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**Water Quality Analysis of Eutrophication for the Lower North
Branch Patapsco River Basin
in Anne Arundel, Baltimore, Carroll, and Howard Counties, and
Baltimore City, Maryland**

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List of Abbreviations

BOD	Biochemical Oxygen Demand
BSID	Biological Stressor Identification
CES	Coastal Environmental Services
COMAR	Code of Maryland Regulations
CWA	Clean Water Act
DNR	Department of Natural Resources
DO	Dissolved Oxygen
EPA	United States Environmental Protection Agency
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
mg/l	Milligrams Per Liter
mi ²	Square Miles
NPDES	National Pollution Discharge Elimination System
NRCS	National Resources Conservation Service
SCS	Soil Conservation Service
SSURGO	Soil Survey Geography
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSI	Trophic State Index
USGS	United States Geological Survey
WQLS	Water Quality Limited Segment
µg/l	Micrograms Per Liter

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 required 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 (CFR 2007).

The Lower North Branch of the Patapsco River (Patapsco LNB) (basin code 02130906) was identified on the State's 303(d) List as impaired by nutrients, sediments, and heavy metals (1996 listing); fecal coliform and impacts to biological communities (2002 listing); and polychlorinated biphenyls (PCBs) in fish tissue (2008 listing). The Patapsco LNB was delisted for heavy metals in 2005, following EPA concurrence with MDE's analysis of heavy metal data collected during 2001-2002. The analysis showed no heavy metals impairment, except for Herbert Run where data on copper (Cu) and lead (Pb) was inconclusive. Subsequent water quality analyses (WQAs) of Cu and Pb for Herbert Run (based on 2005-2006 data) were included as an appendix to the *2008 Integrated Report of Surface Water Quality in Maryland* (Integrated Report) approved by EPA in 2008 (MDE 2008a). Upon EPA approval, the Cu and Pb impairment listings for Herbert Run were removed. The 1996 nutrients listing was refined in the 2008 Integrated Report and phosphorus was identified as the specific impairing substance. Consequently, for the purpose of this report the terms "nutrients" and "phosphorus" will be used interchangeably. The fecal coliform listing will be addressed by a fecal bacteria TMDL, scheduled for submittal to EPA in 2009. The listing for sediments will be addressed by a sediment TMDL, also scheduled for submittal to EPA in 2009. The listings for PCBs in fish tissue and impacts to biological communities will be addressed separately at a future date.

A data solicitation for information pertaining to pollutants, including nutrients, in the Patapsco River basin was conducted by MDE in November 2007, and all readily available data from the past five years have been considered. Currently, there are no specific numeric criteria for nutrients in Maryland's water quality standards. Nutrients typically do not have a direct impact on aquatic life; rather, they mediate impacts through excessive algal growth leading to low dissolved oxygen. Therefore, the evaluation of potentially eutrophic conditions due to nutrient over-enrichment will be based on whether nutrient-related parameters (i.e., dissolved oxygen levels and chlorophyll *a* concentrations) are found to impair designated uses in the Patapsco LNB (in this case, protection of aquatic life and wildlife, fishing, and swimming).

Recently, MDE developed a biological stressor identification (BSID) methodology to identify the most probable cause(s) of the existing biological impairments in Maryland 8-digit watersheds based on the suite of available physical, chemical, and land use data (MDE 2009a). The BSID analysis for the Patapsco LNB indicates inorganic pollutants and flow/sediment related stressors are associated with impacts to biological communities; these findings will be addressed separately. The BSID study did not identify any nutrient stressors present and/or nutrient stressors showing a significant association with degraded biological conditions (MDE 2009b).

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The results of the BSID study, combined with the analysis of recent water quality data (including dissolved oxygen, chlorophyll *a*, and nutrients) presented in this report, indicate that the Patapsco LNB watershed is not being impaired by nutrients.

This WQA supports the conclusion that a TMDL for nutrients is not necessary to achieve water quality standards in the Patapsco LNB. Although the waters of the Patapsco LNB do not display signs of eutrophication, the State reserves the right to require future controls if evidence suggests that nutrients from the basin are contributing to downstream water quality problems. In December 2007, EPA approved TMDLs of nitrogen and phosphorus for the Baltimore Harbor. The Patapsco LNB watershed is located upstream of the Baltimore Harbor and drains into the Harbor's tidal waters. Although the amount of nutrients entering the Patapsco LNB is not causing localized impairments, it is contributing to the eutrophication of the downstream tidal waters of the Harbor. Therefore, the TMDL for the Baltimore Harbor requires nutrient reductions in the Patapsco LNB necessary to meet water quality standards in the Harbor. On the same principle, additional reductions may also be required by the forthcoming Chesapeake Bay TMDL, currently under development and due to be established by EPA by the end of 2010.

Barring the receipt of contradictory data, this report will be used to support a revision of the phosphorus listing for the Patapsco LNB watershed, from Category 5 ("waterbody is impaired, does not attain the water quality standard, and a TMDL is required") to Category 2 ("waterbodies meeting some [in this case nutrients-related] water quality standards, but with insufficient data to assess all impairments") when MDE proposes the revision of the Integrated Report.

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 required 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 (CFR 2007).

A segment identified as a WQLS may not require the development and implementation of a TMDL if more recent information invalidates previous findings. The most common scenarios that would eliminate the need for a TMDL are: 1) analysis of more recent data indicating that the impairment no longer exists (i.e., water quality standards are being met); 2) results of a more recent and updated water quality modeling which demonstrates that the segment is attaining standards; 3) refinements to water quality standards or to the interpretation of those standards accompanied by analysis demonstrating that the standards are being met; or 4) identification and correction of errors made in the initial listing.

The Lower North Branch of the Patapsco River (Patapsco LNB) (basin code 02130906) was identified on the State's 303(d) List as impaired by nutrients, sediments, and heavy metals (1996 listing); fecal coliform and impacts to biological communities (2002 listing); and PCBs in fish tissue (2008 listing). The Patapsco LNB was delisted for heavy metals in 2005, following EPA concurrence with the Maryland Department of the Environment (MDE)'s analysis of heavy metal data collected during 2001-2002. The analysis showed no heavy metals impairment, except for Herbert Run where data on copper (Cu) and lead (Pb) was inconclusive. Subsequent water quality analyses (WQAs) of Cu and Pb for Herbert Run (based on 2005-2006 data) were included as an appendix to the *2008 Integrated Report of Surface Water Quality in Maryland* (Integrated Report) approved by EPA in 2008 (MDE 2008a). Upon EPA approval, the Cu and Pb impairment listings for Herbert Run were removed. The 1996 nutrients listing was refined in the 2008 Integrated Report and phosphorus was identified as the specific impairing substance. Consequently, for the purpose of this report the terms "nutrients" and "phosphorus" will be used interchangeably. The fecal coliform listing will be addressed by a fecal bacteria TMDL, scheduled for submittal to EPA in 2009. The listing for sediments will be addressed by a sediment TMDL, also scheduled for submittal to EPA in 2009. The listings for PCBs in fish tissue and impacts to biological communities will be addressed separately at a future date.

This report provides an analysis of recent data that supports the removal of the nutrients (phosphorus) listing for the Patapsco LNB watershed when MDE proposes the revision of the State's Integrated Report. The remainder of this report lays out the general setting of the Patapsco LNB watershed area, presents a discussion of the water quality characteristics in the basin in terms of the existing water quality standards relating to nutrients, and presents an analysis of the available nutrient data. This analysis supports the conclusion that the waters of the Patapsco LNB watershed do not display signs of eutrophication or nutrient over-enrichment.

2.0 GENERAL SETTING

Location

The Patapsco LNB watershed is a free flowing stream system that is part of the Patapsco River basin of the Chesapeake Bay watershed (see Figure 1). The Patapsco LNB watershed drains from northwest to southeast into the tidal portion of the Patapsco River mainstem. Upstream watersheds include Liberty Reservoir and the South Branch Patapsco River. The watershed area of 75,756 acres is located in portions of Anne Arundel, Baltimore, Carroll, and Howard Counties, and Baltimore City.

Geology/Soils

The Patapsco LNB watershed lies within the Piedmont and Coastal Plain provinces of Central Maryland. The Piedmont province is characterized by gentle to steep rolling topography, low hills, and ridges. The surficial geology is characterized by crystalline rocks of volcanic origin, consisting primarily of schist and gneiss. These formations are resistant to short-term erosion and often determine the limits of stream bank and stream bed. These crystalline formations decrease in elevation from northwest to southeast and eventually extend beneath the younger sediments of the Coastal Plain. The fall line represents the transition between the Atlantic Coastal Plain province and the Piedmont province. The Atlantic Coastal Plain surficial geology is characterized by thick, unconsolidated marine sediments deposited over the crystalline rock of the Piedmont province. The deposits include clays, silts, sands, and gravels (CES 1995).

The Patapsco LNB watershed drains from northwest to southeast, following the dip of the underlying crystalline bedrock in the Piedmont province. The surface elevations range from approximately 620 feet to sea level at the Chesapeake Bay shorelines. Stream channels of the sub-watersheds are well incised in the Eastern Piedmont, and exhibit relatively straight reaches and sharp bends, reflecting their tendency to following zones of fractured or weathered rock. The stream channels broaden abruptly as they flow down across the fall line into the soft, flat Coastal Plain sediments (CES 1995).

The watershed is comprised primarily of B and C type soils with some soil types A and D also present. Soil type is categorized by four hydrologic soil groups developed by the Soil Conservation Service (SCS). The definitions of the groups are as follows:

Group A: Soils with high infiltration rates, typically deep well-drained to excessively drained sands or gravels.

Group B: Soils with moderate infiltration rates, generally moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Group C: Soils with slow infiltration rates, mainly soils with a layer that impedes downward water movement or soils with moderately fine to fine texture.

Group D: Soils with very slow infiltration rates, mainly clay soils, soils with a permanently high water table, and shallow soils over nearly impervious material (SCS 1977).

The soil distribution within the watershed is approximately 5.1% soil group A; 41.8% soil group B; 40.9% soil group C; and 12.2% soil group D. Soil data were obtained from Soil Survey Geographic (SSURGO) coverage created by the National Resources Conservation Service (NRCS).

Land Use

The Patapsco LNB watershed contains mostly urban and forest land uses (see Figure 2). The forested areas are mainly along the Patapsco River. The urban areas are more prevalent in the downstream portion of the watershed. The land use distribution in the watershed is approximately 50% urban; 39% forest/herbaceous; 10% agricultural; and 1% water (MDP 2002).

Point Sources

There are a total of twelve municipal and industrial point source facilities with permits regulating their discharges in the Patapsco LNB. Of these, only two municipal wastewater treatment plants (WWTPs) have National Pollution Discharge Elimination System (NPDES) permits regulating the discharge of nutrients (see Table 1 below).

