards in the permit. In the Anacostia watershed, the District totaled 658 acres managed for the 2016-2020 period, more than the 307 acres managed required in the permit (DOEE, 2022). Increases in acres managed will reduce runoff, thereby reducing the amount of toxic pollutants from the watershed that enter the Anacostia River.

Under the MS4 Permit, the District implements several stormwater management and source control activities, including illicit discharge detection and elimination, enhanced street sweeping, construction site and industrial facility inspections and enforcement, and household hazardous waste collections. Implementation approaches, including BMPs that reduce pollutant loading, such as installing bioretention systems and green roofs, and other pollution reduction measures, such as street sweeping, erosion and sediment control, and planting trees, will be effective in reducing stormwater runoff and associated pollutant loads, including the toxic pollutants addressed in these TMDLs. These practices can also help mitigate the effect of climate change. Through 2020, there have been approximately 2,000 bioretention and 430 green roof BMPs installed in the MS4 area (DOEE, 2022). The 2021 annual report for the MS4 permit identified approximately 412,000 square feet of green roof was added, 6,100 miles of streets were swept, and 8,200 trees were planted in 2021 (DOEE, 2022). For the same report year, 65 illicit discharges were detected and 63 discharges to the MS4 permit area were eliminated. Additional information on current practices and future measures to managing stormwater runoff can be found in the District's revised Stormwater Management Plan that was published in 2022 (DOEE, 2022).

In addition to these BMPs typically designed for developed areas, DOEE's Watershed Protection Division has developed and implemented several projects in the Anacostia watershed (e.g., Kingman Lake, Nash Run, and Pope Branch stream restoration) to restore damaged riparian areas and to educate the public on the role of riparian buffers in reducing pollution. These efforts directly support the implementation of these TMDLs in less developed areas such as the subwatersheds east of the river by reducing pollutant loading from stormwater and sediment. Since the publication of the 2016 plan, several new restoration projects were installed in the Anacostia watershed. In 2017, restoration projects in Hickey Run and along Texas Avenue resulted in restoring 6,800 feet of stream length (DOEE, 2022). These restoration activities, and planned future restoration activities, mitigate the effects of both climate change and stormwater runoff that can include pollutants established in TMDLs herein.

Under the Comprehensive Stormwater Management Enhancement Amendment Act of 2008, it is illegal to sell, use, or permit the use of coal tar pavement products in the District. Later in 2019, the Limitations on Products Containing Polycyclic Aromatic Hydrocarbons Amendment Act of 2018 expanded the law to include sealants containing steam cracked asphalt and any other products with PAH concentrations greater than 0.1 percent by weight on the list of banned sealant products. Violators of this ban are subject to a daily fine of up to $2,500. Contractors, property owners, and businesses that sell pavement sealant are regulated by the law. DOEE routinely inspects properties for compliance and there is a coal tar tip form that can be filled out online if a violation is suspected. DOEE inspects at least 60 properties per year for compliance with the ban. Recently, DOEE completed about 110 inspections (DOEE, 2022). It is expected that PAH concentrations across the District will decrease as result of these bans, decreasing the amount entering surface waters from stormwater runoff across the watershed.

Also, if it is determined that the applicable BMPs are not being implemented or DOEE finds that individual sites or facilities are causing pollution, DOEE may take enforcement actions to achieve compliance with the District's WQS. The combination of both BMP implementation and other control and enforcement measures should continue to reduce arsenic, chlordane, copper, DDT and its metabolites, dieldrin, heptachlor epoxide, PAH 1, PAH 2, PAH 3, and zinc in the District's waters.

9.1.2 CSS Load Reductions

To comply with its Long-Term Control Plan (LTCP), DC Water is implementing the DC Clean Rivers Project, a large (about $2.7 billion) infrastructure project to upgrade the District's water and sewer systems to reduce nutrient discharges and CSOs to local rivers. The Clean Rivers Project is comprised of a variety of projects to control CSOs, including pumping station rehabilitations, green infrastructure, and a system of underground storage and conveyance tunnels. Construction of a 2.4 mile-long storage and conveyance tunnel for the Anacostia River (the Anacostia River Tunnel) was completed in 2018. Between March 2018 and early December 2019, the Anacostia Tunnel System captured about 7 billion gallons of combined sewer overflow (about 90 percent capture rate of CSOs). Through November 2022, the Tunnel System captured about 1.5 billion gallons of CSO (reducing the CSO volume discharged to the

Anacostia River by about 93 percent). A second tunnel in the Anacostia watershed, the Northeast Boundary Tunnel, is expected to be completed in 2023. Upon completion, the overall tunnel system will capture 98 percent of the CSO volume that would have otherwise entered the Anacostia River and instead treat that water at the Blue Plains Advanced Wastewater Treatment Plant. The tunnel system will also reduce the loadings of toxic pollutants that would otherwise enter the Anacostia River via stormwater runoff.

9.2 Nonpoint Source Reductions

Reasonable assurance that nonpoint source control measures will achieve expected load reductions increases the probability that the pollution reduction levels specified in the TMDL will be achieved and, therefore, applicable WQS will be attained.

Load allocations to nonpoint sources within the District are prescribed only for the identified contaminated sites. The remediation of the legacy contaminated sites (Table 3-1), several of which are federal facilities, in the Anacostia River watershed will result in a reduction of toxic pollutant loads to the Anacostia River. For example, environmental investigations at Poplar Point found that soil was contaminated with metals, pesticides, PCBs, and PAHs. A RI and a FS are being conducted at Poplar Point by the District with oversight from the National Park Service. RI activities began in 2018 and the final RI report and FS are scheduled to be completed in March 2024 and December 2024, respectively. The Proposed Plan and ROD will follow in the future years. It is expected that the plan will decrease toxic loads from the site and make progress towards achieving the TMDL endpoints. Other site studies that may aid in achievement of TMDL endpoints include ongoing work at PEPCO, Washington Gas and Light East Station, and WNY. These sites are being investigated under legal agreements. In addition, clean up at CSX Benning Yard is covered by a separate legal agreement (DOEE, 2020) and that work may result in reducing toxic pollutant loads to the river.

For areas that do not have ongoing studies, the ARSP Interim ROD (see Section 9.2) has identified 11 early action areas where PCB and associated pollutant (e.g., chlordane) contamination will be reduced using carbon amendments, dredging, and capping of contaminated sediments. DOEE is undertaking remediation in accordance with the District's Brownfields Revitalization Amendment Act, the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the National Oil and Hazardous Substances Pollution Contingency Plan (DOEE, 2020).

9.3 Chesapeake Bay Agreement and TMDL

A new Chesapeake Bay Watershed Agreement was signed on June 16, 2014, which includes goals and outcomes for mitigation and ultimate elimination of toxic contaminants in the Chesapeake Bay watershed (CBP, 2014). The toxic contaminant goal is to "ensure that the Bay and its rivers are free of effects of toxic contaminants on living resources and human health" (CBP, 2014). Objectives for the toxic contaminant outcomes regarding PCBs or pesticides include 1) characterizing the occurrence, concentrations, sources, and effects of PCBs, 2) identifying BMPs that may provide benefits for reducing toxic contaminants in waterways, 3) improving practices and controls that reduce and prevent effects of toxic contaminants, and 4) building on existing programs to reduce the amount and effects of PCBs in the Bay and watershed. Implementation of the toxic contaminant goal and outcomes under the new Bay agreement would aid attainment of the TMDL endpoints established herein.

The climate resiliency goal of the Chesapeake Bay Watershed Agreement is to "increase the resiliency of the Chesapeake Bay watershed, including its living resources, habitats, public infrastructure and communities, to withstand adverse impacts from changing environmental and climate conditions" (CBP, 2014). This goal addresses the impact that climate change may have on aquatic systems and acknowledges that climate change must be considered to achieve the other Watershed Agreement goals, like the toxic contaminant goal.

The Chesapeake Bay Program (CBP) also promotes water quality improvements in many ways, including monitoring, publishing water quality studies, supporting studies on or providing framework for managing toxic chemicals, and hosting numerous workshops on water quality-related issues. CBP's continued actions related to toxics contaminants will further aid progress towards the attainment of water quality goals in the Anacostia River.

In 2019, DOEE released the "District of Columbia's Phase III Watershed Implementation Plan for the Chesapeake Bay" (WIP). In that plan, the District included actions to further reduce pollution and address the impacts of climate change on water quality in District waters by 2025. For example, DOEE is in the process of revising its floodplain regulations to increase the District's resilience and account for sea level rise. Another example is assessing stormwater performance standards considering future precipitation scenarios under the NPDES permit. The plan also noted that, in anticipation of more extreme weather events associated with climate change, the Phase III WIP loads for DC Water's Blue Plains was based on design capacity rather than current flows. The District was the first jurisdiction among Bay jurisdictions (i.e., Maryland, West Virginia, New York, Delaware, Virginia, and Pennsylvania) to commit to reduce additional pollutant loads (6,000 pounds of nitrogen and 1,028 pounds of phosphorus), associated with climate change as part of its Phase III WIP (DOEE, 2019). Practices, projects, and programs that reduce nitrogen and pollutant loads can also reduce the pollutant load associated with metals and toxic contaminants established in this TMDL.

The Chesapeake Bay TMDL is implemented using an accountability framework that includes short-term goals for each jurisdiction that are called milestones. The milestones help ensure progress toward having pollution reduction measures in place to restore the Bay and its tidal rivers (EPA, 2023). The District's updates to the 2020-2021 milestones included a review of performance standards related to future storms affected by climate change. The District's 2022-2023 milestone commitments include incorporating new design changes for stormwater BMPs to account for increases in storm size and initiating potential regulatory changes to the District's two- and five-year peak discharge requirements in the District's stormwater performance standards that consider both quantity and quality of stormwater runoff (DOEE, 2022). The practices that are used to prevent, reduce, and treat increases in runoff and associated pollutant loads due to climate change can also reduce the loads associated with metals and toxic contaminants in this TMDL.

9.4 Anacostia River Sediment Project

DOEE's ARSP, which includes about nine miles of the tidal portion of the Anacostia River, identified sediment contamination in the tidal Anacostia River, Kingman Lake, and Washington Channel. DOEE is remediating the river under the District's Brownfields Revitalization Amendment Act, which requires that DOEE select a remedy in accordance with CERCLA, and the National Contingency Plan. The ARSP study area, however, is not a CERCLA site.

Earlier phases of the ARSP included a Remedial Investigation and Feasibility Study (RI/FS). Through the RI, it was determined that elevated concentrations of contaminants, specifically PCBs (but also included PAHs, dioxins, heavy metals, and pesticides) from industrial, urban, and human activities exist in sediment throughout the Anacostia River. After feedback from stakeholders on the proposed plan, DOEE released the Interim Record of Decision (ROD) in September 2020. This Interim ROD identifies and describes early actions to clean up hotspots (i.e., the areas most contaminated by PCBs in the river). The Interim ROD estimates that cleaning up the 11 early action areas will greatly reduce contamination in the system. The ROD, however, also targets other contaminants in addition to PCBs, specifically dioxin, chlordane, and dioxin-like PCBs. Areas will be remediated through a combination of carbon amendments, capping, and sediment dredging, and progress determined through post-remedial monitoring. It is expected that the remediation efforts will begin in Washington Channel in 2025, the Anacostia River mainstem in 2026 and Kingman Lake in 2026. Estimated costs for remediating those areas is, at a minimum, $50 million. More information can be found on the ARSP website: Anacostia River Sediment Project.

Remediation of the PCB hotspots is also expected to reduce other pollutants (e.g., metals, organochlorine pesticides, and PAHs) that coexist in the PCB-contaminated sediment. It is reasonable to conclude that the remediation of contaminated sediment at the 11 early actions areas will decrease the time it will take for water quality to approach the TMDL endpoints.

9.5 Monitoring

DOEE will perform post-TMDL monitoring to refine its understanding regarding the contribution of each of the addressed pollutants (i.e., arsenic, chlordane, copper, DDT and its metabolites, dieldrin, heptachlor epoxide, PAH 1, PAH 2, PAH 3, and zinc) from each source to improve control actions and management. DOEE will compile and analyze the monitoring data to evaluate progress toward attaining the TMDL endpoints. Post-TMDL monitoring will help DOEE determine whether planned control actions are performing as intended, or whether further measures need to be implemented.

DOEE monitors the concentrations of arsenic, chlordane, copper, DDT and its metabolites, dieldrin, heptachlor epoxide, PAH 1, PAH 2, PAH 3, and zinc, as well as many other pollutants, in fish tissue approximately every 2-3 years, and utilizes the results to determine use support for Class D Waters (protection of human health, as it relates to fish consumption) and to develop new or update existing fish consumption advisories, if necessary. DOEE partners with the U.S. Fish and Wildlife Service to conduct fish tissue monitoring and the most recent study, was completed in summer 2023. As the consumption of contaminated fish is the main pathway for these toxic pollutants to impact human health, DOEE is committed to continuing to conduct fish tissue studies for toxic pollutants.

Post-TMDL monitoring will provide important information to stakeholders and District residents regarding public health. Also, given that the legacy pollutants are no longer actively used in the District and are expected to decline over time, data will be analyzed to assess trends and/or progress toward the TMDL endpoints for those pollutants. Concurrently, DOEE is supporting local, citizen-led monitoring programs that will provide a further efficient and comprehensive means to monitor measurable reductions to loadings. The District has robust local, regional, and national stakeholders and watershed groups that share a common goal to protect and restore water quality. These groups have the capacity to, and often do, conduct watershed outreach and education activities, monitoring, research, and advocacy for implementation of water-quality improvements, such as TMDLs. Activities and engagement conducted by these stakeholders provide additional assurance that implementation will continue to occur to address nonpoint sources of pollution generally, including the toxic pollutants addressed in these TMDLs.

For the Anacostia River Sediment Project (ARSP), DOEE will implement baseline and performance monitoring for early action areas (hot spots) in the Anacostia River Mainstem, Kingman Lake, and Washington Channel. The interim remedy will remediate sediment with the highest concentrations of PCBs in the river. The baseline monitoring targets four constituents of concern in sediment that pose a risk to human health or to ecological receptors: total PCB congeners (human health), dioxin toxic equivalent (TEQ) (ecological), chlordane (ecological), and dioxin-like PCB TEQ (human health and ecological). The Baseline and Performance Monitoring Plan addresses these contaminants of concern as well as PAHs. Pre-remediation monitoring will evaluate baseline conditions before remedial action is implemented, and post-remedial or long-term monitoring will be conducted to assess the effectiveness of remedial actions after they are implemented.

The Baseline and Performance Monitoring Plan establishes protocols for collecting and analyzing data on multiple indicators that will be used to evaluate progress toward the achievement of the Remedial Action Objectives of the ARSP. The monitoring program will measure surface sediment, porewater, surface water, benthic, and forage and game fish. The indicators will be sampled every two to three years for contaminants of concern until pollutant reduction goals are met for three consecutive periods. Forage and game fish tissue will also be sampled every three years until pollutant reduction goals are met for three consecutive periods. The surface water monitoring results will inform DOEE's bioaccumulation and ARSP surface water models (Tetra Tech, 2019).

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APPENDIX A: UNIMPAIRED SEGMENTS

TMDLs and associated allocations are presented for the below unimpaired waterbody-pollutant combinations for all 10 toxic pollutants in the District. These unimpaired waters do not require TMDLs under EPA's implementing regulations (40 C.F.R. § 130.7) because they are not listed as impaired on the District's Integrated Report for the associated pollutants. However, DOEE chose to establish informational TMDLs for these waters. Furthermore, the source-specific allocations presented below are incorporated into the TMDLs provided in Section 5 of the TMDL report because those allocations are required to meet downstream water quality in the tidal mainstem Anacostia River.

