UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

FEB 0 6 2002

Ms. Denise Ferguson Southard
Assistant Secretary
Maryland Department of the Environment
2500 Broening Highway Baltimore,
Maryland 21224

Re: Worton Creek
Total Maximum Daily Load (TMDL)

Dear Ms. Southard:

The U.S. Environmental Protection Agency (EPA), Region III, is pleased to approve the Worton Creek Total Maximum Daily Load (TMDL), submitted to the U.S. Environmental Protection Agency (USEPA) by the Maryland Department of Environment (MDE) by letter dated December 6, 2001 and received December 11, 2001, with complete data files received on January 16, 2002. The TMDL was established and submitted in accordance with Section 303(d)(1)(c) and (2) of the Clean Water Act. The TMDL was established to address impairment of water quality as identified in Maryland's 1996 Section 303(d) list. Maryland identifies the impairment for this water quality limited waterbody based on low dissolve oxygen levels and nuisance levels of algae. Worton Creek is located in Allegany and Garrett Counties.

In accordance with Federal regulations found in 40 CFR § 130.7, a TMDL must: be designed to meet water quality standards; include, as appropriate, both wasteload allocations from point sources and load allocations from non-point sources; consider the impacts of background pollutant contributions; take critical stream conditions into account (the conditions when water quality is most likely to be violated); consider seasonal variations; include a margin of safety (which accounts for any uncertainties in the relationship between pollutant loads and instream water quality); and be subject to public participation. The enclosure to this letter describes how the Worton Creek Pond TMDL and supporting satisfies each of these requirements. The supporting documentation provided with the TMDL report, specifically, the Technical Memorandum provides one allocation scenario with individual point and nonpoint source allocation. USEPA relied upon this information in reviewing and approving the TMDL submittal and in preparing USEPA's Decision Rationale. USEPA expects for future TMDLs that the Technical Memorandum will be included in any public notice of the TMDLs.

Following the approval of this TMDL, MDE shall incorporate it into the state's Water Quality Management Plan pursuant to 40 CFR §130.7(d)(2). Also, any new or revised National Pollution Discharge Elimination System (NPDES) permits with applicable effluent limits must be consistent with the TMDL's wasteload allocation pursuant to 40 CFR § 122.44(d)(1)(vii)(B)(2). If an NPDES permit is issued with an effluent limitation that does not reflect the wasteload allocatin contained in the approved TMDL and Technical Memorandum, it is expected that Maryland will document this change in the permit Fact Sheet, as discussed in USEPA's Decision Rationale.

If you have any questions or concerns, please call me or have your staff contact Mr. Thomas Henry, the TMDL Program Manager, at (215) 814-5752.

Sincerely,

/S/

Rebecca W. Hammer, Director
Water Protection Division

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Water Protection Division

Enclosure

cc: Mr. Jim George, MDE Mr.
Robin Groves, MDE

Decision Rationale

Total Maximum Daily Loads of Nitrogen and Phosphorus to Worton Creek, Kent County, Maryland

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by the state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety, that may be discharged to a water quality-limited water body.

This document sets forth the United States Environmental Protection Agency's (USEPA) rationale for approving the TMDLs for nitrogen and phosphorus in Worton Creek watershed. The TMDL was established to address impairments of water quality, caused by nutrients as identified in Maryland's 1996 Section 303(d) lists. The Maryland Department of the Environment (MDE), submitted the *Total Maximum Daily Loads of Nitrogen and Phosphorus to Worton Creek, Kent County, MD*, dated December 2001, to USEPA for final review on December 11, 2001. Follow-up information was received on January 16, 2002. Worton Creek as part of the Stillpond Creek/Fairlee Creek watershed was first identified on Maryland's 1996 Section 303(d) list for nutrients and suspended sediments. Suspended sediments will be addressed separately by MDE in a separate TMDL document.

USEPA's rationale is based on the TMDL Report and information contained in the Appendix to the report. USEPA's review determined that the TMDLs meet the following eight regulatory requirements pursuant to 40 CFR Part 130.

1) The TMDLs are designed to implement applicable water quality standards.
2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDLs consider the impacts of background pollutant contributions.
4) The TMDLs consider critical environmental conditions.
5) The TMDLs consider seasonal environmental variations.
6) The TMDLs include a margin of safety.
7) There is reasonable assurance that the TMDLs can be met.
8) The TMDLs have been subject to public participation.

There are no point sources in this watershed. Maryland provided adequate land use and loading data in the TMDL report, but did not distribute the total load allocation to specific land use categories in the TMDL report. In the past, Maryland has included a Technical Memorandum breaking down the load allocation to specific land uses. However, Maryland used site specific data for the load allocation which could not be broken down into specific land uses. Therefore, Maryland included a gross load allocation for the low-flow and average-flow TMDLs. These gross load allocations are presented in Tables 1 and 2. Nonpoint source loading rates represent a cumulative impact from all sources, including naturally occurring and human-induced sources.

