Baltimore Harbor and Curtis Creek/Bay Polychlorinated Biphenyls (PCB) TMDL Implementation Plan Update

Final Draft

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Prepared for:

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List of Acronyms

BMP	Best Management Practice
EPA	Environmental Protection Agency
MDE	Maryland Department of The Environment
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated Biphenyls
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance and Quality Control
SAP	Sampling and Analysis Plan
SOPs	Standard Operating Procedures
SW-WLA	Stormwater Wasteload Allocation
TMDL	Total Maximum Daily Load
WIP	Watershed Implementation Plan
WLA	Waste Load Allocation
WQS	Water Quality Standard

1. Background and Introduction

In 2012, the U.S. Environmental Protection Agency (EPA) Region III approved Maryland Department of the Environment's (MDE) Total Maximum Daily Load (TMDL) for Polychlorinated Biphenyls (PCBs) for the Baltimore Harbor, Curtis Creek/Bay, and Bear Creek portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment (MDE, 2012). This report will be referred to as the Baltimore Harbor PCB TMDL. Among other objectives, the Baltimore Harbor PCB TMDL established PCB waste load allocations (WLAs) for PCB sources to achieve reductions needed to meet applicable water quality standards (WQSs).

An aggregate stormwater WLA (SW-WLA) was assigned to regulated stormwater from National Pollutant Discharge Elimination System (NPDES) stormwater permit holders in Anne Arundel County for portions of the Baltimore Harbor Embayment and Curtis Creek/Bay watersheds within Anne Arundel County. Anne Arundel County (the County) is an NPDES Phase I Municipal Separate Storm Sewer System (MS4) permit holder.

Anne Arundel County developed the Baltimore Harbor and Curtis Creek/Bay PCB TMDL Restoration Plan in 2016, and the Baltimore Harbor and Curtis Creek/Bay PCB TMDL Action Strategy in 2019. In 2022, MDE issued a Guidance for Developing Local PCB TMDL Stormwater Wasteload Allocation (SW-WLA) Watershed Implementation Plans (WIPs) document (MDE, 2022). This document will be referred to as the MDE PCB TMDL WIP Guidance. MDE's PCB TMDL WIP Guidance states that jurisdictions are expected to complete and/or revise their existing PCB TMDL Restoration Plans (now referred to as "Implementation Plans") and accompanying PCB Source Assessments (desktop analysis) once per permit term. This guidance outlines a process that includes: performing a Source Assessment, performing a Subwatershed Risk Assessment, development of a Monitoring Plan, and conducting multi-phase (Phase I, Phase II, Phase III) monitoring to identify sources of PCBs in the landscape.

This document serves as an update to the original Restoration Plan (Anne Arundel County, 2016) to satisfy the requirements of the MDE PCB TMDL WIP Guidance. The Desktop Source Assessment and Subwatershed Risk Assessment were completed in 2024 and are detailed in the Source Trackdown Technical Memorandum provided as Appendix A. A Sampling and Analysis Plan (SAP) was created in 2025 and is provided as Appendix B.

1.1 PCBs Background

PCBs are a group of manmade chemicals comprised of 209 biologically and chemically stable congeners that bind strongly to sediment and do not readily degrade. PCBs are soluble in organic and hydrocarbon solvents and are slightly soluble in water. Of the 209 congeners, the most commonly used mixture of congeners is called Arochlor. PCBs were manufactured and widely used from 1929 to 1979 in caulk, paints, dyes, motor oil, and electrical equipment, such as transformers. PCBs were banned in 1979 due to their impacts on human health and the environment, however, they are still found in older vehicles and electronics, in the soils of industrial areas where PCBs were manufactured, and in older buildings where PCB laden caulk and paint were used (EPA, 2018).

1.2. Baltimore Harbor and Curtis Creek PCB Local TMDL

The Baltimore Harbor and Curtis Creek watersheds are located within the Patapsco River Mesohaline Chesapeake Bay Segment and the Baltimore Harbor 8- Digit watershed (02130903). Both Curtis Creek and Baltimore Harbor watersheds are located on the southwest shore of the Baltimore Harbor and share political boundaries with Baltimore City to the north. This effort focuses on portions of the

Baltimore Harbor and Curtis Creek watersheds located within the County. A locator map is provided in Figure 1.