Total Maximum Daily Load Tables for Unimpaired Segments

Table A-1 Daily Loads for Unimpaired Segments for Arsenic

Segment	Source	TMDL (g/day)
Hickey Run[1]	MS4	15.76
	MSGP	1.58
	Point Sources/WLAs	**17.34**
	Total Hickey Run	**17.34**
Watts Branch[2]	MD Upstream Load[3]	21.60
	Contaminated Sites	0.21
	Nonpoint Sources/LAs	**21.82**
	MS4	14.50
	Pepco (DC0000094)[4]	0.09
	Point Sources/WLAs	**14.59**
	Total Watts Branch	**36.40**
Popes Branch[1]	MS4	6.34
	Point Sources/WLAs	**6.34**
	Total Popes Branch	**6.34**

[1]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[2]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[3]Upstream land-based loads from the Maryland portion of the Watts Branch watershed.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-2 Daily Loads for Unimpaired Segments for Copper

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	1086.07
	Contaminated Sites	40.31
	Nonpoint Sources/LAs	**1126.38**
	MS4	2198.71
	Point Sources/WLAs	**2198.71**
	Total Nash Run	**3325.09**
Hickey Run[2]	MS4	4982.18
	MSGP	528.98
	Point Sources/WLAs	**5511.16**
	Total Hickey Run	**5511.16**
Watts Branch[3]	MD Upstream Load[4]	4115.19
	Contaminated Sites	41.83
	Nonpoint Sources/LAs	**4157.02**
	MS4	4878.27
	Pepco (DC0000094)[5]	12.94
	Point Sources/WLAs	**4891.21**
	Total Watts Branch	**9048.23**
Kingman Lake[2]	MS4	3241.45
	Point Sources/WLAs	**3241.45**
	Total Kingman Lake	**3241.45**
Fort Chaplin Run[2]	MS4	1502.56
	Point Sources/WLAs	**1502.56**
	Total Fort Chaplin Run	**1502.56**
Fort Dupont Creek	Contaminated Sites	29.34
	Nonpoint Sources/LAs	**29.34**
	MS4	2697.59
	Point Sources/WLAs	**2697.59**
	Total Fort Dupont Creek	**2726.92**
Popes Branch[2]	MS4	1557.63
	Point Sources/WLAs	**1557.63**
	Total Popes Branch	**1557.63**
Fort Davis Tributary[2]	MS4	1201.46
	Point Sources/WLAs	**1201.46**
	Total Fort Davis Tributary	**1201.46**
Texas Avenue Tributary[2]	MS4	1269.53
	Point Sources/WLAs	**1269.53**
	Total Texas Avenue Tributary	**1269.53**

Fort Stanton Tributary[2]	MS4	850.50
	Point Sources/WLAs	**850.50**
	Total Fort Stanton Tributary	**850.50**

[1]Upstream land-based loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[4]Upstream land-based loads from the Maryland portion of the Watts Branch watershed.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-3 Daily Loads for Unimpaired Segments for Zinc

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	1298.90
	Contaminated Sites	169.18
	Nonpoint Sources/LAs	**1468.08**
	MS4	2449.72
	Point Sources/WLAs	**2449.72**
	Total Nash Run	**3917.80**
Hickey Run[2]	MS4	5312.11
	MSGP	618.95
	Point Sources/WLAs	**5931.06**
	Total Hickey Run	**5931.06**
Watts Branch[3]	MD Upstream Load[4]	4747.66
	Contaminated Sites	150.50
	Nonpoint Sources/LAs	**4898.16**
	MS4	5491.30
	Pepco (DC0000094)[5]	241.55
	Point Sources/WLAs	**5732.85**
	Total Watts Branch	**10631.00**
Kingman Lake[2]	MS4	3042.12
	Point Sources/WLAs	**3042.12**
	Total Kingman Lake	**3042.12**
Fort Chaplin Run[2]	MS4	1495.19

Fort Chaplin Run[2] (continued)	***Point Sources/WLAs***	**1495.19**
	Total Fort Chaplin Run	**1495.19**
Fort Dupont Creek	Contaminated Sites	256.53
	Nonpoint Sources/LAs	**256.53**
	MS4	2198.98
	Point Sources/WLAs	**2198.98**
	Total Fort Dupont Creek	**2455.51**
Popes Branch[2]	MS4	1463.03
	Point Sources/WLAs	**1463.03**
	Total Popes Branch	**1463.03**
Fort Davis Tributary[2]	MS4	1184.34
	Point Sources/WLAs	**1184.34**
	Total Fort Davis Tributary	**1184.34**
Texas Avenue Tributary[2]	MS4	1264.35
	Point Sources/WLAs	**1264.35**
	Total Texas Avenue Tributary	**1264.35**
Fort Stanton Tributary[2]	MS4	852.92
	Point Sources/WLAs	**852.92**
	Total Fort Stanton Tributary	**852.92**

[1]Upstream land-based loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[4]Upstream land-based loads from the Maryland portion of the Watts Branch watershed.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-4 Daily Loads for Unimpaired Segments for Chlordane

Segment	Source	TMDL (g/day)
Fort Chaplin Run[1]	MS4	0.012
	Point Sources/WLAs	**0.012**
	Total Fort Chaplin Run	**0.012**
Fort Dupont Creek	Contaminated Sites	0.001
	Nonpoint Sources/LAs	**0.001**
	MS4	0.019

Fort Dupont Creek (continued)	***Point Sources/WLAs***	**0.019**
	Total Fort Dupont Creek	**0.020**
Fort Davis Tributary[1]	MS4	0.009
	Point Sources/WLAs	**0.009**
	Total Fort Davis Tributary	**0.009**
Fort Stanton Tributary[1]	MS4	0.005
	Point Sources/WLAs	**0.005**
	Total Fort Stanton Tributary	**0.005**

[1]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-5 Daily Loads for Unimpaired Segments for DDT and its Metabolites

Segment	Source	TMDL (g/day)
Nash Run	MD Upstream Load[1]	8.52E-04
	Contaminated Sites	0.0014
	Nonpoint Sources/LAs	**0.0022**
	MS4	0.0025
	Point Sources/WLAs	**0.0025**
	Total Nash Run	**0.0048**
Watts Branch[2]	MD Upstream Load[3]	0.0041
	Contaminated Sites	0.0012
	Nonpoint Sources/LAs	**0.0052**
	MS4	0.0041
	Pepco (DC0000094)[4]	0.0002
	Point Sources/WLAs	**0.0042**
	Total Watts Branch	**0.0095**
Fort Chaplin Run[5]	MS4	0.0009
	Point Sources/WLAs	**0.0009**
	Total Fort Chaplin Run	**0.0009**
Fort Dupont Creek	Contaminated Sites	1.91E-04
	Nonpoint Sources/LAs	**1.91E-04**
	MS4	0.0019
	Point Sources/WLAs	**0.0019**
	Total Fort Dupont Creek	**0.0021**
Fort Davis Tributary[5]	MS4	7.04E-04
	Point Sources/WLAs	**7.04E-04**
	Total Fort Davis Tributary	**7.04E-04**
Fort Stanton Tributary[5]	MS4	4.12E-04

Fort Stanton Tributary[5] (continued)	***Point Sources/WLAs***	**4.12E-04**
	Total Fort Stanton Tributary	**4.12E-04**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[3]Upstream loads from the Maryland portion of the Watts Branch watershed.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated land and the load attributed to its discharge.

[5]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-6 Daily Loads for Unimpaired Segments for Dieldrin

Segment	Source	TMDL (g/day)
Hickey Run[1]	MS4	0
	MSGP	0
	Point Sources/WLAs	**0**
	Total Hickey Run	**0**
Kingman Lake[1]	MS4	0
	Point Sources/WLAs	**0**
	Total Kingman Lake	**0**
Fort Chaplin Run[1]	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Chaplin Run	**0**
Fort Dupont Creek	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Dupont Creek	**0**
Popes Branch[1]	MS4	0
	Point Sources/WLAs	**0**
	Total Popes Branch	**0**
Fort Davis Tributary[1]	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Davis Tributary	**0**
Fort Stanton Tributary[1]	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Stanton Tributary	**0**

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-7 Daily Loads for Unimpaired Segments for Heptachlor Epoxide

Segment	Source	TMDL (g/year)
Hickey Run[1]	MS4	7.67E-03
	MSGP	7.74E-04
	Point Sources/WLAs	**8.45E-03**
	Total Hickey Run	**8.45E-03**
Watts Branch[2]	MD Upstream Load[3]	8.03E-03
	Contaminated Sites	1.95E-04
	Nonpoint Sources/LAs	**0.0082**
	MS4	8.25E-03
	Pepco (DC0000094)[4]	8.66E-05
	Point Sources/WLAs	**8.33E-03**
	Total Watts Branch	**0.0166**
Kingman Lake[1]	MS4	4.53E-03
	Point Sources/WLAs	**4.53E-03**
	Total Kingman Lake	**4.53E-03**
Fort Chaplin Run[1]	MS4	2.45E-03
	Point Sources/WLAs	**2.45E-03**
	Total Fort Chaplin Run	**2.45E-03**
Fort Dupont Creek	Contaminated Sites	1.42E-04
	Nonpoint Sources/LAs	**1.42E-04**
	MS4	3.94E-03
	Point Sources/WLAs	**3.94E-03**
	Total Fort Dupont Creek	**4.08E-03**
Fort Davis Tributary[1]	MS4	1.97E-03
	Point Sources/WLAs	**1.97E-03**
	Total Fort Davis Tributary	**1.97E-03**
Fort Stanton Tributary[1]	MS4	1.46E-03
	Point Sources/WLAs	**1.46E-03**
	Total Fort Stanton Tributary	**1.46E-03**

[1]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[2]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[3]Upstream land-based loads from the Maryland portion of the Watts Branch watershed.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-8 Daily Loads for Unimpaired Segments for the PAH 1 Group

Segment	Source	TMDL (g/day)
Watts Branch[1]	MD Upstream Load[2]	33.74
	Contaminated Sites	5.67
	Nonpoint Sources/LAs	**39.41**
	MS4	40.29
	Pepco (DC0000094)[3]	3.56
	Point Sources/WLAs	**43.85**
	Total Watts Branch	**83.26**
Fort Chaplin Run[4]	MS4	9.80
	Point Sources/WLAs	**9.80**
	Total Fort Chaplin Run	**9.80**
Fort Dupont Creek	Contaminated Sites	3.63
	Nonpoint Sources/LAs	**3.63**
	MS4	11.33
	Point Sources/WLAs	**11.33**
	Total Fort Dupont Creek	**14.96**
Fort Davis Tributary[4]	MS4	7.72
	Point Sources/WLAs	**7.72**
	Total Fort Davis Tributary	**7.72**

[1]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[2]Upstream loads from the Maryland portion of the Watts Branch watershed.

[3]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[4]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-9 Daily Loads for Unimpaired Segments for the PAH 2 Group

Segment	Source	TMDL (g/day)
Watts Branch[1]	MD Upstream Load[2]	0.01
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0.01**
	MS4	0

Watts Branch[1] (continued)	Pepco (DC0000094)[3]	0
	Point Sources/WLAs	**0**
	Total Watts Branch	**0.01**
Fort Chaplin Run[4]	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Chaplin Run	**0**
Fort Dupont Creek	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Dupont Creek	**0**
Fort Davis Tributary[4]	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Davis Tributary	**0**

[1]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.
[2]Upstream loads from the Maryland portion of the Watts Branch watershed.
[3]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.
[4]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-10 Daily Loads for Unimpaired Segments for the PAH 3 Group

Segment	Source	TMDL (g/day)
Watts Branch[1]	MD Upstream Load[2]	0.001
	Contaminated Sites	0
	Nonpoint Sources/LAs	**0.001**
	MS4	0
	Pepco (DC0000094)[3]	0
	Point Sources/WLAs	**0**
	Total Watts Branch	**0.001**
Fort Chaplin Run[4]	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Chaplin Run	**0**
Fort Dupont Creek	Contaminated Sites	0
	Nonpoint Sources/LAs	**0**
	MS4	0

Fort Dupont Creek (continued)	***Point Sources/WLAs***	**0**
	Total Fort Dupont Creek	**0**
Fort Davis Tributary[4]	MS4	0
	Point Sources/WLAs	**0**
	Total Fort Davis Tributary	**0**

[1]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.
[2]Upstream loads from the Maryland portion of the Watts Branch watershed.
[3]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[4]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Annual Load Tables for Unimpaired Segments

Table A-11 Annual Loads for Unimpaired Segments for Arsenic

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Hickey Run[1]	MS4	2647.22	91.49	56.31	97.87
	MSGP	246.27	8.51	5.65	97.71
	Point Sources/WLAs	**2893.49**	**100**	**61.96**	**97.86**
	Total Hickey Run	**2893.49**	**100**	**61.96**	**97.86**
Watts Branch[2]	MD Upstream Load[3]	2591.50	35.20	95.55	96.31
	Contaminated Sites	1481.18	20.12	0.95	99.94
	Nonpoint Sources/LAs	**4072.68**	**55.32**	**96.50**	**97.63**
	MS4	3063.37	41.61	64.13	97.91
	Pepco (DC0000094)[4]	225.67	3.07	0.38	99.83
	Point Sources/WLAs	**3289.04**	**44.68**	**64.52**	**98.04**
	Total Watts Branch	**7361.72**	**100**	**161.01**	**97.81**
Popes Branch[1]	MS4	622.62	100	15.87	97.45
	Point Sources/WLAs	**622.62**	**100**	**15.87**	**97.45**
	Total Popes Branch	**622.62**	**100**	**15.87**	**97.45**

[1]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[2]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[3]Upstream loads from the Maryland portion of the Watts Branch watershed.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-12 Annual Loads for Unimpaired Segments for Copper

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Nash Run	MD Upstream Load[1]	4238.37	23.38	4238.37	0
	Contaminated Sites	5311.76	29.30	157.31	97.04
	Nonpoint Sources/LAs	**9550.13**	**52.67**	**4395.68**	**53.97**
	MS4	8580.47	47.33	8580.47	0
	Point Sources/WLAs	**8580.47**	**47.33**	**8580.47**	**0**
	Total Nash Run	**18130.60**	**100**	**12976.15**	**28.43**
Hickey Run[2]	MS4	21680.40	90.40	21680.40	0
	MSGP	2301.90	9.60	2301.90	0
	Point Sources/WLAs	**23982.30**	**100**	**23982.30**	**0**
	Total Hickey Run	**23982.30**	**100**	**23982.30**	**0**
Watts Branch[3]	MD Upstream Load[4]	19959.86	38.04	19959.86	0
	Contaminated Sites	6762.41	12.89	202.87	97.00
	Nonpoint Sources/LAs	**26722.26**	**50.92**	**20162.73**	**24.55**
	MS4	23661.01	45.09	23661.01	0
	Pepco (DC0000094)[5]	2092.12	3.99	62.76	97.00
	Point Sources/WLAs	**25753.13**	**49.08**	**23723.77**	**7.88**
	Total Watts Branch	**52475.39**	**100**	**43886.50**	**16.37**
Kingman Lake[2]	MS4	9083.76	100	8745.12	3.73
	Point Sources/WLAs	**9083.76**	**100**	**8745.12**	**3.73**
	Total Kingman Lake	**9083.76**	**100**	**8745.12**	**3.73**
Fort Chaplin Run[2]	MS4	5240.77	100	5240.77	0
	Point Sources/WLAs	**5240.77**	**100**	**5240.77**	**0**
	Total Fort Chaplin Run	**5240.77**	**100**	**5240.77**	**0**
Fort Dupont Creek	Contaminated Sites	1379.82	21.38	55.19	96.00
	Nonpoint Sources/LAs	**1379.82**	**21.38**	**55.19**	**96.00**
	MS4	5075.35	78.62	5075.35	0
	Point Sources/WLAs	**5075.35**	**78.62**	**5075.35**	**0**
	Total Fort Dupont Creek	**6455.17**	**100**	**5130.54**	**20.52**
Popes Branch[2]	MS4	4529.63	100	4529.63	0
	Point Sources/WLAs	**4529.63**	**100**	**4529.63**	**0**
	Total Popes Branch	**4529.63**	**100**	**4529.63**	**0**
Fort Davis Tributary[2]	MS4	3943.71	100	3943.71	0
	Point Sources/WLAs	**3943.71**	**100**	**3943.71**	**0**
	Total Fort Davis Tributary	**3943.71**	**100**	**3943.71**	**0**