Table 1- Phosphorus and Nitrogen TMDLs Summary for Low Flow, May 1 through October 31

Parameter	Rate	TMDL	WLA[1]	LA[2]	MOS[3]
Nitrogen	lbs/month	351	0	333	18
Phosphorus	lbs/month	22	0	21	1

1 WLA = Waste Load Allocation
2 LA = Load Allocation
3 MOS = Margin of Safety

Table 2 - Phosphorus and Nitrogen TMDLs Summary average annual flow

Parameter	Rate	TMDL	WLA[1]	LA[2]	MOS[3]
Nitrogen	lbs/year	18,016	0	17,476	540
Phosphorus	lbs/year	1,382	0	1,341	41

1 WLA = Waste Load Allocation
2 LA = Load Allocation
3 MOS = Margin of Safety

The TMDL is a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standards. The TMDL is a scientifically-based strategy which considers current and foreseeable conditions, the best available data, and accounts for uncertainty with the inclusion of a “margin of safety” value. Conditions, available data and the understanding of the natural processes can change more than anticipated by the margin of safety. The option is always available to refine the TMDL for re-submittal to USEPA for approval.

Summary

Worton Creek’s[1] headwaters originate near the intersection of Maryland’s routes 297 and 298 (Worton Park). Two smaller tributaries, Mill Creek and Tim’s Creek, feed Worton Creek. Worton Creek finally drains to the Chesapeake Bay. Worton Creek and Mill Creek together are approximately 6.5 miles (10.5 km) in length. Worton Creek alone is only 2.5 miles (4 km). Worton Creek watershed has an area of approximately 11,656 acres (18.2 sq. miles). Figure 1 shows the location of Worton Creek. The land uses in the watershed consist of forest and other herbaceous (2,958 acres or 25.4 %), mixed agriculture (6,957 acres or 59.7 %), water (800 acres or 6.9 %), and urban (941 acres or 8 %).[2]

[1] Worton Creek is located within Kent County, Maryland and is part of the Upper Eastern Shore Tributary Basin. It is contained within sub-basin 02–13-06.

[2] This information is based on the 1997 Maryland Office of Planning land cover data and 1997 Farm Service Agency (FSA) information..

