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Water Quality Analysis of Eutrophication for the Middle Patuxent River, Howard County, Maryland

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List of Abbreviations

BOD	Biochemical Oxygen Demand
COMAR	Code of Maryland Regulation
CWA	Clean Water Act
DNR	Department of Natural Resources
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
MBSS	Maryland Biological Stream Survey
MDP	Maryland Department of Planning
MDE	Maryland Department of the Environment
mg/l	Milligrams Per Liter
mi ²	Square miles
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
USGS	U.S. Geological Survey
WQLS	Water Quality Limited Segment
μg/l	Micrograms Per Liter

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EXECUTIVE SUMMARY

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. This list of impaired waters is commonly referred to as the "303(d) List". For each WQLS, the State is to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

Middle Patuxent River (basin code 02131106, non-tidal watershed) was identified on the State's list of WQLSs as impaired by nutrients (1996), sediments (1996), metals-zinc (1996) and impacts to biological communities (2002). This document upon EPA approval, addresses the nutrient impairment in Middle Patuxent River; the listings for sediment, metals-zinc, and impact to biological communities will be addressed at a future date. The metals listing will be addressed in 2006.

An analysis of recent monitoring data shows that the dissolved oxygen criterion and designated uses associated with nutrients are being met in Middle Patuxent River. This analysis supports the conclusion that a TMDL for nutrients is not necessary to achieve water quality standards in this case. Barring the receipt of contradictory data, this report will be used to support a nutrients listing change for the Middle Patuxent River from Category 5 "waterbodies impaired by one or more pollutants requiring a TMDL" to Category 2 "Surface waters that are meeting some standards and have insufficient information to determine attainment of other standards", when the Maryland Department of the Environment (MDE) proposes the revision of Maryland's 303(d) List for public review in the future. Although the waters of Middle Patuxent River do not display signs of eutrophication, the State reserves the right to require future controls in the Middle Patuxent River watershed if evidence suggests nutrients from the basin are contributing to downstream water quality problems.

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1.0 INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. This list of impaired waters is commonly referred to as the "303(d) list". For each WQLS, the State is to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

In addition to the successful implementation of a TMDL, there are four other scenarios that may be used to address an impaired waterbody: 1) more recent data indicating that the impairment no longer exists (*i.e.*, water quality standards are being met); 2) more recent and updated water quality modeling which demonstrates that the segment is now attaining standards; 3) refinements to water quality standards, or the interpretation of those standards, which result in standards being met; or 4) correction to errors made in the initial listing.

The Middle Patuxent River (basin code 02131106) was first identified on the 1996 303(d) List, submitted to EPA by the Maryland Department of the Environment (MDE), as impaired by nutrients, sediments, and metals-zinc. It was identified on the 2002 303(d) list for impairment of biological communities. This report provides more recent information that supports the removal of the nutrients listing for Middle Patuxent River when the 303(d) List is revised; therefore, the aforementioned first scenario most closely applies, with the qualification that initial listing for nutrients was suspected due to the lack of data. The sediment, metals and biological impairment listings will be addressed at a future date.

The remainder of this report lays out the general setting of the waterbody within the Middle Patuxent River watershed, presents a discussion of the water quality characteristics in the basin, and provides conclusions with regard to the current water quality characteristics and the current standards. The data will demonstrate that the Middle Patuxent River is achieving water quality standards in relation to nutrients.

2.0 GENERAL SETTING

The Middle Patuxent River watershed is located in the center of Howard County (Figure 1). Its headwaters are in the northern portion of the county, originating primarily in agricultural areas. The river flows through various farms and subdivisions, and the more southern portions (below MD-Route 108) are near the Columbia business center, in the Planned Service Area. The main transportation corridors in the watershed are Interstate -70 across the northern section, Interstate-95, and MD-Routes 29 in the southern portion, and 32, which runs the length of the watershed. The drainage area of Middle Patuxent River watershed is 37,052 acres.