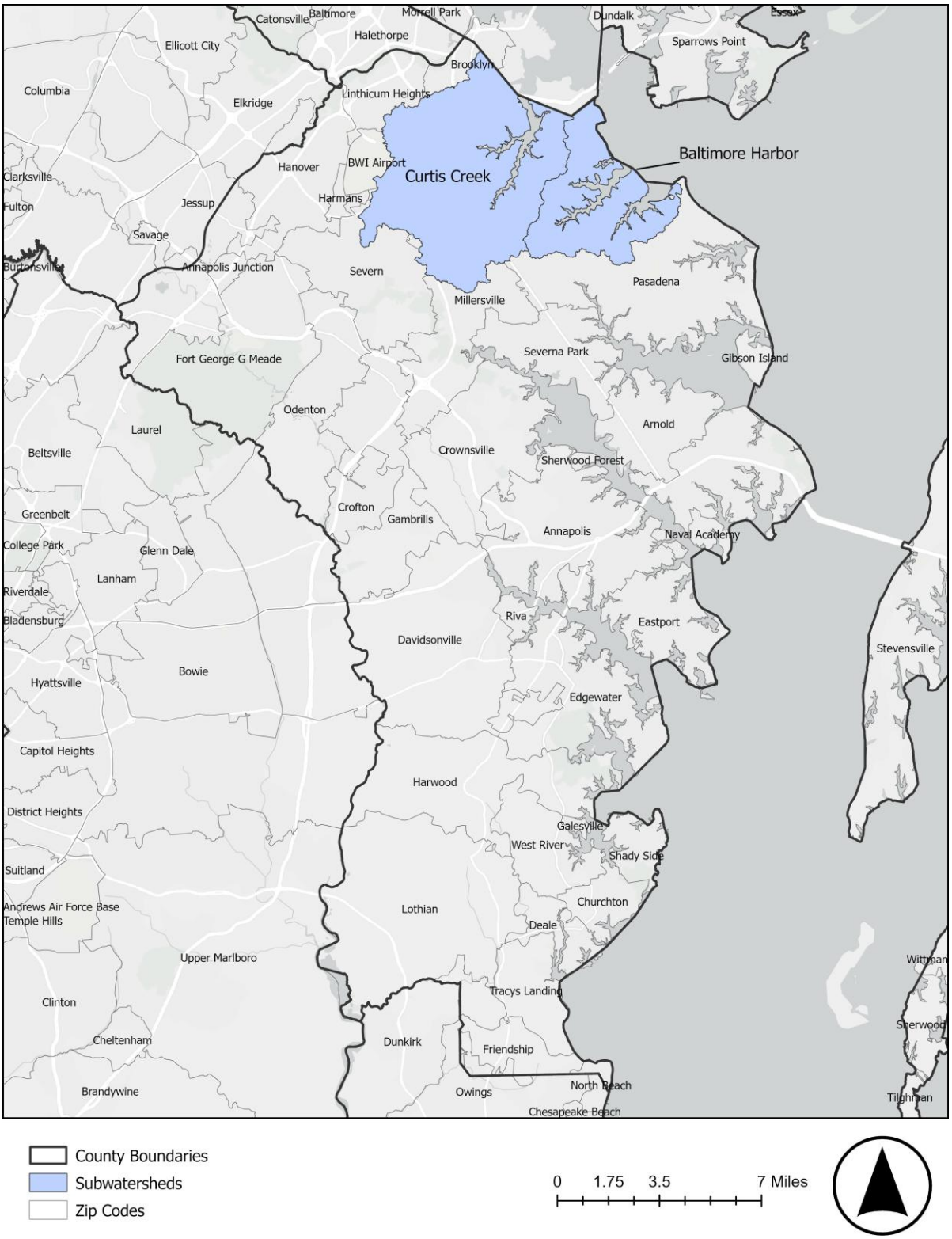

Figure 1. Locator Map

These two watersheds have impaired waters listings according to Maryland's Final 2024 Integrated Report of Surface Water Quality. The County's 2016 PCB Restoration Plan specifically addresses the Baltimore Harbor and Curtis Creek PCB TMDL as approved by the EPA in 2012. For more detail regarding the Baltimore Harbor and Curtis Creek watersheds, and the development of the PCB TMDL please refer to the Baltimore Harbor PCB TMDL document (MDE, 2012) and the original TMDL Restoration Plan (Anne Arundel County, 2016).

Subwatersheds for the TMDL segments were defined in the Baltimore Harbor and Curtis Creek/Bay PCB TMDL Action Strategy (Anne Arundel County, 2019) as defined in Table 1 and depicted in Figure 2.

Table 1. Subwatershed IDs and Names within TMDL Basins

TMDL Watershed	Subwatershed ID	Subwatershed Name
Baltimore Harbor	PT0	Stony Creek
	PT4	Swan Creek
	PT9	Cox Creek
	PTA	Patapsco Tidal
	PTB	Rock Creek
	PTH	Nabbs Creek
	PTI	Patapsco Tidal
	PTJ	Patapsco Tidal
	PTK	Patapsco Tidal
Curtis Creek	PT1	Unnamed Tributary
	PT2	Cabin Branch 2
	PT3	Cabin Branch
	PT5	Furnace Creek
	PT6	Curtis Creek
	PT7	Sawmill Creek 1
	PT8	Marley Creek 1
	PTC	Back Creek
	PTD	Sawmill Creek 2
	PTE	Marley Creek 2
	PTF	Marley Creek 3
	PTG	Marley Creek 4