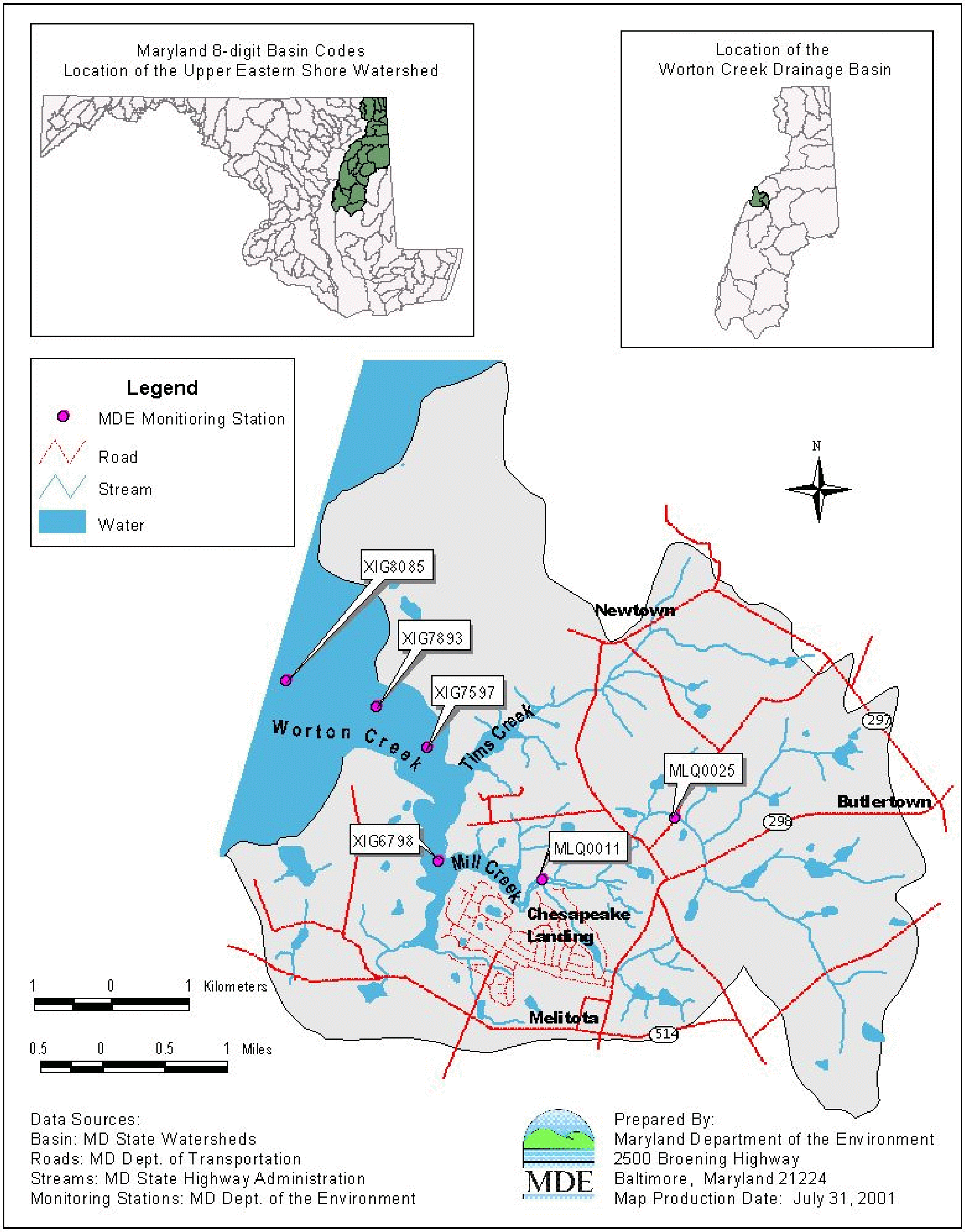

Figure 1 - Location of Worton Creek in Maryland

In response to the requirements of Section 303(d) of the Clean Water Act (CWA), MDE listed Worton Creek, as part of the Still Pond Creek/Fairlee Creek Watershed on the 1996 Section 303(d) list of impaired waterbodies. It was listed as being impaired by nutrients due to signs of eutrophication, expressed as high chlorophyll *a* concentrations. Eutrophication is the over-enrichment of aquatic systems by excessive inputs of nutrients (nitrogen and phosphorus). The nutrients act like fertilizer leading to excessive growth of aquatic plants, which eventually die and decompose, leading to bacterial consumption of dissolved oxygen (DO) and DO concentrations below what is necessary to support the designated use.

MDE developed these TMDLs to address the excessive nutrient enrichment that Worton Creek is currently experiencing. These TMDLs are designed to satisfy the water quality standards and designated uses of Worton Creek for nutrients. Impairments due to suspended sediments are not addressed by these TMDLs.

In order to address the impairments of Worton Creek from the Section 303(d) list, MDE believes it is necessary to control excessive nutrient input to the system. Nitrogen, phosphorus and BOD are factors which exert influence on not only the concentrations of DO in a waterbody but also biomass (typically characterized as algae or phytoplankton and measured as chlorophyll-a for modeling purposes). Figure 2 (taken from EPA 823-B-97-002, page 2-14) illustrates the interrelationship of major kinetic processes for BOD, DO, and nutrient analysis.

