Water Quality Analysis of Eutrophication for the Evitts Creek Basin in Allegany County, Maryland

FINAL

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List of Abbreviations

BIBI	Benthic Index of Biotic Integrity
BSID	Biological Stressor Identification
CWA	Clean Water Act
DNR	Department of Natural Resources
DO	Dissolved Oxygen
EPA	United States Environmental Protection Agency
FIBI	Fish Index of Biotic Integrity
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
mg/l	Milligrams Per Liter
NPDES	National Pollution Discharge Elimination System
RESAC	Regional Earth Science Applications Center
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSI	Trophic State Index
USGS	United States Geological Survey
WQA	Water Quality Analysis
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. For each WQLS listed in the *Integrated Report of Surface Water Quality in Maryland* (*Integrated Report*) (MDE 2008a), 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 (CFR 2009).

The Evitts Creek watershed (basin code 02141002) (2008 *Integrated Report* Assessment Unit ID: MD-02141002) was identified in Maryland's 2008 *Integrated Report* as impaired by nutrients (1996 listing, Lake Habeeb – 1998 listing), sediment (1996 listing), pH (1996 listing, Rocky Gap Run – 2006 listing), and impacts to biological communities (2006 listing) (MDE 2008a). A Water Quality Analysis (WQA) for low pH was completed in 2005 to address the 1996 listing. A TMDL for nutrients to address the 1998 Lake Habeeb listing was completed in 1999, and a TMDL for sediments was completed in 2006. The 1996 nutrients listing was refined in the 2008 *Integrated Report* by identifying phosphorus as the specific impairing substance. Consequently, for the purpose of this report the terms nutrients and phosphorus will be used interchangeably. The listings for impacts to biological communities and the 2006 Rocky Gap Run pH listing will be addressed separately at a future date.

A data solicitation for information pertaining to pollutants, including nutrients, in the Evitts Creek basin was conducted by Maryland Department of the Environment (MDE) in September 2005, and all readily available data from the past five years have been considered. Currently, Maryland's water quality standards do not contain specific numeric criteria for nutrients. 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 Evitts Creek watershed (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 Evitts Creek watershed indicates inorganic pollutants and flow/sediment stressors are associated with impacts to biological communities; these findings will be addressed separately. The BSID analysis for the Evitts Creek watershed did not identify any nutrient stressors present and/or nutrient stressors showing a significant association with degraded biological conditions (MDE 2009b). The results of the BSID study, combined with the analysis of recent water quality data presented in this report, indicate that the Evitts Creek watershed is not being impaired by nutrients.

This analysis supports the conclusion that a TMDL for nutrients is not necessary to achieve water quality standards in the Evitts Creek watershed. Although the waters of the Evitts Creek

watershed do not display signs of eutrophication, the State reserves the right to require future controls in the watershed if evidence suggests that nutrients from the basin are contributing to downstream water quality problems. For instance, reductions may be required by the forthcoming Chesapeake Bay TMDL, which is currently under development and scheduled to be completed by the EPA at the end of 2010.

Barring the receipt of contradictory data, this report will be used to support a revision of the nutrients (i.e., phosphorus) listing for the Evitts Creek 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. For each WQLS listed in the *Integrated Report of Surface Water Quality in Maryland* (*Integrated Report*) (MDE 2008a), 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 (CFR 2009).

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 likely scenarios obviating 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 Evitts Creek watershed (basin code 02141002) (2008 *Integrated Report* Assessment Unit ID: MD-02141002) was identified in Maryland's 2008 *Integrated Report* as impaired by nutrients (1996 listing, Lake Habeeb – 1998 listing), sediment (1996 listing), pH (1996 listing, Rocky Gap Run – 2006 listing), and impacts to biological communities (2006 listing) (MDE 2008a). A Water Quality Analysis (WQA) for low pH was completed in 2005 to address the 1996 listing. A TMDL for nutrients to address the 1998 Lake Habeeb listing was completed in 1999, and a TMDL for sediments was completed in 2006. The 1996 nutrients listing was refined in the 2008 *Integrated Report* by identifying phosphorus as the specific impairing substance. Consequently, for the purpose of this report the terms nutrients and phosphorus will be used interchangeably. The listings for impacts to biological communities and the 2006 Rocky Gap Run pH listing 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 Evitts Creek watershed when Maryland Department of the Environment (MDE) proposes the revision of the State's *Integrated Report*. The remainder of this report lays out the general setting of the Evitts Creek watershed area and presents a discussion of the water quality characteristics in the basin in terms of the existing water quality standards relating to nutrients. This analysis supports the conclusion that the waters of the Evitts Creek watershed do not display signs of eutrophication or nutrient over-enrichment.

2.0 GENERAL SETTING

Location

The Evitts Creek watershed is located in the North Branch Potomac River Sub-basin of the Chesapeake Bay watershed (see Figures 1 and 2). The watershed area covers 19,600 acres in Allegany County, Maryland and 39,800 acres in Bedford County, Pennsylvania. The watershed drains from Bedford County, Pennsylvania, in a southwesterly direction into Allegany County, Maryland, where it empties into the North Branch Potomac River just southeast of Cumberland, Maryland. Due to the steep terrain, geologic structure, and rock units, the drainage patterns of the sub-watersheds have headwaters on steep slopes (ACPD 2007). Additionally, there are no "high quality", or Tier II, stream segments (Benthic Index of Biotic Integrity (BIB)/Fish Index of Biotic Integrity (FIBI) aquatic health scores > 4 (scale 1 – 5)) located within the watershed requiring the implementation of Maryland's antidegradation policy. Lastly, the total population in the Evitts Creek watershed is approximately 18,000 (US Census Bureau 2000).

