Comment Response Document for the Total Maximum Daily Loads of Nitrogen, Phosphorus and Biochemical Oxygen Demand for the Lower Wicomico River Wicomico County and Somerset County, Maryland

Introduction

The Maryland Department of the Environment (MDE) has conducted a public review of the proposed Total Maximum Daily Loads (TMDLs) for Nitrogen, Phosphorus and Biochemical Oxygen Demand (BOD) in the Lower Wicomico River. The public comment period was open from November 3, 2000 through December 4, 2000. MDE received 1 set of written comments.

Below is a description of the commentor, his affiliation, and the date he submitted comments. In the pages that follow, comments are summarized in conjunction with MDE's responses.

List of Commentors

Author	Affiliation	DATE
Newell W. Messick	Deputy Director of the Department of Public Works, City of Salisbury	12/4/00

Comments and Responses

1. The commentor questions the original 1996 listing, the data used to support the listing, and the pursuant development of a TMDL for nutrients and BOD. He notes that the waterbody was listed with an asterisk by nutrients and question if the 1996 listing was for a local impairment or solely for its impact on the Chesapeake Bay. Finally, he questions the sources of the impairment included on the 303(d) list.

   Response: The Lower Wicomico Creek first appeared on the 1996 303(d) list as being impaired by nutrients, fecal coliform, and sediment. The suspected causes were nonpoint sources and natural. The asterisk by nutrients on the 1996 list indicated that the waterbody contributed nutrients to the Chesapeake Bay; however, it did not mean that there was no local impairment. The 1996 listing was based on information provided in the 1995 305(b) Report entitled "Maryland Water Quality Inventory, 1993 – 1995." The report states "high nutrient levels, elevated ammonia and low dissolved oxygen in deeper waters were observed at Chesapeake Bay Tributary water quality monitoring station in lower Wicomico River (MET7.1)."

Water quality monitoring data collected in 1998, was used by MDE to better define the impairment(s) in the Lower Wicomico River. The 1998 data clearly indicates excessive nutrients in the system as evidenced by chlorophyll *a* concentrations above MDE's management goal, in the upper estuary, and several low dissolved oxygen measurements near the mouth of the river. This data verifies that impairments do exist in the Lower Wicomico River, and was considered sufficient to justify the development of a TMDL for nutrients in the Lower Wicomico River. The justification for the development of the TMDL was not solely based on the two low dissolved oxygen measurements as the commentor suggests. In addition, the TMDL analysis indicated future dissolved oxygen violations would occur if BOD loads were not limited. Thus, MDE is required to include a TMDL for BOD.

Although MDE identified possible sources of the impairments during the 1996 listing process, those judgements were based on limited information and did not preclude other possible sources. When further analysis was preformed as part of the TMDL development process, the influences of the point sources were better characterized, and included in the allocations.

2. The commentor questions the use of a steady-state model for the Lower Wicomico River. He questions its application to a tidally influenced waterbody. He questions possible errors created by using the box-model formulation, and the characteristic lengths used in the model. The commentor contends that the model does not capture diurnal variations in dissolved oxygen due to chlorophyll *a* concentrations.

   Response: The model used in the Lower Wicomico River, the Water Quality Analysis Simulation Program version 5.1 (WASP5.1), is distributed by U.S. EPA's Center for Exposure Assessment Modeling, and provides a generalized framework for modeling contaminant fate and transport in surface waters. It is a very versatile program, capable of being applied in a time-variable or steady-state mode, spatial simulation in one, two or three dimensions, and using linear or non-linear estimations of water quality kinetics. To date, WASP5.1 has been employed in many modeling applications for regulatory decision, which have included river, lake, estuarine and ocean environments. The model has been used to investigate water quality concerns regarding dissolved oxygen, eutrophication, and toxic substances. WASP5.1 has been used in a wide range of applications by regulatory agencies, consulting firms, academic researchers and others. It has been used extensively to simulate water quality in tidally influenced rivers.

   The box-model approach to the simulation of water quality has also been applied extensively. The commentor's concerns related to the instantaneous mixing within each model cell (box) are worth consideration; however, this phenomenon does not introduce a significant error. The model behaves in a stable manner, and the concentration gradients between contiguous model segments are not severe enough to require decreased segment sizes. In areas of higher concentration gradients, the segment sizes are smaller thus providing sufficient accuracy. The smaller segment sizes are also reflected in the characteristic lengths (the length between the center of one segment to the center of the contiguous segment). Similarly sized characteristic lengths have been used in past modeling of the Wicomico River (Hydroscience, 1973).