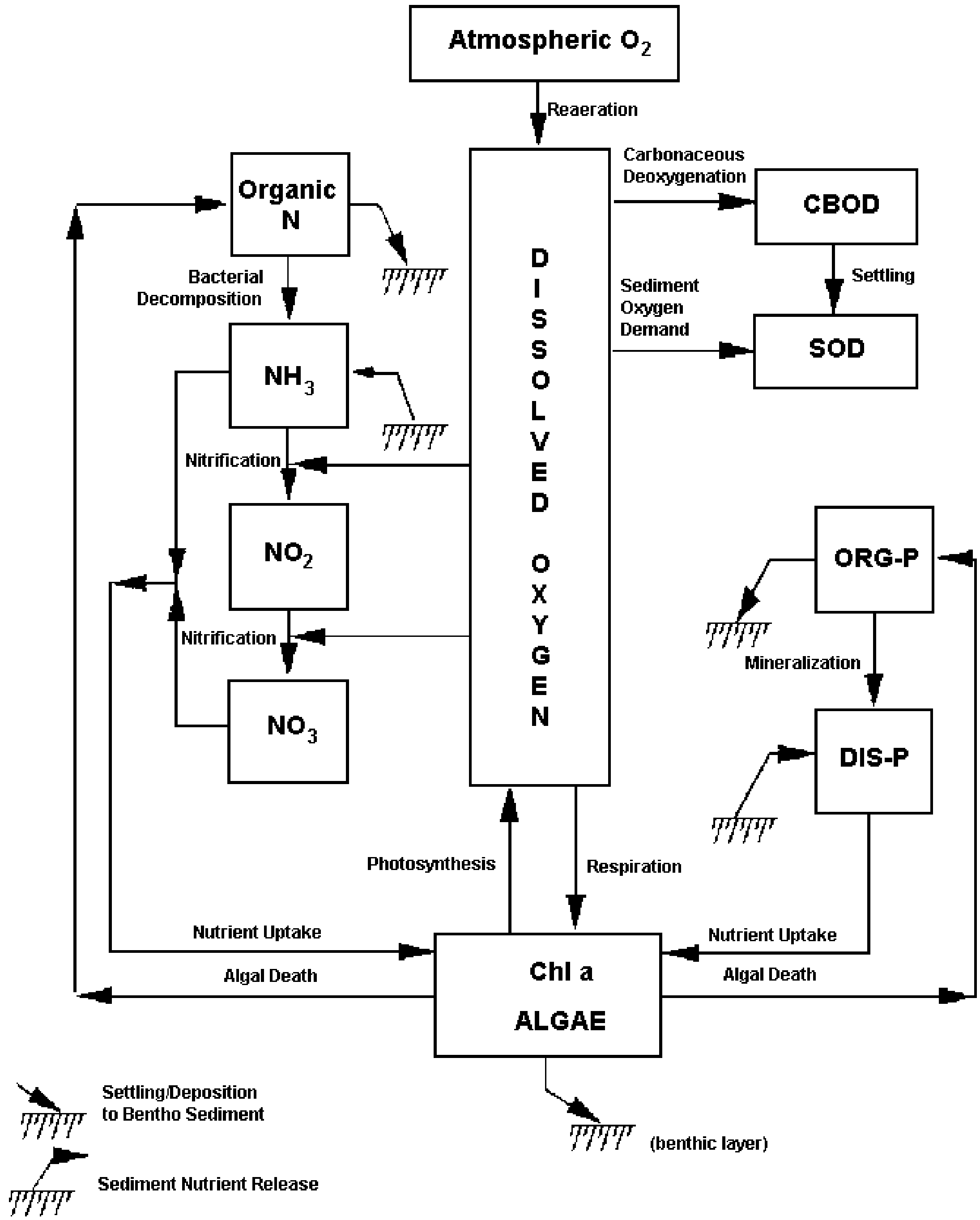

Figure 2 - Illustration of the interrelationship of major kinetic processes for BOD, DO, and nutrient analysis

Nutrient enrichment and subsequent algal growth are a concern in rivers and streams because of their effect on DO concentrations. Growing plants provide a net addition of DO to the stream on an average daily basis, yet respiration can cause low DO levels at night that can affect the survival of less tolerant fish species. Also, if environmental conditions cause a die-off of either microscopic or macroscopic plants, the decay of biomass can cause severe oxygen depressions. Therefore, excessive plant growth can affect a stream's ability to meet both average daily and instantaneous DO standards[3]. In addition, excessive nutrients lead to an overabundance of aquatic plant growth.

MDE uses the Water Quality Analysis Simulation Program version 5.1 (WASP5.1)[4] model to evaluate the link between nutrient loadings, algal growth, and DO. This water quality simulation program provides a generalized framework for modeling contaminant fate and transport in surface waters and is based on the finite-segment approach (Di Toro *et al.,* 1983). WASP5.1 is supported and distributed by U.S. EPA's Center for Exposure Assessment Modeling (CEAM) in Athens, Georgia (Ambrose *et al.*, 1993).

The model analysis is based on representing current conditions within Worton Creek and determining the necessary reductions in nutrient loadings from various sources to achieve and maintain water quality standards. WASP5.1 is a general-purpose modeling system for assessing the fate and transport of conventional and toxic pollutants in surface waterbodies (Ambrose, 1987)[5]. The model can be applied in one, two, or three dimensions and includes two sub-models (EUTRO5 and TOXI5) to investigate water quality/eutrophication and toxics impairments. EUTRO5 can simulate the transport and transformation of eight state variables including DO, carbonaceous BOD, phytoplankton carbon and chlorophyll-a, ammonia, nitrate, organic nitrogen, organic phosphorus, and orthophosphate.

The WASP5.1 model was implemented in a steady-state mode. This mode of using WASP5.1 simulates constant flow, and average water body volume over the tidal cycle. The tidal mixing is accounted for using dispersion coefficients, which quantify the exchange of substances between WASP5.1 model segments. The model simulates an equilibrium state of the water body, which in this case, considered low flow and average flow conditions, described in more detail below.

WASP5.1 has been previously applied in a number of regulatory and water quality management applications and is an appropriate linkage evaluation tool for Worton Creek. Based on this analysis, MDE has determined that the levels of nutrient input to Worton Creek specified by the TMDLs will ensure that water quality standards are achieved by controlling algae blooms and maintaining the DO water quality criterion. See Tables 1 and 2 for a summary of the allowable loads.

The spatial domain of Worton Creek model extends from the confluence of Worton Creek with the Chesapeake Bay for about 3 miles up to the head of tide. Twenty-one WASP5.1 model segments represent this modeling domain. Fifteen segments are located in the Worton-Mill Creek length. The remaining six segments are located in the upper reaches of Worton Creek and in a small tributary called Tim's Creek. Concentrations of relevant water quality parameters,

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[3] Technical guidance Manual for Developing Total Maximum Daily Loads, Book 2: Streams and Rivers, Part 1: Biochemical Oxygen Demand/Dissolved Oxygen and Nutrients/Eutrophication. Section 4.2.1.2. March 1997. EPA 823-B-097-002.

[4] Ambrose, R.B., T.A. Wool, and J.L. Martin. 1993. The water quality simulation program, WASP5 version 5.10. Part A: Model documentation. U.S. EPA, ORD, ERL, Athens, GA.

[5] Compendium of Tools for Watershed Assessment and TMDL Development. May 1997. EPA 841-B-97-006.

observed in 1999 in the “free flowing” station of the river, serve as the model's upstream boundary. A diagram of the WASP5.1 model segmentation is presented in Appendix A of the TMDL report. Freshwater flows and NPS loadings from these subwatersheds are taken into consideration by dividing the drainage basin into 11 subwatersheds and assuming that flows and loadings are direct inputs to the model.