Geology/Soils

The Evitts Creek watershed lies within the Ridge and Valley Province of Western Maryland, between South Mountain in Washington County and Dans Mountain in western Allegany County. Two distinct topographic and geologic zones separate the Province: the Great Valley (Hagerstown Valley), a wide, flat, and open valley formed on Cambrian and Ordovician limestone, dolomite, and alluvial fan deposits alongside the bordering mountains; and the Allegheny Ridge, which is described as having erosion resistant sandstone in the northeast-southwest direction. The surface geology is characterized by folded and faulted sedimentary rocks, layered limestone and shale, and mountainous soils composed of clay, clay loams, and sandy and stony loams (DNR 2009; MGS 2009; and MDE 2000).

The soils in the watershed are in the Elliber-Dekalb-Opequon Association. The Elliber soils are on both the top and sides of the ridges and are deep over cherty limestone. They also contain large quantities of chert fragments. The Dekalb soils are moderately deep over sandstone and are mostly very stony. The Opequon soils are generally on the sides of the limestone ridges (USDA 1977).

Land Use

The 2002 Maryland Department of Planning (MDP) land use/land cover data and the Regional Earth Science Application Center (RESAC) land use/land cover data show that the Evitts Creek watershed MDP data applied for the Maryland watershed characterization and RESAC for the Pennsylvania watershed characterization) is comprised primarily of forest (see Figure 3). The land use distribution for the entire watershed (i.e., Maryland and Pennsylvania portions) is approximately 78% forest; 10% agricultural; 8% urban; and 4% pasture (MDP 2002; RESAC 2000). The land use distribution for the Maryland portion of the watershed is 68% forest; 18% urban; 7% agricultural; and 7% pasture (MDP 2002).

Point Sources

There are a total of two municipal point source facilities with permits to discharge in the Evitts Creek watershed. Of these two facilities, neither is regulated by a National Pollution Discharge Elimination System (NPDES) permit for the discharge of nutrients.