Texas Avenue Tributary[2]	MS4	4351.93	100	4351.93	0
	Point Sources/WLAs	**4351.93**	**100**	**4351.93**	**0**
	Total Texas Avenue Tributary	**4351.93**	**100**	**4351.93**	**0**
Fort Stanton Tributary[2]	MS4	6302.04	100	6302.04	0
	Point Sources/WLAs	**6302.04**	**100**	**6302.04**	**0**
	Total Fort Stanton Tributary	**6302.04**	**100**	**6302.04**	**0**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[4]Upstream loads from the Maryland portion of the Watts Branch watershed.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-13 Annual Loads for Unimpaired Segments for Zinc

Segment	**Source**	**Baseline Load (g/year)**	**Baseline Load (%)**	**TMDL (g/year)**	**Load Reduction (%)**
Nash Run	MD Upstream Load[1]	6732.03	28.72	6732.03	0
	Contaminated Sites	4012.47	17.12	876.82	78.15
	Nonpoint Sources/LAs	**10744.49**	**45.84**	**7608.85**	**29.18**
	MS4	12696.59	54.16	12696.59	0
	Point Sources/WLAs	**12696.59**	**54.16**	**12696.59**	**0**
	Total Nash Run	**23441.09**	**100**	**20305.44**	**13.38**
Hickey Run[2]	MS4	33824.98	89.56	33824.98	0
	MSGP	3941.20	10.44	3941.20	0
	Point Sources/WLAs	**37766.17**	**100**	**37766.17**	**0**
	Total Hickey Run	**37766.17**	**100**	**37766.17**	**0**
Watts Branch[3]	MD Upstream Load[4]	31505.52	42.02	31505.52	0
	Contaminated Sites	5033.68	6.71	998.72	80.16
	Nonpoint Sources/LAs	**36539.20**	**48.73**	**32504.24**	**11.04**
	MS4	36440.34	48.60	36440.34	0
	Pepco (DC0000094)[5]	2003.65	2.67	1602.92	20
	Point Sources/WLAs	**38443.99**	**51.27**	**38043.26**	**1.04**
	Total Watts Branch	**74983.20**	**100**	**70547.50**	**5.92**
Kingman Lake[2]	MS4	12530.61	100	12530.61	0
	Point Sources/WLAs	**12530.61**	**100**	**12530.61**	**0**
	Total Kingman Lake	**12530.61**	**100**	**12530.61**	**0**
Fort Chaplin Run[2]	MS4	7974.86	100	7974.86	0

Fort Chaplin Run[2] (continued)	***Point Sources/WLAs***	**7974.86**	**100**	**7974.86**	**0**
	Total Fort Chaplin Run	**7974.86**	**100**	**7974.86**	**0**
Fort Dupont Creek	Contaminated Sites	1255.86	16.51	740.96	41
	Nonpoint Sources/LAs	**1255.86**	**16.51**	**740.96**	**41.00**
	MS4	6351.38	83.49	6351.38	0
	Point Sources/WLAs	**6351.38**	**83.49**	**6351.38**	**0**
	Total Fort Dupont Creek	**7607.24**	**100**	**7092.34**	**6.77**
Popes Branch[2]	MS4	6632.15	100	6632.15	0
	Point Sources/WLAs	**6632.15**	**100**	**6632.15**	**0**
	Total Popes Branch	**6632.15**	**100**	**6632.15**	**0**
Fort Davis Tributary[2]	MS4	6059.05	100	6059.05	0
	Point Sources/WLAs	**6059.05**	**100**	**6059.05**	**0**
	Total Fort Davis Tributary	**6059.05**	**100**	**6059.05**	**0**
Texas Avenue Tributary[2]	MS4	6666.34	100	6666.34	0
	Point Sources/WLAs	**6666.34**	**100**	**6666.34**	**0**
	Total Texas Avenue Tributary	**6666.34**	**100**	**6666.34**	**0**
Fort Stanton Tributary[2]	MS4	9627.02	100	9627.02	0
	Point Sources/WLAs	**9627.02**	**100**	**9627.02**	**0**
	Total Fort Stanton Tributary	**9627.02**	**100**	**9627.02**	**0**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[3]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[4]Upstream loads from the Maryland portion of the Watts Branch watershed.

[5]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-14 Annual Loads for Unimpaired Segments for Chlordane

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Fort Chaplin Run[1]	MS4	5.329	100	0.073	98.63
	Point Sources/WLAs	**5.329**	**100**	**0.073**	**98.63**
	Total Fort Chaplin Run	**5.329**	**100**	**0.073**	**98.63**
Fort Dupont Creek	Contaminated Sites	0.758	13.02	0.003	99.62
	Nonpoint Sources/LAs	**0.758**	**13.02**	**0.003**	**99.62**
	MS4	5.066	86.98	0.077	98.49
	Point Sources/WLAs	**5.066**	**86.98**	**0.077**	**98.49**
	Total Fort Dupont Creek	**5.825**	**100**	**0.080**	**98.63**
Fort Davis Tributary[1]	MS4	4.094	100	0.053	98.72

Fort Davis Tributary[1] (continued)	***Point Sources/WLAs***	**4.094**	**100**	**0.053**	**98.72**
	Total Fort Davis Tributary	**4.094**	**100**	**0.053**	**98.72**
Fort Stanton Tributary[1]	MS4	6.138	100	0.081	98.67
	Point Sources/WLAs	**6.138**	**100**	**0.081**	**98.67**
	Total Fort Stanton Tributary	**6.138**	**100**	**0.081**	**98.67**

[1]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-15 Annual Loads for Unimpaired Segments for DDT and its Metabolites

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Nash Run	MD Upstream Load[1]	0.2944	12.45	0.0022	99.25
	Contaminated Sites	1.4498	61.32	0.0036	99.75
	Nonpoint Sources/LAs	**1.7442**	**73.77**	**0.0058**	**99.67**
	MS4	0.6201	26.23	0.0065	98.95
	Point Sources/WLAs	**0.6201**	**26.23**	**0.0065**	**98.95**
	Total Nash Run	**2.3643**	**100**	**0.0123**	**99.48**
Watts Branch[2]	MD Upstream Load[3]	1.4619	28.02	0.0158	98.92
	Contaminated Sites	1.8287	35.05	0.0045	99.75
	Nonpoint Sources/LAs	**3.2906**	**63.07**	**0.0203**	**99.38**
	MS4	1.6704	32.01	0.0157	99.06
	Pepco (DC0000094)[4]	0.2566	4.92	0.0006	99.77
	Point Sources/WLAs	**1.9270**	**36.93**	**0.0163**	**99.15**
	Total Watts Branch	**5.2176**	**100**	**0.0366**	**99.30**
Fort Chaplin Run[5]	MS4	0.3990	100	0.0036	99.10
	Point Sources/WLAs	**0.3990**	**100**	**0.0036**	**99.10**
	Total Fort Chaplin Run	**0.3990**	**100**	**0.0036**	**99.10**
Fort Dupont Creek	Contaminated Sites	0.2193	30.29	0.0005	99.77
	Nonpoint Sources/LAs	**0.2193**	**30.29**	**0.0005**	**99.77**
	MS4	0.5047	69.71	0.0050	99.01
	Point Sources/WLAs	**0.5047**	**69.71**	**0.0050**	**99.01**
	Total Fort Dupont Creek	**0.7240**	**100**	**0.0055**	**99.24**
Fort Davis Tributary[5]	MS4	0.3075	100	0.0026	99.15
	Point Sources/WLAs	**0.3075**	**100**	**0.0026**	**99.15**
	Total Fort Davis Tributary	**0.3075**	**100**	**0.0026**	**99.15**
Fort Stanton Tributary[5]	MS4	0.4449	100	0.0038	99.15
	Point Sources/WLAs	**0.4449**	**100**	**0.0038**	**99.15**
	Total Fort Stanton Tributary	**0.4449**	**100**	**0.0038**	**99.15**

[1]Upstream loads from the Maryland portion of the Nash Run watershed.

[2]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[3]Upstream loads from the Maryland portion of the Watts Branch watershed.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated land and the load attributed to its discharge.

[5]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-16 Annual Loads for Unimpaired Segments for Dieldrin

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Hickey Run[1]	MS4	4.1655	88.84	0	100
	MSGP	0.5231	11.16	0	100
	Point Sources/WLAs	**4.6886**	**100**	**0**	**100**
	Total Hickey Run	**4.6886**	**100**	**0**	**100**
Kingman Lake[1]	MS4	1.4418	100	0	100
	Point Sources/WLAs	**1.4418**	**100**	**0**	**100**
	Total Kingman Lake	**1.4418**	**100**	**0**	**100**
Fort Chaplin Run[1]	MS4	0.9656	100	0	100
	Point Sources/WLAs	**0.9656**	**100**	**0**	**100**
	Total Fort Chaplin Run	**0.9656**	**100**	**0**	**100**
Fort Dupont Creek	Contaminated Sites	0.4201	40.61	0	100
	Nonpoint Sources/LAs	**0.4201**	**40.61**	**0**	**100**
	MS4	0.6144	59.39	0	100
	Point Sources/WLAs	**0.6144**	**59.39**	**0**	**100**
	Total Fort Dupont Creek	**1.0345**	**100**	**0**	**100**
Popes Branch[1]	MS4	0.7788	100	0	100
	Point Sources/WLAs	**0.7788**	**100**	**0**	**100**
	Total Popes Branch	**0.7788**	**100**	**0**	**100**
Fort Davis Tributary[1]	MS4	0.7282	100	0	100
	Point Sources/WLAs	**0.7282**	**100**	**0**	**100**
	Total Fort Davis Tributary	**0.7282**	**100**	**0**	**100**
Fort Stanton Tributary[1]	MS4	1.2066	100	0	100
	Point Sources/WLAs	**1.2066**	**100**	**0**	**100**
	Total Fort Stanton Tributary	**1.2066**	**100**	**0**	**100**

[2]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-17 Annual Loads for Unimpaired Segments for Heptachlor Epoxide

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Hickey Run[1]	MS4	3.4984	90.93	0.0327	99.07
	MSGP	0.3491	9.07	0.0033	99.05
	Point Sources/WLAs	**3.8475**	**100**	**0.036**	**99.06**
	Total Hickey Run	**3.8475**	**100**	**0.036**	**99.06**
Watts Branch[2]	MD Upstream Load[3]	3.3330	34.12	0.0371	98.89
	Contaminated Sites	2.2233	22.76	0.0009	99.96
	Nonpoint Sources/LAs	**5.5563**	**56.88**	**0.0380**	**99.32**
	MS4	3.9569	40.51	3.9569	0
	Pepco (DC0000094)[4]	0.2554	2.61	0.2554	0
	Point Sources/WLAs	**4.2123**	**43.12**	**4.2123**	**0**
	Total Watts Branch	**9.7686**	**100**	**4.2503**	**56.49**
Kingman Lake[1]	MS4	1.5733	100	0.0132	99.16
	Point Sources/WLAs	**1.5733**	**100**	**0.0132**	**99.16**
	Total Kingman Lake	**1.5733**	**100**	**0.0132**	**99.16**
Fort Chaplin Run[1]	MS4	0.8972	100	0.0089	99.01
	Point Sources/WLAs	**0.8972**	**100**	**0.0089**	**99.01**
	Total Fort Chaplin Run	**0.8972**	**100**	**0.0089**	**99.01**
Fort Dupont Creek	Contaminated Sites	0.2366	20.29	0.0003	99.87
	Nonpoint Sources/LAs	**0.2366**	**20.29**	**0.0003**	**99.87**
	MS4	0.9296	79.71	0.0083	99.11
	Point Sources/WLAs	**0.9296**	**79.71**	**0.0083**	**99.11**
	Total Fort Dupont Creek	**1.1662**	**100**	**0.0086**	**99.26**
Fort Davis Tributary[1]	MS4	0.6827	100	0.0071	98.96
	Point Sources/WLAs	**0.6827**	**100**	**0.0071**	**98.96**
	Total Fort Davis Tributary	**0.6827**	**100**	**0.0071**	**98.96**
Fort Stanton Tributary[1]	MS4	1.0621	100	0.0097	99.09
	Point Sources/WLAs	**1.0621**	**100**	**0.0097**	**99.09**
	Total Fort Stanton Tributary	**1.0621**	**100**	**0.0097**	**99.09**

[1]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

[2]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[3]Upstream loads from the Maryland portion of the Watts Branch watershed.

[4]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-18 Annual Loads for Unimpaired Segments for the PAH 1 Group

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Watts Branch[1]	MD Upstream Load[2]	254.23	40.52	254.23	0
	Contaminated Sites	42.71	6.81	42.71	0
	Nonpoint Sources/LAs	**296.94**	**47.33**	**296.94**	**0**
	MS4	303.58	48.39	303.58	0
	Pepco (DC0000094)[3]	26.85	4.28	26.85	0
	Point Sources/WLAs	**330.43**	**52.67**	**330.43**	**0**
	Total Watts Branch	**627.37**	**100**	**627.37**	**0**
Fort Chaplin Run[4]	MS4	66.25	100	66.25	0
	Point Sources/WLAs	**66.25**	**100**	**66.25**	**0**
	Total Fort Chaplin Run	**66.25**	**100**	**66.25**	**0**
Fort Dupont Creek	Contaminated Sites	15.81	24.24	15.81	0
	Nonpoint Sources/LAs	**15.81**	**24.24**	**15.81**	**0**
	MS4	49.39	75.76	49.39	0
	Point Sources/WLAs	**49.39**	**75.76**	**49.39**	**0**
	Total Fort Dupont Creek	**65.20**	**100**	**65.20**	**0**
Fort Davis Tributary[4]	MS4	50.45	100	50.45	0
	Point Sources/WLAs	**50.45**	**100**	**50.45**	**0**
	Total Fort Davis Tributary	**50.45**	**100**	**50.45**	**0**

[1]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[2]Upstream loads from the Maryland portion of the Watts Branch watershed.

[3]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[4]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-19 Annual Loads for Unimpaired Segments for the PAH 2 Group

Segment	Source	Baseline Load (g/year)	Baseline Load (%)	TMDL (g/year)	Load Reduction (%)
Watts Branch[1]	MD Upstream Load[2]	600.10	38.58	0.03	99.99
	Contaminated Sites	120.58	7.75	0	100
	Nonpoint Sources/LAs	**720.68**	**46.33**	**0.03**	**100**
	MS4	718.85	46.22	0	100
	Pepco (DC0000094)[3]	115.84	7.45	0	100

Watts Branch[1] (continued)	***Point Sources/WLAs***	**834.69**	**53.67**	**0**	**100**
	Total Watts Branch	**1555.37**	**100**	**0.03**	**100**
Fort Chaplin Run[4]	MS4	156.20	100	0	100
	Point Sources/WLAs	**156.20**	**100**	**0**	**100**
	Total Fort Chaplin Run	**156.20**	**100**	**0**	**100**
Fort Dupont Creek	Contaminated Sites	64.38	36.34	0	100
	Nonpoint Sources/LAs	**64.38**	**36.34**	**0**	**100**
	MS4	112.78	63.66	0	100
	Point Sources/WLAs	**112.78**	**63.66**	**0**	**100**
	Total Fort Dupont Creek	**177.16**	**100**	**0**	**100**
Fort Davis Tributary[4]	MS4	118.85	100	0	100
	Point Sources/WLAs	**118.85**	**100**	**0**	**100**
	Total Fort Davis Tributary	**118.85**	**100**	**0**	**100**

[1]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[2]Upstream loads from the Maryland portion of the Watts Branch watershed.