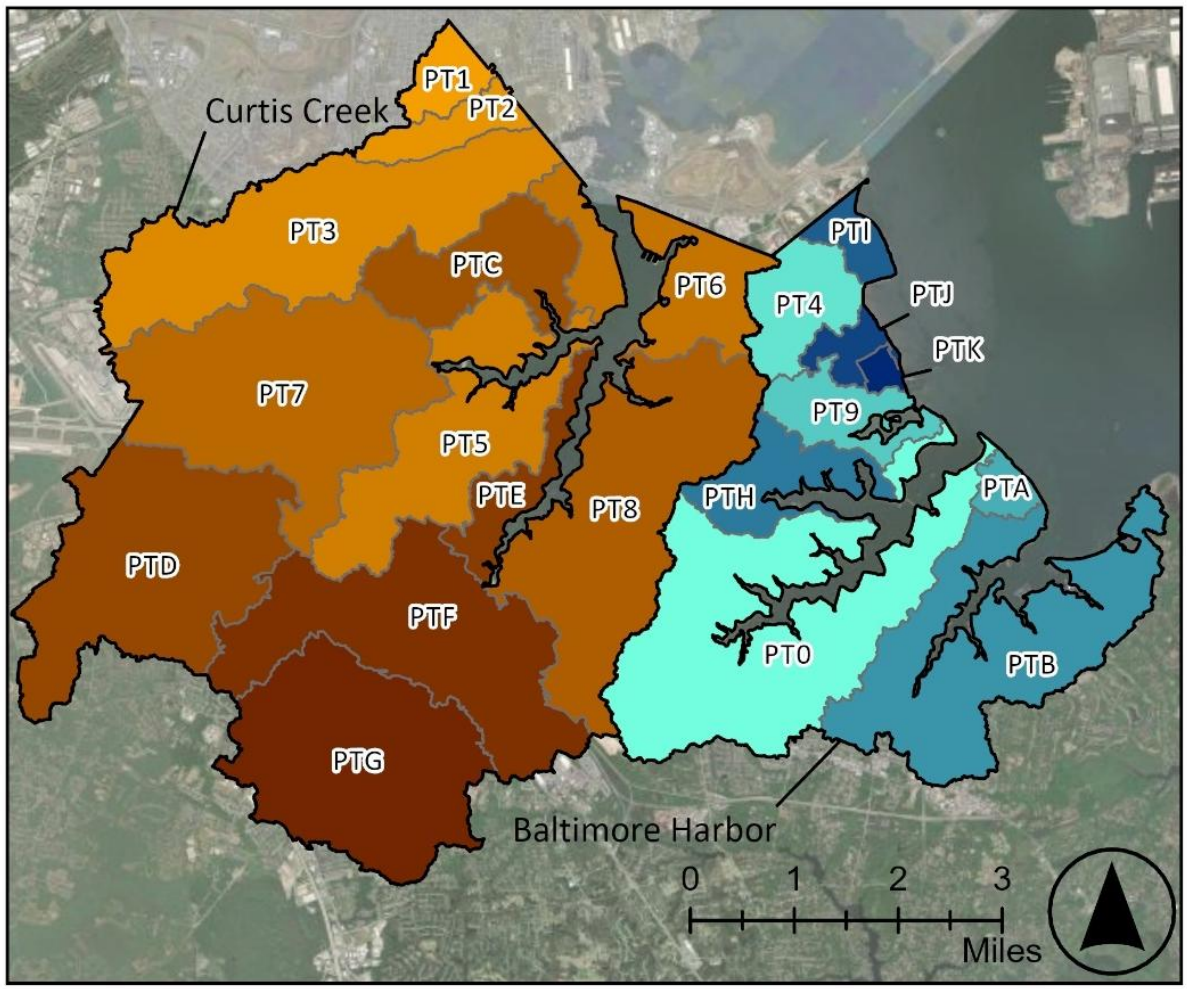

Figure 2. Delineated TMDL Subwatershed Areas

2. Source and Subwatershed Risk Assessments

In accordance with MDE's PCB TMDL WIP Guidance, and to better understand and characterize PCB sources in the Baltimore Harbor Embayment and Curtis Creek, a Source Assessment and Subwatershed Risk Assessment was completed in 2024. Section 2 of this report provides an overview of the Assessments, while a more detailed summary of the results is presented in the Source Trackdown Technical Memorandum, included in Appendix A.

2.1 PCB Source Assessment

The potential presence of PCBs in each subwatershed was based on the sources identified in MDE's PCB TMDL WIP Guidance and are identified below in Table 2. The risk for each PCB source was categorized into three tiers. The three tiers were assigned based on individual source categories having a "high," "medium," or "low" potential for release of PCB contamination into wastewater, stormwater, or groundwater.

Table 2. Potential Sources of PCB Soil Contamination and Corresponding Tier Placement

Tier	PCB Source
Tier 1	PCB Transformers (via EPA's PCB Transformer Registry Database)
	Hazardous Waste Sites (Superfund/CERCLA sites)
	Military Installations
Tier 2	PCB Releases (via National Response Center Database)
	Historic Landfills
	MDE Permitted Solid Waste Acceptance Facilities (active and closed)
	MDE Permitted Sewage Sludge Utilization Activities
Tier 3	PCB Activities (via EPA PCB Activities Database)
	Toxic Release Inventory (TRI) Facilities (via EPA TRI Database)
	Public Angler Access Sites
	Sanitary Sewer Overflows

2.2 Subwatershed Prioritization and Risk Assessment

Once PCB sources were identified within the TMDL subwatersheds, a risk assessment was applied to determine which subwatersheds have the greatest potential for PCB contamination. This assessment was based on the number of potential PCB sources identified in the PCB Source Assessment and will inform jurisdictions as to which TMDL Subwatersheds should be prioritized for source trackdown investigations. The TMDL Subwatershed Risk Assessment was developed by MDE based on an approach developed by Howard County's PCB TMDL Restoration Plan for the Patuxent River (April 2020). For more information on the potential PCB source categories, please refer to MDE's PCB TMDL WIP Guidance document.