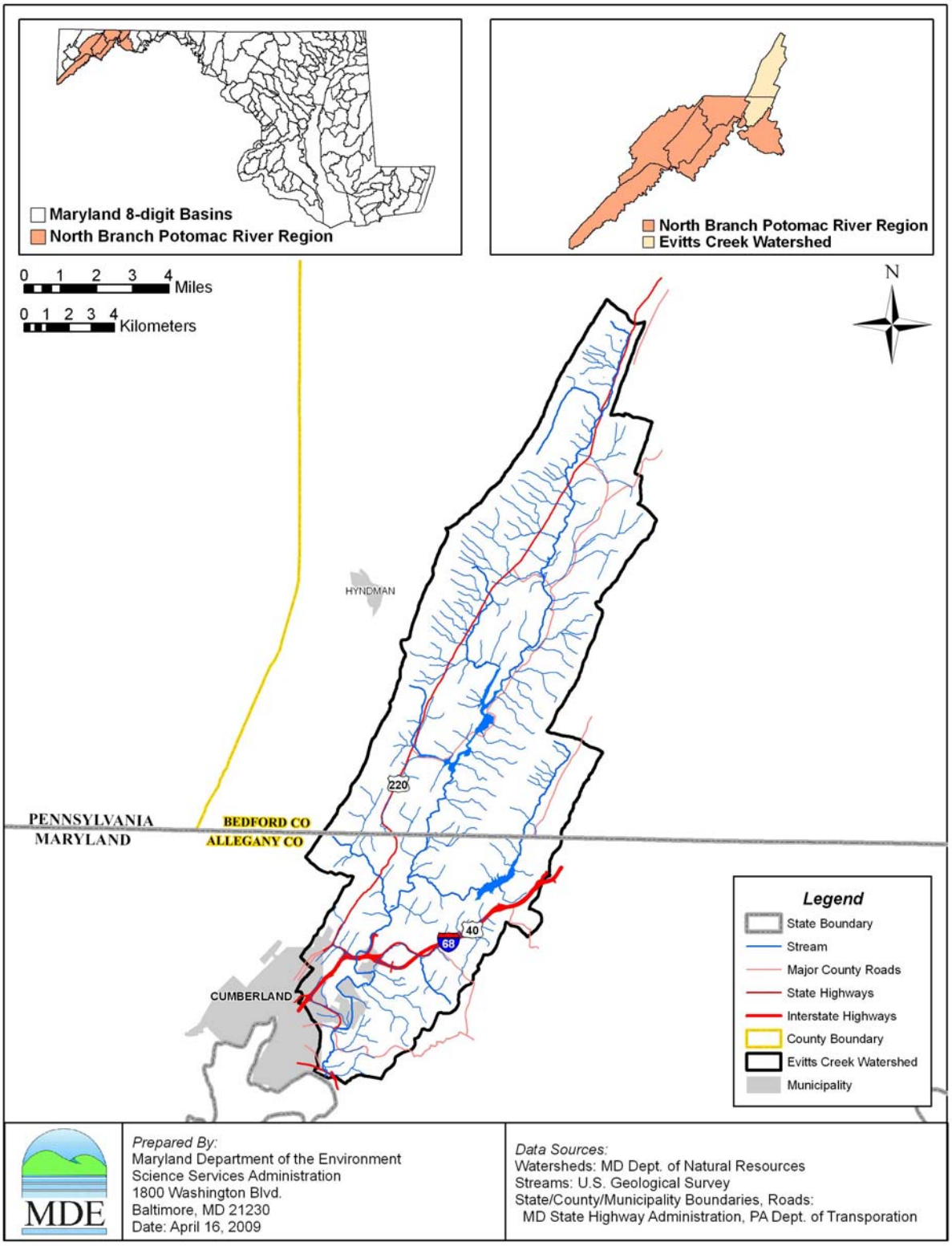

Figure 1: Location Map of the Evitts Creek Watershed

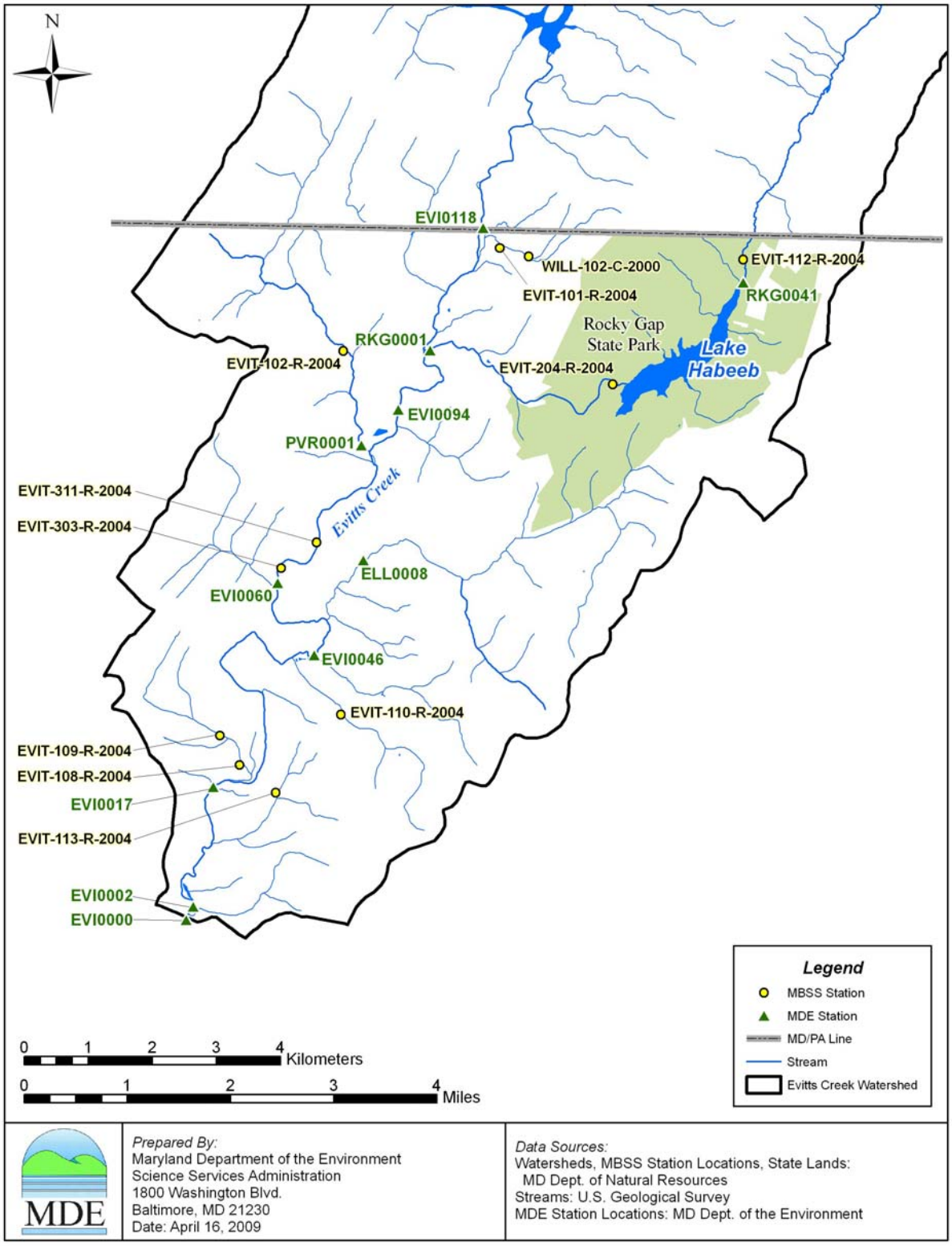

Figure 2: Monitoring Stations in the Evitts Creek Watershed

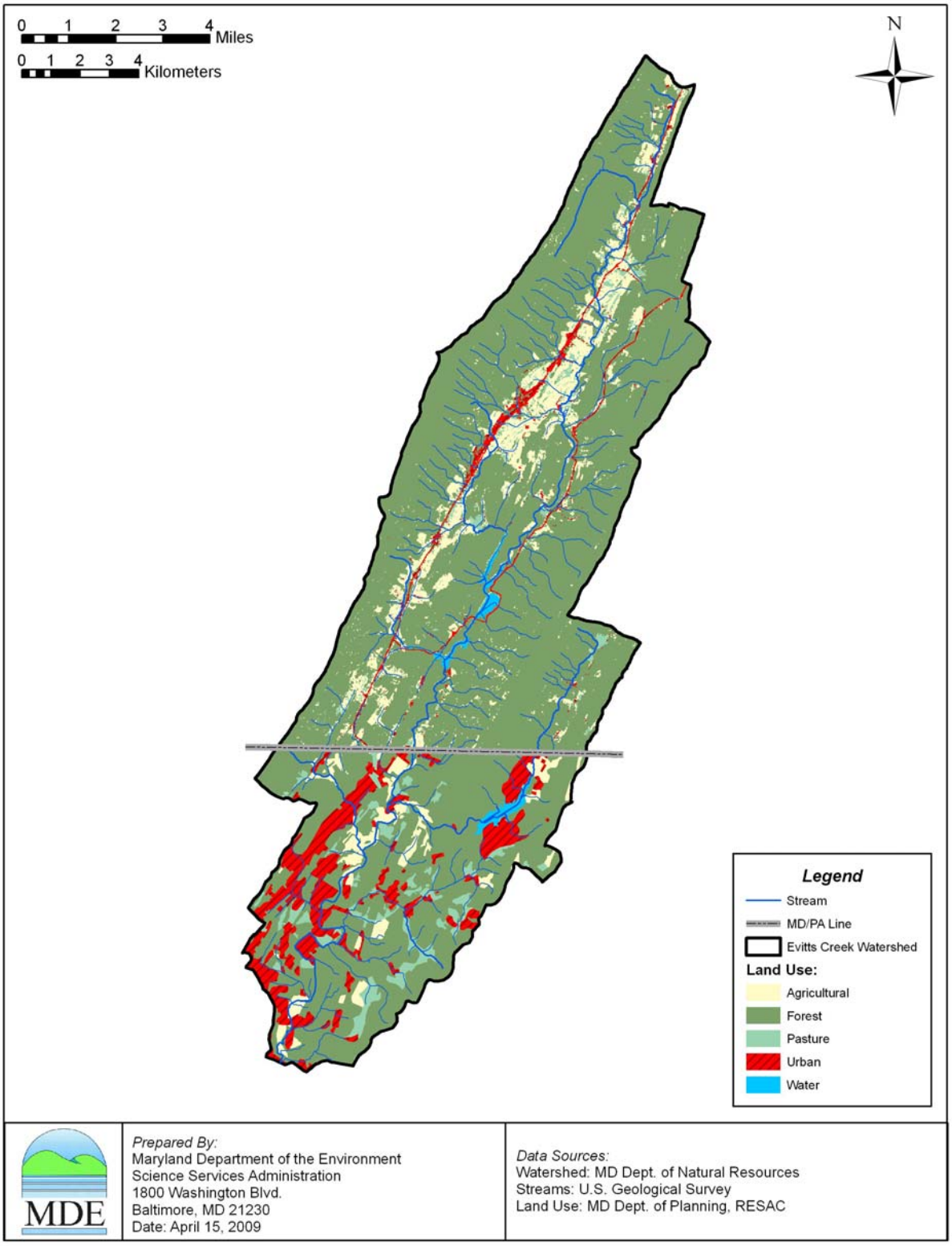

Figure 3: Land Use of the Evitts Creek Watershed

3.0 WATER QUALITY CHARACTERIZATION

The Maryland Surface Water Use Designation for the Evitts Creek mainstem is Use IV-P (Recreational Trout Waters and Public Water Supply). The tributaries of Evitts Creek are designated as Use III-P (Nontidal Cold Water and Public Water Supply) (COMAR 2009a,b).

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 Evitts Creek watershed. The dissolved oxygen (DO) concentration to protect Use IV-P waters "may not be less than 5 milligrams per liter (mg/l) at any time" and to protect Use III-P waters "may not be less than 5 milligrams/liter at any time, with a minimum daily average of not less than 6 milligrams/liter" (COMAR 2009c,d). The water quality data presented in this section will show that DO concentrations in Evitts Creek 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 Evitts Creek watershed is strongly associated with the urban land use 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 2005. All readily available water quality data from the past five years have been considered for this analysis. Water quality data from MDE surveys conducted from March 1999 through March 2004 were used. Data from Maryland Biological Stream Survey (MBSS) sampling conducted in 2000 and 2004 were also used. Table 2 lists the water quality monitoring stations in the Evitts Creek watershed with their geographical coordinates. Figures 4 through 7 provide graphical representation of the collected data for the parameters discussed below.