[3]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[4]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Table A-20 Annual Loads for Unimpaired Segments for the PAH 3 Group

Segment	**Source**	**Baseline Load (g/year)**	**Baseline Load (%)**	**TMDL (g/year)**	**Load Reduction (%)**
Watts Branch[1]	MD Upstream Load[2]	494.783	38.61	0.003	100
	Contaminated Sites	102.996	8.04	0	100
	Nonpoint Sources/LAs	**597.779**	**46.65**	**0.003**	**100**
	MS4	590.534	46.09	0	100
	Pepco (DC0000094)[3]	93.051	7.26	0	100
	Point Sources/WLAs	**683.585**	**53.35**	**0**	**100**
	Total Watts Branch	**1281.364**	**100**	**0.003**	**100**
Fort Chaplin Run[4]	MS4	128.931	100	0	100
	Point Sources/WLAs	**128.931**	**100**	**0**	**100**
	Total Fort Chaplin Run	**128.931**	**100**	**0**	**100**
Fort Dupont Creek	Contaminated Sites	52.087	35.21	0	100
	Nonpoint Sources/LAs	**52.087**	**35.21**	**0**	**100**
	MS4	95.849	64.79	0	100
	Point Sources/WLAs	**95.849**	**64.79**	**0**	**100**
	Total Fort Dupont Creek	**147.936**	**100**	**0**	**100**

Fort Davis Tributary[4]	MS4	98.234	100	0	100
	Point Sources/WLAs	**98.234**	**100**	**0**	**100**
	Total Fort Davis Tributary	**98.234**	**100**	**0**	**100**

[1]The District delineates Watts Branch as two assessment units, but for the purposes of this TMDL, Watts Branch #1 and #2 were combined.

[2]Upstream loads from the Maryland portion of the Watts Branch watershed.

[3]The loads for this individual discharger include both the land-based load attributed to the contaminated site and the load attributed to its discharge.

[4]No LA is presented for these segments because all stormwater runoff is captured by the MS4.

Note 1: The MOS is implicit.

Note 2: Columns may not precisely add to totals due to rounding.

Contaminated Site LAs for Unimpaired Segments

Daily LAs

Table A-21 Contaminated Site Daily LAs for Unimpaired Segments for Arsenic

Segment	Contaminated Site	LA (g/day)
Watts Branch	Kenilworth Park Landfill North	0.21

Table A-22 Contaminated Site Daily LAs for Unimpaired Segments for Copper

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	40.31
Fort Dupont Creek	CSX	29.34
Watts Branch	Kenilworth Park Landfill North	41.83

Table A-23 Contaminated Site Daily LAs for Unimpaired Segments for Zinc

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	169.18
Fort Dupont Creek	CSX	256.53
Watts Branch	Kenilworth Park Landfill North	150.50

Table A-24 Contaminated Site Daily LAs for Unimpaired Segments for Chlordane

Segment	Contaminated Site	LA (g/day)
Fort Dupont Creek	CSX	7.35E-04

Table A-25 Contaminated Site Daily LAs for Unimpaired Segments for DDT and its Metabolites

Segment	Contaminated Site	LA (g/day)
Nash Run	Kenilworth Park Landfill North	1.39E-03
Fort Dupont Creek	CSX	1.91E-04
Watts Branch	Kenilworth Park Landfill North	1.16E-03

Table A-26 Contaminated Site Daily LAs for Unimpaired Segments for Dieldrin

Segment	Contaminated Site	LA (g/day)
Fort Dupont Creek	CSX	0

Table A-27 Contaminated Site Daily LAs for Unimpaired Segments for Heptachlor Epoxide

Segment	Contaminated Site	LA (g/day)
Fort Dupont Creek	CSX	1.42E-04
Watts Branch	Kenilworth Park Landfill North	1.95E-04

Table A-28 Contaminated Site Daily LAs for Unimpaired Segments for the PAH 1 Group

Segment	Contaminated Site	LA (g/day)
Fort Dupont Creek	CSX	3.63
Watts Branch	Kenilworth Park Landfill North	5.67

Table A-29 Contaminated Site Daily LAs for Unimpaired Segments for the PAH 2 Group

Segment	Contaminated Site	LA (g/day)
Fort Dupont Creek	CSX	0
Watts Branch	Kenilworth Park Landfill North	0

Table A-30 Contaminated Site Daily LAs for Unimpaired Segments for the PAH 3 Group

Segment	Contaminated Site	LA (g/day)
Fort Dupont Creek	CSX	0
Watts Branch	Kenilworth Park Landfill North	0

Annual LAs

Table A-31 Contaminated Site Annual LAs for Unimpaired Segments for Arsenic

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Watts Branch	Kenilworth Park Landfill North	1481.18	0.95	99.94

Table A-32 Contaminated Site Annual LAs for Unimpaired Segments for Copper

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Nash Run	Kenilworth Park Landfill North	5311.76	157.31	97.04
Fort Dupont Creek	CSX	1379.82	55.19	96.00
Watts Branch	Kenilworth Park Landfill North	6762.41	202.87	97.00

Table A-33 Contaminated Site Annual LAs for Unimpaired Segments for Zinc

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Nash Run	Kenilworth Park Landfill North	4012.47	876.82	78.15
Fort Dupont Creek	CSX	1255.86	740.96	41.00
Watts Branch	Kenilworth Park Landfill North	5033.68	998.72	80.16

Table A-34 Contaminated Site Annual LAs for Unimpaired Segments for Chlordane

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Fort Dupont Creek	CSX	0.758	0.003	99.62

Table A-35 Contaminated Site Annual LAs for Unimpaired Segments for DDT and its Metabolites

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Nash Run	Kenilworth Park Landfill North	1.450	0.004	99.75
Fort Dupont Creek	CSX	0.219	0.001	99.77
Watts Branch	Kenilworth Park Landfill North	1.829	0.005	99.75

Table A-36 Contaminated Site Annual LAs for Unimpaired Segments for Dieldrin

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Fort Dupont Creek	CSX	0.4201	0	100

Table A-37 Contaminated Site Annual LAs for Unimpaired Segments for Heptachlor Epoxide

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Fort Dupont Creek	CSX	0.24	3.00E-04	99.87
Watts Branch	Kenilworth Park Landfill North	2.22	9.00E-04	99.96

Table A-38 Contaminated Site Annual LAs for Unimpaired Segments for the PAH 1 Group

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Fort Dupont Creek	CSX	15.81	15.81	0

Watts Branch	Kenilworth Park Landfill North	42.71	42.71	0

Table A-39 Contaminated Site Annual LAs for Unimpaired Segments for the PAH 2 Group

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Fort Dupont Creek	CSX	64.38	0	100
Watts Branch	Kenilworth Park Landfill North	120.58	0	100

Table A-40 Contaminated Site Annual LAs for Unimpaired Segments for the PAH 3 Group

Segment	Contaminated Site	Baseline Load (g/year)	LA (g/year)	Load Reduction (%)
Fort Dupont Creek	CSX	52.09	0	1
Watts Branch	Kenilworth Park Landfill North	103	0	1

MSGP WLAs for Unimpaired Segments

Table A-41 Daily WLAs for Individual MSGP Facilities for Unimpaired Segments

Segment	Facility	Drains To	Arsenic (g/day)	Copper (g/day)	Zinc (g/day)	Dieldrin (g/day)	Heptachlor Epoxide (g/day)
Hickey Run	DCR053008	MS4	0.48	159.36	186.47	0	2.33E-04
	DCR053030	MS4	0.49	165.00	193.06	0	2.42E-04
	DCR053043	MS4	0.10	34.30	40.14	0	5.02E-05
	DCR053046	MS4	0.08	27.06	31.66	0	3.96E-05
	DCR05J000	MS4	0.20	65.38	76.50	0	9.57E-05
	DCR05J003	MS4	0.23	77.87	91.12	0	1.14E-04

Table A-42 Annual WLAs for Individual MSGP Facilities for Unimpaired Segments

Segment	Facility	Drains To	Arsenic (g/year)	Copper (g/year)	Zinc (g/year)	Dieldrin (g/year)	Heptachlor Epoxide (g/year)
Hickey Run	DCR053008	MS4	1.70	693.48	1187.35	0	9.94E-04
	DCR053030	MS4	1.76	718.01	1229.34	0	1.03E-03
	DCR053043	MS4	0.37	149.26	255.56	0	2.14E-04
	DCR053046	MS4	0.29	117.75	201.60	0	1.69E-04
	DCR05J000	MS4	0.70	284.52	487.13	0	4.08E-04
	DCR05J003	MS4	0.83	338.88	580.21	0	4.86E-04

Appendix B: CLIMATE CHANGE SCENARIO METHODOLOGY AND RESULTS

Climate Change Analysis for the Anacostia River Watershed Toxics TMDL

Contract: 68HERC20D0016
March 14th, 2023

PRESENTED TO

US Environmental Protection Agency, Region 3,

District of Columbia Department of Energy and Environment,

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TASK 2 SUMMARY

Tetra Tech developed Loading Simulation Program C++ (LSPC) model simulations for watershed loading and Environmental Fluid Dynamics Code (EFDC) model simulations for hydrodynamic and fate and transport modeling of toxic constituents in the Anacostia River watershed for two time horizons: a near-term horizon around 2035 and a long-term horizon around 2055. Land use and land cover, TMDL allocation pollutant loads, and initial and boundary conditions remained identical to the 2014-2017 TMDL allocation scenario. Tetra Tech used projections of precipitation quantity and intensity, air temperature, and sea level rise from datasets generated by the Chesapeake Bay Modeling Workgroup (CBMW) in 2017 and 2019 (Shenk, et al., 2021) to represent the two time horizons, with suitable modifications as needed.

CONTENTS

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
CBMW	Chesapeake Bay Modeling Workgroup
CMIP5	Coupled Model Intercomparison Project 5
CWA	Clean Water Act
DCA	Ronald Reagan Airport
DOEE	District Department of Energy and the Environment
EFDC	Environmental Fluid Dynamics Code
EPA	Environmental Protection Agency
ET	Evapotranspiration
LSPC	Loading Simulation Program C++
LULC	Land Use Land Cover
NOAA	National Oceanic and Atmospheric Administration
PAH	Polyaromatic Hydrocarbon
SLR	Sea Level Rise
RCP	Representative Concentration Pathway
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
VU	Verification Unit

1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA) Region 3 coordinated with the District of Columbia Department of Energy and Environment (DOEE) to replace existing total maximum daily loads (TMDLs) for toxic impairments (metals, organochlorine pesticides, and polycyclic aromatic hydrocarbons [PAHs]) in the Anacostia River, its tributaries, and Kingman Lake. The Anacostia River was originally listed as impaired on the District of Columbia's 1998 Clean Water Act (CWA) Section 303(d) list. TMDLs were developed for those listings in 2003, but they were later challenged in court because they did not include a daily load expression. A subsequent court order set a date for the vacatur of EPA's approval of the existing TMDLs. In 2017 the court order was amended to extend that deadline three times: first, until January 31, 2020, then until September 30, 2021, and finally, until April 1, 2024. In addition, during that time a Remedial Investigation conducted under the Anacostia River Sediment Project resulted in the development of a large monitoring dataset to better characterize surface waters, bed sediment, pore water, manhole sediment quality, and tributary loading of sediment and contaminants in the watershed. Further, DOEE has published an interim Record of Decision to reduce sediment contamination at 11 different sites in the Anacostia River.

Tetra Tech delivered a TMDL load allocation and attenuation analysis on March 17, 2021. Consequently, draft replacement TMDLs were released for public notice and comment on July 9, 2021. As a result of comments raised by the public, EPA Region 3 and DOEE are spending additional time to analyze the effects of climate change on the draft TMDLs and attenuation of toxic pollutants in the Anacostia River. Under a contract with EPA Region 3, Tetra Tech has been tasked with performing this analysis. This report describes modeling that has been undertaken by Tetra Tech for EPA and DOEE to perform an analysis of the effects of climate change on the TMDLs and on the attenuation of toxic pollutants in the Anacostia River, its tributaries, and Kingman Lake following implementation of the TMDL allocations.

2.0 TASK 2 SCOPE OF WORK

Tetra Tech simulated the fate and transport of ten toxic pollutants/pollutant groups under conditions of climate induced changes in precipitation quantity and intensity, air temperature, and sea level rise (SLR). These are the three principal drivers of hydrometeorological change in this system (see Section 3.4 below). The projected climate change effects and time horizons selected for this analysis were chosen to be consistent with the Chesapeake Bay Program's medium- to long-term planning outlook (Shenk, et al., 2021). Therefore, the analysis assumes that climate change will occur according to the Coupled Model Intercomparison Project 5's (CMIP5) stabilization Representative Concentration Pathway (RCP) (Van Vuuren, et al., 2011) in which radiative forcing stabilizes to 4.5W/m^2 before the year 2100 (RCP 4.5) for two four-year periods, namely, 2034-2037 and 2054-2057, henceforth labeled the 2035 and 2055 time horizons. A brief description of these scenarios is given in Table 2-1. In this analysis, these periods respectively represent one near-term and one long-term time horizon.

Table 2-1. Crosswalk between scenarios defined in this report, Tetra Tech modeling report, and CBMW climate change report.

Scenario	Period	Description	Relationship to Tetra Tech TMDL modeling report	Relationship to CBMW analysis
TMDL baseline	2014-2017	Baseline current pollution conditions without TMDL load allocations, and <u>not used in this report</u>.	TMDL baseline scenario	NA

Scenario	Period	Description	Relationship to Tetra Tech TMDL modeling report	Relationship to CBMW analysis
TMDL allocation	2014-2017	Assigned TMDL load allocations, treated as the "baseline" for this study	TMDL load allocation scenario	NA
Near-term or 2035 climate change	2034-2037	Assigned TMDL load allocations with climate change projections at 2035	NA	Linear interpolation of climate projections at 2016 between CBMW's "baseline" in 1995 and their "near-term" scenario at 2025 + change between their "medium-term" scenario at 2035 and near-term scenario.
Long-term or 2055 climate change	2054-2057	Assigned TMDL load allocations with climate change projections at 2055	NA	Linear interpolation of climate projections at 2016 between CBMW's baseline and their near-term scenario + change between their "long-term" scenario at 2055 and near-term scenario.
2035 climate change natural attenuation	2034-2037	Assigned TMDL allocations and estimates of natural attenuation timeframes of toxic bed sediments under climate change projections at 2035	NA	Linear interpolation of climate projections at 2016 between CBMW's "baseline" in 1995 and their "near-term" scenario at 2025 + change between their "medium-term" scenario at 2035 and near-term scenario.
2055 climate change natural attenuation	2054-2057	Assigned TMDL allocations and estimates of natural attenuation timeframes of toxic bed sediments under climate change projections at 2055	NA	Linear interpolation of climate projections at 2016 between CBMW's baseline and their near-term scenario + change between their "long-term" scenario at 2055 and near-term scenario.