The relative risk of PCB contamination for each TMDL Subwatershed is based on: (1) the number of potential PCB sources identified in the PCB Source Assessment, and (2) level of PCB contamination risk associated with each PCB source category. Those watersheds with the highest Total Risk scores will be

prioritized for source trackdown investigations. The results of the Subwatershed Prioritization Strategy are depicted in Table 3. and Figure 3.

Table 3. Source Trackdown Prioritization Results

TMDL Catchment	Tier 1 PCB Sources	Tier 2 PCB Sources	Tier 3 PCB Sources	Total PCB Sources	Total Risk Score	Rank
PT3	9	0	6	15	96	1
PT9	4	1	44	49	89	2
PT6	5	3	2	10	67	3
PT5	3	1	11	15	46	4
PTH	4	0	0	4	40	5
PT8	3	0	4	7	34	6
PT0	0	0	30	30	30	7
PT4	2	1	3	6	28	8
PTG	2	0	5	7	25	9
PT7	2	0	4	6	24	10
PT2	1	2	3	6	23	11
PTF	1	0	11	12	21	12
PTE	0	0	18	18	18	13
PTI	1	1	0	2	15	14
PTB	1	0	4	5	14	15
PTC	1	0	0	1	10	16
PT1	0	1	1	2	6	17
PTA	0	0	2	2	2	18
PTD	0	0	2	2	2	18
PTJ	0	0	0	0	0	20
PTK	0	0	0	0	0	20

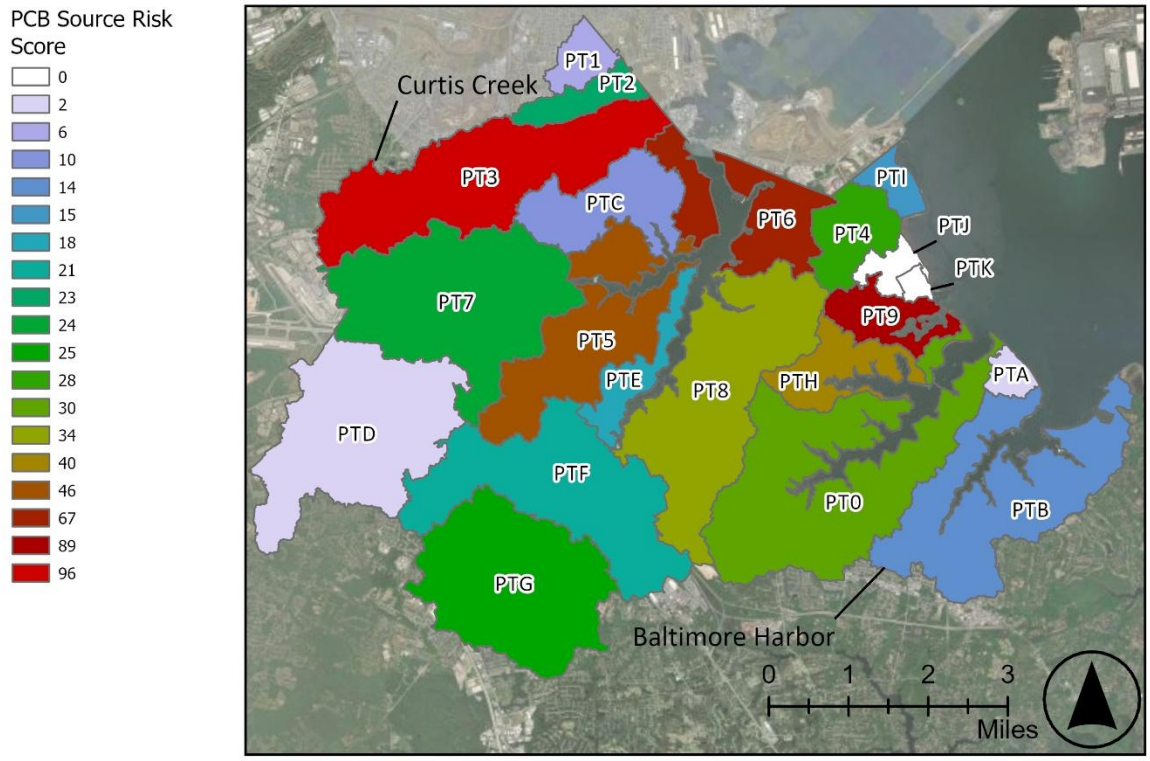

Figure 3. TMDL Prioritization Results showing the total PCB source risk score for each subwatershed.

Although urban land use associated with PCB-era development (i.e. development that occurred during the 1929-1979 PCB manufacturing era) was not included in the risk tier assignment or resultant risk assessment, the information is useful in this context and was evaluated as an additional layer of risk evaluation. Results of PCB-era land use calculations for each subwatershed are shown in Table 4.