Table 1: Point Source Facilities Discharging Nutrients to Patapsco LNB

Facility	NPDES Number	Maximum Permitted Flow (mgd)
Deep Run WWTP	MD0056618	1.25
Holiday Mobile Estates WWTP	MD0053082	0.125

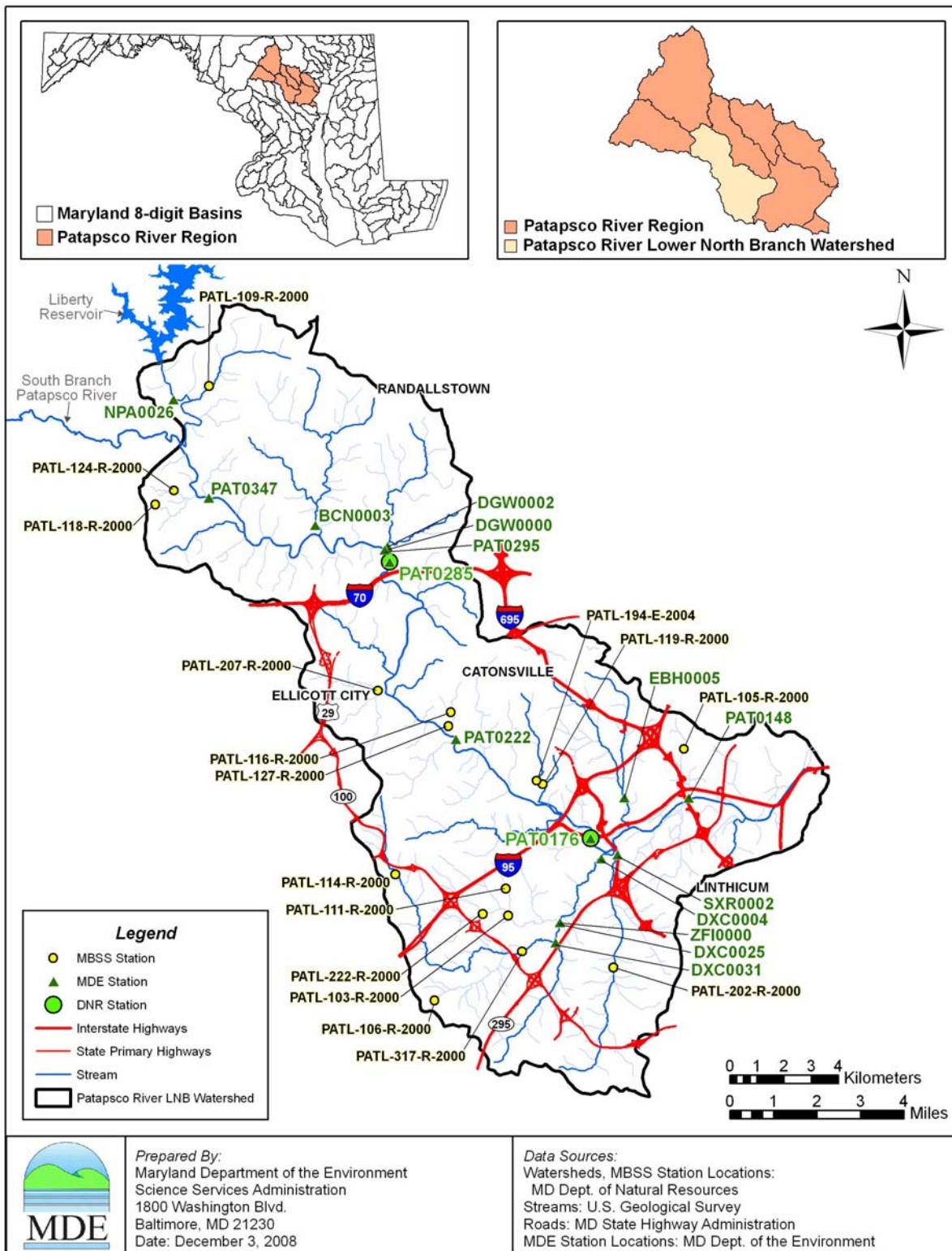


Figure 1: Location Map and Monitoring Stations of the Lower North Branch Patapsco River Watershed

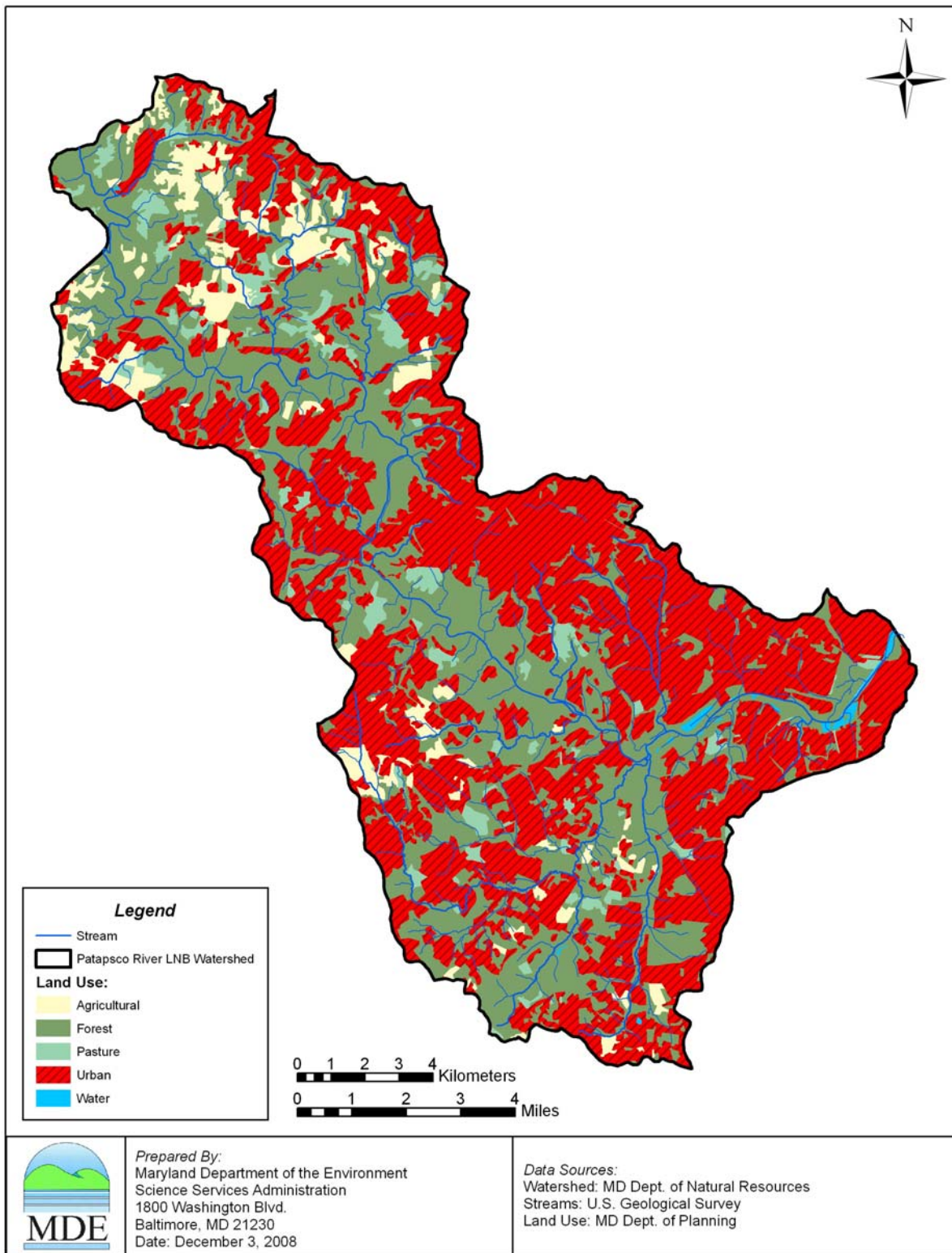


Figure 2: Land Use of the Lower North Branch Patapsco River Watershed

3.0 WATER QUALITY CHARACTERIZATION

The Maryland Surface Water Use Designation in the Code of Maryland Regulations (COMAR) for the waters of the Patapsco LNB is Use I (Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life), with one tributary, Brice Run (and its tributaries), designated as Use III (Nontidal Cold Water) (COMAR 2008a,b,c). 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 support of aquatic life, primary or secondary contact recreation, drinking water supply, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. The criteria developed to protect the designated use may differ and are dependent on the specific designated use(s) of a waterbody.

Currently, there are no specific numeric criteria for nutrients in Maryland's water quality standards. Therefore, the evaluation of potentially eutrophic conditions due to nutrient over-enrichment will be based on whether nutrient-related parameters (i.e., dissolved oxygen levels and chlorophyll *a* concentrations) are found to impair designated uses in the Patapsco LNB. The dissolved oxygen (DO) concentration to protect Use I and Use IV waters "may not be less than 5 milligrams per liter (mg/l) at any time" and to protect Use III waters "may not be less than 5 mg/l at any time, with a minimum daily average of not less than 6 mg/l" (COMAR 2008d). The water quality data presented in this section will show that DO concentrations in the Patapsco LNB and its tributaries meet these criteria, and that Maryland's narrative criteria for chlorophyll *a* are also met.

In addition to the DO and chlorophyll *a* data analysis, the results of a new biological stressor identification (BSID) analysis demonstrate that any biological impairment in the watershed is not caused by nutrient enrichment. Instead, the analysis suggests that the degradation to biological communities in the Patapsco LNB River is strongly associated with the extensive urban nature of the watershed, which results in altered hydrology and elevated levels of sulfate, chlorides, and (electrical) conductivity (MDE 2009b).

A data solicitation was conducted in 2007. All readily available water quality data from the past five years have been considered for this analysis. Water quality data from MDE surveys conducted along the Patapsco LNB from October 1999 through September 2000, October 2002 through December 2005, and January 2007 through December 2007, were used. Maryland Department of Natural Resources (DNR) data used in the analysis were from December 1998 through June 2007. Data from Maryland Biological Stream Survey (MBSS) sampling conducted in March, June, and July 2000, and April and October 2004, were also used. Table 2 lists the water quality monitoring stations in the Patapsco LNB watershed with their geographical coordinates. Figures 3 through 6 provide graphical representation of the collected data for the parameters discussed below.