There are 12,877 acres (35.0%) park and forest lands evenly dispersed throughout the watershed. The watershed contains 15,302 acres (41.0%) of urban land use. The only major community is Columbia. Agricultural land uses are dispersed through out the watershed, constituting 8,700 acres (23%). The land use distribution is based on 2002 Maryland Department of Planning (MDP) land use/land cover data. The Middle Patuxent River land use coverage is displayed in Figure 2.

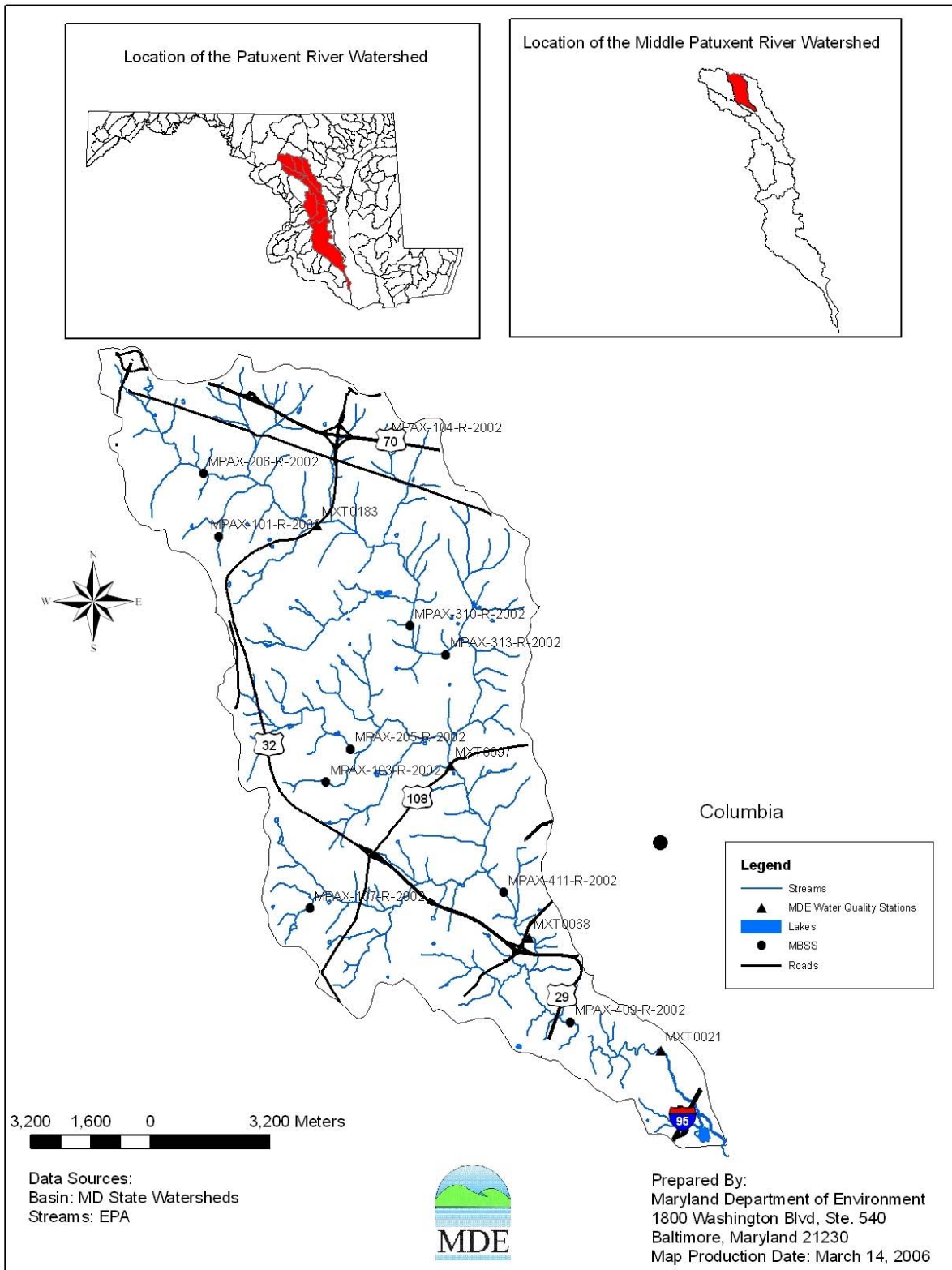


Figure 1: Middle Patuxent River Location Map and Monitoring Stations

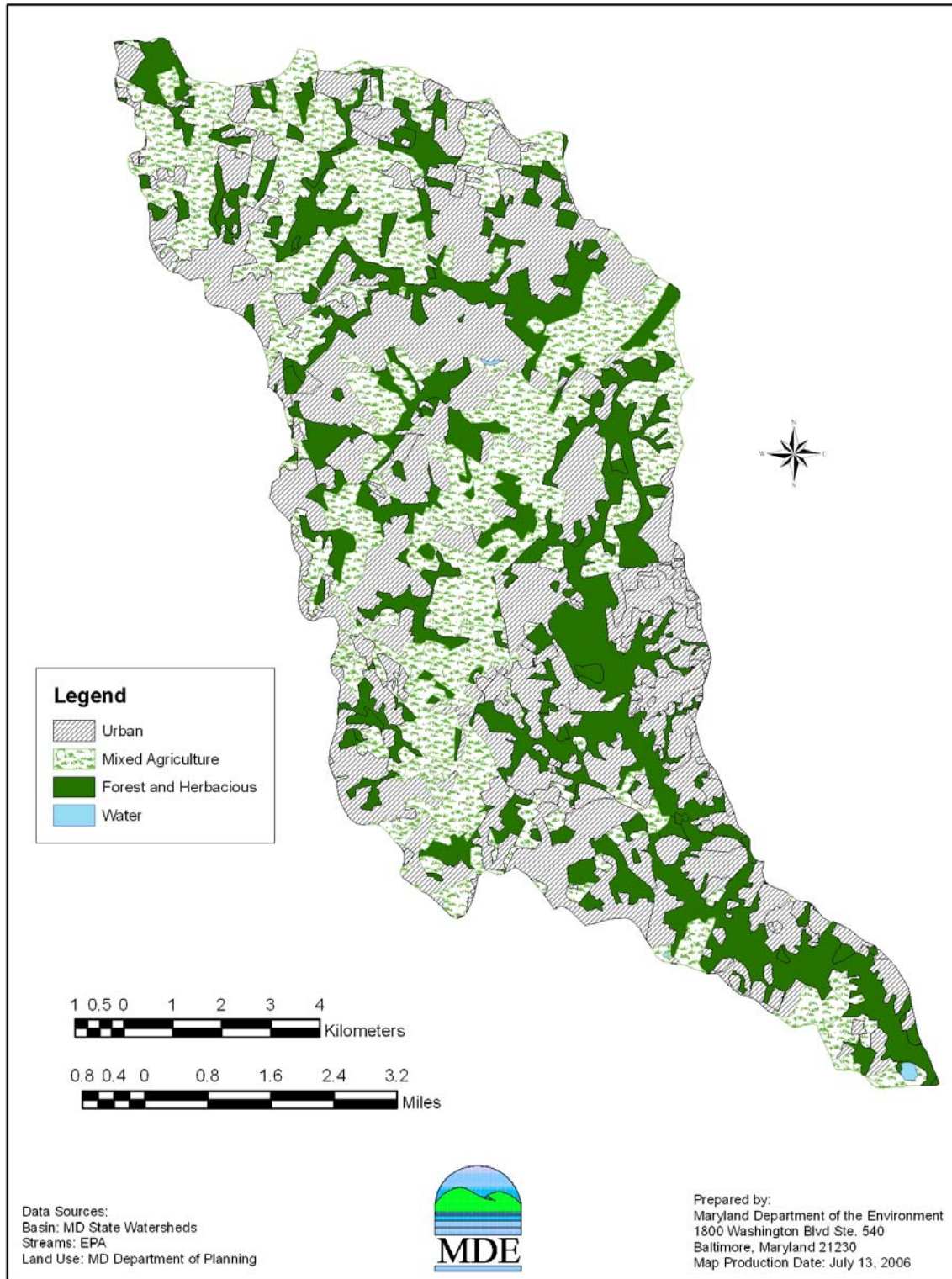


Figure 2: Land Use Map of the Middle Patuxent River Watershed

3.0 WATER QUALITY CHARACTERIZATION

A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include activities such as swimming, drinking water supply, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ among waters with different designated uses.

The Maryland Surface Water Use Designation for the Middle Patuxent River (non-tidal watershed) is Use I-P, water contact recreation, fishing, protection of aquatic life and wildlife and public water supply (Code of Maryland Regulations (COMAR) 26.08.02.08M). The DO criteria to protect Use I-P water may not be less than 5 mg/l at any time (COMAR 26.08.02.03-3B(1)). The water quality data presented in this section will show DO concentrations meet the appropriate criteria.