Table 1: Water Quality Stations in the Evitts Creek Watershed Monitored During 1999-2004

Station ID	Agency/Program	Latitude (Decimal-Degrees)	Longitude (Decimal-Degrees)
ELL0008	MDE	39.6761	-78.7084
EVI0000	MDE	39.6251	-78.7393
EVI0002	MDE	39.6269	-78.7381
EVI0017	MDE	39.6438	-78.7349
EVI0046	MDE	39.6626	-78.7170
EVI0060	MDE	39.6726	-78.7239
EVI0094	MDE	39.6973	-78.7026
EVI0118	MDE	39.7230	-78.6878
PVR0001	MDE	39.6922	-78.7092
RKG0001	MDE	39.7057	-78.6970
RKG0041	MDE	39.7160	-78.6404
EVIT-101-R-2004	DNR[1]/MBSS	39.7203	-78.6847
EVIT-102-R-2004	DNR/MBSS	39.7055	-78.7128
EVIT-108-R-2004	DNR/MBSS	39.6470	-78.7302
EVIT-109-R-2004	DNR/MBSS	39.6511	-78.7338
EVIT-110-R-2004	DNR/MBSS	39.6543	-78.7120
EVIT-112-R-2004	DNR/MBSS	39.7193	-78.6405
EVIT-113-R-2004	DNR/MBSS	39.6432	-78.7235
EVIT-204-R-2004	DNR/MBSS	39.7015	-78.6637
EVIT-303-R-2004	DNR/MBSS	39.6747	-78.7233
EVIT-311-R-2004	DNR/MBSS	39.6785	-78.7169
WILL-102-C-2000	DNR/MBSS	39.7192	-78.6794

Notes: DNR = Department of Natural Resources

3.1 Dissolved Oxygen

MDE samples were taken in the Evitts Creek watershed from March 1999 through December 2002, and December 2003 through March 2004. MBSS samples were taken during spring and summer in 2000 and 2004. Samples taken during the growing season (May through October) show DO concentrations ranging from 5.8 to 11.2 mg/l, with all values above the Use IV criterion of 5 mg/l and only one value below the daily average Use III-P criterion of 6 mg/l. This one MBSS sample represents only 1% of the data. The growing season DO data are presented graphically in Figure 4, and all MDE and MBSS DO data are presented in tabular form in Appendix A. Given the overwhelming level 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 Evitts Creek watershed.