3.0 BACKGROUND

Tetra Tech simulated the fate and transport of the ten toxic pollutants/pollutant groups listed in Table 3-1 below, under conditions of near-term and long-term climate change. To perform a self-consistent and appropriate comparison with previous simulation results (Tetra Tech, 2021), model characteristics other than meteorological and SLR updates were not changed, except for the Potomac River inflow, which will be described below. For example, conditions such as land use and land cover (LULC), tributary and tidal river bathymetry, and toxic pollutants/pollutant groups management and policy were represented identically to the TMDL allocation scenario.

3.1 WATERBODY AND WATERSHED OVERVIEW

The 170-square-mile Anacostia River watershed originates in Montgomery and Prince George's Counties, Maryland, and terminates at the confluence with the Potomac River in the District of Columbia. Approximately 80% of the watershed is in Maryland and 20% is in the District of Columbia. The upper tributaries are nontidal freshwater, while the mainstem of the Anacostia River is tidally influenced. Additional details are available in the

TMDL modeling report (Tetra Tech, 2021). Figure 3.1-1 is a map of the Anacostia River watershed illustrating the modeling domain used to develop the TMDLs and perform the attenuation analysis (Tetra Tech, 2021).

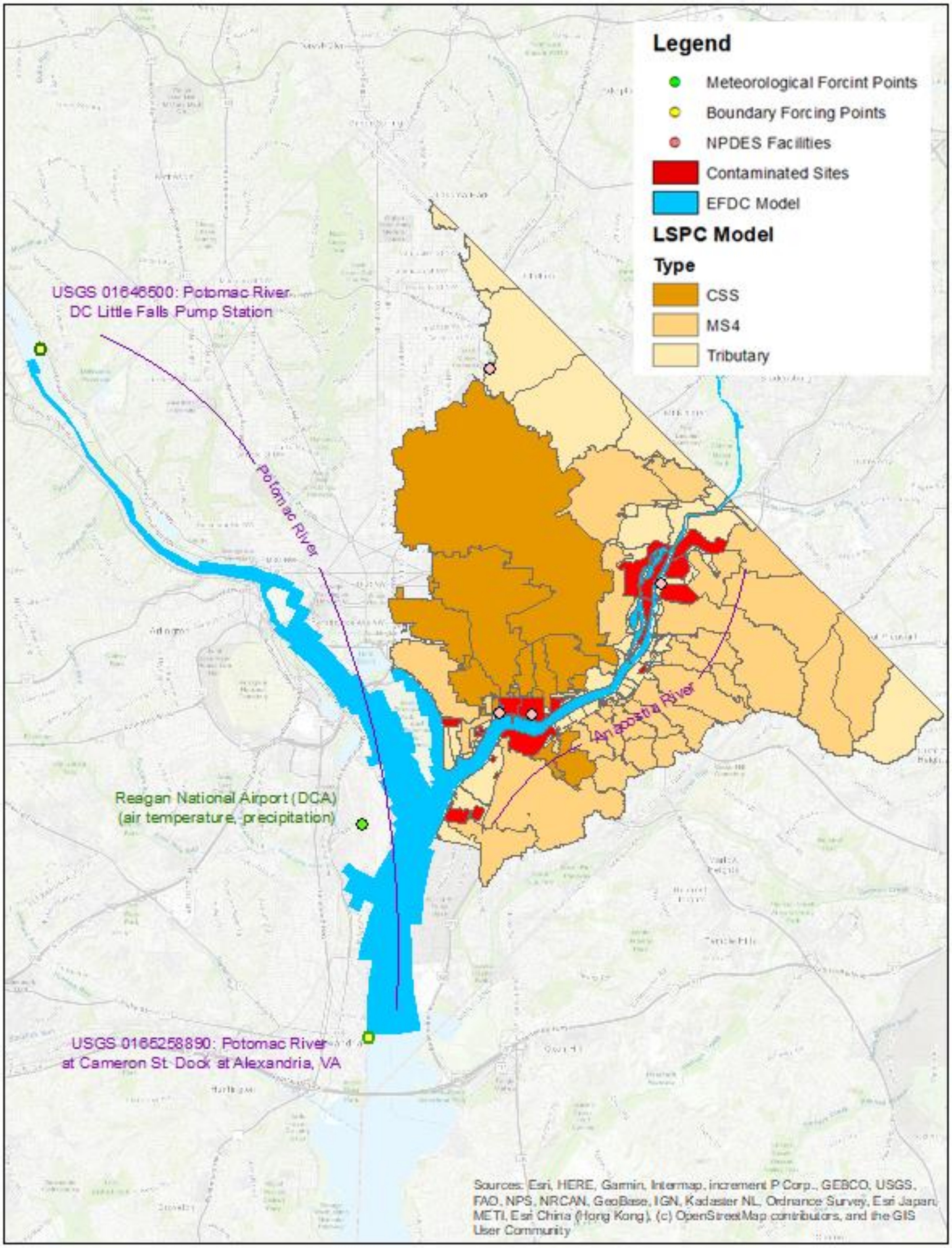

Figure 3.1-1. Anacostia River watershed and LSPC and EFDC model domains within the District of Columbia (Tetra Tech, 2021).

3.2 IMPAIRMENTS AND LISTINGS

CWA sections 303(d) and 305(b) include requirements and responsibilities for states and the District of Columbia related to identifying impaired waters and conducting water quality inventories. The District of Columbia submits Integrated Reports to EPA, which fulfill the requirements of both those sections. To consistently evaluate the impacts of climate change without altering the assumptions in the TMDL allocation scenario, the specific details of the impairments and designated uses remain identical to those listed in the TMDL modeling report (Tetra Tech, 2021). Tetra Tech simulated the fate and transport of the ten toxic pollutants/pollutant groups listed in Table 3-1.

Table 3-1. Toxic constituents that were simulated

Number	Pollutant Group (where applicable)	Pollutant
1	--	Arsenic
2	--	Copper
3	--	Zinc
4	--	Chlordane
5	--	Dieldrin
6	DDT	4,4'-DDD
		4,4'-DDE
		4,4'-DDT
7	--	Heptachlor Epoxide
8	PAH 1 (2+3 ring)	Acenaphthene
		Anthracene
		Naphthalene
		Fluorene
9	PAH 2 (4 ring)	Benzo[a]anthracene
		Chrysene
		Fluoranthene
		Pyrene
10	PAH 3 (5 + 6 ring)	Benzo[a]pyrene
		Benzo[b]fluoranthene
		Benzo[k]fluoranthene
		Dibenzo[a,h]anthracene
		Indeno[1,2,3-c,d]pyrene

3.3 WATERSHED AND RIVER MODELING

The LSPC model was used to simulate surface and subsurface runoff, sediment transport, and pollutant loads from the watershed and the hydraulics of the nontidal portion of the Anacostia River (Figure 2.1-1) (Tetra Tech, 2021). The LSPC model was used to provide updated loads based on the altered precipitation quantities and intensities under the future climate projections and the TMDL allocation scenario. The stormwater, sediment influxes and loads from the LSPC model were applied to the EFDC model of the tidal Anacostia River (Figure 3.1-1). In this region, the tidal influences from the Potomac River and the wider river channel with more complex bathymetry necessitate the use of a three-dimensional hydrodynamic model (Tetra Tech, 2021). Therefore, the sediment transport and the fate and transport of each of the toxic pollutants/pollutant groups listed in Table 3-1 were modeled using LSPC in the nontidal Anacostia River and using EFDC in the tidal Anacostia River.

To remain consistent with the assumptions of the TMDL allocation scenario (see Section 4.0 below), the coupled LSPC-EFDC model was run for each of the toxic pollutants/pollutant groups without modifying the LULC or pollutant sources. Only the principal hydrometeorological forcing variables were updated using the climate change projections for the Chesapeake Bay. Further, the model structure, including the representation of the hydrologic response units in LSPC and the grid in EFDC remained unaltered. To directly compare the timeseries of the model results between the TMDL allocation scenario and the future time horizons, four-year model runs were performed as stated in Section 2.0 above. The details of the model setup are presented in Sections 3.0 and 4.0 in the TMDL modeling report (Tetra Tech, 2021).

3.4 CLIMATE CHANGE ASSUMPTIONS AND LIMITATIONS

The analysis primarily utilized climate change projections for monthly air temperature and precipitation quantity and intensity, sea level rise, and flow and water temperature changes in the Potomac River, developed by the CBMW in 2017 and 2019 (Shenk, et al., 2021). This approach was adopted to align the future horizons as closely as possible to a larger regional modeling effort. As the CBMW projected climate change future horizons from a Chesapeake Bay Climate baseline in the mid-1990s (midpoint in year 1995), and the TMDL allocation scenario investigated earlier is the period between 2014 and 2017 (midpoint in year 2016), the following reasoning is applied to adopt a common baseline period and ultimately develop an Anacostia River climate baseline (the TMDL allocation scenario in Table 2-1) representing the more recent timeframe. The Chesapeake Bay climate baseline and Anacostia River climate baseline representations discussed for this work relate to climate representation and are distinct from the TMDL baseline pollutant loading scenario for the Anacostia River Toxic Constituents TMDL (see Table 2-1; Tetra Tech, 2021).

The CBMW projected air temperature, precipitation, and SLR in 2025 from the historic records such that a linear trend in the changes to these quantities in each month of the year is well justified over the period of 1995 to 2025 (Shenk, et al., 2021). Therefore, all the shifts in meteorological conditions between 1995 and 2025 will be adjusted to those between 1995 and 2016 by linearly interpolating these shifts until 2016 (see below). Consequently, all the shifts used in this study for climate projections will be relative to the TMDL allocation scenario reported earlier (Tetra Tech, 2021). In this analysis, the climate change effects on solar radiation, cloud cover, and wind will not be considered because they were not studied by the CBMW. There is much uncertainty in the approaches related to climate change effects on wind speed, making future projections unreliable (Wohland, Omrani, Witthaul, & Keenlyside, 2019). The SLR-impacted tidal water surface elevations in the Potomac River at the future time horizons will be obtained directly from the CBMW's estuarine model's outputs from the grid cell corresponding to Alexandria, VA on the Potomac River.

Meteorological forcings. Meteorological data that were used include precipitation, potential evapotranspiration (ET), air temperature, dew point temperature, wind speed, cloud cover, and solar radiation. As reported in the TMDL modeling report, hourly temperature records from the Washington Reagan Airport (DCA) (Tetra Tech, 2021), adjusted by additive constants corresponding to the month during which the records occur were used for air temperature. Hourly precipitation records from DCA, adjusted by multiplicative constants corresponding to the month during which the records occur, and further modified by the CBMW's "Delta method" (Shenk, et al., 2021) to represent intensification of wet spells were used for precipitation. These constants are shown in Table 3-2. The rationale behind the additive constants for air temperature is that the CBMW reported median air temperature change values (Shenk, et al., 2021), so that

$$\boldsymbol{T_{i,j}(t) = T(t) + d_{i,j}} \tag{1}$$

where $T(t)$ is the hourly air temperature record at DCA, $d_{i,j}$ is the additive constant temperature rise corresponding to the future time horizon i in month j, and $T_{i,j}(t)$ is the synthetic hourly air temperature record that will be created for the climate change analysis.
The additive constants for air temperature, obtained from the CBMW (Gopal Bhatt, CBMW, personal communication), were the median delta change for the District of Columbia for each of the future time horizons from which a fraction of the median delta change for the 2014-2017 time horizon was subtracted for each month. This was accomplished as follows:

$$d_{ij} = \underbrace{d_{ij}^{i-1990s}}_{\substack{\text{Additive rise} \\ \text{from 1990s} \\ \text{to horizon } i}} - \underbrace{\frac{21}{30} d_{2025j}^{2025-1990s}}_{\substack{\text{Linear interpolation of additive} \\ \text{rise to conditions in 2016 using} \\ \text{trend from 1995–2025}}}$$

The rationale behind the multiplicative constants for monthly precipitation quantity is that the CBMW reported median percent changes in these values (Shenk, et al., 2021),

$$\boldsymbol{Q_{i,j} = b_{i,j} Q_j; b_{i,j} = \left(1 + \frac{\tilde{p}_{i,j}}{100}\right)} \tag{2}$$

where $Q_{i,j}$ is the total quantity of precipitation in future time horizon i in month j, Q_j is the is the total quantity of precipitation in under the TMDL allocation scenario in month j, $b_{i,j}$ is the multiplicative constant precipitation change factor corresponding to the future time horizon, and $\tilde{p}_{i,j}$ is the percent change in precipitation from the TMDL allocation scenario. Hence, the change in quantity of precipitation in future time horizon i in month j will be

$$\Delta Q_{i,j} = \frac{\tilde{p}_{i,j}}{100} Q_j$$

The constants for precipitation, obtained from the CBMW (Gopal Bhatt, CBMW, personal communication), were the median delta change for the District of Columbia for each of the future time horizons from which a fraction of the median delta change for the 2014-2017 time horizon was subtracted for each month. These were used to obtain a $\boldsymbol{\tilde{p}_{i,j}}$ value for each month, which was then modified using the second part of Equation **Error! Reference source not found.** to obtain a $b_{i,j}$ value for each month. This is

$$\tilde{p}_{ij} = \left(p_{ij} - \frac{21}{30} p_{2025j}\right)$$

Here, p_{ij} is the percent change in precipitation from the Chesapeake Bay Climate Baseline circa the 1990s. The rationale behind the application of the Delta method for quantifying precipitation intensification is that rainfall events over the 20th century have intensified non-uniformly, such that the most intense rainfall events have increased more than the least intense rainfall events.

The CBMW's Delta method was also used to represent the intensification of precipitation due to climate change in a sequence of four steps (Gopal Bhatt, CBMW, personal communication):

1. First, it was noted that the observed changes in rainfall intensity over the 20th century in Chesapeake Bay were grouped into deciles and reported by the CBMW in their Figure 2-7 are $dI_{i=\{1,2,\cdots,10\}}$ = 2.9%, 2.9%, 2.9%, 2.9%, 2.9%, 2.3%, 1.2%, 5.8%, 11.7% and 64.3% (Shenk, et al., 2021). That is, the intensities of the lowest 10% of nonzero precipitation events increased on average by $dI_1 = 2.9\%$, those of the next highest 10% of nonzero precipitation events increased on average by $dI_2 = 2.9\%$, and so on, until those of the second highest 10% of nonzero precipitation events increased on average by $dI_9 = 11.7\%$. and those of the highest 10% of nonzero precipitation events increased on average by $dI_{10} = 64.3\%$.
2. Second, the hourly timeseries of precipitation records from 2014 to 2017 were separated into zero precipitation and nonzero precipitation events, and the nonzero precipitation events were ranked from lowest, $r = 1$, to highest, $r = 10$.
3. Third, the ranked nonzero precipitation events were grouped into decile or 10-percentile bins.
4. Fourth, the precipitation record, $P(t)$, at time t from DCA station in month j which is either zero or nonzero and falling in bin r is applied to the identical timestamp in the future time horizon i as

$$\boldsymbol{P_{i,j}(t)} = \begin{cases} \boldsymbol{0} & ; \boldsymbol{P(t) = 0} \\ \boldsymbol{P(t) + \Delta Q_{i,j} \cdot \frac{dI_r(t)}{\sum_{q=1}^{m} dI_q} \cdot \frac{1}{n_r}} & ; \boldsymbol{P(t) \neq 0} \end{cases} \tag{3}$$

where $P_{i,j}(t)$ is the synthetic hourly precipitation record that will be created for the climate change analysis, $dI_r(t)$ is the observed intensification rate of precipitation events in the r^{th} decile bin the precipitation record $P(t)$ falls into, and n_r is the number of precipitation records in month j that fell into the r^{th} decile bin.