Table 4. Land Use Categorization for PCB and non-PCB Era Development

TMDL Subwatershed	PCB Era Urban Land Use (%)	Non-PCB Era Urban Land Use (%)	Non-Urban Land Use (%)
PT3	32.00	50.95	17.05
PT9	8.30	68.10	23.61
PT6	11.45	22.54	66.02
PT5	52.72	29.11	18.17
PTH	44.08	42.95	12.97
PT8	26.83	42.09	31.08
PT0	67.90	10.3	21.70
PT4	2.58	39.90	57.52
PTG	41.67	35.46	22.86
PT7	60.22	18.75	21.03

TMDL Subwatershed	PCB Era Urban Land Use (%)	Non-PCB Era Urban Land Use (%)	Non-Urban Land Use (%)
PT2	20.34	19.85	59.82
PTF	51.79	24.64	23.57
PTE	64.08	8.91	27.01
PTI	0.00	76.63	23.37
PTB	40.30	30.13	29.57
PTC	40.30	49.23	10.48
PT1	84.80	9.13	6.03
PTA	87.45	8.49	4.06
PTD	26.54	28.73	44.73
PTJ	0.00	16.37	83.63
PTK	0.00	13.2	86.8

3. Monitoring Approach and Source Trackdown Investigation

Following the completion of the Desktop Source Assessment and the Subwatershed Risk Assessment, the next step was to develop a monitoring plan and initiate the multi-phase monitoring. MDE's PCB TMDL WIP Guidance defines the multi-phase monitoring as follows:

PHASE I SOURCE TRACKDOWN	PHASE II SOURCE TRACKDOWN	PHASE III SOURCE TRACKDOWN
Subwatershed PCB Screening	**In-stream Subwatershed PCB Characterization**	**MS4 PCB Characterization**
Confirm the presence of PCBs at levels of concern within individual subwatersheds indicating the need for further investigation to identify discrete sources of PCBs.	Comprehensive in-stream PCB characterization within these Phase I subwatersheds to identify specific areas of concern within the stream network that contain upland sources of PCBs.	Identify sources of PCBs within the storm sewershed.

3.1 Sampling and Analysis Plan (SAP) for Phase 1 Sampling

This section summarizes Phase I Sampling and Analysis Plan (SAP) for Baltimore Harbor and Curtis Creek/Bay watersheds. The full SAP, completed in July 2025, can be found in Appendix B.

3.1.1. SAMPLING METHODS

The County's Phase I sampling approach will adhere to MDE's PCB TMDL WIP Guidance whereby a single sampling location will be situated at the outlet of each selected subwatershed, where feasible. Results from subwatershed sampling will be compared with a reference threshold and TMDL water column endpoint to determine whether subwatersheds will or will not require further source trackdown investigations. A brief description of the Phase I methods is provided below.

In accordance with MDE's PCB TMDL WIP Guidance, single time-integrative passive samplers will be placed in the water column at each Phase I sampling location, for a minimum of three months. After retrieval, the passive samplers will be collected and shipped to Eurofins Environment Testing America Knoxville, Tennessee, for PCB congener analysis by EPA 1668A (US EPA, 2003), a low detection level congener-based method, and PRC analysis.

3.1.2. SAMPLING LOCATIONS

MDE's PCB TMDL WIP Guidance requires a single sampling site at the outlet of each subwatershed with the goal of identifying sampling locations that are representative of the entire drainage area of the subwatershed and are not influenced by backwater conditions.

Monitoring stations were identified using digital data and aerial imagery and later verified in the field. Monitoring stations were located in the downstream portions of each subwatershed while also considering accessibility, ownership, perennial flow, and absence of tidal influence. Where possible, sites were chosen where Anne Arundel County has previously performed biological and/or water quality monitoring, as site conditions and permission to access the property have already been determined.

Four subwatersheds - PTA, PTI, PTJ, and PTK - were deemed unsuitable for Phase I monitoring due to lack of a stream channel with perennial flow (these four subwatersheds were also determined by the

Source Assessment as "low risk," thus ranking low on the source trackdown prioritization list). Table 5 and Figure 4 identify the 17 proposed monitoring locations. Appendix A includes maps of each of the monitoring locations.

**Note: As of the preparation of this document, Anne Arundel County has completed Phase III monitoring in the Sawmill Creek I (PT7) subwatershed, and Phase I monitoring in the Cabin Branch (PT3) and Marley Creek 3 (PTF) subwatersheds. The most downstream monitoring site in each of those subwatersheds is included in Table 5 and Figure 4.*