III. Discussion of Regulatory Conditions

The EPA finds that Maryland has provided sufficient information to meet all of the eight basic requirements for establishing nitrogen, phosphorus, TMDL for Worton Creek. EPA therefore approves the TMDLs, and supporting documentation for nitrogen and phosphorus in Worton Creek. The EPA’s approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to implement the applicable water quality standards.

MDE has indicated that algal blooms due to excessive nutrient input have caused violations of the water quality standards and designated uses applicable to Worton Creek. The designated use of Worton Creek is Use I. The DO water quality criterion to support this use indicates that DO concentrations may not be less than 5 milligrams per liter (mg/L) at any time. While Maryland does not have numeric water quality criteria for nitrogen and phosphorus, Maryland interprets its General Water Quality Criteria to provide numerical objectives for nitrogen and phosphorus which will support the DO water quality criterion as well as a surrogate indicator (chlorophyll-a)[6] to determine acceptable algae levels in Worton Creek. Chlorophyll-a is desirable as an indicator because algae are either the direct (e.g., nuisance algal blooms) or indirect (e.g., high/low DO and pH and high turbidity) cause of most problems related to excessive nutrient enrichment[7]. The WASP5.1 model used by Maryland will help to determine those nutrient levels and compliance with the DO criterion and chlorophyll-a levels.

The presence of aquatic plants in a waterbody can have a profound effect on the DO resources and the variability of the DO throughout a day or from day to day[8]. This is due to the photosynthetic and respiration processes of aquatic plants which can cause large diurnal variations in DO that are harmful to fish. Photosynthesis is the process by which plants utilize solar energy to convert simple inorganic nutrients into more complex organic molecules[9].
Due to the need for solar energy, photosynthesis only occurs during daylight hours and is represented by the following simplified equation (proceeds from left to right):

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[6] Chlorophyll-a is typically used as a measure of algal biomass in natural waters because most algae have chlorophyll as the primary pigment for carbon fixation (EPA 823-B-97-002).

[7] Supra, footnote 3

[8] Principles of Surface Water Quality Modeling and Control. Robert V. Thomann., and J.A. Mueller. 1987. Page 283.

[9] Surface Water-Quality Modeling. Steven C. Chapra. 1997. Page 347.

$$\begin{array}{ccccccc} 6CO_2 & + & 6H_2O & \leftrightarrow & C_6H_{12}O_6 & + & 6O_2 \\ (Carbon\ Dioxide) & & (Water) & & (Sugar) & & (Oxygen) \end{array}$$

In this reaction, photosynthesis is the conversion of carbon dioxide and water into sugar and oxygen such that there is a net gain of DO in the waterbody. Conversely, respiration and decomposition operate the process in reverse and convert sugar and oxygen into carbon dioxide and water resulting in a net loss of DO in the waterbody. Respiration and decomposition occur at all times and are not dependent on solar energy. Waterbodies exhibiting typical diurnal variations of DO experience the daily maximum in mid-afternoon during which photosynthesis is the dominant mechanism and the daily minimum in the predawn hours during which respiration and decomposition have the greatest effect on DO and photosynthesis is not occurring. In order to ensure that the DO concentration of 5 mg/L is met at all times, MDE calculates both the daily average DO concentrations and the minimum diurnal DO concentrations as a result of photosynthesis and respiration of phytoplankton using the WASP5.1 model.

In addition to the negative effects on DO, an overabundance of aquatic plant growth adversely impacts the aesthetic and recreational uses of a waterbody by decreasing water clarity and forming unsightly floating algae blooms which also hinder navigation. MDE utilizes chlorophyll-a, a surrogate indicator for algal biomass[10], to evaluate the link between nutrient loadings and aquatic plant levels necessary to support the designated uses of Worton Creek. Again, using their General Water Quality Criteria, MDE establishes a numeric chlorophyll-a goal of 50 µg/L. This level is based on the goals/strategies recommended by the Algal Bloom Expert Panel to prevent the occurrence of algal blooms similar to those experienced in the Potomac Estuary in 1983[11]. Specifically, the panel believed that nuisance conditions from algal blooms occurred when chlorophyll-a concentrations exceeded 100 µg/l. Similar to the nutrient-DO evaluation, MDE uses the WASP5.1 model to determine acceptable levels of loadings of nutrients to achieve a chlorophyll-a concentration of 50 µg/l.

EPA finds that the TMDLs for nitrogen and phosphorus will ensure that the designated use and water quality criteria for Worton Creek are met and maintained.

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[10] Biomass is defined as the amount, or weight, of a species, or group of biological organisms, within a specific volume or area of an ecosystem (EPA 823-B-97-002).

[11] Thomann, R.V., N.J. Jaworski, S.W. Nixon, H.W. Paerl, and J. Taft. March 14, 1985. Algal Bloom Expert Panel. The 1983 Algal Bloom in the Potomac Estuary. Prepared for the Potomac Strategy State/EPA Management Committee.