Maryland's water quality standards presently do not impose a limit on the concentration of nutrients in the water column. Rather, Maryland manages nutrients indirectly by limiting their effects expressed in terms of excess algal growth and low dissolved oxygen (DO). Because biochemical oxygen demand (BOD) also consumes DO, this potentially confounding factor must be considered in the analysis if low DO is observed.

Maryland's general water quality criteria prohibit pollution of waters of the State by any material in amounts sufficient to create nuisance or interfere with designated uses (COMAR 26.08.02.03B(2)). Excessive eutrophication, indicated by elevated levels of chlorophyll *a*, can produce nuisance levels of algae and interfere with designated uses such as fishing and swimming. The analysis demonstrates no excessive algal growth as indicated by low chlorophyll *a* values in the data set.

A data solicitation was conducted in January 2005. All available resources (Department of Natural Resources (DNR), U.S. Geological Survey (USGS), Chesapeake Bay Program data) were also investigated to determine if there were other available data in the Middle Patuxent River watershed. All readily available water quality data were considered for this analysis. Water quality data from MDE surveys conducted along the Middle Patuxent River during October 1999 through September 2000 were used to perform this analysis. Dissolved oxygen, BOD, Chlorophyll *a*, total nitrogen, and total phosphorus data was obtained from these surveys. Dissolved oxygen data from 10 Maryland Biological Stream Survey (MBSS) stations were also used during March 2002 through April 2002. Table 1 shows the list of MDE and MBSS stations with their geographical coordinates and descriptive location in the Middle Patuxent River watershed. Figure 3 provides graphical representation of the collected data for the parameters discussed below.

Table 1: Locations of Water Quality Stations Monitored During 1999-2000 in Middle Patuxent River.

#	STATION_ID	SOURCE	LAT	LONG
1	MXT0021	MDE	39.16015	-76.85213
2	MXT0068	MDE	39.18743	-76.89310
3	MXT0097	MDE	39.22905	-76.91731
4	MXT0183	MDE	39.28718	-76.95870
5	MPAX-409-R-2002	MBSS	39.16695	-76.88012
6	MPAX-205-R-2002	MBSS	39.23292	-76.94827
7	MPAX-101-R-2002	MBSS	39.28438	-76.98931
8	MPAX-107-R-2002	MBSS	39.19453	-76.96099
9	MPAX-103-R-2002	MBSS	39.22494	-76.95604
10	MPAX-313-R-2002	MBSS	39.25573	-76.91871
11	MPAX-104-R-2002	MBSS	39.30770	-76.93681
12	MPAX-206-R-2002	MBSS	39.29960	-76.99392
13	MPAX-411-R-2002	MBSS	39.19834	-76.90084
14	MPAX-310-R-2002	MBSS	39.26278	-76.92978

3.1 Dissolved Oxygen

During the October 1999 through April 2002 sampling period, DO concentrations ranged from 4.60 mg/l to 14.50 mg/l. The data show that only one of the values fell below the criterion of 5 mg/l during the entire sampling period (1.9% of the monitoring values). This data is summarized in Figure 3. Tabular data is presented in Appendix A.