Table 5. Baltimore Harbor and Curtis Creek Subwatershed Phase I Monitoring Sites

Subwatershed ID	Subwatershed Name	Coordinates		Notes
		Latitude	Longitude	
PT0	Stony Creek	39.139067	-76.554286	
PT1	Unnamed Tributary	39.22684	-76.604206	
PT2	Cabin Branch 2	39.213787	-76.605651	
PT3	Cabin Branch	39.209521	-76.60107	Phase I monitoring completed March 2025.
PT4	Swan Creek	39.193304	-76.541335	
PT5	Furnace Creek	39.176962	-76.604929	
PT6	Curtis Creek	39.185206	-76.567743	
PT7	Sawmill Creek 1	39.183128	-76.614159	Phase I monitoring completed December 2020. Phase II monitoring completed November 2022. Phase III monitoring completed March 2025.
PT8	Marley Creek 1	39.156108	-76.590455	
PT9	Cox Creek	39.174007	-76.535656	
PTA	Patapsco Tidal	N/A	N/A	Perennial stream not present
PTB	Rock Creek	39.135173	-76.526225	
PTC	Back Creek	39.194494	-76.593398	
PTD	Sawmill Creek 2	39.164031	-76.639215	
PTE	Marley Creek 2	39.162909	-76.592576	
PTF	Marley Creek 3	39.148697	-76.604095	Phase I monitoring completed March 2025.
PTG	Marley Creek 4	39.138701	-76.610192	
PTH	Nabbs Creek	39.168455	-76.544866	

Subwatershed ID	Subwatershed Name	Coordinates		Notes
		Latitude	Longitude	
PTI	Patapsco Tidal	N/A	N/A	Perennial stream not present
PTJ	Patapsco Tidal	N/A	N/A	Perennial stream not present
PTK	Patapsco Tidal	N/A	N/A	Perennial stream not present

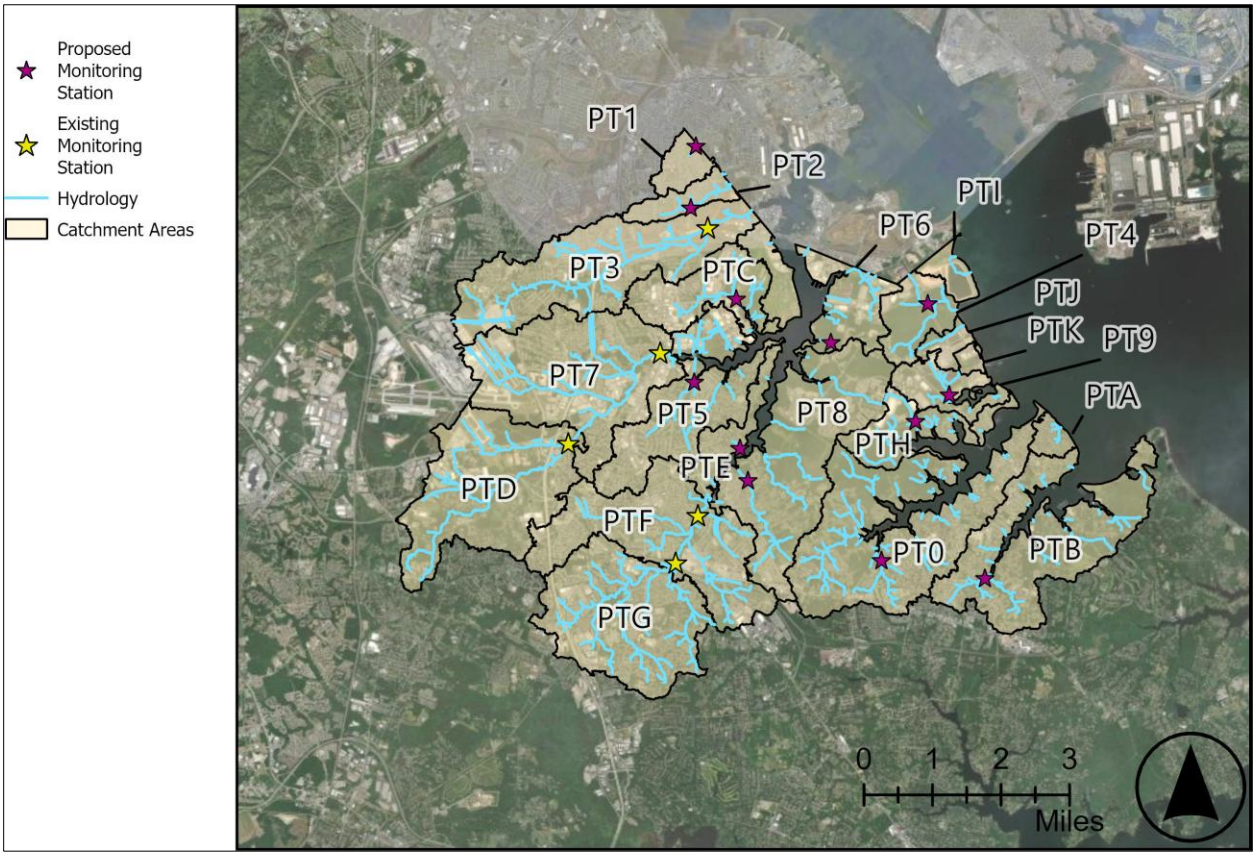

Figure 4. Baltimore Harbor and Curtis Creek Phase I Monitoring Locations

3.1.3. REFERENCE SITE SELECTION

Two reference sites per TMDL watershed are required for PCB screening to establish background levels of PCBs. Reference sites should have concurrent sampling within a portion of a subwatershed where no urban development or potential source of PCBs are present as identified through the PCB Source Assessment.