Steady-state models do not directly simulate diurnal dissolved oxygen variations. However, WASP5.1 performs a post-correction to calculate the daily variance in dissolved oxygen concentrations due to photosynthesis and respiration of algae.

3. The commentor questions the data used in the TMDL analysis, and its connection to the tidal cycle. The commentor suggests the need for additional data collection over the tidal cycle.

   Response: Federal guidance stipulates that TMDLs are to be developed using the best readily available data, provided the data is sufficient. As elaborated upon below, the data used to develop the proposed TMDL meets both the criteria of being sufficient, and of being the best data readily available.

   The data was sufficient to develop an analytical tool calibrated for the specific water body of concern. Although the calibration data was collected at an instantaneous point in the tidal cycle, the model kinetic coefficients, which are fixed during the calibration process, are independent of the point in time during the tidal cycle. That is, these model coefficients, once fixed, are not expected to change with reasonable variations in tides. The important factor when considering the influence of tidal variation during the calibration process concerns the correct estimation of the effects of transport due to tidal mixing. (see comment #4)

4. The commentor questions the parameterization of tidal dispersion, and the specific values used by MDE. He argues that one set of coefficients may not be representative over varying flows.

   Response: Parameterization of the effects of dispersive mixing as in WASP5.1 has been used in a wide range of applications by regulatory agencies, consulting firms, academic researchers and others. The method MDE uses to determine the dispersion coefficients is a widely accepted method. The model is set up to simulate salinity. As a conservative substance, salt is an appropriate constituent for use in calibrating the dispersive mixing in the system.

   The specific dispersion coefficients used in this model application are well within reasonable bounds. A 1973 report by Hydroscience, gave a range of the dispersion coefficients in the Lower Wicomico River from 0.3 to 0.8 mi^2/day. This same report included data from a dye study near the Salisbury WWTP, which showed the dispersion coefficients varying from 0.04 to 0.26 mi^2/day. The dispersion coefficients used in MDE's model range from 0.8 mi^2/day near the mouth of the river to 0.04 mi^2/day near the Salisbury plant. The dispersion coefficients were calibrated using salinity data (see page A2 of the TMDL Appendix A).

   It is true that the dispersion coefficients may vary as the flow varies. However, the difference in flow between the low flow calibration of the dispersion coefficients and the 7Q10 flow used in the low flow TMDL analysis is minimal. Thus it is expected that the dispersion coefficients would vary only slightly if at all. The dispersion coefficients calibrated for low flow were used to simulate salinity gradients for high flow conditions.

There was very limited salinity data during the high flow period. Still, the model results did match the observed data. This second calibration shows that the calibrated low flow dispersion coefficients produce reasonably accurate estimations of longitudinal transport over varying flows.

5. The commentor questions various elements of the calibration of the model. He notes that the model overestimates the nitrate + nitrite concentrations over most of the river. He questions several peak concentrations just below the Salisbury WWTP. He also questions the dissolved oxygen calibration.

   Response: The primary focus of this modeling effort was to assess the effects of nutrients and BOD on the mainstem of the Lower Wicomico River. The calibration plots for the mainstem of the river are reasonably accurate, and support results that are consistent with regulatory decision-making methods used elsewhere in Maryland. For all model output parameters in the calibration of the model, the simulated water quality captures the trend in the observed data.

   The low flow calibration of the model shows ammonia, phosphate and nitrate/nitrite peaks near the Salisbury WWTP. These peaks are based on actual WWTP discharge flow and boundary concentration data. Based on simple instantaneous mixing calculations for the river flow and the Salisbury discharge, the model outputs are well within reasonable ranges. One must also note the small scale of the vertical on the graphs which tends to exaggerate the appearance of a peak in concentrations.

   As can be seen in Figure A11 of Appendix A, the average daily dissolved oxygen values from the model results adequately matched the observed dissolved oxygen values. As to the commentor's concern regarding the dissolved oxygen peak 2 miles downstream of the Salisbury WWTP, there was no data at that exact location to verify the model output. The model output did capture the upstream and downstream data, and can be expected to properly simulate the processes that affect dissolved oxygen between these points.

6. The commentor questions the difference in environmental parameters and kinetic coefficients that were used in the LWREM and the eutrophication model developed for the Wicomico Creek Tributary.