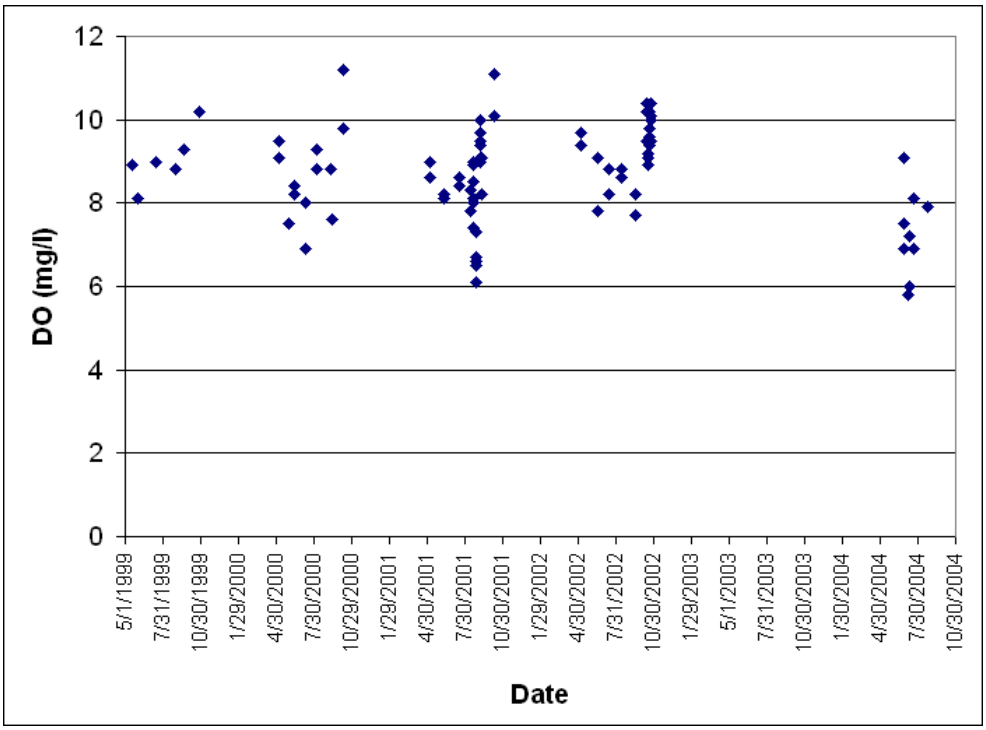

Figure 4: Evitts Creek Watershed Dissolved Oxygen Data for Growing Season Periods May 1999 through October 2004

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 2009e). 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 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 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" (COMAR 2009f). 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 micrograms per liter (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, adapted from 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 Evitts Creek watershed, as indicated by low chlorophyll *a* concentrations in comparison with those values.

MDE monitoring data in the Evitts Creek watershed show growing season (May through October) averages, by station, between 0.5 and 1.8 µg/l. These samples show observed chlorophyll *a* concentrations ranging from 0.1 to 3.6 µg/l (no samples greater than 10 µg/l). These monitoring data values suggest that chlorophyll *a* concentrations are not causing any nuisance in the Evitts Creek watershed or interfering with its designated uses.

The growing season chlorophyll *a* data are presented graphically in Figure 5, and all MDE chlorophyll *a* data are presented in tabular form in Appendix A.