As these conditions (no development, no potential sources of PCBs) do not exist within the Baltimore Harbor and Curtis Creek subwatersheds, the County will continue to leverage its existing reference sites established as part of prior PCB monitoring initiatives—one in the Severn River watershed (Anne Arundel County) and the other in the Back River watershed (Baltimore County). Both sites have received approval from MDE, and previous monitoring activities have verified that PCB concentrations at these sites are below TMDL endpoint concentrations. These sites are identified in Figure 5.

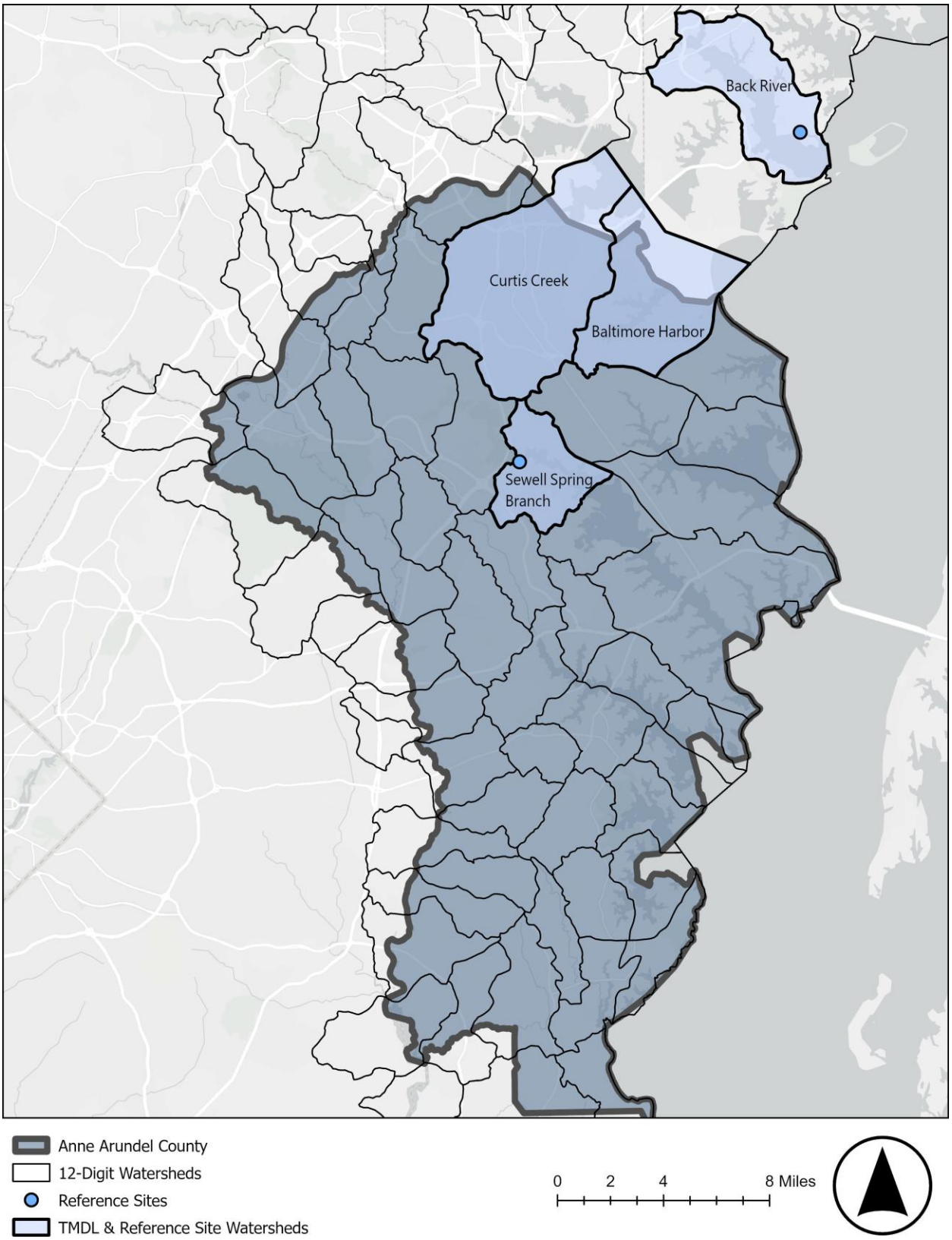

Figure 5. Baltimore Harbor and Curtis Creek Reference Site Locations

3.1.4. DATA ANALYSIS

The monitoring results from Phase I are intended to inform and shape the monitoring of subsequent phases as the County works to narrow down potential specific sources of PCBs. As PCBs are ubiquitous in the environment, identifying the right mechanisms for determining PCB presence at levels of concern is necessary to identify hotspots amongst the noise.

Comparisons to the reference threshold (as defined in MDE's PCB TMDL WIP Guidance) and appropriate water quality standards will help to identify sites with elevated levels of PCBs. These values include Maryland's Numerical Criteria for Toxic Substances in Surface Waters, which include the freshwater chronic criterion of 14 ng/L for protection of life in non-tidal systems and the human health criterion of 0.64 ng/L that addresses the consumption of PCB-contaminated fish. The TMDL endpoint for the Baltimore Harbor and Curtis Creek subwatersheds was established during TMDL development and resulted in a PCB water column threshold concentration and endpoint of 0.27 ng/L (MDE, 2012).