3.2 Biochemical Oxygen Demand (BOD)

Because BOD also consumes DO, this potentially confounding factor must be considered in the analysis if low DO is observed. During the October 1999 through September 2000 sampling period, BOD concentrations ranged from 0.1 mg/l to 3.8 mg/l. Again, please refer to Figure 3 for graphical representations of this data; data tables are presented in Appendix A. Please note that all but one of the DO concentrations were above 5 mg/l during the sampling period.

3.3 Chlorophyll *a*

Chlorophyll *a* data was collected during the entire period from October 1999 through September 2000 covering the algal growing season, when concentrations are at their peak. Observed chlorophyll *a* concentrations are low and do not reach levels higher than 7.6 µg/l.

The low chlorophyll *a* concentrations found in Middle Patuxent River suggests that chlorophyll *a* photosynthesis and respiration will have no significant effect on observed DO values. Nothing out of the ordinary was observed during sampling event. This data is summarized in Figure 3. Tabular data is presented in Appendix A.

3.4 Nutrients

During the October 1999 through September 2000 sampling period, total phosphorus (TP) concentrations ranged from 0.01 mg/l to 1.01 mg/l and total nitrogen (TN) concentrations ranged from 1.99 mg/l to 3.75 mg/l. Please refer to Figure 3 for graphical representations of this data; data tables are presented in Appendix A.