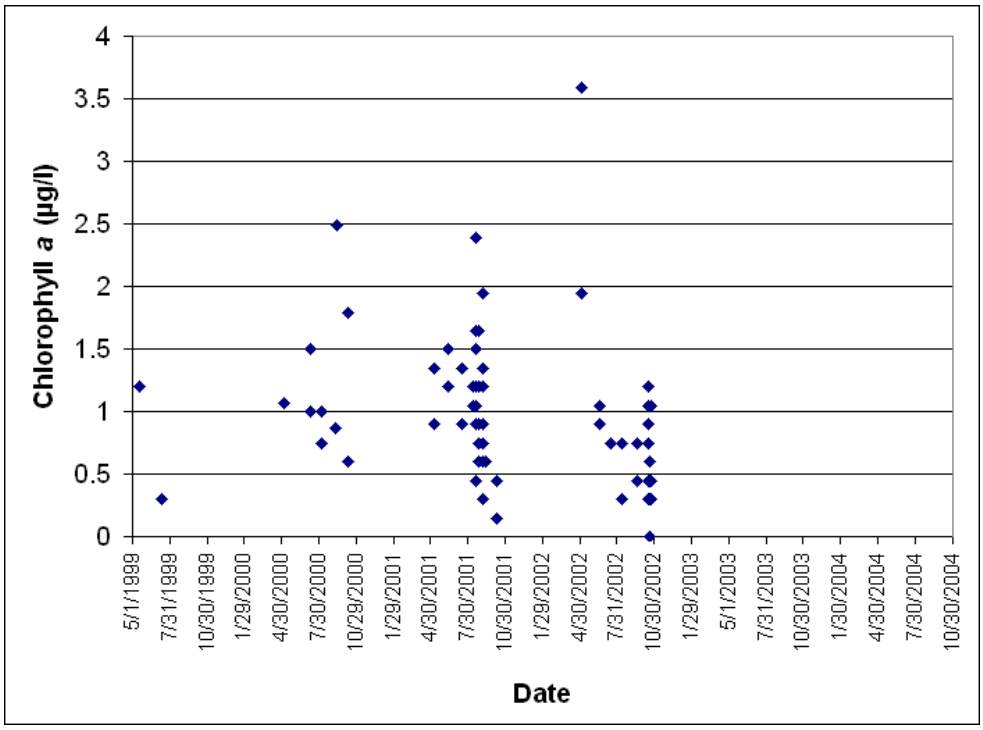

Figure 5: Evitts Creek Watershed Chlorophyll *a* Data for Growing Season Periods May 1999 through October 2004

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 Evitts Creek watershed (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 Evitts Creek watershed have been collected as part of this study and the results are presented here for informational purposes, graphically in Figures 6 and 7 (growing season TN and TP MDE data), and in tabular form in Appendix A (all MDE and MBSS TN and TP data). In general MDE data show TN concentrations during the growing season (May through October) ranging from 0.07 to 2.15 mg/l and TP concentrations ranging from 0.002 to 0.14 mg/l.

In the absence of specific numeric criteria to evaluate the TP and TN monitoring data results, MDE evaluated these results using its BSID methodology, which compared Evitts Creek watershed 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 Evitts Creek watershed further support this conclusion.

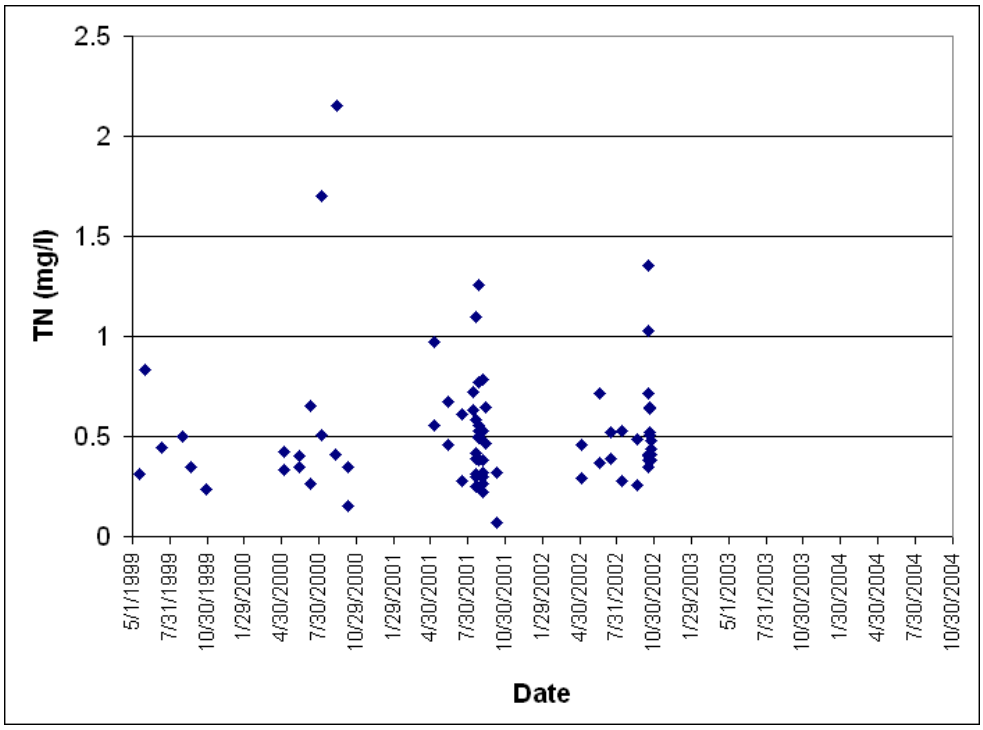

Figure 6: Evitts Creek Watershed Total Nitrogen Data for Growing Season Periods May 1999 through October 2004