Monitoring sites showing PCB concentrations at or below both the reference threshold and the TMDL water column endpoint will be considered as having no significant PCB sources, and no further source trackdown efforts will be pursued in future monitoring phases.

Monitoring sites with PCB concentrations at or above the TMDL endpoint will be interpreted as indicative of significant PCB sources within those areas, and those subwatersheds will be subject to further source trackdown investigations. It is the County's goal to conduct Phase II investigations for all subwatersheds where water column PCB concentrations exceed the TMDL endpoint, with the possibility of needing to prioritize subwatersheds with the highest concentrations if funding is limited.

For subwatershed sites where PCB concentrations exceed the reference threshold but remain below the TMDL water column endpoint, the County will coordinate with MDE to determine whether these subwatersheds can be excluded from further source trackdown investigations based on existing data and findings from the PCB Source Assessment or if additional sampling will be necessary.

4. Next Steps

The PCB Source Assessment, Subwatershed Prioritization Strategy, and Phase I Source Trackdown Monitoring are components of the overall process to identify and prioritize subwatersheds within the Baltimore Harbor and Curtis Creek subwatersheds that required further source trackdown investigations to identify discrete sources of PCB.

The next step is to begin Phase I monitoring. Once complete, results will be shared and discussed with MDE prior to initiating Phase II and Phase III. These monitoring efforts are required via the MDE PCB TMDL WIP Guidance and are summarized below.

4.1 Phase II Source Trackdown

The PCB Source Assessment, Risk Assessment, and Phase I monitoring aim to identify and rank subwatersheds needing further investigation to locate discrete PCB sources. Subwatersheds prioritized through this process will undergo Phase II source trackdown investigations, involving comprehensive in-stream PCB characterization to attempt to pinpoint areas where upland PCB sources may be entering the stream network. This work will also aim to determine whether PCBs are delivered to surface waters directly from adjacent land areas, from contaminated streambeds/banks, or transported via the MS4 storm sewer system. The County will use additional datasets (such as mapping NPDES wastewater and stormwater outfalls) to refine monitoring site selection, with MDE assisting where data are unavailable.

Monitoring site placement depends on watershed size, stream miles, confluences, outfalls, and proximity to suspected sources. Denser coverage is recommended in high-risk areas; low-risk areas may only require outlet monitoring. Elevated results may trigger additional bracketing and sampling rounds.

Each site will deploy a passive water column sampler for three months and collect a composite surficial sediment sample from three cross-section points, targeting fine materials. Samples are analyzed for total PCBs, total organic carbon, and grain size using sensitive congener-based methods (EPA Method 1668 preferred).

The County will map results in GIS and apply statistical analysis to identify significant sources, defined as outlier concentrations or large upstream-to-downstream increases exceeding TMDL endpoints.

If discrete sources are found, further investigation through MDE regulatory mechanisms is required. If none are identified, sources may be diffuse or due to legacy sediments, requiring further investigation or remediation. Sites below reference thresholds generally require no further action unless upstream levels are higher.

Required deliverables include data/assessment reports identifying bracketed stream sections, recommending Phase III or additional Phase II work, and noting sources for regulatory or remedial action.

4.2 Phase III Source Trackdown

Phase III source trackdown is required when Phase II monitoring identifies stream sections with upland PCB sources entering through the MS4. This phase focuses on characterizing PCBs within the storm sewershed to locate specific sources, including contamination from groundwater infiltration, resuspension of legacy sediments in the sewer system, or direct discharges.

Phase III is also necessary in subwatersheds where Phase I and II monitoring were not feasible, such as areas with direct drainage, no defined stream network, or tidal influence. The PCB Source Assessment and Subwatershed Prioritization Strategy will help determine which storm sewersheds require

investigation. For these areas, jurisdictions must evaluate additional datasets to identify potential PCB sources, an effort not required under earlier phases.

The process has two stages:

1. **Outfall and Stormwater BMP Monitoring**: All active outfalls and BMPs discharging to bracketed stream sections identified in Phase II are monitored. Techniques may include automated storm-event sampling or passive sediment traps. Samples are analyzed for PCB concentration using low-detection congener-based methods (EPA Method 1668 preferred), plus total organic carbon (TOC) and grain size for sediment. Results are compared to TMDL endpoints and Phase II data to identify upland or in-pipe PCB sources.
2. **Sewer Trackback Monitoring**: Outfalls/BMPs with elevated PCBs undergo up-pipe investigations, including in-pipe, catch basin, and inlet sampling, to pinpoint contamination sources. Monitoring consistency across locations ensures comparability.

Areas with few potential sources may receive reduced monitoring unless elevated concentrations warrant further work. Outfalls are re-sampled during trackback to assess concentration changes and confirm source areas. If discrete PCB sources are identified, further investigation through MDE regulatory mechanisms is required. Contamination from legacy sediments or diffuse sources may require remediation or stormwater management practices to address the sources.

5. References

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Appendix A: Source Trackdown Technical Memo

Appendix B: Sampling and Analysis Plan