The rationale is that the total precipitation in in month j computed using Equation **Error! Reference source not found.** will be

$$Q_{i,j} = \sum_{t=1}^{m} P_{i,j}(t) = \sum_{t=1}^{m} P(t) + \frac{\Delta Q_{i,j}}{\sum_{q=1}^{m} dI_q} \sum_{t=1}^{m} \frac{dI_r(t)}{n_r} = Q_j + \Delta Q_{i,j}$$

The last summation over all precipitation records is equivalent to a summation over all the decile bins into which precipitation records fall into in that month as

$$\sum_{t=1}^{m} \frac{dI_r(t)}{n_r} = \sum_{q=1}^{m} \frac{n_q dI_q}{n_q} = \sum_{q=1}^{m} dI_q$$

as there are n_q records in the q^{th} decile bin in that month. So, the change in quantity of precipitation in future time horizon i in month j is recovered using Equation **Error! Reference source not found.**.

While the use of these formulations is extremely simple and does not account for stochasticity in hourly meteorological patterns, the use of these “shifted” timeseries is appropriate because, the flushing time of the Anacostia River is typically about 20 days and can range up to 100 days during prolonged droughts (Interstate Commission on the Potomac River Basin, 1988). So, hourly variability within each month will be averaged out.

Table 3-2. Additive and multiplicative meteorological constants for climate change analysis.

	Future time horizon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Air temperature, d_{ij} (°C)	2035	0.76	0.71	0.49	0.78	0.67	0.60	0.68	0.75	0.77	0.61	0.57	0.69
	2055	1.21	1.36	0.99	1.19	1.39	1.39	1.35	1.35	1.32	1.49	0.84	1.22
Precipitation, $\tilde{p}_{i,j}$	2035	0.031	0.041	0.005	0.038	0.021	0.030	0.038	0.051	0.032	0.013	0.005	0.086
	2055	0.037	0.077	0.025	0.058	0.068	0.047	0.025	0.062	0.025	0.040	0.057	0.117
Sea level rise, $h_{i,j}$ (m)	2035	0.188	0.182	0.184	0.184	0.185	0.187	0.187	0.187	0.188	0.189	0.188	0.195
	2055	0.444	0.440	0.444	0.441	0.445	0.449	0.449	0.450	0.451	0.454	0.452	0.461

Hydrologic forcings from the watershed. The LSPC model provides overland and subsurface runoff and sediment and pollutant loads corresponding to the altered precipitation quantities and intensities under the future climate projections and the TMDL allocation scenario. The USGS monitoring station location 01646500 near Little Falls along the upstream Potomac River (Figure 3-2) is used to provide freshwater inflows to the Potomac River as a non-modeled boundary condition in the TMDL modeling. Based on estimates presented in Figure 4-29 of the CBP Modeling Workgroup Report, streamflow and water temperature for the Potomac River were increased to reflect both near-term and long-term climate change conditions. Streamflow rates at the Little Falls boundary were uniformly increased by 2.7% and 6.25% for 2035 and 2055 scenarios, respectively.

Estimates for water temperature increase on the Potomac River were not presented. Instead, water temperature increases based on results from the Anacostia River LSPC model were applied to the Potomac River. The water temperature boundary was uniformly increased by 1.9% and 3.6% for the 2035 and 2055 scenarios, respectively.

Sea level rise and the tidal boundary at Alexandria, VA. The primary drivers of mixing and estuarine circulation in the Chesapeake Bay and its tributaries, including the Potomac River, are likely freshwater inflows, change in tidal amplitudes, and relative SLR (Ross, Najjar, & Li, 2021). Therefore, in this analysis, the effects of these variables are isolated and considered. The relative SLR (RSLR) is the SLR relative to the vertical movement of the land nearby (USEPA, 2021). The instantaneous tidal water surface elevations measured at the USGS tide gage at the Potomac River at Cameron Station Dock at Alexandria in Virginia (monitoring station location 0165258890, see Figure 3-2) were used (USGS, 2022) between 2014 and 2017 shifted additively by the constants shown in **Error! Reference source not found.**. The rationale behind the additive constants to account for SLR is that the CBMW reported median air temperature change values (Shenk, et al., 2021), so that

$$\boldsymbol{H_{i,j}(t) = H(t) + h_{i,j}} \tag{4}$$

where $H(t)$ is the hourly water surface elevation above a given datum at the USGS tide gage at the Potomac River at Cameron Station Dock at Alexandria in Virginia (monitoring station location 0165258890) between 2014 and 2017, $h_{i,j}$ is the additive constant SLR corresponding to the future time horizon i in month j, and $H_{i,j}(t)$ is the synthetic hourly water surface elevation record that will be created for the climate change analysis. These constants were read off from the RSLR projections from the Chesapeake Bay estuarine circulation model developed by the CBMW in the grid cell corresponding to the USGS gage 0165258890 which is very close to the free boundary of the EFDC grid at Alexandria, VA (Richard Tian, CBMW, personal Communication). The Chesapeake Bay estuarine circulation model grid is shown overlayed on the TMDL EFDC grid in Figure 3-2. The timeseries of water surface elevations measured from the long-term mean sea surface elevation above a set datum were provided by CBMW for a ten-year period spanning four time horizons centered at 1995, 2025, 2035 and 2055.

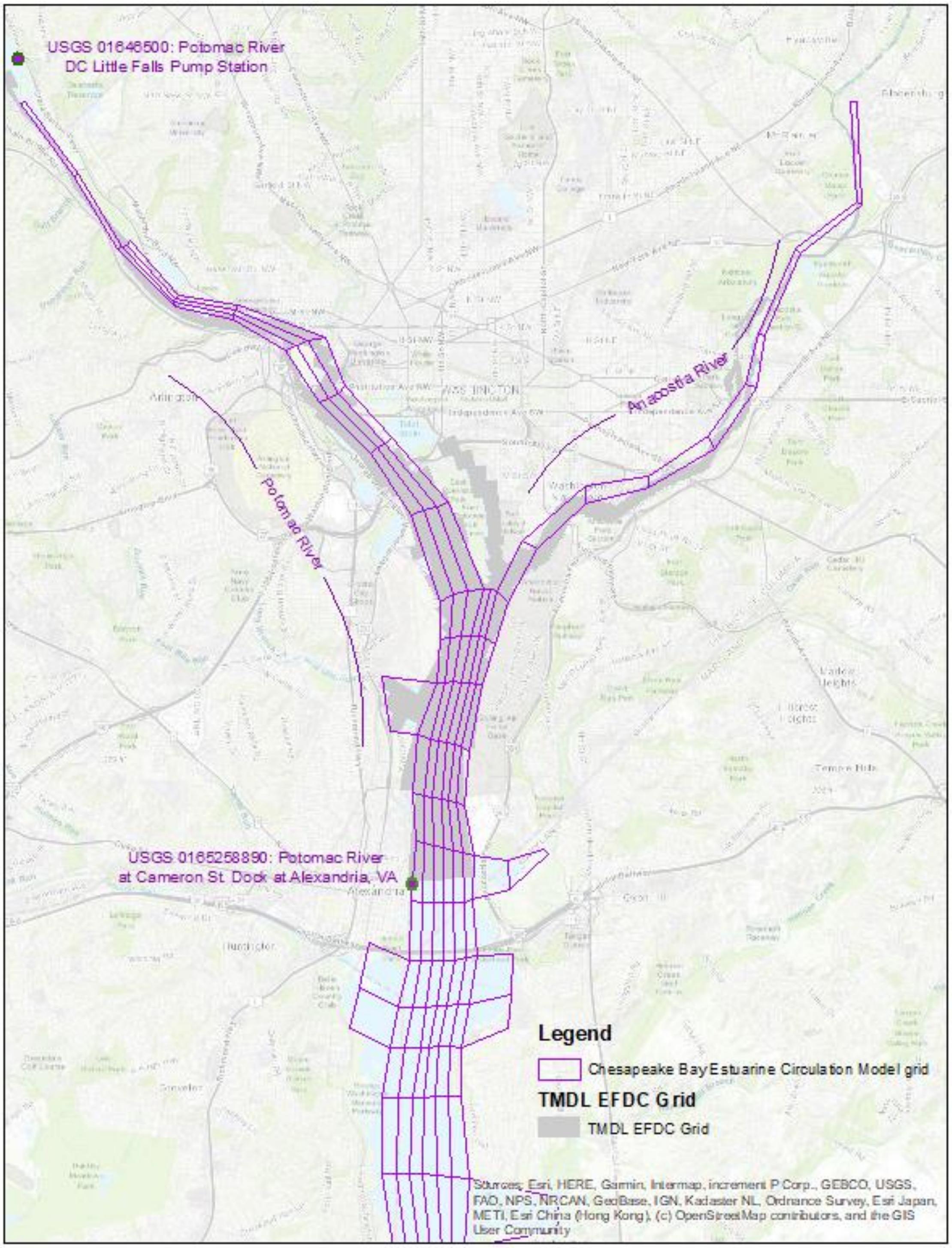

Figure 3-2. Chesapeake Bay estuarine circulation model grid near the confluence of the Potomac River, and locations of USGS gage stations on the Potomac River at Little Falls (USGS 01646500) and at Alexandria's Cameron Street Dock (USGS 0165258890).

Similar to the additive constants for air temperature, the additive constants for SLR were the delta change for the specified computational grid cell for each of the future time horizons from which a fraction of the median delta change for the 2014-2017 time horizon was subtracted for each month. This was accomplished as follows:

$$h_{ij} = \underbrace{h_{ij}^{i-1990s}}_{\substack{\text{Additive rise}\\ \text{from 1990s}\\ \text{to horizon } i}} - \underbrace{\frac{21}{30} h_{2025j}^{2025-1990s}}_{\substack{\text{Linear interpolation of additive}\\ \text{rise to conditions in 2016 using}\\ \text{trend from 1995−2025}}} \quad (4)$$

These constants are shown in Table 3-2.

Assumptions and limitations. There are several assumptions and limitations in this climate change analysis. To remain consistent with the CBMW's analysis, this analysis considered the effects of rising air temperature and increasing precipitation quantity and intensity, and alterations to the freshwater inflows, stream temperature, and sediment loads from the Potomac River. It will not consider the effects of other meteorological or water quality drivers, either because they were not included in the CBMW's analysis, or because the projections involve too much uncertainty at the watershed scale (as in the case of windspeed).

In the case of freshwater inflows into the Potomac River, the CBMW's projections in their Figure 4-29 estimated only a nominal increase of about 5% from 2025 to 2050 (Shenk, et al., 2021). Although this increase is very small compared to the volumetric flowrate associated with the RSLR, this change was included to remain consistent with CBMW and leverage regional efforts. As the change in streamflow is minimal, it is not expected that the dilution effect of water temperature to be significantly different from the conditions in the 2014-2017 period. However, changes in the water temperature of the Potomac River were updated as discussed previously based on results of the LSPC watershed model climate change scenarios.

Updated sediment loading for the Potomac is the result of increased flow volumes only, and suspended sediment concentrations were not updated. Additional clean sediment concentrations entering the Potomac River would effectively reduce the attenuation duration of toxic constituents in the tidal Anacostia River sediments. Therefore, by not including a projected increase in the sediment concentration (Shenk, et al., 2021), the analysis conservatively overpredicts the time needed for natural attenuation to occur. This would result in an implicit margin of safety built into the analysis.

In addition, the analysis assumes that the projections of RSLR at Alexandria, VA are identical to those obtained from the CBMW's estuarine model solution at the nearest grid cell to this location. Another assumption is that the hourly timeseries of air temperature, precipitation, and tidal water surface elevations were exactly replicated with additive or multiplicative biases as shown in Equations **Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.**. Under the assumptions of linearity in the climate trends until 2025, the period of 2014 to 2017 were considered as linearly interpolated from the trend between the 1990s and the CBMW's future time horizon of 2025.

4.0 CLIMATE CHANGE AND ATTENUATION SCENARIO DEVELOPMENT

For each future time horizon (2035 and 2055) and for each toxic pollutant/pollutant group in Table 3-1, Tetra Tech conducted two sets of model runs. The first set of runs (Climate Change Scenario) represents conditions in which the TMDL load and wasteload allocations specified in the four-year period between 2014 and 2017 (Tetra Tech, 2021) were implemented. The second set of runs (Climate Change Natural Attenuation Scenario) was designed to estimate how long natural attenuation of toxic constituents in bed sediment will take considering climate change impacts, relative to the natural attenuation results documented in the TMDL.

The Climate Change Scenario runs used the paired LSPC-EFDC model of the TMDL allocation scenario to assess change in water column concentrations for each pollutant/pollutant group for the 2035 and 2055 time horizons. The purpose of these runs is to determine the impacts of climate change on the TMDL allocations, specifically whether and when the TMDL allocations, once implemented, will result in attainment of the TMDL endpoints under future climactic conditions. The Climate Change Natural Attenuation Scenarios are additional model runs performed to represent bed sediment concentrations at existing concentrations (i.e., no reductions to bed sediment) and retaining landside TMDL allocations. The purpose of the second set of runs is to estimate the change in bed sediment attenuation as a result of climate change and the impact of natural attenuation on the achievement of the TMDL endpoints. This results in a total of 20 LSPC runs and 40 EFDC runs across the two future time horizons for the 10 toxic pollutants/pollutant groups.

For the Climate Change Scenarios, the TMDL allocations remained identical to those reported earlier (Tetra Tech, 2021). Similarly, the Climate Change Natural Attenuation Scenario analyses were performed in a manner identical to those completed previously. In these analyses, the model was run for a period of four years and the concentrations of toxic pollutants in the bed sediment were extrapolated linearly to calculate the time needed for existing bed sediment pollutant concentrations to decrease to concentrations that support meeting TMDL endpoints for the water column. In other words, the times for the bed sediment concentrations to meet the bed sediment targets identified in the TMDL were estimated. This step identifies the future year at which natural attenuation may be expected to result in meeting the bed sediment endpoints calculated in the TMDL, and therefore the water column criteria, under climate change conditions.

The attenuation timeframes predicted under each of the two climate change scenarios were then be compared to the attenuation timeframes predicted under the TMDL allocation scenario to see what the effects of climate change will be on the TMDL allocation scenario and predicted water quality attainment. In each future time horizon, i, for each pollutant/pollutant group, p, within each assessment unit, u, the following quantitative metric indicates whether attainment of bed sediment targets, and therefore, the TMDL endpoints, under the climate change scenarios is likely to occur faster than, slower than, or at an approximately equal rate to attainment during the TMDL allocation scenario:

$$\Delta C_{i,p,u} = c_{i,p,u} - c_{p,u}$$

where $c_{i,p,u}$ is the concentration of the pollutant/pollutant group, p, within assessment unit, u, in the future time horizon, i, and $c_{p,u}$ is the concentration of the pollutant/pollutant group, p, within assessment unit, u, in the TMDL allocation scenario. In addition to this quantitative metric, a qualitative color-coded metric given by

$$\Delta A_{i,p,u} = c_{i,p,u} - s_p$$

will indicate for the TMDL endpoint (which is the most stringent water quality criterion for each pollutant/pollutant group, s_p) whether attainment is achieved under the future time horizons.

5.0 CLIMATE CHANGE AND ATTENUATION SCENARIO RESULTS

5.1 CLIMATE CHANGE SCENARIO RESULTS

5.1.1 LSPC Watershed Model Results

The LSPC watershed model was run first to simulate updated temperature and precipitation conditions described in Section 4. Results for each subwatershed of the Anacostia River watershed were obtained and ultimately linked to the EFDC hydrodynamic model representing the tidal portion of the Anacostia River. Simulated streamflows and toxicant loadings from subwatersheds were summarized by pour point, or the points at which tributaries are discharged to the tidal Anacostia River.