Table 2: Water Quality Stations in Patapsco LNB Watershed Monitored During 1998-2007

Station ID	Agency/Program	Latitude (Decimal-Degrees)	Longitude (Decimal-Degrees)
BCN0003	MDE	39.3225	-76.8244
DGW0000	MDE	39.3144	-76.7939
DGW0002	MDE	39.3155	-76.7933
DXC0004	MDE	39.2109	-76.7021
DXC0025	MDE	39.1895	-76.7201
DXC0031	MDE	39.1828	-76.7217
EBH0005	MDE	39.2313	-76.6921
NPA0026	MDE	39.3647	-76.8851
PAT0148	MDE	39.2311	-76.6645
PAT0176	MDE	39.2177	-76.7066
PAT0222	MDE	39.2509	-76.7642
PAT0285	MDE	39.3102	-76.7925
PAT0295	MDE	39.3142	-76.7946
PAT0347	MDE	39.3318	-76.8700
SXR0002	MDE	39.2122	-76.6950
ZFI0000	MDE	39.1896	-76.7199
PAT0176	DNR/CORE	39.2179	-76.7052
PAT0285	DNR/CORE	39.3123	-76.7922
PATL-103-R-2000	DNR/MBSS	39.1919	-76.7421
PATL-105-R-2000	DNR/MBSS	39.2473	-76.6664
PATL-106-R-2000	DNR/MBSS	39.1636	-76.7738
PATL-109-R-2000	DNR/MBSS	39.3691	-76.8700
PATL-111-R-2000	DNR/MBSS	39.2010	-76.7431
PATL-114-R-2000	DNR/MBSS	39.2058	-76.7903
PATL-116-R-2000	DNR/MBSS	39.2599	-76.7663
PATL-118-R-2000	DNR/MBSS	39.3296	-76.8931
PATL-119-R-2000	DNR/MBSS	39.2358	-76.7272
PATL-124-R-2000	DNR/MBSS	39.3341	-76.8850
PATL-127-R-2000	DNR/MBSS	39.2553	-76.7674
PATL-194-E-2004	DNR/MBSS	39.2370	-76.7297
PATL-202-R-2000	DNR/MBSS	39.1744	-76.6971
PATL-207-R-2000	DNR/MBSS	39.2671	-76.7978
PATL-222-R-2000	DNR/MBSS	39.1925	-76.7530
PATL-317-R-2000	DNR/MBSS	39.1798	-76.7361

3.1 Dissolved Oxygen

DNR samples were taken in the Patapsco LNB from December 1998 through June 2007. MDE samples were taken from October 1999 through September 2000, October 2002 through December 2005, and January 2007 through December 2007, and MBSS samples were taken in March, June, and July 2000, and April and August 2004. Samples taken during the growing season (May through October) show DO concentrations ranging from 4.6 to 12.5 mg/l, with only two values (out of 288) below the DO criterion for Use I waters of 5 mg/l (4.6 and 4.9 mg/l). There is one monitoring station located in Brice Run (BCN0003), a tributary of the Patapsco LNB designated as Use III. All five samples at this station have DO concentrations above the Use III criterion of 6 mg/l, with a lowest value of 8.6 mg/l. The DO data are presented graphically in Figure 3 and in tabular form in Appendix A. Although the criterion concentration for Use I is 5 mg/l DO “at all times,” MDE does not consider that the two values below the criterion, representing 0.5% of MDE monitoring samples, are indicative of a pattern of use impairment. Given the overwhelming percentage of attainment indicated by the total data used in the analysis, MDE considers that the water quality standard for DO is being met in the Patapsco LNB.

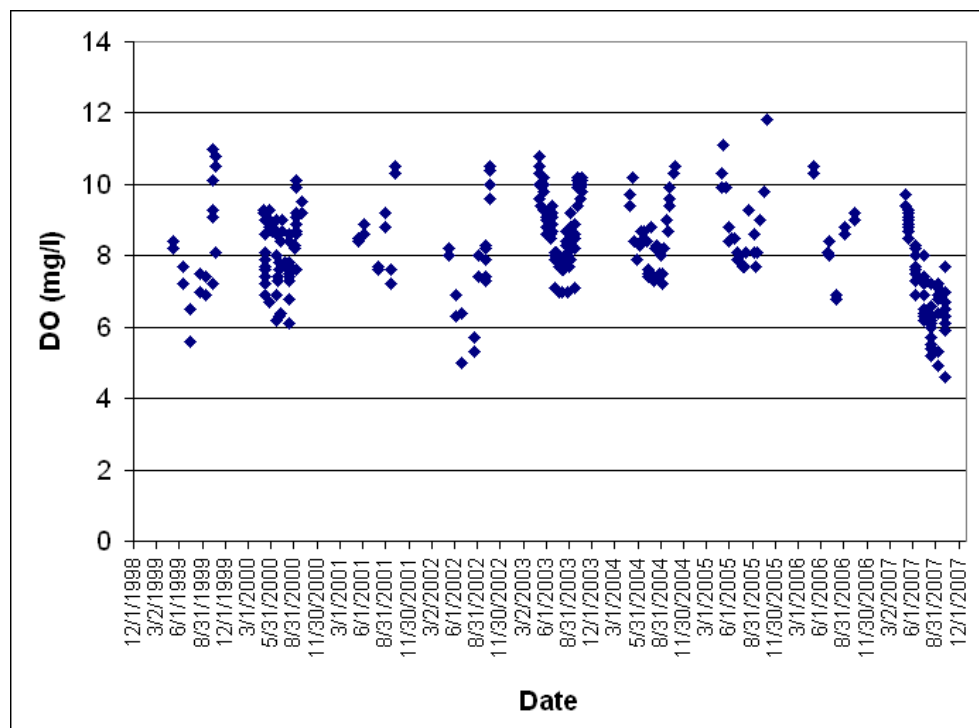


Figure 3: Lower North Branch Patapsco River Dissolved Oxygen Data for Growing Season Periods May 1999 through October 2007

3.2 Chlorophyll *a*

Currently, Maryland water quality standards do not specify numeric criteria for chlorophyll *a*. However, pollution of waters of the State by any material in amounts sufficient to create a nuisance or interfere with designated uses is prohibited (COMAR 26.08.02.03B(2)). Elevated chlorophyll *a* concentrations, a measure of algal growth, may indicate poor water quality that cannot support a waterbody's designated uses and may constitute a nuisance condition. Nuisance levels of algae can interfere with uses related to recreational activities such as fishing, boating, and aesthetic appreciation. High chlorophyll *a* levels can also present taste, odor, and treatment problems in water supply systems.

Narrative water quality criteria are an important component of the State's water quality standards, but are difficult to incorporate into quantitative water quality or TMDL analyses. In the case of free-flowing non-tidal waters, there is an insufficient understanding of the relationship between chlorophyll *a* concentrations and the waterbody's designated use impairment. However, the Code of Maryland Regulations (COMAR) includes narrative criteria for acceptable chlorophyll *a* levels in tidal waters. Maryland's numeric interpretation of these criteria for application in estuarine waters, as described in previously approved nutrient TMDLs, is as follows:

The chlorophyll *a* concentration goal used by the State in estuarine TMDL analyses is based on guidelines set forth by Thomann and Mueller (1987) and by the EPA Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2, Part 1 (1997). The chlorophyll *a* narrative criterion (COMAR 26.08.02.03-3C(10)) states: "Chlorophyll *a* - Concentrations of chlorophyll *a* in free-floating microscopic aquatic plants (algae) shall not exceed levels that result in ecologically undesirable consequences that would render tidal waters unsuitable for designated uses." The Thomann and Mueller guidelines acknowledge that "Undesirable levels of phytoplankton [chlorophyll *a*] vary considerably depending on water body." MDE has determined, per Thomann and Mueller, that it is acceptable to maintain chlorophyll *a* concentrations below a maximum of 100 µg/L, and to target, with some flexibility depending on waterbody characteristics, a 30-day rolling average of approximately 50 µg/L (with some flexibility depending on waterbody characteristics). (MDE 2006)

Maryland has also developed guidelines for application of the narrative criteria in drinking water reservoirs. The guidelines, as described in previously approved TMDLs, are as follows:

The chlorophyll *a* endpoints selected for public water supply reservoirs are (a) a ninetieth-percentile instantaneous concentration not to exceed 30 µg/l in the surface layers, and (b) a 30-day moving average concentration not to exceed 10 µg/l in the surface layers. The concentration of 10 µg/l corresponds to a score of approximately 53 on the Carlson's Trophic State Index (TSI). This is at the boundary of mesotrophic and eutrophic conditions, which is an appropriate trophic state at which to manage these reservoirs. Mean chlorophyll *a* concentrations exceeding 10 µg/l are associated with peaks exceeding 30 µg/l, which in turn are associated with a shift to blue-green assemblages, which present taste, odor and treatment problems (Walker 1984).

Achieving these chlorophyll *a* endpoints should thus safeguard such reservoirs from nuisance algal blooms. (MDE 2008b).

Using the chlorophyll *a* targets for tidal waters and public water supply reservoirs described above as screening values for non-tidal waters, the following data analysis reflects an absence of excessive algal growth in the Patapsco LNB, as indicated by low chlorophyll *a* concentrations in comparison with those values.

DNR and MDE monitoring data in the Patapsco LNB show growing season (May through October) averages, by station, between 0.7 and 5.1 µg/l. These samples show observed chlorophyll *a* concentrations ranging from 0.15 to 33 µg/l, with only five out of 288 samples greater than 10 µg/l. These monitoring data values suggest that chlorophyll *a* concentrations are not causing any nuisance in the Patapsco LNB or interfering with its designated uses.

The chlorophyll *a* data are presented graphically in Figure 4 and in tabular form in Appendix A.

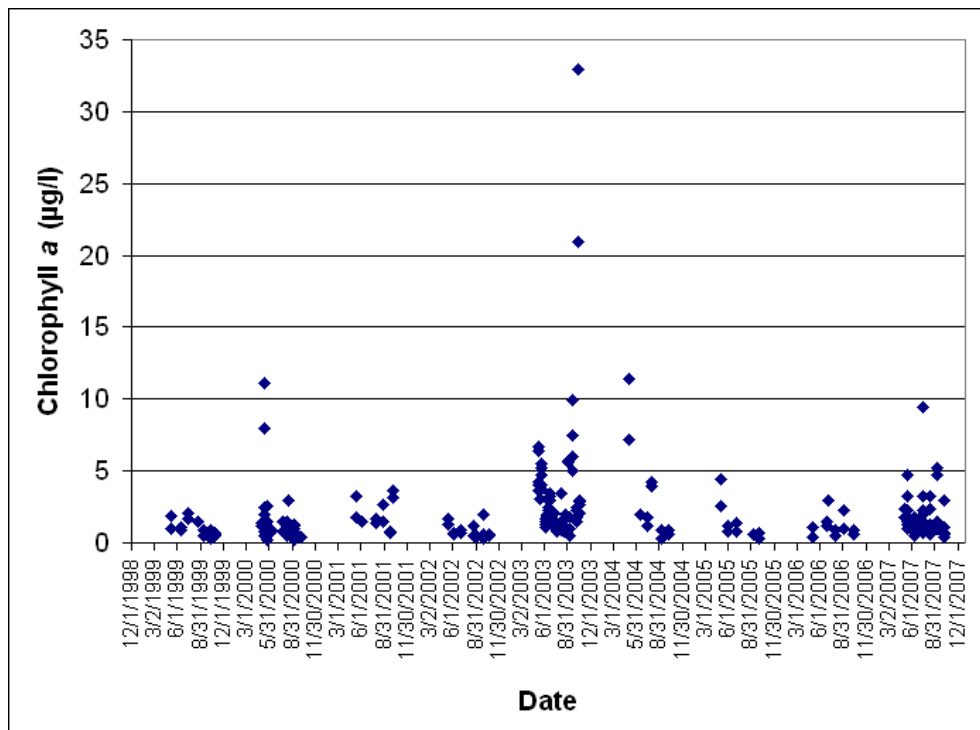


Figure 4: Lower North Branch Patapsco River Chlorophyll *a* Data for Growing Season Periods May 1999 through October 2007

3.3 Nutrients

In the absence of State water quality standards with specific numeric limits for nutrients, evaluation of potentially eutrophic conditions is based on whether nutrient-related parameters (i.e., dissolved oxygen levels and chlorophyll *a* concentrations) are found to impair the designated uses in the Patapsco LNB (in this case protection of aquatic life and wildlife, fishing, and swimming). Consequently, the nutrients data presented in this section are for informational purposes only.