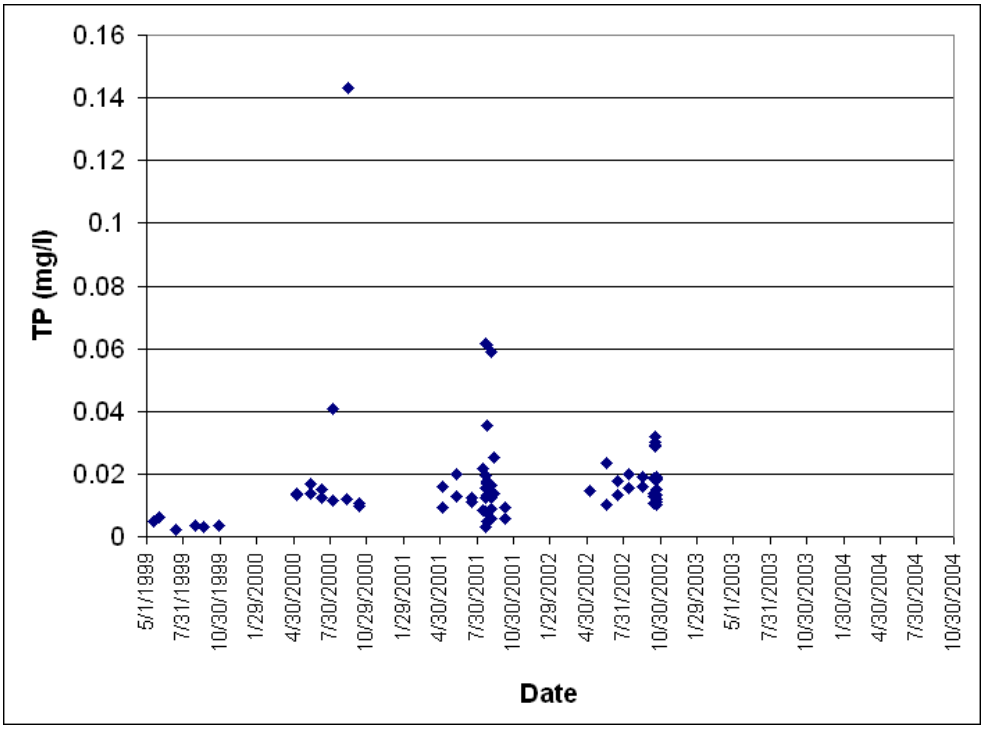

Figure 7: Evitts Creek Watershed Total Phosphorus Data for Growing Season Periods May 1999 through October 2004

3.4 Biological Stressor Identification Analysis

In the process of evaluating the existing biological impairments, MDE developed a biological stressor identification 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 Evitts Creek 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 Evitts Creek watershed. Rather, the BSID analysis results suggest that biological degradation in the Evitts Creek watershed is strongly associated with the urban land use of the watershed, which has resulted in altered hydrology and elevated levels of sulfate, chlorides, and (electrical) conductivity. Furthermore, although only 18% of the Maryland portion of the watershed is urban (See Section 2.0), the watershed areas immediately adjacent to the actual stream system are highly urban. 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 Evitts Creek watershed BSID analysis, MDE concludes that currently the Evitts Creek watershed is not being impaired by nutrients. (The BSID analysis indicates inorganic pollutants and flow/sediment 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 Evitts Creek 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") (MDE 2008a), when MDE proposes the revision of Maryland's *Integrated Report*.

Although the waters of the Evitts Creek watershed 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. For instance, reductions may be required by the forthcoming Chesapeake Bay TMDL, which is currently under development and scheduled to be completed by the EPA at 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 *a* (µg/l)	TN (mg/l)	TP (mg/l)
ELL0008	3/8/2001	12.1	1.35	1.41	0.013
ELL0008	3/26/2001	13.3	1.05	1.35	0.006
ELL0008	4/3/2001	13.8	4.19	0.85	0.007
ELL0008	8/21/2001	8.0	2.39	0.25	0.008
ELL0008	8/27/2001	6.6	1.64	0.50	0.013
ELL0008	9/6/2001	9.7	1.35	0.22	0.014
EVI0000	10/15/2002	10.4	0.45	0.40	0.011
EVI0000	10/17/2002	9.2	1.20	1.35	0.032
EVI0000	10/21/2002	9.8	0.00	0.64	0.012
EVI0000	10/23/2002	10.1	0.30	0.41	0.010
EVI0000	11/12/2002	9.7	1.20	0.30	0.011
EVI0000	11/13/2002	9.9	1.64	0.80	0.024
EVI0000	11/15/2002	10.5			
EVI0000	11/18/2002	9.4	1.20	0.88	0.018
EVI0000	12/9/2002	14.1	1.50	0.42	0.007
EVI0000	12/8/2003	12.8	1.05	0.60	0.005
EVI0000	2/9/2004	13.6	1.79	1.10	0.018
EVI0000	2/10/2004	12.6	1.50	1.06	0.013
EVI0000	2/12/2004	12.9	0.90	1.09	0.014
EVI0000	3/29/2004	10.7	2.54	0.96	0.012
EVI0002	11/8/1999	12.0	0.25		
EVI0002	12/6/1999	11.7		0.42	0.009
EVI0002	1/18/2000	14.1	1.20	0.44	0.003
EVI0002	2/14/2000	12.2	27.66	2.05	0.104
EVI0002	3/6/2000	11.1	2.78	0.74	0.013
EVI0002	4/10/2000	12.1	2.09	0.48	0.009
EVI0002	5/8/2000	9.1		0.34	0.013
EVI0002	6/12/2000	8.4		0.34	0.017
EVI0002	7/10/2000	8.0	1.00	0.26	0.013
EVI0002	8/7/2000	8.8	0.75	1.70	0.041
EVI0002	9/12/2000	7.6	2.49	2.15	0.143
EVI0002	10/11/2000	11.2	0.60	0.16	0.010
EVI0002	11/2/2000	11.0	0.43	0.12	0.011
EVI0002	12/11/2000	13.4	0.60	0.33	0.005
EVI0002	1/17/2001	12.5		0.36	0.014
EVI0002	2/13/2001	12.4	3.14	0.46	0.006
EVI0002	3/8/2001	11.7	1.20	0.80	0.014
EVI0002	3/13/2001	10.2	4.78	0.62	0.015
EVI0002	3/26/2001	12.6	1.79	0.65	0.010
EVI0002	4/3/2001	12.2	1.94	0.55	0.008
EVI0002	4/11/2001	9.5	3.44	0.74	0.022
EVI0002	5/8/2001	9.0	1.35	0.55	0.010
EVI0002	6/12/2001	8.2	1.50	0.46	0.020
EVI0002	7/17/2001	8.4	1.35	0.28	0.012
EVI0002	8/14/2001	7.8	1.05	0.73	0.022
EVI0002	8/21/2001	9.0	0.90	0.31	0.012
EVI0002	8/27/2001	6.7	1.20	0.55	0.035