The results of the subwatershed aggregation show a variation in pollutant loading, not only by type of toxicant, but by tributary system. For example, Figure 5-1 shows the area-weighted loading rate by contributing watershed in mg/acre/day for the TMDL allocation scenario. An area-weighted loading rate is shown to compare larger watersheds with smaller watersheds by normalizing the acreage. The loading rates vary between watersheds, with higher pesticide loading rates along Northeast Branch Anacostia River, Buzzard Point, and along the Washington Channel. Lower loading rates are clustered along the western side of the tidal Anacostia River, which is serviced by the combined sewer system (CSS), which conveys most of these loads to the Blue Plains Treatment Facility.

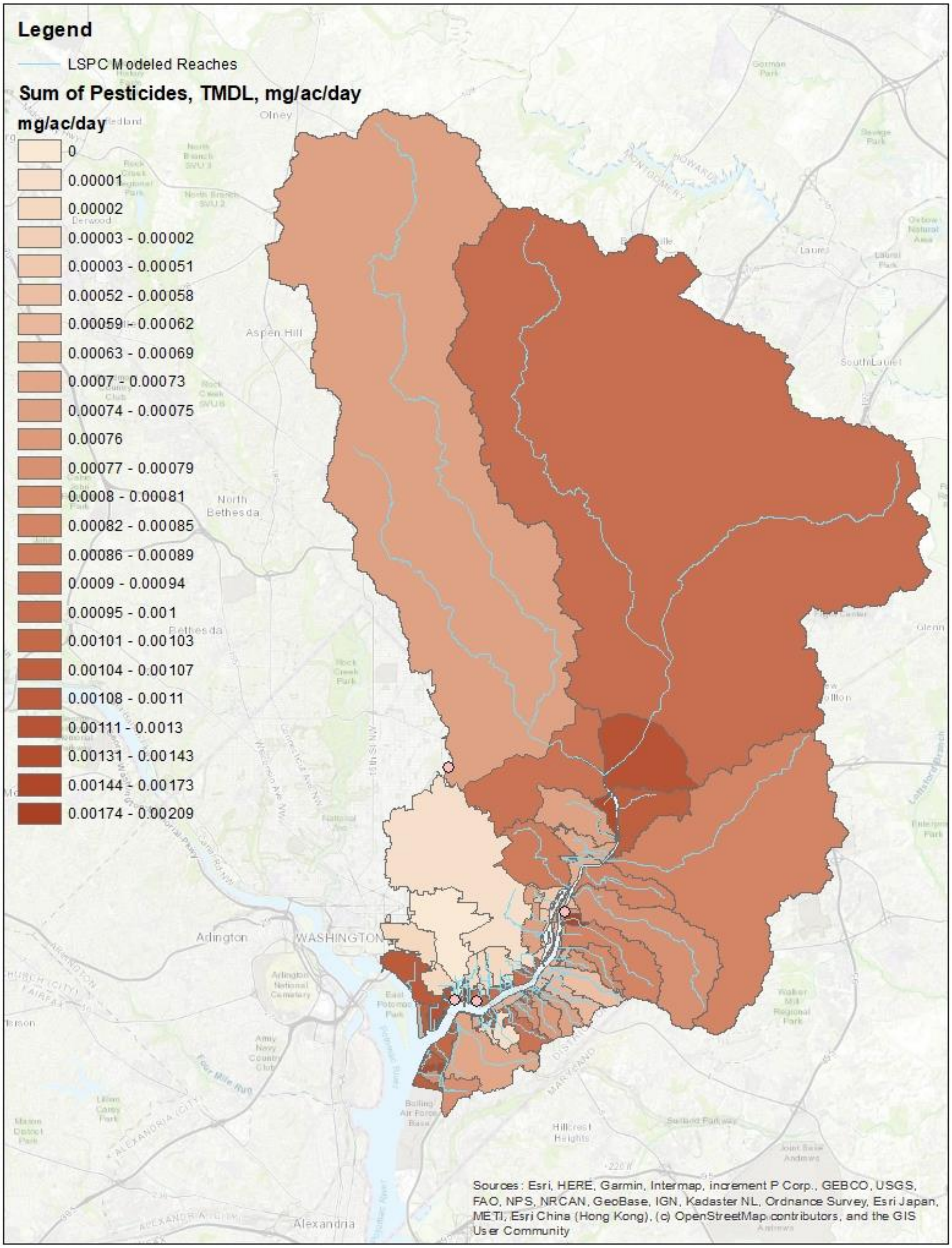

Figure 5-1. Pesticide loading rates (mg/ac/day) by watershed under the TMDL allocation scenario.

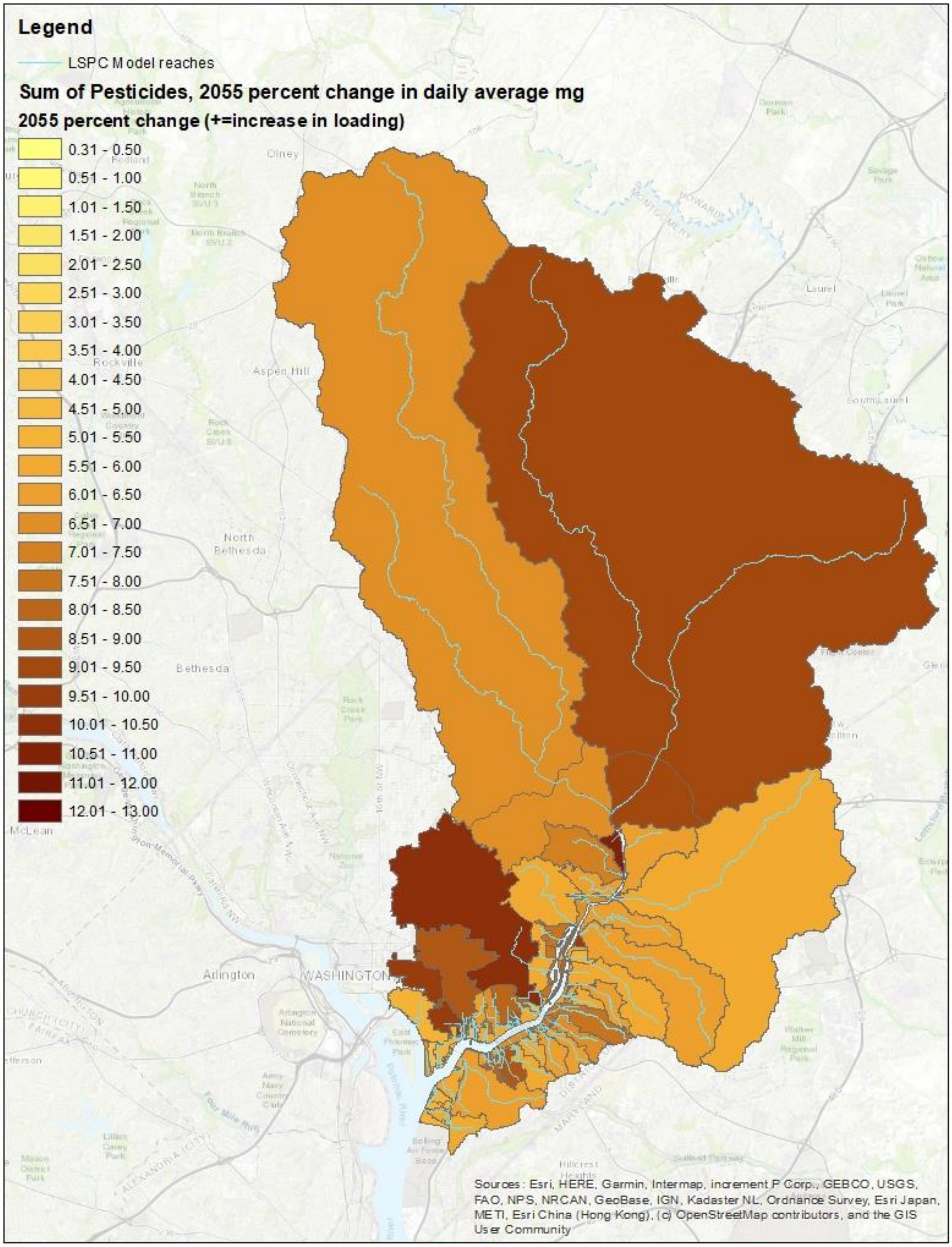

Figure 5-1. Change in pesticide loading rates (percent) by watershed under the 2055 Climate Change Scenario.

Figure 5-2 shows the change in area-weighted pesticide loading for the 2055 climate change scenario. Under the 2055 Climate Change Scenario, total pesticide loading increases in all subwatersheds by between 0.3 and 13%[1]. Lower increases in loading occur in watersheds where previously high loading rates were exhibited. Higher increases generally occur in areas that formerly contributed smaller loads, except for the Northeast Branch Anacostia River. Significantly, the largest percent increases are seen in the CSS watersheds[2], as additional rainfall volume and intensity in these subwatersheds create additional overflows and increase loading to the tidal Anacostia River.

5.1.2 EFDC Model Results

The results of the LSPC watershed modeling of climate change scenarios we linked to the EFDC hydrodynamic model of the Anacostia River to simulate fate and transport in the tidal portion of the study area. As described above in Section 3.4, sea level rise and atmospheric forcings were applied to the EFDC model domain in addition to increased loads from the LSPC watershed model. The discussion below describes the aggregate impact of these climate change components, and the impact on natural attenuation for both near-term and long-term climate impacts.

5.1.2.1 Impacts of Climate Change on Tidal Anacostia River Water Quality

The TMDL analysis segmented the tidal Anacostia River into 16 verification units, or VUs, representing discrete regions of the system in order to acknowledge the variable physical characteristics within the system, as well as levels of contamination of toxic pollutants. As described in the TMDL modeling report, these VUs used the tidal assessment unit boundaries used for impairment listings as a template for subdivision so that each VU can be linked back for assessment purposes.

The results of the near-term (circa 2035) and long-term (circa 2055) climate change scenarios are shown in Table 5.1 and Table 5.2, respectively. These tables show the difference between the TMDL allocation scenario, which is characterized by watershed TMDL allocations and bed sediment reductions that meet TMDL endpoints under existing climate conditions during the modeling period of 2014-2017, and the climate change scenarios which take into account predicted climactic conditions. Tables 5.1 and 5.2 present the comparison of water column concentrations across VUs in the tidal Anacostia River and across the 10 pollutants/pollutant groups with the maximum 30-day average concentration as a metric.

[1] Changes in area-weighted pesticide loading for the 2035 climate change scenario are less substantial than those in 2035 (not shown), but follow similar trends.

[2] It is important to note that the basis for comparison is the 2014-2017 time period. Beginning in March of 2018, a portion of the CSS in the Anacostia River watershed was connected to the Anacostia River Tunnel, which has significantly reduced overflows to the tidal Anacostia River due to its storage capacity and conveyance to Blue Plains Advanced Wastewater Treatment Plant. The conveyance was not updated in these scenarios in order to isolate the impacts of climate change.

Table 5.1 Comparison of the TMDL allocation scenario and near-term 2035 climate change scenario water column results for the tidal Anacostia River by VU and toxicant.

2035 Climate Change Scenario	Pollutant:	Heptachlor epoxide	Chlordane	Dieldrin	DDT	Arsenic	Copper	Zinc	PAH1	PAH2	PAH3	
	TMDL Endpoint (ug/l):	3.20E-05	3.20E-04	1.20E-06	1.80E-05	0.14	8.96	117.18	50.00	1.30E-03	1.30E-04	
	Bed Target (ug/kg):	3.55E-01	-	-	-	-	-	-	-	-	-	
	Verification Unit	Change in Maximum 30-day Average Concentration (%)										Average:
Upstream	MD Northwest Branch-1	2.4%	0.8%	-0.2%	1.8%	2.4%	0.2%	2.4%	3.3%	1.1%	1.0%	1.5%
	MD Tidal Anacostia-1	3.8%	3.3%	-2.9%	2.8%	0.2%	0.5%	-1.5%	-4.4%	-1.7%	-1.5%	-0.2%
	Anacostia #2-10	3.7%	3.2%	-4.3%	2.8%	-0.2%	-1.3%	-2.5%	-4.8%	-2.3%	-1.9%	-0.7%
	Anacostia #2-9	3.7%	3.3%	-5.8%	2.9%	-2.7%	-2.2%	-4.9%	-6.5%	-4.6%	-4.4%	-2.1%
	Anacostia #2-8	3.7%	3.2%	-6.7%	2.8%	-3.4%	-2.8%	-6.2%	-4.0%	-5.9%	-5.6%	-2.5%
	Kingman Lake-2	3.6%	3.3%	-4.8%	3.0%	-1.2%	-0.9%	-0.4%	-10.1%	-1.6%	-1.8%	-1.1%
	Anacostia #2-7	4.0%	3.6%	-6.5%	3.2%	-3.7%	-2.5%	-5.4%	-6.3%	-5.6%	-5.3%	-2.4%
	Anacostia #2-6	1.0%	4.4%	-5.5%	4.0%	-3.6%	-1.7%	-4.6%	-10.4%	-4.9%	-4.3%	-2.6%
	Kingman Lake-1	4.6%	4.4%	-5.8%	4.0%	-2.4%	-1.5%	-3.7%	-12.1%	-4.1%	-3.9%	-2.1%
	Anacostia #2-5	0.1%	4.4%	-5.0%	4.1%	-3.1%	-1.5%	-3.9%	-16.3%	-4.3%	-3.5%	-2.9%
	Anacostia #2-4	0.1%	4.2%	-4.7%	3.8%	-2.5%	-1.4%	-3.8%	-18.2%	-3.5%	-3.2%	-2.9%
	Anacostia #2-3	-0.6%	4.3%	-4.4%	2.2%	-2.2%	-1.6%	-4.1%	-14.7%	-3.6%	-3.2%	-2.8%
	Anacostia #2-2	-1.2%	4.3%	-4.3%	1.0%	-2.0%	-1.6%	-4.2%	-13.5%	-3.4%	-3.1%	-2.8%
	Anacostia #2-1	-1.2%	4.3%	-4.2%	-0.5%	-1.8%	-1.5%	-4.2%	-12.3%	-3.3%	-3.0%	-2.8%
	Anacostia #1-2	-0.9%	4.1%	-3.8%	-0.4%	-1.2%	-1.5%	-4.4%	-8.5%	-2.9%	-2.6%	-2.2%
Downstream	Anacostia #1-1	3.9%	3.6%	-1.3%	-0.1%	-0.3%	-1.6%	-3.7%	0.3%	-1.4%	-1.2%	-0.2%
	Average:	1.9%	3.7%	-4.4%	2.3%	-1.7%	-1.4%	-3.4%	-8.7%	-3.3%	-3.0%	

30-day avg concentration decrease >5%
30-day avg concentration increase >5%
Exceeds TMDL Endpoint

While the results of the LSPC simulations suggest that additional toxicant loads are generated under climate change conditions for both near-term and long-term scenarios, the tidal Anacostia River receiving these loads shows improvement in some areas for some pollutant groups. The results of the comparison show variability across pollutants, and also by location in the tidal Anacostia River system. For both the 2035 and 2055 climate change scenarios, PAH concentrations improve downstream of the upstream-most VU, as do metals in general. Pesticides, on the other hand, tend to increase in concentration, except for dieldrin. Dieldrin improvements track similarly to the PAH groups. Locationally, VUs downstream of the Anacostia 2-7 VU are negatively impacted by climate change, likely due to increased CSS contributions in this region that were discussed in Section 5.1.1. This is particularly evident in the 2055 scenario where there is a greater intensification of precipitation. Furthermore, although there are increases in toxicant concentrations in these areas, only one toxicant in one verification unit exceeds the TMDL endpoint under the TMDL allocations and bed sediment reductions called for in the TMDLs. The maximum 30-day average heptachlor epoxide concentrations exceed the TMDL endpoint in the Anacostia 1-1 VU in the 2055 climate change scenario. This is the only VU and pollutant that would exceed the water column TMDL endpoint under near-term or long-term climate change conditions under the TMDL allocations and bed sediment reductions called for in the TMDLs.