Total nitrogen (TN) and total phosphorus (TP) data for the Patapsco LNB have been collected as part of this study and the results are presented here for informational purposes, graphically in Figures 5 and 6, and in tabular form in Appendix A. In general, DNR, MDE, and MBSS data show TN concentrations during the growing season (May through October) ranging from 0.23 to 4.87 mg/l and TP concentrations ranging from 0.01 to 1.18 mg/l.

In the absence of specific numeric criteria to assess the TP and TN monitoring data results, MDE evaluated these results using its BSID methodology, which compared Patapsco LNB parameters to the results from similar control sites (i.e., watersheds with no biological impairments) and concluded that nutrients are not likely stressors associated with the degraded biological conditions (MDE 2009b). Current DO conditions in the Patapsco LNB further support this conclusion.

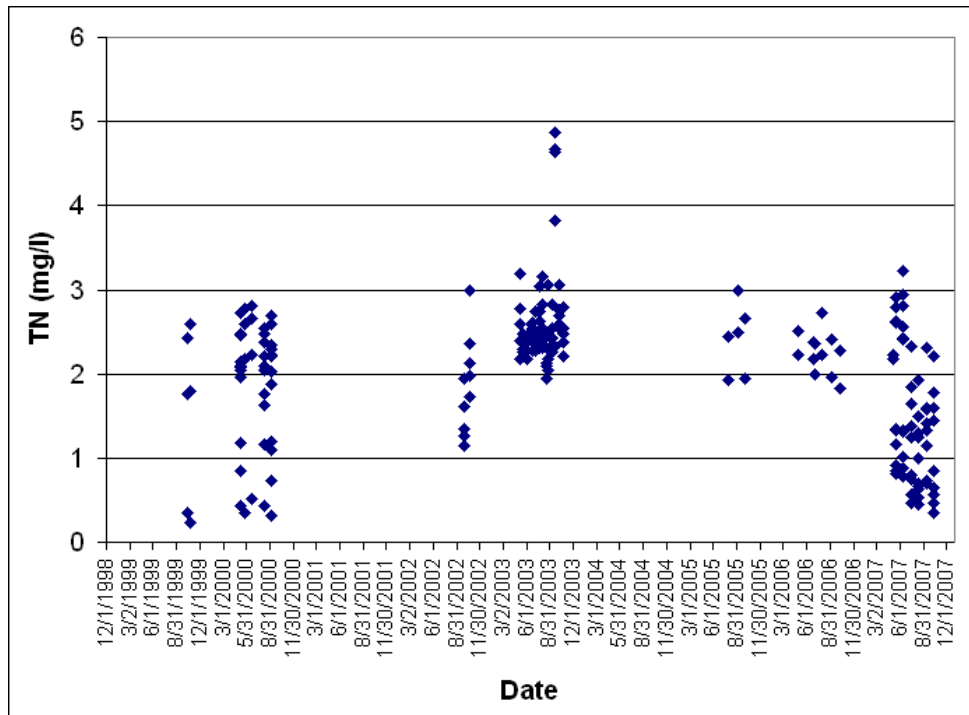


Figure 5: Lower North Branch Patapsco River Total Nitrogen Data from May 1999 through October 2007

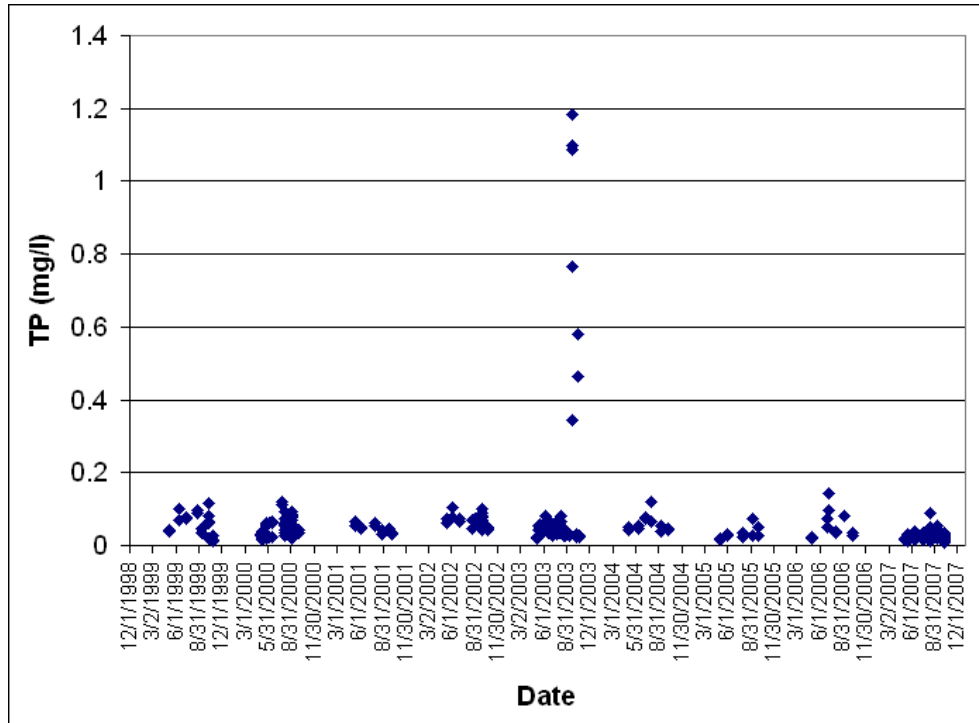


Figure 6: Lower North Branch Patapsco River Total Phosphorus Data from May 1999 through October 2007

3.4 Biological Stressor Identification Analysis

In the process of evaluating the existing biological impairments, MDE developed a biological stressor identification (BSID) methodology (MDE 2009a). The BSID methodology uses data available from the statewide DNR MBSS. These data are presented in Appendix A. The current MDE biological assessment methodology is a three-step process: (1) a data quality review, (2) a systematic vetting of the dataset, and (3) a watershed assessment that presents the results of this assignment in terms of currently used Integrated Report listing categories.

The BSID analysis for the Patapsco LNB watershed did not identify nutrients as potential stressors or indicate any significant association between current nutrient levels and the degraded biological conditions (MDE 2009b). According to this report, nutrients are not causing any impairment to aquatic life or biological communities in the Patapsco LNB. The BSID analysis results suggest rather that biological degradation in the Patapsco LNB is strongly associated with the extensive urban nature of the watershed, which has resulted in altered hydrology and elevated levels of sulfate, chlorides, and (electrical) conductivity. As explained in the BSID report, urbanization of landscapes generates broad and inter-related forms of degradation (i.e., hydrological, morphological, and water chemistry) that can affect stream ecology and biological composition. Scientific literature has established a link between highly urbanized landscapes and degradation in the aquatic health of non-tidal stream ecosystems.

4.0 CONCLUSION

Based on the analysis of data presented in the preceding section of this report, indicating that DO and chlorophyll *a* concentrations are meeting water quality criteria, and on the results of the Patapsco LNB BSID analysis, MDE concludes that currently the Patapsco LNB watershed is not being impaired by nutrients. (The BSID analysis for the Patapsco LNB indicates inorganic pollutants and flow/sediment related stressors are associated with impacts to biological communities; these findings will be addressed separately.) Barring the receipt of contradictory data, this report will be used to support a revision of the phosphorus listing for the Patapsco LNB watershed, from Category 5 (“waterbody is impaired, does not attain the water quality standard, and a TMDL is required”) to Category 2 (“waterbodies meeting some [in this case nutrients-related] water quality standards, but with insufficient data to assess all impairments”), when MDE proposes the revision of Maryland’s Integrated Report.

Although the waters of the Patapsco LNB do not display signs of eutrophication, the State reserves the right to require future controls if evidence suggests that nutrients from the basin are contributing to downstream water quality problems. In December 2007, EPA approved TMDLs of nitrogen and phosphorus for the Baltimore Harbor. The Patapsco LNB watershed is located upstream of the Baltimore Harbor and drains into the Harbor’s tidal waters. Although the amount of nutrients entering the Patapsco LNB is not causing localized impairments, it is contributing to the eutrophication of the downstream tidal waters of the Harbor. Therefore, the TMDL for the Baltimore Harbor requires nutrient reductions in the Patapsco LNB necessary to meet water quality standards in the Harbor. On the same principle, additional reductions may also be required by the forthcoming Chesapeake Bay TMDL, currently under development and due to be established by EPA by the end of 2010.