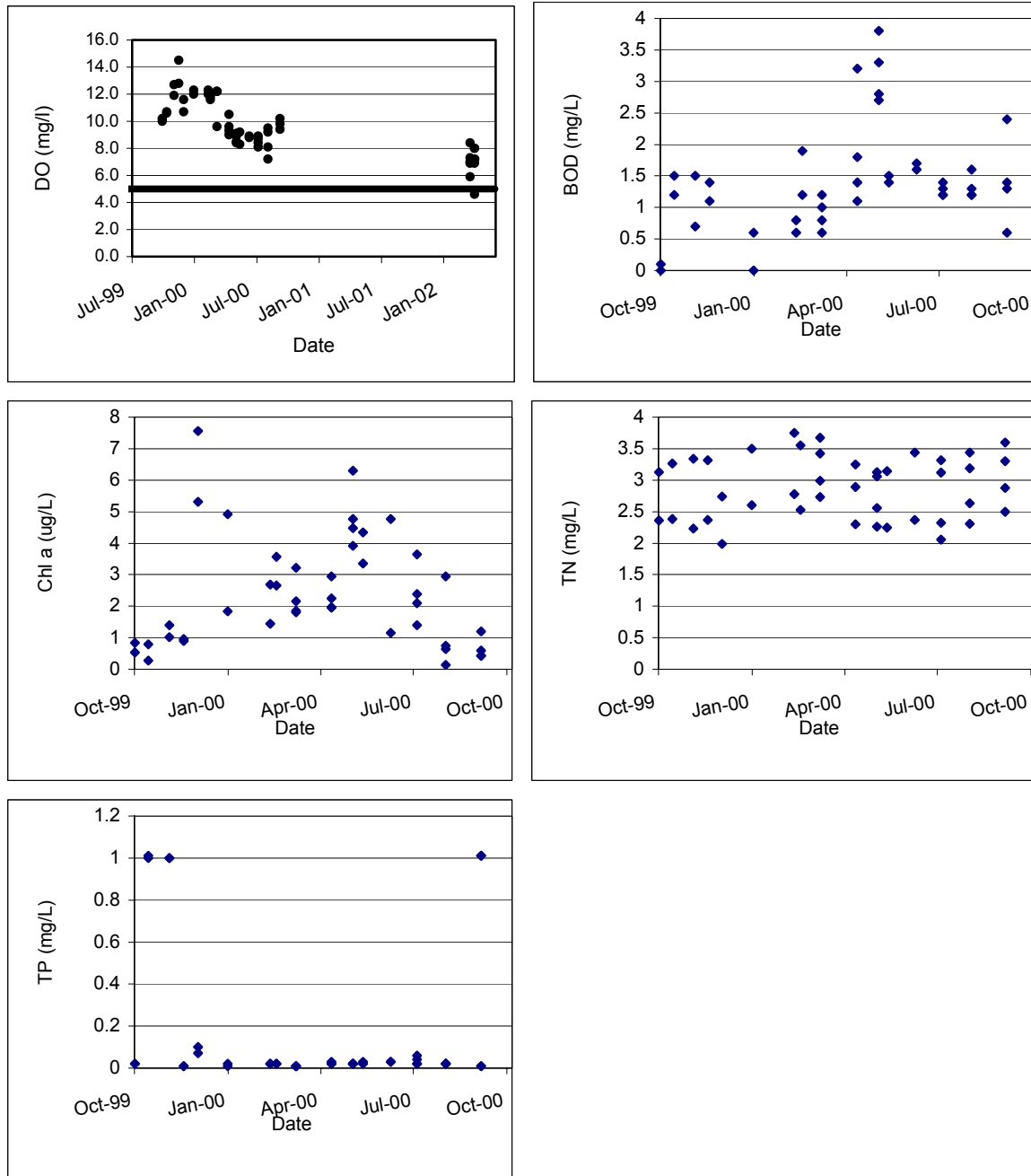


Figure 3: Middle Patuxent River Water Quality Data from October 1999 through April 2002

4.0 CONCLUSION

The data presented above clearly demonstrates that excessive algal growth does not exist in Middle Patuxent River, as indicated by low chlorophyll *a*. Similarly, 98.1% of the DO concentrations are above the criterion of 5.0 mg/l. Based on 305(b) guidance, MDE applies a “rule-of-thumb” that a waterbody is impaired by a chemical contaminant in the water column when greater than 10% of the samples exceed the applicable criteria. This water quality analysis shows only 1.9% violation of criteria within the watershed if the 5.0 mg/L criterion is applied with the synoptic surveys conducted during the 1999-2002. This result does not exceed the 10% rule MDE has defined as a standard for determining impairment.

Barring the receipt of contradictory data, this report will be used to support a nutrients listing change for the Middle Patuxent River from Category 5 (“waterbodies impaired by one or more pollutants requiring a TMDL”) to Category 2 (“Surface waters that are meeting some standards and have insufficient information to determine attainment of other standards”), when the Maryland Department of the Environment (MDE) proposes the revision of Maryland’s 303(d) List for public review in the future. Although the waters of Middle Patuxent River do not display signs of eutrophication, the State reserves the right to require future controls in the Middle Patuxent River watershed if evidence suggests nutrients from the basin are contributing to downstream water quality problems.

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REFERENCES

Code of Maryland Regulations, 26.08.02.08M, 26.08.02.03-3B(1), 26.08.02.03B(2)

Maryland Department of the Environment, 2004 FINAL List of Impaired Surface Waters [303(d) List] and Integrated Assessment of Water Quality in Maryland.

Maryland Department of Planning, 2002 Land Use, Land Cover Map Series. 2002.