2) *The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.*

Total Allowable Loads

The critical season for excessive algal growth in Worton Creek has been identified by Maryland as the summer months. During these months, flow in the channel is reduced resulting in slower moving, warmer water which has less dilution potential and is susceptible to algal blooms and low DO concentrations. In order to control the algal activity and its impacts on water quality, particularly with respect to DO levels, Maryland has established individual TMDLs for nitrogen and phosphorus that are applicable from May 1 through October 31. Maryland presented these as monthly loads to be consistent with the monthly concentration limits that are required by National Pollutant Discharge Elimination System (NPDES) permits. Expressing the TMDLs as monthly loads is consistent with federal regulations at 40 CFR 130.2(i), which state that TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.

The average annual TMDLs are being established to protect water quality in Worton Creek and loading limits on average annual loads contribute to water quality problems observed in the low flow critical season. The average annual TMDLs were presented by Maryland as yearly loads. It should be noted that limits placed on average annual loads are accounted for indirectly by adjusting bottom sediment nutrient fluxes and sediment oxygen demand (SOD) to be consistent with reductions in average annual loads (See Appendix A of the TMDL report).

The EPA's regulations at 40 CFR 130.2(i), also define "total maximum daily load (TMDL)" as the "sum of individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background." As the total loads provided by Maryland equal the sum of the individual wasteload allocations for point sources and the land-based load allocations for nonpoint sources set forth below, the TMDLs for nitrogen and phosphorus for Worton Creek are consistent with Section 130.2(i). Pursuant to 40 CFR 130.6 and 130.7(d)(2), these TMDLs and supporting documentation, should be incorporated into Maryland's current water quality management plan. See Tables 1and 2 for a summary of the allowable loads.

Waste Load Allocation

EPA regulations require that an approvable TMDL include individual waste load allocations for each point source. The watershed that drains to Worton Creek has no permitted point source discharges of nutrients. A waste load allocation of zero was assigned to Worton Creek. Hence, for both the low flow and average annual TMDLs, the entire allocation, except for the margin of safety, is being made to nonpoint sources.

Load Allocation

Maryland provided adequate land use and loading data in the TMDL report, but did not distribute the total load allocation to specific land use categories in the TMDL report. Maryland included a gross load allocation for the low-flow and average-flow TMDLs. These gross load allocations were presented in Tables 1 and 2. According to federal regulations at 40 CFR 130.2(g), load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. In previous nutrient TMDLs, Maryland used loading coefficients from on the Chesapeake Bay Program. However, in these TMDLs, MDE used observed site data.

MDE's estimate of annual loads is the best estimate available that is based on observed data. The data was collected in 1999, a fairly average year, in which the annual rainfall of 43.9 inches was slightly above the 10 year average of 37.5 inches over 1990-2000. The range of annual rainfall for this period was 30 inches to 58 inches. The Chesapeake Bay Program's loads, by contrast, are based on a coarse scaled watershed model that is not calibrated for this particular watershed. MDE's estimate is further supported by the results of water quality modeling, which indicated that loads higher than what was estimated on the basis of observed data would result in unrealistically elevated nutrients and algal levels in the creek. Therefore, MDE's estimate of nonpoint source loads is considered reasonable. The analysis used to estimate the maximum allowable load to the water body (TMDL) does not depend on the baseline estimate of NPS loads. Thus, any uncertainty in the baseline NPS estimation does not affect the certainty of the estimated TMDL.

Finally, as part of the source assessment, MDE considered that nutrient loads from the Chesapeake Bay might affect Worton Creek. It is possible that, during high flow events from the Susquehanna River, fresh water intrusions cause algal growth or nutrient-laden sedimentation, which could have secondary effects at later times (e.g., during low flow conditions). The fresh water intrusions from such high-flow events are observed in the salinity profile data collected in 1999 (See Appendix A of the TMDL report); however, determining the nutrient-related effects is an active area of research that is beyond the scope of this TMDL analysis. MDE utilized loading coefficients based on the Chesapeake Bay Watershed Model to estimate current nonpoint source loads and for calculating the percentage of the loads that could be controlled. These loadings were not used in the model for TMDL development.

As noted above, a breakdown by land use was not determined for nonpoint source loads during low and average flows. These nonpoint source loads, which were based on observed concentrations, account for "natural" and human-induced components. The specific load allocations for the TMDLs during average flow are presented in Table 4. Table 5 presents the gross load allocations for low flow.

Table 4 - Summary of average flow load allocations for Nitrogen and Phosphorus

Parameter	"Existing"[1] Nonpoint Source Load (lbs/year)	LA (lbs/year)	Reduction needed (%)
Nitrogen	25,000	17,476	30
Phosphorus	1,884	1,341	29

[1] Based on1999 observed field data. Reflects what is considered as current conditions.

Table 5 - Summary of low-flow load allocations for Nitrogen, Phosphorus, and BOD

Parameter	"Existing"[1] Nonpoint Source Load (lbs/month)	LA (lbs/month)	Reduction needed (%)
Nitrogen	504	333	34
Phosphorus	32	21	34

[1] Based on1999 observed field data. Reflects what is considered as current conditions.

The TMDL report states a 35% reduction for average flow loads and 40% reduction for low flow loads. These load reductions are based on reductions in controllable loads. The load reductions shown in Tables 5 and 6 are total load reductions and does not take in to account whether the land use loads are controllable or not controllable.