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Appendix A – Tabular Water Quality Data

Table A-1: MDE Water Quality Data

Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
BCN0003	3/15/2000	12.1	2.74	2.79	0.027
BCN0003	4/12/2000	11.5	5.23	2.33	0.019
BCN0003	5/10/2000	9.0	7.97	2.48	0.022
BCN0003	8/9/2000	8.6	0.83	2.55	0.056
BCN0003	9/7/2000	10.1	0.54	2.59	0.043
DGW0000	1/17/2007	14.3	0.75	1.40	0.009
DGW0000	2/27/2007	13.4	2.74	2.07	0.030
DGW0000	3/13/2007	13.2	1.25	1.16	0.007
DGW0000	4/24/2007	11.0	1.74	0.90	0.007
DGW0000	5/15/2007	9.3	1.00	1.34	0.012
DGW0000	6/12/2007	8.0	0.75	1.31	0.022
DGW0000	7/17/2007	8.0	1.28	0.80	0.019
DGW0000	8/14/2007	7.2	0.80	0.66	0.026
DGW0000	9/11/2007	7.1	4.76	0.69	0.035
DGW0000	10/10/2007	7.7	1.12	0.35	0.029
DGW0000	11/14/2007	10.9	1.20	0.70	0.010
DGW0000	12/11/2007	12.2	1.50	0.98	0.011
DGW0002	3/15/2000	13.0	2.74	1.17	0.009
DGW0002	4/12/2000	11.7	0.25	1.04	0.006
DGW0002	5/10/2000	8.6	1.99		
DGW0002	8/9/2000	8.4	0.83	1.17	0.034
DGW0002	9/7/2000	9.9	0.15	1.19	0.027
DXC0004	3/15/2000	11.0	1.00	0.87	0.016
DXC0004	4/12/2000	10.0	0.75	0.73	0.016
DXC0004	5/10/2000	7.6	1.00	0.84	0.016
DXC0004	8/9/2000				
DXC0004	9/7/2000	8.6		0.73	0.020
DXC0004	1/17/2007	11.8	0.50	0.99	0.013
DXC0004	2/27/2007	12.1	1.50	1.33	0.039
DXC0004	3/13/2007	11.0	0.75	0.82	0.018
DXC0004	4/24/2007	8.3		0.77	0.021
DXC0004	5/15/2007	8.5	4.73	0.86	0.022
DXC0004	6/12/2007	6.9	0.50	0.88	0.020
DXC0004	7/17/2007	6.3	2.24	0.57	0.018
DXC0004	8/14/2007	5.4	0.75	0.53	0.015
DXC0004	9/11/2007	6.9	1.09	0.73	0.021
DXC0004	10/10/2007	5.9		0.46	0.015
DXC0004	11/14/2007	9.6	1.20	0.74	0.015
DXC0004	12/11/2007	10.9	1.31	0.81	0.018
DXC0025	1/17/2007	11.4	1.00	1.17	0.017
DXC0025	2/27/2007	12.4	2.74	1.21	0.037
DXC0025	3/13/2007	11.5	1.50	0.91	0.015
DXC0025	4/24/2007	8.8	1.74	0.74	0.017
DXC0025	5/15/2007	8.8	3.24	0.92	0.029
DXC0025	6/12/2007	7.3	1.25	1.01	0.038

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
DXC0025	7/17/2007	6.2	3.24	0.75	0.031
DXC0025	8/14/2007	6.2	3.29	0.71	0.024
DXC0025	9/11/2007				
DXC0025	10/10/2007	6.1	0.56	0.84	0.024
DXC0025	11/14/2007	9.9	2.39	1.09	0.023
DXC0025	12/11/2007	11.6	2.43	0.91	0.017
DXC0031	1/17/2007	12.1	0.50	1.09	0.007
DXC0031	2/27/2007	12.3	1.74	1.21	0.025
DXC0031	3/13/2007	11.5	1.50	1.04	0.007
DXC0031	4/24/2007	8.8	1.00	0.88	0.012
DXC0031	5/15/2007	9.2	1.00	1.17	0.022
DXC0031	6/12/2007	7.5	0.75	1.02	0.015
DXC0031	7/17/2007	6.5	0.75	0.75	0.020
DXC0031	8/14/2007	6.1	2.39	0.63	0.021
DXC0031	9/11/2007	6.4	1.50	1.15	0.023
DXC0031	10/10/2007	6.3	0.65	0.57	0.009
DXC0031	11/14/2007	10.0	0.90	0.76	0.014
DXC0031	12/11/2007	11.4	2.62	0.83	0.013
EBH0005	3/15/2000	13.1	1.50	1.63	0.012
EBH0005	4/12/2000	11.5	2.74	1.82	0.031
EBH0005	5/10/2000	9.0	11.11	2.07	0.027
EBH0005	8/9/2000	7.3	1.50	1.62	0.041
EBH0005	9/7/2000	9.1		2.02	0.027
NPA0026	10/13/1999	7.2		0.35	0.018
NPA0026	10/26/1999	8.1	0.45	0.24	0.013
NPA0026	11/16/1999	9.3	0.25	0.21	0.012
NPA0026	11/30/1999	9.8	0.30	0.36	0.019
NPA0026	12/14/1999	10.6	1.00	0.31	0.019
NPA0026	1/11/2000	11.4	1.50	0.38	0.016
NPA0026	1/24/2000	12.3	1.00	0.37	0.008
NPA0026	2/23/2000	11.5	1.50	0.35	0.012
NPA0026	2/29/2000	10.6	2.17	0.31	0.011
NPA0026	3/15/2000	11.2	1.74	0.30	0.010
NPA0026	4/12/2000	12.5	1.25	0.18	0.007
NPA0026	5/10/2000	6.9	0.75	0.43	0.021
NPA0026	5/24/2000	6.7	0.21	0.35	0.018
NPA0026	6/20/2000	6.9		0.52	0.023
NPA0026	8/9/2000	6.1	1.00	0.44	0.027
NPA0026	9/7/2000	7.6	0.41	0.31	0.023
PAT0148	3/15/2000	11.0	2.24	2.10	0.021
PAT0148	4/12/2000	10.8	2.14	1.85	0.021
PAT0148	5/10/2000	7.2	1.25	1.96	0.037
PAT0148	8/9/2000	6.8	1.50	1.76	0.062
PAT0148	9/7/2000	8.7	1.00	1.87	0.060
PAT0148	10/2/2002	7.9	1.99	1.15	0.044
PAT0148	10/22/2002	9.6	0.50	1.73	0.042
PAT0148	11/13/2002	9.6	2.14	1.32	0.067
PAT0148	12/3/2002	12.1		2.29	0.031
PAT0148	12/17/2002	13.4	1.25	2.27	0.044
PAT0148	1/7/2003	12.7	1.25	2.35	0.039
PAT0148	1/22/2003	13.2		3.03	0.021
PAT0148	2/4/2003	12.9	1.74	2.63	0.038

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0148	3/4/2003	13.3	1.00	2.25	0.060
PAT0148	3/18/2003	10.7	1.50	2.22	0.024
PAT0148	3/31/2003	10.7	9.47	1.93	0.047
PAT0148	4/22/2003	9.1	1.92	2.13	0.018
PAT0148	5/6/2003	9.6	6.41	2.17	0.022
PAT0148	5/20/2003	9.3	5.23	2.26	0.058
PAT0148	6/3/2003	8.6	1.71	2.18	0.056
PAT0148	6/17/2003	8.5	1.25	2.41	0.053
PAT0148	6/24/2003	8.7	3.24	2.29	0.064
PAT0148	7/8/2003	7.1	1.50	2.28	0.041
PAT0148	7/22/2003	7.0	1.25	2.31	0.032
PAT0148	8/5/2003	7.0	3.49	2.31	0.043
PAT0148	8/19/2003	8.0		1.94	0.034
PAT0148	8/26/2003	7.0	1.05	2.04	0.028
PAT0148	9/9/2003	7.9	1.74	2.25	0.031
PAT0148	9/23/2003	7.1	4.98	2.33	0.345
PAT0148	10/7/2003	9.4	1.50	2.55	0.031
PAT0148	10/21/2003	9.8	2.06	2.22	0.026
PAT0148	1/17/2007	12.2	1.50	2.32	0.018
PAT0148	2/27/2007	11.8	4.73	2.25	0.042
PAT0148	3/13/2007	11.5	1.25	2.38	0.020
PAT0148	4/24/2007	8.1	2.74	2.13	0.020
PAT0148	5/15/2007	8.5	1.74	2.62	0.021
PAT0148	6/12/2007	8.3	1.00	2.42	0.025
PAT0148	7/17/2007	6.4	0.85	1.37	0.022
PAT0148	8/14/2007	5.2	1.10	1.24	0.036
PAT0148	9/11/2007	4.9	5.23	1.59	0.044
PAT0148	10/10/2007	4.6	0.37	1.60	0.034
PAT0148	11/14/2007	9.8	0.80	1.81	0.019
PAT0148	12/11/2007	11.4	1.50	2.07	0.017
PAT0176	10/13/1999	11.0	0.27	1.76	0.060
PAT0176	10/26/1999	10.5	0.68	1.79	0.015
PAT0176	11/16/1999	10.9	1.50	2.01	0.022
PAT0176	11/30/1999	12.1	1.25		
PAT0176	12/14/1999	12.2	8.97	1.90	0.113
PAT0176	1/11/2000	12.1	3.49	2.81	0.049
PAT0176	1/24/2000	13.5	0.50	3.11	0.016
PAT0176	2/23/2000	13.0	0.75	2.47	0.021
PAT0176	2/29/2000	11.3	3.99	2.95	0.096
PAT0176	3/15/2000	11.9	2.74	2.34	0.018
PAT0176	3/15/2000	11.9	1.99	2.28	0.018
PAT0176	4/12/2000	10.9	2.74	2.11	0.018
PAT0176	4/12/2000	10.9	2.24	2.08	0.016
PAT0176	5/10/2000	8.1	1.00	2.09	0.032
PAT0176	5/10/2000	8.1	1.00	2.05	0.033
PAT0176	5/24/2000	8.8	1.50	2.17	0.060
PAT0176	6/20/2000	8.6		2.23	0.065
PAT0176	8/9/2000	7.5	1.00	2.05	0.055
PAT0176	8/9/2000	7.5	0.50	2.09	0.056
PAT0176	9/7/2000	8.9	1.25	2.22	0.069
PAT0176	9/7/2000	8.9	0.75	2.22	0.068
PAT0176	10/2/2002	8.2	0.25	1.27	0.055