   Response: In general, small differences in model parameters should be expected due to the difference in the watershed size and the physical, biological, and chemical environments of the two systems. All parameters for both models are well within the range of literature values. The commentor is referred to Table A6 of the Appendix to note that for both the Lower Wicomico River and the Wicomico Creek, there were no ammonia fluxes during high flow conditions.

7. The commentor questions whether the model result of a dissolved oxygen peak of 25 mg/l in the low flow baseline scenario is possible.

Response: Dissolved oxygen concentrations close to 25 mg/l have been observed in the Back River, Maryland. Dr. Walter Boynton of the University of Maryland conducted the Back River study and he communicated to the Department that these high concentrations are possible in the Lower Wicomico River under critical conditions, such as calm waters, high temperatures, and high chlorophyll *a* concentrations.

8. The commentor questions the ability of the TMDL document to demonstrate a cause and effect relationship between nutrient sources and water quality impairment. The commentor also questions the correlation between dissolved oxygen and chlorophyll *a*.

   Response: The major scenarios presented in the document, along with the calibration of the model, clearly demonstrate the cause and effect relationship between nutrients and BOD to chlorophyll *a* and dissolved oxygen. Figure A11 shows the calibration of the model during low flow conditions. The 1998 conditions of the calibration represent an intermediate level of loading to the system relative to the baseline scenario and future TMDL scenario. The 1998 conditions indicate few instances of dissolved oxygen below 5 mg/l and chlorophyll *a* concentrations that exceed MDE's management goal. The baseline scenario represents the greatest load to the system, out of all the TMDL model scenarios. For this scenario, Figure A13 shows increased instances of dissolved oxygen concentrations below 5 mg/l and even greater chlorophyll *a* concentrations than observed in 1998. The future condition scenario represents decreased loading to the system consistent with a TMDL. For this scenario, Figure A15 shows that the dissolved oxygen remains above 5 mg/l at all locations along the river, and the chlorophyll *a* concentrations remain below MDE's management goal.

9. The commentor questions the validity of the model runs documented in the TMDL, and notes no intermediate runs were provided between the baseline scenarios and final future condition scenarios. The commentor notes that no analyses were included in the TMDL document regarding the sensitivity of the model to variations in point and nonpoint source loads.

   Response: As part of the TMDL development process, the model's sensitivity to both point and nonpoint source loads was investigated. During low flow conditions, it was found that reductions to nonpoint source loads had a limited effect on the concentrations of chlorophyll *a* or dissolved oxygen in the water column. Various combinations of point and nonpoint source reductions were investigated before the final future conditions scenarios were developed. Many factors were taken into consideration, such as the feasibility of reductions from various sources. The results of these model runs were not included in the TMDL in deference to brevity and simplicity in the TMDL presentation.

10. The commentor notes that no estimation in uncertainties in nonpoint source loads or flows was provided.

    Response: Insufficient data was available to estimate the uncertainty in nonpoint source loads or flow. The TMDL allocations include margins of safety in recognition of such uncertainties.

11. The commentor questioned if groundwater base flow to the streams was investigated.

    Response: Contributions from groundwater were included as part of the low flow nonpoint source loads. These loads were based on observed water quality data, which reflect contributions from point sources, nonpoint sources and groundwater. Also, most of the 7Q10 flows were based on a nearby U. S. Geological Survey gage, which included the contributions of groundwater flows to the gaged stream.

12. The commentor questions the assumptions used to estimate low flow. He also notes several inconsistencies between flow tables in the Appendix.

    Response: There are a total of 11 subwatersheds in the Lower Wicomico Basin. Based on observations in the field, during low flow conditions not all subwatersheds contribute freshwater flow to the system. During low flow conditions subwatersheds 1, 3, 5, 9, part of 4 (Green Hill Creek), part of 10 (Shiles Creek), and parts of 2 (Rockawalkin Creek and Owens Creek) were assumed to be contributing freshwater flow to the system.

    MDE has also correct a typographic error on page A23, Table A4. Subwatershed 2 should have included low flow and 7Q10 flow contributions, and now does.

13. The commentor questions the chlorophyll *a* boundary conditions used in the baseline and future condition scenarios.

    Response: The chlorophyll *a* concentrations used for boundaries in the baseline scenario run represent an average of the 1998 low flow water quality data. After nutrient reductions were applied to the nonpoint source loads, some of the chlorophyll *a* boundaries were adjusted downward. This adjustment in chlorophyll *a* concentrations was based on the available nutrients and the nitrogen and phosphorus ratios in algae.