Appendix A: Tabular Water Quality Data

Station	Date	DO mg/l	TN mg/l	TP mg/l	Chl_a µg/L	BOD mg/l
MXT0021	10/14/99	10.00	2.36	0.02	0.53	0.1
MXT0021	10/27/99	10.70	2.38	1.01	0.28	1.2
MXT0021	11/17/99	12.70	2.23	1.00	1.40	0.7
MXT0021	12/1/99	12.80	2.37	0.01	0.90	1.4
MXT0021	12/15/99	10.70	1.99	0.10	7.56	
MXT0021	1/13/00	12.30	2.60	0.01	1.83	0
MXT0021	2/24/00	12.30	2.78	0.02	1.44	0.6
MXT0021	3/1/00	11.60	2.53	0.02	2.66	1.9
MXT0021	3/20/00	12.20	2.73	0.01	1.80	1
MXT0021	4/24/00	9.30	2.30	0.02	1.96	1.8
MXT0021	5/15/00	8.50	2.26	0.02	4.76	2.7
MXT0021	5/25/00	8.30	2.25	0.02	3.36	1.5
MXT0021	6/21/00	8.80	2.37	0.03	1.16	1.6
MXT0021	7/17/00	8.40	2.06	0.06	2.38	1.2
MXT0021	8/14/00	7.20	2.31	0.02	0.14	1.6
MXT0021	9/18/00	9.40	2.50	0.01	0.42	2.4
MXT0068	3/20/00	12.20	2.99	0.01	2.16	1.2
MXT0068	4/24/00	9.60			1.96	1.4
MXT0068	5/15/00	8.90	2.56	0.02	6.30	3.3
MXT0068	7/17/00	8.70	2.32	0.04	2.10	1.3
MXT0068	8/14/00	8.10	2.63	0.02	0.63	1.3
MXT0068	9/18/00	9.80	2.88	1.01	0.42	1.3
MXT0097	3/20/00	12.20	3.42	0.01	1.85	0.6
MXT0097	4/24/00	9.60	2.89	0.02	2.24	1.1
MXT0097	5/15/00	9.00	3.06	0.02	3.92	2.8
MXT0097	7/17/00	8.40	3.12	0.02	1.40	1.4
MXT0097	8/14/00	8.10	3.19	0.02	0.74	1.2
MXT0097	9/18/00	9.50	3.30	1.01	0.59	0.6
MXT0183	10/14/99	10.20	3.13	0.02	0.84	0
MXT0183	10/27/99	10.60	3.26	1.00	0.79	1.5
MXT0183	11/17/99	11.90	3.34	1.00	1.01	1.5
MXT0183	12/1/99	14.50	3.32	0.01	0.95	1.1
MXT0183	12/15/99	11.60	2.74	0.07	5.32	
MXT0183	1/13/00	12.00	3.50	0.02	4.92	0.6
MXT0183	2/24/00	12.00	3.75	0.02	2.69	0.8
MXT0183	3/1/00	11.80	3.55	0.02	3.57	1.2
MXT0183	3/20/00	12.20	3.67	0.01	3.22	0.8
MXT0183	4/24/00	10.50	3.25	0.03	2.94	3.2
MXT0183	5/15/00	9.10	3.13	0.02	4.48	3.8
MXT0183	5/25/00	9.20	3.14	0.03	4.34	1.4
MXT0183	6/21/00	8.90	3.44	0.03	4.76	1.7
MXT0183	7/17/00	8.90	3.32	0.02	3.64	1.2
MXT0183	8/14/00	9.20	3.44	0.02	2.94	1.2
MXT0183	9/18/00	10.20	3.60	0.01	1.20	1.4

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Station	Date	DO mg/l	TN mg/l	TP mg/l	Chl_a µg/L	BOD mg/l
MPAX-101-R-2002	3/21/02	6.9				
MPAX-103-R-2002	3/21/02	7				
MPAX-104-R-2002	3/21/02	7.3				
MPAX-107-R-2002	4/3/02	6.9				
MPAX-205-R-2002	3/21/02	5.9				
MPAX-206-R-2002	4/3/02	8				
MPAX-310-R-2002	3/21/02	8.4				
MPAX-313-R-2002	4/4/02	7.2				
MPAX-409-R-2002	4/3/02	4.6				
MPAX-411-R-2002	4/3/02	8				