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0176	10/22/2002	10.5		1.98	0.052
PAT0176	11/13/2002	10.2	0.64	1.59	0.061
PAT0176	12/3/2002	13.1		2.57	0.034
PAT0176	12/17/2002	13.4	1.50	2.41	0.049
PAT0176	1/7/2003	13.2	1.50	2.58	0.039
PAT0176	1/22/2003	13.6	0.50	3.50	0.023
PAT0176	2/4/2003	13.7	1.25	3.00	0.025
PAT0176	3/4/2003	13.7	1.25	2.49	0.062
PAT0176	3/18/2003	11.7	2.43	2.34	0.022
PAT0176	3/31/2003	11.0	10.96	2.20	0.033
PAT0176	4/22/2003	9.5	2.35	2.39	0.016
PAT0176	5/6/2003	10.0	6.73	2.40	0.021
PAT0176	5/20/2003	9.8	5.48	2.30	0.051
PAT0176	6/3/2003	8.8	1.50	2.37	0.050
PAT0176	6/17/2003	8.6	1.99	2.40	0.047
PAT0176	6/24/2003	8.9	3.24	2.54	0.054
PAT0176	7/8/2003	8.0	1.31	2.31	0.029
PAT0176	7/22/2003	8.0	1.00	2.49	0.033
PAT0176	8/5/2003	7.6	0.85	2.42	0.038
PAT0176	8/19/2003	8.7	0.75	2.09	0.032
PAT0176	8/26/2003	7.9	1.79	2.17	0.025
PAT0176	9/9/2003	8.3	0.50	2.34	0.030
PAT0176	9/23/2003	8.6	9.97	3.83	0.766
PAT0176	10/7/2003	9.9	1.50	2.59	0.022
PAT0176	10/21/2003	10.1	2.06	2.38	0.024
PAT0176	1/17/2007	12.7	1.00	2.36	0.013
PAT0176	2/27/2007	11.6	5.73	2.35	0.040
PAT0176	3/13/2007	11.9	1.50	2.50	0.020
PAT0176	4/24/2007	7.2	2.99	2.28	0.016
PAT0176	5/15/2007	9.0	1.74	2.61	0.017
PAT0176	6/12/2007	7.5	0.75	2.56	0.025
PAT0176	7/17/2007	7.2	1.92	1.64	0.022
PAT0176	8/14/2007	6.0	1.30	1.29	0.035
PAT0176	9/11/2007	6.8	1.50	1.41	0.030
PAT0176	10/10/2007	6.3	0.65	1.45	0.028
PAT0176	11/14/2007	10.6	0.40	2.16	0.020
PAT0176	12/11/2007	12.3	1.12	2.32	0.011
PAT0222	3/15/2000	12.1	2.74	2.44	0.016
PAT0222	4/12/2000	11.9	1.25	2.10	0.014
PAT0222	5/10/2000	7.9	1.25	2.14	0.032
PAT0222	8/9/2000	7.7	1.28	2.22	0.063
PAT0222	9/7/2000	9.2	0.75	2.34	0.092
PAT0222	10/2/2002	8.3	0.50	1.34	0.071
PAT0222	10/22/2002	10.4	0.50	2.13	0.048
PAT0222	11/13/2002	10.3	0.43	1.71	0.063
PAT0222	12/3/2002	12.8		2.58	0.028
PAT0222	12/17/2002	13.3	0.75	2.41	0.037
PAT0222	1/7/2003	13.3	1.50	2.75	0.041
PAT0222	1/22/2003	13.7	0.50	3.69	0.022
PAT0222	2/4/2003	13.8	1.50	3.09	0.026
PAT0222	3/4/2003	14.3	1.00	2.56	0.063
PAT0222	3/18/2003	10.9	2.80	2.46	0.021

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0222	3/31/2003	10.6	9.97	2.29	0.035
PAT0222	4/22/2003	8.8	2.56		0.016
PAT0222	5/6/2003	10.5	4.27	2.59	0.019
PAT0222	5/20/2003	10.0	4.73	2.36	0.049
PAT0222	6/3/2003	9.1	1.07	2.28	0.047
PAT0222	6/17/2003	8.7	2.24	2.43	0.045
PAT0222	6/24/2003	9.2	2.99	2.37	0.046
PAT0222	7/8/2003	7.9	2.06	2.42	0.030
PAT0222	7/22/2003	7.8	0.75	2.62	0.035
PAT0222	8/5/2003	7.8	0.85	2.54	0.040
PAT0222	8/19/2003	8.7		2.12	0.033
PAT0222	8/26/2003	8.1	1.05	2.29	0.029
PAT0222	9/9/2003	9.2	1.00	2.43	0.028
PAT0222	9/23/2003	8.9	4.98	4.67	1.085
PAT0222	10/7/2003	10.1	1.74	2.70	0.023
PAT0222	10/21/2003	10.2	2.80	2.48	0.025
PAT0222	1/17/2007	12.9	1.25	2.44	0.015
PAT0222	2/27/2007	11.3	4.73	2.49	0.044
PAT0222	3/13/2007	12.0	1.25	2.51	0.018
PAT0222	4/24/2007	6.8	2.99	2.31	0.014
PAT0222	5/15/2007	9.1	1.50	2.80	0.015
PAT0222	6/12/2007	8.2	1.00	2.81	0.026
PAT0222	7/17/2007	7.3	1.50	1.84	0.031
PAT0222	8/14/2007	6.3		1.49	0.051
PAT0222	9/11/2007	6.9	1.12	1.60	0.039
PAT0222	10/10/2007	7.0	0.56	1.77	0.032
PAT0222	11/14/2007	10.8	0.40	2.57	0.021
PAT0222	12/11/2007	12.6	1.12	2.52	0.017
PAT0285	1/11/2000	12.6	2.99	2.71	0.056
PAT0285	1/24/2000	14.8	0.75	3.49	0.017
PAT0285	2/23/2000	13.0	0.75	2.82	0.021
PAT0285	2/29/2000	12.0	3.49	2.67	0.081
PAT0285	3/15/2000	12.0	1.74	2.59	0.019
PAT0285	4/12/2000	11.3	1.00	2.32	0.016
PAT0285	5/10/2000	7.4	0.50	2.45	0.032
PAT0285	5/24/2000	9.3	1.07	2.60	0.053
PAT0285	6/20/2000	9.0		2.66	0.066
PAT0285	8/9/2000	7.8	0.64	2.37	0.075
PAT0285	9/7/2000	8.7	0.50	2.30	0.080
PAT0285	10/2/2002	7.3	0.50	1.61	0.078
PAT0285	10/22/2002	10.0	0.50	2.36	0.047
PAT0285	11/13/2002	10.1	0.85	1.79	0.061
PAT0285	12/3/2002	13.2		2.88	0.030
PAT0285	12/17/2002	13.4	1.25	2.63	0.039
PAT0285	1/7/2003	13.7	1.74	2.87	0.045
PAT0285	1/7/2003	13.3			
PAT0285	1/22/2003	13.2		3.71	0.028
PAT0285	1/22/2003	13.4			
PAT0285	2/4/2003	13.7	1.25	3.20	0.035
PAT0285	2/4/2003	13.5			
PAT0285	3/4/2003	14.1	1.50	2.60	0.051
PAT0285	3/4/2003	13.9			

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0285	3/18/2003	11.7	3.36	2.68	0.023
PAT0285	3/18/2003	12.1			
PAT0285	3/31/2003	12.5	8.72	2.29	0.033
PAT0285	4/22/2003	11.0	2.99	2.62	0.015
PAT0285	4/22/2003	11.0			
PAT0285	5/6/2003	10.8	3.63	2.78	0.019
PAT0285	5/6/2003	10.3			
PAT0285	5/20/2003	9.8	3.99	2.38	0.043
PAT0285	5/20/2003	10.2			
PAT0285	6/3/2003	9.0	1.07	2.46	0.043
PAT0285	6/3/2003	9.0			
PAT0285	6/17/2003	8.7	2.49	2.48	0.042
PAT0285	6/17/2003	8.7			
PAT0285	6/24/2003	9.4	3.24	2.42	0.045
PAT0285	7/8/2003	8.1	1.31	2.47	0.034
PAT0285	7/8/2003	8.0			
PAT0285	7/22/2003	7.8	1.00	2.74	0.037
PAT0285	7/22/2003	7.8			
PAT0285	8/5/2003	7.7	1.07	2.83	0.043
PAT0285	8/5/2003	7.8			
PAT0285	8/19/2003	8.4	0.75	2.31	0.032
PAT0285	8/19/2003	8.3			
PAT0285	8/26/2003	7.8	1.64	2.46	0.033
PAT0285	9/9/2003	8.5	1.00	2.55	0.028
PAT0285	9/9/2003	8.7			
PAT0285	9/23/2003	8.5	7.48	4.87	1.184
PAT0285	9/23/2003	8.5			
PAT0285	9/23/2003	8.5			
PAT0285	10/7/2003	10.2	2.24	2.76	0.025
PAT0285	10/7/2003	10.0			
PAT0285	10/21/2003	10.0	2.62	2.54	0.025
PAT0285	10/21/2003	10.0			
PAT0285	11/6/2003	9.4			
PAT0285	11/13/2003	10.2			
PAT0285	11/20/2003	10.8			
PAT0285	11/20/2003	10.8			
PAT0285	12/4/2003	12.9			
PAT0285	12/11/2003	12.6			
PAT0285	12/11/2003	12.6			
PAT0285	12/18/2003	13.0			
PAT0285	1/8/2004	13.5			
PAT0285	1/23/2004	15.1			
PAT0285	1/29/2004	14.5			
PAT0285	2/10/2004	12.6			
PAT0285	2/20/2004	12.9			
PAT0285	2/25/2004	13.1			
PAT0285	3/4/2004	12.0			
PAT0285	3/8/2004	12.1			
PAT0285	3/18/2004	13.1			
PAT0285	4/8/2004	10.9			
PAT0285	4/13/2004	11.3			
PAT0285	4/13/2004	11.3			

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0285	4/22/2004	9.4			
PAT0285	5/13/2004	10.2			
PAT0285	5/19/2004	8.4			
PAT0285	5/27/2004	7.9			
PAT0285	6/10/2004	8.3			
PAT0285	6/24/2004	8.7			
PAT0285	6/28/2004	8.5			
PAT0285	7/9/2004	8.4			
PAT0285	7/14/2004	7.5			
PAT0285	7/22/2004	8.8			
PAT0285	8/12/2004	8.2			
PAT0285	8/17/2004	8.3			
PAT0285	8/26/2004	7.5			
PAT0285	9/10/2004	8.2			
PAT0285	9/23/2004	9.0			
PAT0285	9/29/2004	8.7			
PAT0285	9/29/2004	8.7			
PAT0285	10/7/2004	9.9			
PAT0285	10/21/2004	10.3			
PAT0285	10/26/2004	10.5			
PAT0285	11/10/2004	12.0			
PAT0285	11/22/2004	11.1			
PAT0285	12/8/2004	11.6			
PAT0285	12/15/2004	13.5			
PAT0285	12/20/2004	13.4			
PAT0285	1/5/2005	11.4			
PAT0285	1/13/2005	12.2			
PAT0285	1/20/2005	14.2			
PAT0285	2/2/2005	14.2			
PAT0285	2/14/2005	12.9			
PAT0285	2/22/2005	13.2			
PAT0285	3/16/2005	13.3			
PAT0285	4/14/2005	11.2			
PAT0285	5/5/2005	11.1			
PAT0285	5/19/2005	9.9			
PAT0285	6/8/2005	8.5			
PAT0285	6/23/2005	8.5			
PAT0285	7/13/2005	8.0			
PAT0285	7/26/2005	7.7			
PAT0285	8/4/2005	8.1			
PAT0285	8/18/2005	9.3			
PAT0285	9/15/2005	7.7			
PAT0285	9/22/2005	8.1			
PAT0285	10/18/2005	9.8			
PAT0285	10/28/2005	11.8			
PAT0285	11/2/2005	11.4			
PAT0285	11/18/2005	12.4			
PAT0285	12/1/2005	11.0			
PAT0285	12/15/2005	14.3			
PAT0295	1/17/2007	12.4	1.25	2.62	0.026
PAT0295	2/27/2007	12.9	3.74	2.70	0.045
PAT0295	3/13/2007	12.3	1.50	2.69	0.021