14. The commentor questions the role of storm events and their relationship to nonpoint source loads.

    Response: Although the time-variable deposition of sediments due to changes in stream flow was not simulated explicitly, the steady-state application of the model used for this TMDL analysis did account for bottom sediment chemistry. The roles of bottom sediments, including the effects of prior sedimentation, were addressed in two ways in this TMDL analysis. First, baseline bottom chemistry was estimated on the basis of research literature and knowledge of the characteristics of the subject waterbody, which accounted for previously deposited sediments, for instance, from storm events prior to low flow conditions. Second, an estimation was made of the change in bottom chemistry that occurs as a result of changes in nitrogen and phosphorus concentrations, which affect the concentration of chlorophyll *a* and organic nitrogen and phosphorus and therefore the amount of organic matter settling to the bottom sediments.

15. The commentor questions the variance in nonpoint source loads to different water quality segments, for the calibration of the model.

Response: The method for estimating low flow nonpoint source loads used in the calibration of the model, based on the 1998 water quality data, was explained on page A3 of the Appendix. In summary, the boundary data for segment 18 was based on water quality station TTC0011; the boundary data for segment 23 was based on data from station WIW0221. No water quality stations were located at the boundaries of segments 14 and 22. The boundary information for these segments was estimated on average data from stations WIW0241 and ADW0001. Based on comparable land uses, these two stations were chosen as reasonable representations of water quality for the two segments.

16. The commentor states that the average annual flow scenarios are not justified by documented impairments in the water quality data, and that the scenarios provide an unrealistic combination of watershed loads and receiving water conditions. The commentor is also concerned about the accuracy of applying of the Chesapeake Bay Program's (CBP) land use loading rates to estimate average annual nonpoint source loads.

    Response: One of the reasons MDE proposes average annual nutrients limits is due to the seasonal impacts of nutrients deposited during higher flow periods. In the Lower Wicomico River, nutrients are deposited in the system during the winter-spring period when river flows are generally high. These nutrients support the spring diatom bloom. A significant portion of the organic matter produced during the spring and fall blooms eventually decomposes after reaching estuarine sediments. These "recycled" nutrients are important in supporting summer and fall algae production (Boynton et al., 1991).

    A necessary element of the TMDL development process is the investigation of critical conditions. MDE considered the combination of average annual loads and flows with summer temperature and light factors to be a reasonable simulation of critical conditions during average annual conditions. These assumptions also constitute a built-in margin of safety, which reduces the explicit margin of safety from 5% (as used for the low flow conditions) to 3%.

    The CBP watershed model and resulting land use loading rates have been extensively peer reviewed. They represent the best readily available data for the estimation of average annual nonpoint source loads. These types of land use loading rates have been used in other TMDLs approved by U.S. EPA.

17. The commentor questions whether the TMDL included nutrient reductions from the Draft TMDLs for Wicomico Creek and Johnson Pond in the Lower Wicomico Analysis.

    Response: Both the draft Wicomico Creek TMDLs and draft Johnson Pond TMDLs were incorporated to the extent possible into the Lower Wicomico River TMDL. The results of the draft TMDLs for Wicomico Creek were directly incorporated into the TMDL. The Wicomico Creek corresponded to subwatershed 9 in the Lower Wicomico basin. Results from the Wicomico Creek low flow and average annual TMDLs were used as direct inputs for the respective scenarios in the Lower Wicomico River analysis. Further explanation can be found in the Appendix on page A8.

The results of the draft Johnson Pond TMDL were incorporated to the extent possible. There was no explicit low flow TMDL for the Johnson Pond TMDL. Observed nutrient concentrations were used, and serve as a margin of safety. It is expected that the load reductions necessary to meet the average annual TMDL will help to achieve the estimated 40% reduction in controllable nonpoint source loads necessary for the Lower Wicomico River low flow TMDL. For the average annual TMDL, the nonpoint source phosphorus loads were reduced to match the average annual TMDL for Johnson Pond.