Table 5.2 Comparison of the TMDL allocation scenario and long-term 2055 climate change scenario water column results for the tidal Anacostia River by VU and toxicant.

2055 Climate Change Scenario	Pollutant:	Heptachlor epoxide	Chlordane	Dieldrin	DDT	Arsenic	Copper	Zinc	PAH1	PAH2	PAH3	
	TMDL Endpoint (ug/l):	3.20E-05	3.20E-04	1.20E-06	1.80E-05	0.14	8.96	117.18	50.00	1.30E-03	1.30E-04	
	Bed Target (ug/kg):	3.55E-01	-	-	-	-	-	-	-	-	-	
	Verification Unit	Change in Maximum 30-day Average Concentration (%)										Average:
Upstream	MD Northwest Branch-1	2.5%	3.2%	1.6%	4.8%	6.3%	3.0%	8.3%	9.3%	4.9%	4.4%	4.8%
	MD Tidal Anacostia-1	4.4%	3.8%	-6.0%	3.1%	0.4%	3.8%	-1.2%	-9.3%	-2.9%	-2.6%	-0.7%
	Anacostia #2-10	4.6%	3.9%	-9.5%	3.3%	0.3%	-0.2%	-5.5%	-10.5%	-5.5%	-5.0%	-2.4%
	Anacostia #2-9	4.6%	4.0%	-12.7%	3.4%	-2.8%	-1.9%	-11.5%	-11.4%	-10.7%	-10.2%	-4.9%
	Anacostia #2-8	4.3%	3.8%	-14.2%	3.3%	-5.7%	-3.2%	-13.9%	-6.3%	-13.1%	-12.6%	-5.8%
	Kingman Lake-2	4.7%	4.3%	-8.2%	3.9%	-1.2%	1.7%	3.7%	-27.1%	-0.3%	-1.5%	-2.0%
	Anacostia #2-7	5.6%	5.0%	-13.8%	4.4%	-7.5%	-3.3%	-12.2%	-11.2%	-12.6%	-12.2%	-5.8%
	Anacostia #2-6	3.2%	6.6%	-11.5%	5.9%	-7.1%	-0.8%	-9.5%	-17.8%	-10.5%	-9.4%	-5.1%
	Kingman Lake-1	6.7%	6.2%	-11.2%	5.7%	-4.0%	-1.1%	-5.3%	-26.3%	-6.7%	-6.7%	-4.3%
	Anacostia #2-5	2.2%	6.4%	-10.3%	5.8%	-6.4%	-1.3%	-8.1%	-18.4%	-8.7%	-7.5%	-4.6%
	Anacostia #2-4	1.9%	5.9%	-9.7%	5.3%	-4.9%	-2.2%	-7.7%	-12.8%	-7.3%	-6.8%	-3.8%
	Anacostia #2-3	1.0%	5.8%	-9.2%	3.6%	-4.4%	-2.7%	-8.4%	-11.3%	-7.5%	-6.8%	-4.0%
	Anacostia #2-2	0.4%	5.8%	-9.0%	2.3%	-3.9%	-2.7%	-8.5%	-9.9%	-7.3%	-6.6%	-3.9%
	Anacostia #2-1	-0.2%	5.9%	-8.7%	0.6%	-3.4%	-2.5%	-8.5%	-8.5%	-6.9%	-6.3%	-3.9%
	Anacostia #1-2	-0.8%	6.4%	-7.8%	-0.2%	-2.1%	-2.4%	-8.8%	-3.9%	-6.0%	-5.4%	-3.1%
Downstream	Anacostia #1-1	**6.3%**	6.3%	-1.9%	0.0%	-0.4%	-2.1%	-6.3%	7.0%	-2.7%	-2.4%	0.4%
	Average:	3.2%	**5.2%**	-8.9%	3.4%	-2.9%	-1.1%	-6.5%	-10.5%	-6.5%	-6.1%	

30-day avg concentration decrease >5%

30-day avg concentration increase >5%

Exceeds TMDL Endpoint

5.1.2.2 Impacts of Climate Change on Natural Attenuation of Bed Sediments

The attenuation timeframes predicted under each of the two climate change scenarios are compared to the attenuation timeframes predicted under the TMDL allocation scenario to illustrate what effects climate change will have on the TMDL allocation scenario and predicted water quality attainment. Table 5.3 shows the length of time needed for each pollutant/pollutant group to achieve the bed sediment target concentrations called for under the TMDL scenario in each VU. Table 5.4 and Table 5.5 show the length of time needed for each pollutant/pollutant group to achieve bed sediment target concentrations in each VU for the 2035 and 2055 climate change scenarios, respectively. Table 5.6 and 5.7 show the difference in the number of years needed to achieve bed sediment targets for the 2035 and 2055 scenarios, respectively. Results for Zinc and PAH 1 are reported as N/A because the TMDL endpoints for those pollutants will be met once the TMDLs are implemented. Therefore, reductions of zinc and PAH 1 concentrations in bed sediment via natural attenuation are not needed to meet the TMDL endpoints for these pollutants. Across the toxic pollutants/pollutant groups, there is a negligible change in the duration of natural attenuation of bed sediments, except in the Kingman Lake and the most downstream VUs in the system. In particular, pollutant concentrations in bed sediment in the lower VU segment of Kingman Lake (Kingman Lake-1) attenuate more rapidly in both the 2035 and 2055 scenarios, whereas the Anacostia 1-1 VUs attenuate more slowly.

Table 5.3 Attenuation Timeline Estimates for Each Pollutant and Tidal Verification Unit for the TMDL Scenario.

		Years needed to attain bed sediment target once TMDL is implemented									
	Verification Unit	Heptachlor epoxide	Chlordane	Dieldrin	DDT	Arsenic	Copper	Zinc	PAH1	PAH2	PAH3
upstream	MD Northwest Branch-1	4	8	8	11	13	8	n/a	n/a	11	11
	MD Tidal Anacostia-1	3	7	6	7	7	5	n/a	n/a	7	7
	Anacostia #2-10	6	10	11	14	12	9	n/a	n/a	12	12
	Anacostia #2-9	6	13	12	16	13	10	n/a	n/a	14	15
	Anacostia #2-8	4	9	9	9	9	7	n/a	n/a	9	9
	Kingman Lake-2	8	17	18	17	25	21	n/a	n/a	23	24
	Anacostia #2-7	8	15	14	17	16	13	n/a	n/a	17	17
	Anacostia #2-6	15	22	26	31	33	23	n/a	n/a	26	27
	Kingman Lake-1	90	117	164	166	204	166	n/a	n/a	199	210
	Anacostia #2-5	12	25	20	25	27	21	n/a	n/a	31	30
	Anacostia #2-4	19	28	38	40	34	29	n/a	n/a	34	32
	Anacostia #2-3	14	20	25	27	31	26	n/a	n/a	32	32
	Anacostia #2-2	21	25	35	39	53	47	n/a	n/a	45	44
	Anacostia #2-1	34	62	59	68	66	55	n/a	n/a	68	69
	Anacostia #1-2	21	34	39	46	46	36	n/a	n/a	49	50
downstream	Anacostia #1-1	33	49	65	59	81	58	n/a	n/a	78	74

* The TMDL does not require bed sediment reductions for zinc and the PAH1 group

Table 5.4 Attenuation Timeline Estimates for Each Pollutant and Tidal Verification Unit for the 2035 Climate Change Scenario.

		Years needed to attain bed sediment target once TMDL is implemented under 2035 climate conditions									
	Verification Unit	Heptachlor epoxide	Chlordane	Dieldrin	DDT	Arsenic	Copper	Zinc	PAH1	PAH2	PAH3
upstream	MD Northwest Branch-1	4	8	7	10	10	7	n/a	n/a	9	9
	MD Tidal Anacostia-1	3	7	7	8	8	6	n/a	n/a	8	8
	Anacostia #2-10	6	9	11	14	12	9	n/a	n/a	12	12
	Anacostia #2-9	6	12	12	15	13	10	n/a	n/a	14	14
	Anacostia #2-8	5	9	9	10	10	7	n/a	n/a	10	10
	Kingman Lake-2	8	17	16	16	23	20	n/a	n/a	22	22
	Anacostia #2-7	7	14	13	16	16	13	n/a	n/a	17	17
	Anacostia #2-6	14	21	23	29	30	21	n/a	n/a	27	24
	Kingman Lake-1	71	94	161	151	182	147	n/a	n/a	179	185
	Anacostia #2-5	11	24	20	24	26	21	n/a	n/a	29	29
	Anacostia #2-4	19	26	38	40	33	30	n/a	n/a	35	31
	Anacostia #2-3	15	24	27	27	31	26	n/a	n/a	32	34
	Anacostia #2-2	21	23	34	38	44	42	n/a	n/a	44	43
	Anacostia #2-1	31	62	57	66	63	51	n/a	n/a	68	65
	Anacostia #1-2	21	35	40	45	47	38	n/a	n/a	52	51
downstream	Anacostia #1-1	34	51	67	60	86	60	n/a	n/a	73	75

* The TMDL does not require bed sediment reductions for zinc and the PAH1 group

Table 5.5 Attenuation Timeline Estimates for Each Pollutant and Tidal Verification Unit for the 2055 Climate Change Scenario.

		Years needed to attain bed sediment target once TMDL is implemented under 2055 climate conditions									
	Verification Unit	Heptachlor epoxide	Chlordane	Dieldrin	DDT	Arsenic	Copper	Zinc	PAH1	PAH2	PAH3
upstream	MD Northwest Branch-1	3	7	6	8	8	6	n/a	n/a	8	8
	MD Tidal Anacostia-1	3	7	7	8	8	6	n/a	n/a	8	8
	Anacostia #2-10	6	9	10	13	12	9	n/a	n/a	12	12
	Anacostia #2-9	6	12	12	14	12	9	n/a	n/a	13	14
	Anacostia #2-8	5	11	11	12	11	8	n/a	n/a	11	11
	Kingman Lake-2	7	16	16	16	23	19	n/a	n/a	21	22
	Anacostia #2-7	7	14	13	16	15	12	n/a	n/a	16	16
	Anacostia #2-6	13	21	23	27	28	20	n/a	n/a	23	22
	Kingman Lake-1	71	101	142	144	168	135	n/a	n/a	166	179
	Anacostia #2-5	12	24	19	23	26	21	n/a	n/a	28	28
	Anacostia #2-4	20	32	40	44	36	31	n/a	n/a	35	33
	Anacostia #2-3	14	23	27	27	32	30	n/a	n/a	33	32
	Anacostia #2-2	21	27	36	39	45	42	n/a	n/a	45	44
	Anacostia #2-1	33	61	59	70	67	52	n/a	n/a	76	67
	Anacostia #1-2	23	38	43	49	51	41	n/a	n/a	55	58
downstream	Anacostia #1-1	37	59	73	61	89	63	n/a	n/a	77	79

* The TMDL does not require bed sediment reductions for zinc and the PAH1 group

Table 5.6 Change in Attenuation Period for the 2035 Climate Change Scenario (years; negative indicates faster attenuation vs. TMDL, positive indicates slower attenuation).

		2035 Climate Change Scenario: Change in Attenuation Period (years; negative indicates faster attenuation vs. TMDL, positive indicates slower attenuation)									
	Verification Unit	Heptachlor epoxide	Chlordane	Dieldrin	DDT	Arsenic	Copper	Zinc	PAH1	PAH2	PAH3
upstream	MD Northwest Branch-1	0	0	-1	-1	-3	-1	n/a	n/a	-2	-2
	MD Tidal Anacostia-1	0	0	1	1	1	1	n/a	n/a	1	1
	Anacostia #2-10	0	-1	0	0	0	0	n/a	n/a	0	0
	Anacostia #2-9	0	-1	0	-1	0	0	n/a	n/a	0	-1
	Anacostia #2-8	1	0	0	1	1	0	n/a	n/a	1	1
	Kingman Lake-2	0	0	-2	-1	-2	-1	n/a	n/a	-1	-2
	Anacostia #2-7	-1	-1	-1	-1	0	0	n/a	n/a	0	0
	Anacostia #2-6	-1	-1	-3	-2	-3	-2	n/a	n/a	1	-3
	Kingman Lake-1	-19	-23	-3	-15	-22	-19	n/a	n/a	-20	-25
	Anacostia #2-5	-1	-1	0	-1	-1	0	n/a	n/a	-2	-1
	Anacostia #2-4	0	-2	0	0	-1	1	n/a	n/a	1	-1
	Anacostia #2-3	1	4	2	0	0	0	n/a	n/a	0	2
	Anacostia #2-2	0	-2	-1	-1	-9	-5	n/a	n/a	-1	-1
	Anacostia #2-1	-3	0	-2	-2	-3	-4	n/a	n/a	0	-4
	Anacostia #1-2	0	1	1	-1	1	2	n/a	n/a	3	1
downstream	Anacostia #1-1	1	2	2	1	5	2	n/a	n/a	-5	1

* The TMDL does not require bed sediment reductions for zinc and the PAH1 group

> 5 Additional years to achieve bed sediment target

> 5 Fewer years to achieve bed sediment target

> 10 Fewer years to achieve bed sediment target

> 20 Fewer years to achieve bed sediment target

Table 5.7 Change in Attenuation Period for the 2055 Climate Change Scenario (years; negative indicates faster attenuation vs. TMDL, positive indicates slower attenuation).

		2055 Climate Change Scenario: Change in Attenuation Period (years; negative indicates faster attenuation vs. TMDL, positive indicates slower attenuation)									
	Verification Unit	Heptachlor epoxide	Chlordane	Dieldrin	DDT	Arsenic	Copper	Zinc	PAH1	PAH2	PAH3
upstream	MD Northwest Branch-1	-1	-1	-2	-3	-5	-2	n/a	n/a	-3	-3
↓	MD Tidal Anacostia-1	0	0	1	1	1	1	n/a	n/a	1	1
	Anacostia #2-10	0	-1	-1	-1	0	0	n/a	n/a	0	0
	Anacostia #2-9	0	-1	0	-2	-1	-1	n/a	n/a	-1	-1
	Anacostia #2-8	1	2	2	3	2	1	n/a	n/a	2	2
	Kingman Lake-2	-1	-1	-2	-1	-2	-2	n/a	n/a	-2	-2
	Anacostia #2-7	-1	-1	-1	-1	-1	-1	n/a	n/a	-1	-1
	Anacostia #2-6	-2	-1	-3	-4	-5	-3	n/a	n/a	-3	-5
	Kingman Lake-1	-19	-16	-22	-22	-36	-31	n/a	n/a	-33	-31
	Anacostia #2-5	0	-1	-1	-2	-1	0	n/a	n/a	-3	-2
	Anacostia #2-4	1	4	2	4	2	2	n/a	n/a	1	1
	Anacostia #2-3	0	3	2	0	1	4	n/a	n/a	1	0
	Anacostia #2-2	0	2	1	0	-8	-5	n/a	n/a	0	0
	Anacostia #2-1	-1	-1	0	2	1	-3	n/a	n/a	8	-2
	Anacostia #1-2	2	4	4	3	5	5	n/a	n/a	6	8
downstream	Anacostia #1-1	4	10	8	2	8	5	n/a	n/a	-1	5

* The TMDL does not require bed sediment reductions for zinc and the PAH1 group

> 5 Additional years to achieve bed sediment target

> 5 Fewer years to achieve bed sediment target

> 10 Fewer years to achieve bed sediment target

> 20 Fewer years to achieve bed sediment target

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APPENDIX C: RESPONSE TO PUBLIC COMMENT

This section will be updated after the public comment period and prior to final submittal to EPA.