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0295	4/24/2007	8.1	2.74	2.56	0.015
PAT0295	5/15/2007	8.9	1.50	2.90	0.021
PAT0295	6/12/2007	8.2	0.50	3.23	0.032
PAT0295	7/17/2007	6.9	0.64	2.32	0.035
PAT0295	8/14/2007	5.5	0.70	1.92	0.087
PAT0295	9/11/2007	5.3	0.93	2.31	0.056
PAT0295	10/10/2007	6.1	0.37	2.22	0.037
PAT0295	11/14/2007	10.6	0.20	3.01	0.023
PAT0295	12/11/2007	12.5	1.25	2.94	0.019
PAT0347	10/13/1999	10.1	0.75	2.42	0.065
PAT0347	10/26/1999	10.8	0.60	2.59	0.027
PAT0347	11/16/1999	11.1	6.98	1.94	0.031
PAT0347	11/30/1999	11.8	1.12	2.56	0.028
PAT0347	12/14/1999	11.8	4.49	2.70	0.065
PAT0347	1/11/2000	12.5	3.24	3.09	0.070
PAT0347	1/24/2000	14.5	0.60	3.68	0.017
PAT0347	2/23/2000	12.9	1.74	3.01	0.026
PAT0347	2/29/2000	12.1	2.74	2.76	0.050
PAT0347	3/15/2000	13.3	2.99	3.10	0.022
PAT0347	4/12/2000	11.8	1.99	2.66	0.015
PAT0347	5/10/2000	8.6	2.49	2.72	0.028
PAT0347	5/24/2000	9.0	2.56	2.78	0.056
PAT0347	6/20/2000	9.0		2.80	0.061
PAT0347	8/9/2000	7.4	0.75	2.47	0.092
PAT0347	9/7/2000	9.1	1.25	2.70	0.077
PAT0347	10/2/2002	7.9	0.50	1.94	0.102
PAT0347	10/22/2002	10.4	0.56	2.98	0.042
PAT0347	11/13/2002	10.1	2.78	2.17	0.070
PAT0347	12/3/2002	13.7	0.50	3.13	0.030
PAT0347	12/17/2002	13.4	1.25		
PAT0347	1/7/2003	13.4	1.50	3.06	0.059
PAT0347	1/22/2003	13.6		3.98	0.030
PAT0347	2/4/2003	12.8	2.99	3.72	0.036
PAT0347	3/4/2003	14.1	1.00	2.97	0.050
PAT0347	3/18/2003	11.8	2.43	2.96	0.027
PAT0347	3/31/2003	12.6	9.72	2.55	0.037
PAT0347	4/22/2003	9.4	4.06	3.00	0.016
PAT0347	5/6/2003	10.8	4.06	3.20	0.023
PAT0347	5/20/2003	9.8	3.74	2.47	0.038
PAT0347	6/3/2003	9.1	1.28	2.45	0.040
PAT0347	6/17/2003	8.6	2.99	2.60	0.036
PAT0347	6/24/2003	9.1	3.49	2.60	0.040
PAT0347	7/8/2003	8.0	1.12	2.75	0.048
PAT0347	7/22/2003	7.7	1.00	3.04	0.037
PAT0347	8/5/2003	7.8	0.85	3.15	0.035
PAT0347	8/19/2003	8.4	0.75	2.49	0.028
PAT0347	8/26/2003	8.0	1.94	3.06	0.041
PAT0347	9/9/2003	8.8		2.82	0.032
PAT0347	9/23/2003	8.2	5.98	4.63	1.099
PAT0347	10/7/2003	9.9	2.49	3.05	0.032
PAT0347	10/21/2003	10.1	2.99	2.79	0.024
SXR0002	3/15/2000	11.3	1.74	1.04	0.017

Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
SXR0002	4/12/2000	10.4	0.50	1.07	0.018
SXR0002	5/10/2000	7.7	0.75	1.18	0.025
SXR0002	8/9/2000				
SXR0002	9/7/2000	9.2	0.25	1.09	0.032
SXR0002	1/17/2007	12.5	0.50	1.32	0.027
SXR0002	2/27/2007	12.0		1.26	0.033
SXR0002	3/13/2007	10.9		1.16	0.013
SXR0002	4/24/2007	7.5	0.75	1.12	0.015
SXR0002	5/15/2007	8.7	1.25	1.33	0.020
SXR0002	6/12/2007	7.5	0.50	1.34	0.022
SXR0002	7/17/2007	7.4		1.24	0.018
SXR0002	8/14/2007	6.6	0.60	1.00	0.014
SXR0002	9/11/2007	7.2	1.09	1.34	0.034
SXR0002	10/10/2007	6.5	0.56	1.59	0.019
SXR0002	11/14/2007	9.8		0.96	0.010
SXR0002	12/11/2007	10.9		0.87	0.016
ZFI0000	1/17/2007	12.4	0.50	0.83	0.008
ZFI0000	2/27/2007	11.5	1.25	1.17	0.022
ZFI0000	3/13/2007	11.5		0.77	0.005
ZFI0000	4/24/2007	10.7	1.50	0.51	0.011
ZFI0000	5/15/2007	9.1	2.24	0.82	0.015
ZFI0000	6/12/2007	7.6	1.74	0.78	0.016
ZFI0000	7/17/2007	7.2	9.40	0.47	0.015
ZFI0000	8/14/2007	5.7	1.05	0.45	0.012
ZFI0000	9/11/2007				
ZFI0000	10/10/2007	6.7	2.99	0.65	0.012
ZFI0000	11/14/2007	9.7		0.52	0.008
ZFI0000	12/11/2007	11.2	0.75	0.64	0.016

Table A-2: DNR Water Quality Data

Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0176	12/1/1998	10.8	2.32		0.022
PAT0176	1/5/1999	13.7	2.99		0.270
PAT0176	2/2/1999	12.3	5.98		0.081
PAT0176	3/9/1999	13.4	2.69		0.034
PAT0176	4/6/1999	10.2	4.19		0.027
PAT0176	5/5/1999	8.4	1.87		0.043
PAT0176	6/16/1999	7.7	1.05		0.070
PAT0176	7/12/1999	6.5	2.09		0.078
PAT0176	8/25/1999	7.5	1.50		0.090
PAT0176	9/15/1999	7.4	0.45		0.033
PAT0176	10/12/1999	9.3	0.90		0.115
PAT0176	11/16/1999	10.5	1.00		0.020
PAT0176	12/14/1999	11.7	6.48		0.105
PAT0176	1/11/2000	12.2	3.29		0.062
PAT0176	2/8/2000	13.1	0.60		0.014
PAT0176	3/6/2000	11.2	1.79		0.040
PAT0176	4/5/2000	10.0	2.84		0.030
PAT0176	5/3/2000	9.2	1.35		0.032
PAT0176	6/7/2000	8.7	0.85		0.024
PAT0176	7/26/2000	7.7	0.75		0.118
PAT0176	8/14/2000	7.3	2.99		0.041
PAT0176	9/6/2000	8.3	1.20		0.094
PAT0176	10/4/2000	9.2	0.40		0.034
PAT0176	11/1/2000	11.0	1.38		0.024
PAT0176	12/5/2000	13.5	1.64		0.013
PAT0176	1/23/2001	14.2	1.05		0.057
PAT0176	2/20/2001	13.5	1.79		0.061
PAT0176	3/26/2001	12.2	2.33		0.030
PAT0176	4/30/2001	9.5	5.05		0.036
PAT0176	5/15/2001	8.4	3.29		0.055
PAT0176	6/6/2001	8.6	1.50		0.046
PAT0176	7/31/2001	7.6	1.68		0.056
PAT0176	8/28/2001	9.2	2.69		0.030
PAT0176	9/24/2001	7.6	0.75		0.041
PAT0176	10/9/2001	10.5	3.59		0.031
PAT0176	11/6/2001	10.1	1.20		0.014
PAT0176	12/4/2001	11.7	0.60		0.022
PAT0176	1/14/2002	12.4	1.05		0.035
PAT0176	2/5/2002	13.1	1.20		0.034
PAT0176	3/5/2002	13.1	2.19		0.039
PAT0176	4/2/2002	9.9			0.019
PAT0176	5/13/2002	8.0	1.31		0.072
PAT0176	6/5/2002	6.9	0.70		0.104
PAT0176	7/1/2002	6.4	0.90		0.075
PAT0176	8/21/2002	5.7	1.17		0.047
PAT0176	9/3/2002	8.0	0.45		0.070
PAT0176	10/1/2002	8.2	0.37		0.080
PAT0176	11/6/2002	10.8	1.20		0.071
PAT0176	12/2/2002	13.8	0.30		0.044
PAT0176	1/7/2003	13.3	1.50		0.049

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0176	2/3/2003	13.4	0.90		0.027
PAT0176	3/3/2003	13.4	4.19		0.122
PAT0176	4/1/2003	12.3			0.039
PAT0176	5/13/2003	9.4	3.89		0.053
PAT0176	6/10/2003	9.2	1.92		0.082
PAT0176	7/15/2003	8.0	1.50		0.062
PAT0176	8/11/2003	7.6	0.90		0.082
PAT0176	9/3/2003	7.7	5.57		0.033
PAT0176	10/15/2003	9.9	20.93		0.466
PAT0176	11/3/2003	9.7	3.42		0.045
PAT0176	12/8/2003	13.2	1.94		0.041
PAT0176	1/6/2004	12.1	3.44		0.043
PAT0176	2/10/2004	12.9	7.03		0.073
PAT0176	3/9/2004	12.3	7.18		0.038
PAT0176	4/6/2004	12.1			0.024
PAT0176	5/3/2004	9.7	7.18		0.051
PAT0176	6/14/2004	8.7			0.054
PAT0176	7/12/2004	7.4	1.79		0.077
PAT0176	8/3/2004	7.3	3.89		0.121
PAT0176	9/8/2004	7.2	0.90		0.053
PAT0176	10/5/2004	9.4	0.60		0.047
PAT0176	11/4/2004	9.1	1.27		0.014
PAT0176	12/2/2004	11.6	2.62		0.046
PAT0176	1/19/2005	13.6	1.64		0.053
PAT0176	2/7/2005	13.4	1.34		0.025
PAT0176	3/7/2005	12.6	3.14		0.022
PAT0176	4/4/2005	12.5	3.59		0.058
PAT0176	5/2/2005	9.9	4.39		0.018
PAT0176	6/1/2005	8.4	1.20		0.032
PAT0176	7/5/2005	7.9	1.35		
PAT0176	8/1/2005	7.7		1.92	0.025
PAT0176	9/8/2005	8.1		2.50	0.027
PAT0176	10/3/2005	9.0	0.70	1.94	0.027
PAT0176	11/1/2005	11.3	0.75	2.66	0.032
PAT0176	12/6/2005	13.6	1.50	2.42	0.021
PAT0176	1/3/2006	12.5	20.33	2.29	0.095
PAT0176	2/2/2006	12.5	4.04	2.17	0.018
PAT0176	3/1/2006	13.0	4.49	2.70	0.024
PAT0176	4/11/2006	10.7	2.69	2.29	0.029
PAT0176	5/1/2006	10.3	1.12	2.23	0.022
PAT0176	6/29/2006	8.1	1.20	2.18	0.074
PAT0176	7/6/2006	8.4		1.99	0.143
PAT0176	8/2/2006	6.8	0.87	2.23	0.040
PAT0176	9/6/2006	8.6	2.24	1.97	0.083
PAT0176	10/11/2006	9.2	0.90	1.82	0.029
PAT0176	11/2/2006	9.6	0.75	1.94	0.037
PAT0176	12/5/2006	13.0	0.75	2.27	0.018
PAT0176	1/4/2007	12.4	1.71	2.06	0.021
PAT0176	2/6/2007	13.2	1.20	2.89	0.034
PAT0176	3/5/2007	14.1	3.29	2.30	0.038
PAT0176	4/3/2007	10.9	5.98	2.19	0.013
PAT0176	5/3/2007	9.4	2.39	2.18	0.020