18. The commentor questioned the use of chlorophyll *a* as a water quality endpoint.

    Response: Although Maryland does not have numeric water quality criteria for chlorophyll *a*, nitrogen, or phosphorus the narrative standards (COMAR§ 26.08.02.03B) apply, especially to eutrophic conditions, a common water quality problem. Narrative criteria are designed for exactly this purpose. MDE must ensure that point and nonpoint source loads to waters of the State do not impair the existing uses of that waterbody.

    MDE's long-standing chlorophyll *a* thresholds are well established, and accepted by EPA for use in regulatory decision making. Threshold values of chlorophyll *a* have been used for over a decade under authority of the State's narrative criteria, to evaluate eutrophic conditions and set water quality endpoints consistent with the designated uses of a waterbody. This has allowed the State to make water quality management decisions that support the mandatory water quality standards and are consistent among the regulated community. Through common usage and public review, literature (Thomann, 1987 and U.S. EPA, 1997) and other published material, and site-specific data, Maryland has found that 50 µg/l is generally achievable and provides adequate protection of a waterbody's designated uses.

19. The commentor questions the equity of the proposed point and nonpoint source reductions.

    Response: MDE expressly reserves the right to allocate the TMDLs among different sources in any manner that is reasonably calculated to achieve water quality standards. In developing the nitrogen and phosphorus reductions necessary to meet the TMDL, MDE accounts for many factors, such as the feasibility of reductions and the contributions of each source to the load. In the Lower Wicomico Basin during the 1998 low flow conditions, the point sources were contributing 70% of the total nitrogen load and 88% of the total phosphorus load to the basin. The nonpoint sources were reduced as much as was considered feasibly possible.

20. The commentor questions MDE's coordination efforts on the Lower Wicomico River analysis, specifically coordination with an ongoing analysis by the City of Salisbury and the Chesapeake Bay Program (CBP).

    Response: MDE held three separate technical coordination meetings with the City of Salisbury. During those meetings, the City was shown the current model progress, and given an opportunity to comment on such progress. MDE's analysis of the Wicomico River has been ongoing since data collection began in 1998. MDE conducted a formal data solicitation initiative in 1999 to assure the best readily available information was considered. The data solicitation step of the process is a milestone designed to bring closure, allowing the analysis and review to proceed. Given that the TMDL can be refined in the future if new information suggests a substantial change is necessary, it is the judgement of the Department that our process was reasonable and that further delay is not warranted. The U.S. EPA Chesapeake Bay Program is fully aware of MDE's TMDL development schedule, which includes the Lower Wicomico River.

NOTE:
MDE has corrected a calculation which slightly affects the TMDL as summarized in the table below. Note that it does not affect the modeling results. The low flow nitrogen and phosphorus nonpoint source (NPS) loads in the draft document presented for public notice were computed as a 31-day average load. They should have been computed using a 30-day averaging period to be consistent with the period used for point source loads. Since the MOS is based on the NPS load, it will also be adjusted slightly downward to reflect a 30-day averaging period. The table below shows the corrected TMDL, load allocation values, and MOS. The point source loads did not change.

Summary of Adjustments to the Draft Low Flow TMDLs

	Draft TMDL (lb/month)	Final TMDL (lb/month)	Draft NPS (lb/month)	Final NPS (lb/month)	Point Source (lb/month)	Draft MOS (lb/month)	Final MOS (lb/month)
Total Nitrogen	**23,127**	**22,900**	**6,751**	**6,535**	**16,038**	**338**	**327**
Total Phosphorus	**5,769**	**5,764**	**157**	**152**	**5,604**	**8**	**8**

References:

Boynton, W.R., J. R. Garber, W. M. Kemp, and R. Summers. "Patterns of nitrogen and phosphorus input, storage, recycling and fate in selected portions of Chesapeake Bay and selected tributary rivers". Draft Manuscript. Chesapeake Biological Laboratory, Solomons, MD 20688. 1991.

Code of Maryland Regulations, 26.08.02.

Hydroscience, Inc. "The Chesapeake Bay Waste Load Allocation Study". Final Report Prepared for the Maryland Department of Natural Resources Water Resources Administration, 1975.

Thomann, Robert V., John A. Mueller "Principles of Surface Water Quality Modeling and Control, " HarperCollins Publisher Inc., New York, 1987.

U.S. EPA, “Technical Guidance Manual for Developing Total Maximum Daily Loads, Book2: Streams and Rivers, Part 1: Biochemical Oxygen Demand/ Dissolved Oxygen and Nutrients/ Eutrophication,” Office of Water, Washington D.C., March 1997.