Allocations Scenarios

EPA realizes that the above total loads for nitrogen and phosphorus is one allocation scenario. As implementation of the established TMDLs proceed or more detailed information becomes available, Maryland may be able to break out the loads into land uses and find other combinations of land use allocations that are feasible and/or cost effective. Any subsequent changes, however, in the TMDLs must conform to gross waste load and load allocations and must ensure that the biological, chemical, and physical integrity of the waterbody is preserved.

The current TMDLs present that there are no point sources in Worton Creek. Federal regulations at 40 CFR 122.44(d)(1)(vii)(B), require that, for an NPDES permit for an individual point source, the effluent limitations must be consistent with the assumptions and requirements of any available wasteload allocation for the discharge prepared by the State and approved by USEPA. USEPA has authority to object to the issuance of an NPDES permit that is inconsistent with wasteload allocations established for that point source. To ensure consistency with these TMDLs, as NPDES permits are issued for the point sources that discharge the pollutants of concern to Worton Creek, any deviation from the wasteload allocations set forth in the TMDL report, and described herein for the particular point source must be documented in the permit Fact Sheet and made available for public review along with the proposed draft permit and the Notice of Tentative Decision. The documentation should; 1) demonstrate that the loading change is consistent with the goals of the TMDL and will implement the applicable water quality standards, 2) demonstrate that the changes embrace the assumptions and methodology of these TMDLs and Technical Memorandum, and 3) describe that portion of the total allowable loading determined in the State's approved TMDL report that remains for other point sources (and future growth where included in the original TMDL) not yet issued a permit under the TMDL. It is also expected that Maryland will provide this Fact Sheet, for review and comment, to each point source included in the TMDL analysis as well as any local and State agency with jurisdiction over land uses for which load allocation changes may be impacted.

In addition, USEPA regulations and program guidance provides for effluent trading. Federal regulations at 40 CFR 130.2 (I) state: "If Best Management Practices (BMPs) or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations may be made less stringent. Thus, the TMDL process provides for nonpoint source control tradeoffs." The State may trade between point sources and nonpoint sources identified in this TMDL as long as three general conditions are met; 1) the total allowable load to the waterbody is not exceeded, 2) the trading of loads from one source to another continues to properly implement the applicable water quality standards and embraces the assumptions and methodology of these TMDLs and Technical Memorandum, and 3) the trading results in enforceable controls for each source. Final control plans and loads should be identified in publicly available planning document, such as the State's water quality management plan (see 40 CFR 130.6 and 130.7(d)(2). These final plans must be consistent with the goals of the approved TMDLs.

Based on the foregoing, EPA has determined that the TMDLs for nitrogen and phosphorus for Worton Creek are consistent with the regulations and requirements of 40 CFR Section 130. Pursuant to 40 CFR 130.6 and 130.7(d)(2), these TMDLs and the supporting documentation, should be incorporated into Maryland's current water quality management plan.

3) The TMDL considers the impacts of background pollutant contributions.

In terms of the low-flow and average-flow TMDL analyses, Maryland used 1999 field data which would adequately consider pollutant contributions from baseflow, which is considered to be most influential during low-flow periods, as well as other nonpoint source contributions such as atmospheric deposition and loads from septic tanks.

4) The TMDLs consider critical environmental conditions.

EPA regulations at 40 CFR 130.7(c)(1) require TMDLs to take into account critical conditions for streamflow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Worton Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable “worst-case” scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition as critical because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

The nutrient TMDL analysis consists of two broad elements, an assessment of low flow loading conditions, and an assessment of annual average loading. The low flow TMDL analysis investigates the critical conditions under which symptoms of eutrophication are typically most acute, that is, in late summer when flows are low, leading to poor flushing of the system, and when sunlight and temperatures are most conducive to excessive algal production.

The water quality model was calibrated to reproduce observed water quality characteristics for both observed low flow and observed high flow conditions. The calibration of the model for these two flow regimes establishes an analysis tool that may be used to assess a range of scenarios with differing flow and nutrient loading conditions. Observed water quality data collected during 1999 was used to support the calibration process, as explained further in the “Nonpoint Source Loadings” section of Appendix A of the TMDL report.

5) The TMDLs consider seasonal environmental variations.

Seasonal variation involve changes in streamflow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flow normally occurs during the colder period of winter and in early spring from snowmelt and spring rain, while low flow typically occurs during warmer summer and early fall drought periods[12]. Consistent with EPA’s discussion regarding critical conditions , the WASP5.1 model and TMDL analysis will effectively consider seasonal environmental variations.

6) The TMDLs include a margin of safety.

A margin of safety (MOS) is required as part of a TMDL in recognition of many uncertainties in the understanding and simulation of water quality in natural systems. For example, knowledge is incomplete regarding the exact nature and magnitude of pollutant loads from various sources and the specific impacts of those pollutants on the chemical and biological quality of complex, natural water bodies. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection.