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0176	6/12/2007	7.7	0.85	2.41	0.020
PAT0285	12/1/1998	10.9	2.39		0.029
PAT0285	1/5/1999	13.6	2.24		0.222
PAT0285	3/9/1999	14.0	1.89		0.021
PAT0285	4/6/1999	10.1	1.65		0.037
PAT0285	5/5/1999	8.2	1.00		0.040
PAT0285	6/16/1999	7.2	0.90		0.100
PAT0285	7/12/1999	5.6	1.65		0.073
PAT0285	8/25/1999	7.0	1.50		0.096
PAT0285	9/15/1999	6.9	0.90		0.048
PAT0285	10/12/1999	9.1	0.45		0.083
PAT0285	11/16/1999	11.0	1.70		0.036
PAT0285	12/14/1999	11.5	10.47		0.120
PAT0285	1/11/2000	11.8	2.39		0.064
PAT0285	2/8/2000	13.1	0.60		0.026
PAT0285	3/6/2000	11.9	2.37		0.034
PAT0285	4/5/2000	10.1	1.79		0.041
PAT0285	5/3/2000	9.3	1.20		0.028
PAT0285	6/7/2000	8.8	0.75		0.062
PAT0285	7/26/2000	7.8	1.50		0.112
PAT0285	8/14/2000	7.4	1.20		0.051
PAT0285	9/6/2000	8.2	0.75		0.086
PAT0285	10/4/2000	9.5	0.40		0.043
PAT0285	11/1/2000	11.2	0.84		0.023
PAT0285	12/5/2000	13.4	1.65		0.015
PAT0285	1/23/2001	14.3	1.50		0.057
PAT0285	2/20/2001	13.3	1.94		0.046
PAT0285	3/26/2001	12.4	2.99		0.025
PAT0285	4/30/2001	10.0	2.06		0.036
PAT0285	5/15/2001	8.5	1.79		0.066
PAT0285	6/6/2001	8.9	1.50		0.050
PAT0285	7/31/2001	7.7	1.35		0.062
PAT0285	8/28/2001	8.8	1.50		0.042
PAT0285	9/24/2001	7.2	0.67		0.046
PAT0285	10/9/2001	10.3	3.18		0.035
PAT0285	11/6/2001	10.0	0.90		0.022
PAT0285	12/4/2001	11.6	1.00		0.024
PAT0285	1/14/2002	11.9	1.50		0.031
PAT0285	2/5/2002	13.3	1.20		0.038
PAT0285	3/5/2002	12.9	2.29		0.034
PAT0285	4/2/2002	10.0	2.19		0.017
PAT0285	5/13/2002	8.2	1.64		0.060
PAT0285	6/5/2002	6.3	0.60		0.076
PAT0285	7/1/2002	5.0	0.70		0.065
PAT0285	8/21/2002	5.3	0.45		0.070
PAT0285	9/3/2002	7.4	0.37		0.072
PAT0285	10/1/2002	7.4	0.56		0.088
PAT0285	11/6/2002	10.8	0.60		0.042
PAT0285	12/2/2002	13.2	0.45		0.035
PAT0285	1/7/2003	13.1	1.94		0.048
PAT0285	2/3/2003	12.8	1.94		0.036
PAT0285	3/3/2003	13.2	4.49		0.146

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Station	Sampling Date	DO (mg/l)	Chlorophyll <i>a</i> (µg/l)	TN (mg/l)	TP (mg/l)
PAT0285	4/1/2003	12.4	8.37		0.032
PAT0285	5/13/2003	9.4	3.09		0.044
PAT0285	6/10/2003	9.2	1.87		0.060
PAT0285	7/15/2003	8.1	1.35		0.048
PAT0285	8/11/2003	7.8	0.90		0.064
PAT0285	9/3/2003	7.9	5.68		0.040
PAT0285	10/15/2003	9.6	32.89		0.581
PAT0285	11/3/2003	10.0	4.15		0.030
PAT0285	12/8/2003	12.9	1.99		0.029
PAT0285	1/6/2004	12.0	4.49		0.032
PAT0285	2/10/2004	13.0	6.88		0.035
PAT0285	3/9/2004	12.2	6.30		0.023
PAT0285	4/6/2004	12.3			0.021
PAT0285	5/3/2004	9.4	11.36		0.044
PAT0285	6/14/2004	8.4	1.99		0.048
PAT0285	7/12/2004	7.6	1.20		0.074
PAT0285	8/3/2004	7.4	4.19		0.064
PAT0285	9/8/2004	7.5	0.30		0.038
PAT0285	10/5/2004	9.6	0.90		0.041
PAT0285	11/4/2004	9.9	1.25		0.028
PAT0285	12/2/2004	11.3	3.36		0.043
PAT0285	1/19/2005	13.4	1.50		0.063
PAT0285	2/7/2005	13.2	1.50		0.024
PAT0285	3/7/2005	13.3	5.77		0.017
PAT0285	4/4/2005	12.3	2.39		0.034
PAT0285	5/2/2005	10.3	2.54		0.017
PAT0285	6/1/2005	8.8	0.80		0.027
PAT0285	7/5/2005	8.1	0.75		
PAT0285	8/1/2005	7.7		2.44	0.035
PAT0285	9/8/2005	8.6	0.60	3.00	0.073
PAT0285	10/3/2005	9.0	0.30	2.65	0.050
PAT0285	11/1/2005	11.2	0.75	2.90	0.029
PAT0285	12/6/2005	13.8	0.93	2.87	0.021
PAT0285	1/3/2006	12.1	26.91	2.82	0.106
PAT0285	2/2/2006	12.5	3.74	2.44	0.015
PAT0285	3/1/2006	13.2	3.42	2.78	0.025
PAT0285	4/11/2006	10.9	1.79	2.47	0.039
PAT0285	5/1/2006	10.5	0.43	2.51	0.020
PAT0285	6/29/2006	8.1	1.50	2.38	0.052
PAT0285	7/6/2006	8.0	2.99	2.36	0.095
PAT0285	8/2/2006	6.9	0.50	2.72	0.036
PAT0285	9/6/2006	8.8	1.00	2.42	0.081
PAT0285	10/11/2006	9.0	0.60	2.28	0.034
PAT0285	11/2/2006	9.8	0.60	2.43	0.036
PAT0285	12/5/2006	12.9	0.60	2.35	0.017
PAT0285	1/4/2007	12.5	1.92	2.16	0.020
PAT0285	2/6/2007	13.9	2.54	3.15	0.015
PAT0285	3/5/2007	12.1	2.24	2.22	0.030
PAT0285	4/3/2007	11.5	4.30	2.26	0.015
PAT0285	5/3/2007	9.7	1.79	2.23	0.014
PAT0285	6/12/2007	7.6	0.66	2.94	0.024

Table A-3: MBSS Water Quality Data

Station	Stream	Date	DO (mg/l)	TN (mg/l)	TP (mg/l)
PATL-109-R-2000	Falls Run	3/7/2000		2.02	0.284
PATL-118-R-2000	Patapsco River UT2	3/7/2000		3.98	0.013
PATL-124-R-2000	Patapsco River UT2 UT1	3/7/2000		2.52	0.018
PATL-105-R-2000	Patapsco River UT3	3/8/2000		1.62	0.015
PATL-116-R-2000	Patapsco River UT4	3/8/2000		1.07	0.013
PATL-119-R-2000	Soapstone Branch UT1	3/8/2000		1.40	0.011
PATL-127-R-2000	Patapsco River UT4	3/8/2000		0.71	0.006
PATL-207-R-2000	Tiber Run	3/8/2000		1.47	0.015
PATL-103-R-2000	Deep Run UT1 UT2	3/9/2000		0.58	0.006
PATL-111-R-2000	Deep Run UT1 UT2	3/9/2000		0.50	0.008
PATL-114-R-2000	Deep Run	3/9/2000		1.67	0.012
PATL-222-R-2000	Deep Run UT2 UT2	3/9/2000		0.35	0.007
PATL-202-R-2000	Stony Run	3/13/2000		0.83	0.016
PATL-106-R-2000	Deep Run UT2	3/15/2000		3.18	0.005
PATL-317-R-2000	Deep Run	3/15/2000		0.85	0.008
PATL-111-R-2000	Deep Run UT1 UT2	6/22/2000	6.2		
PATL-116-R-2000	Patapsco River UT4	6/22/2000	8.0		
PATL-127-R-2000	Patapsco River UT4	6/22/2000	8.7		
PATL-207-R-2000	Tiber Run	6/22/2000	8.6		
PATL-103-R-2000	Deep Run UT1 UT2	6/29/2000	7.3		
PATL-222-R-2000	Deep Run UT2 UT2	6/29/2000	7.4		
PATL-106-R-2000	Deep Run UT2	7/6/2000	6.3		
PATL-114-R-2000	Deep Run	7/6/2000	7.8		
PATL-317-R-2000	Deep Run	7/6/2000	7.6		
PATL-105-R-2000	Patapsco River UT3	7/10/2000	6.4		
PATL-119-R-2000	Soapstone Branch UT1	7/10/2000	8.4		
PATL-109-R-2000	Falls Run	7/12/2000	8.7		
PATL-124-R-2000	Patapsco River UT2 UT1	7/12/2000	9.0		
PATL-194-E-2004	Soapstone Branch UT1	4/22/2004		1.81	0.011
PATL-194-E-2004	Soapstone Branch UT1	8/30/2004	8.0		