Based on EPA guidance, the MOS can be achieved through two approaches (EPA, April 1991). One approach is to reserve a portion of the loading capacity as a separate term in the TMDL. The second approach is to incorporate the MOS as conservative assumptions used in the TMDL

[12]Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2, Part 1, Section 2.33, (EPA 823-B-97-002, 1997)

analysis.

In terms of the low-flow TMDL analysis for nitrogen, phosphorus, and BOD, MDE states that it explicitly allocates 5% of the load allocation value and reserves this for the MOS. In terms of the average-flow TMDL analysis for nitrogen, phosphorus, and BOD, MDE states that it explicitly allocates 3% of the load allocation value and reserves this for the MOS.

In addition to these explicit set-aside MOS, additional safety factors are built into the TMDL development process. The low-flow analysis sets a goal of 50 µg/l for chlorophyll-a, which MDE believes is conservative given the generally acceptable range of chlorophyll-a values for waters meeting their water quality standards of 50 - 100 µg/l.

In the average flow analysis, conservative assumptions are used and result in an implicit MOS. The average flow analysis was run under the assumption of summer temperature and summer solar radiation. When the water is warmer and more sunlight is present, there will be more algal growth and a higher potential for low dissolved oxygen concentrations. The model was also run under steady-state conditions, for 200 days, assuming continuous average flows and loads. It is unlikely that these flows and loads will actually be seen for such an extended period of time during the summer. The higher temperatures and solar radiation are conservative assumptions that represent a significant implicit margin of safety.

7) There is a reasonable assurance that the TMDLs can be met.

EPA requires that there be a reasonable assurance that the TMDLs can be implemented. wasteload allocations will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available wasteload allocation for the discharge prepared by the state and approved by EPA. The watershed that drains to Worton Creek has no permitted point source discharges of nutrients. Hence, for both the low flow and average annual TMDLs, the entire allocation, except for the margin of safety, is being made to nonpoint sources.

For both TMDLs, Maryland has several well-established programs that will be drawn upon: the Water Quality Improvement Act of 1998 (WQIA), and the EPA-sponsored Clean Water Action Plan of 1998 (CWAP), and the State's Chesapeake Bay Agreement's Tributary Strategies for Nutrient Reduction. Also, Maryland has adopted procedures to assure that future evaluations are conducted for all TMDLs that are established.

It is reasonable to expect that nonpoint source loads can be reduced during low flow conditions. While the low flow loads cannot be partitioned specifically into contributing sources, the sources themselves can be identified. These sources include deposition of nutrients and organic matter to the streambed from higher flow events, septic systems failure and wildlife animal contribution. When these sources are controlled in combination, it is reasonable to achieve nonpoint source reductions of the magnitude identified by this TMDL allocation.

The potential influence of high-flow events from the Susquehanna River was noted in the *General Setting and Source Assessment* section of this report. The effects of the Susquehanna/Bay are poorly understood, and could be very complex. The implications for nutrient loadings could range from very little (if the fresh-water flushing does not result in a net increase in load) to very significant. The implications for implementation are similarly uncertain. The Susquehanna/Bay could be a significant nutrient source, implying that a lower proportion of the load is from nonpoint sources in Worton Creek. In such case, load reductions from the Susquehanna, as part of the Chesapeake Bay Agreement, could have a significant positive effect on Worton Creek water quality. Regardless of the uncertainty, nonpoint source reductions associated with the programs outlined above should be pursued aggressively to address the extensive enrichment of the Bay and Worton Creek and to off-set the increasing population pressure.

Finally, Maryland has recently adopted a five-year watershed cycling strategy to manage its waters. Pursuant to this strategy, the State is divided into five regions and management activities will cycle through those regions over a five-year period. The cycle begins with intensive monitoring, followed by computer modeling, TMDL development, implementation activities, and follow-up evaluation. This follow-up monitoring will allow Maryland and EPA to determine whether these TMDLs have been implemented successfully.

8) The TMDLs have been subject to public participation.

The MDE has conducted a public review of the TMDL for nitrogen and phosphorus loadings in Worton Creek. The public comment period was open from October 11, 2001 to November 9, 2001. Only one set of written comments was received by MDE. This was provided along with MDE's response document with the TMDL report.

EPA notified the United States Fish and Wildlife Service (USFWS) and the United States National Marine Fisheries Service (USNMFS) on October 4, 2001 about the availability of the TMDL and where to acquire a copy of the TMDL. EPA did not receive a response from the USFWS or USNMFS on the proposed TMDLs for Worton Creek.

IV. Additional Information

The following table presents the TMDLs in pounds per day.

Flow Regime (Period)	Parameter	TMDL	WLA[1]	LA[2]	MOS[3]
Low-flow (May 1 - Oct. 31)	Nitrogen (lbs/day)[4]	12	0.0	10.9	0.6
	Phosphorus (lbs/day)[4]	1	0.0	0.7	0.03
Average-flow (Nov. 1 - April 30)	Nitrogen (lbs/day)	66	0.0	47.9	17.7
	Phosphorus (lbs/day)	45	0.0	44.0	1.3

[1] WLA = Waste Load Allocation
[2] LA = Load Allocation
[3] MOS = Margin of Safety
[4] 30.5 days per month was used to convert lbs/month to lbs/day