Station	Sampling Date	DO (mg/l)	Chlorophyll *a* (µg/l)	TN (mg/l)	TP (mg/l)
EVI0002	9/6/2001	9.5	1.20	0.32	0.013
EVI0002	9/11/2001	9.1	0.60	0.47	0.025
EVI0002	10/10/2001	11.1	0.15	0.07	0.009
EVI0002	11/14/2001	11.8		0.06	0.006
EVI0002	12/11/2001	13.1	1.35	0.25	0.007
EVI0002	1/15/2002	12.8	1.79	0.31	0.009
EVI0002	2/12/2002	12.2	1.20	0.20	0.005
EVI0002	3/12/2002	11.8	0.60	0.15	0.007
EVI0002	4/9/2002	10.2	1.79	0.15	0.011
EVI0002	5/7/2002	9.7	3.59	0.29	0.015
EVI0002	6/18/2002	9.1	1.05	0.37	0.010
EVI0002	7/16/2002	8.8	0.75	0.39	0.018
EVI0002	8/13/2002	8.8	0.75	0.28	0.020
EVI0002	9/17/2002	7.7	0.75	0.25	0.019
EVI0017	10/15/2002	9.5	0.45	0.41	0.014
EVI0017	10/17/2002	8.9	1.05	1.36	0.030
EVI0017	10/21/2002	9.6	0.30	0.65	0.015
EVI0017	10/23/2002	9.5	0.45	0.48	0.019
EVI0017	11/12/2002	9.5	1.05	0.31	0.012
EVI0017	11/13/2002	10.1	2.69	0.80	0.022
EVI0017	11/15/2002	9.8			
EVI0017	11/18/2002	9.4	1.64	0.90	0.016
EVI0017	12/9/2002	13.7	1.79	0.43	0.008
EVI0017	12/8/2003	13.0	1.05	0.59	0.005
EVI0017	2/9/2004	13.4	1.79	1.05	0.017
EVI0017	2/10/2004	12.5	1.35	1.02	0.012
EVI0017	2/12/2004	13.2	0.90	1.08	0.013
EVI0017	3/29/2004	10.6	2.84	0.93	0.011
EVI0046	3/8/2001	11.7	0.90	0.79	0.012
EVI0046	3/26/2001	12.5	1.35	0.64	0.012
EVI0046	4/3/2001	12.1		0.57	0.007
EVI0046	8/21/2001	8.1	1.05	0.42	0.016
EVI0046	8/27/2001	6.5	0.90	0.49	0.017
EVI0046	9/6/2001	9.1	0.75	0.38	0.013
EVI0060	10/15/2002	10.2	0.30	0.35	0.013
EVI0060	10/17/2002	9.2	0.90	1.03	0.029
EVI0060	10/21/2002	10.2	0.45	0.52	0.013
EVI0060	10/23/2002	10.4	0.30	0.38	0.011
EVI0060	11/12/2002	10.0	0.90	0.36	0.004
EVI0060	11/13/2002	11.1		0.64	0.025
EVI0060	11/15/2002	11.3			
EVI0060	11/18/2002	14.1	1.94	0.66	0.016
EVI0060	12/9/2002	13.7	1.79	0.43	0.007
EVI0060	12/8/2003	12.9	1.20	0.57	0.005
EVI0060	2/9/2004	13.9	1.79	0.94	0.015
EVI0060	2/10/2004	13.4	1.79	0.92	0.014
EVI0060	2/12/2004	13.4	1.05	0.91	0.013
EVI0060	3/29/2004	10.9	3.44	0.93	0.015
EVI0094	10/15/2002	10.2	0.30	0.38	0.018
EVI0094	10/17/2002	9.1	0.75	0.71	0.029
EVI0094	10/21/2002	9.4	0.60	0.51	0.019
EVI0094	10/23/2002	10.0	1.05	0.44	0.018

Station	Sampling Date	DO (mg/l)	Chlorophyll *a* (µg/l)	TN (mg/l)	TP (mg/l)
EVI0094	11/12/2002	10.1	1.50	0.32	0.013
EVI0094	11/13/2002	10.6	3.74	0.47	0.035
EVI0094	11/15/2002	10.7			
EVI0094	11/18/2002	13.2	12.26	0.74	0.054
EVI0094	12/9/2002	13.9	1.94	0.40	0.009
EVI0094	12/8/2003	12.4	5.23	0.64	0.015
EVI0094	2/9/2004	13.8	1.94	0.89	0.015
EVI0094	2/10/2004	12.6	1.64	0.89	0.013
EVI0094	2/12/2004	12.9	0.90	0.84	0.013
EVI0094	3/29/2004	10.8	2.99	0.92	0.015
EVI0118	11/8/1999	11.5	1.00		
EVI0118	12/6/1999	12.2		0.17	0.009
EVI0118	1/18/2000	10.2		0.62	0.004
EVI0118	2/14/2000	12.3	1.79	0.81	0.013
EVI0118	3/6/2000	10.7	5.77	0.94	0.020
EVI0118	4/10/2000	11.3	2.69	0.59	0.011
EVI0118	5/8/2000	9.5	1.07	0.42	0.014
EVI0118	6/12/2000	8.2		0.40	0.014
EVI0118	7/10/2000	6.9	1.50	0.66	0.015
EVI0118	8/7/2000	9.3	1.00	0.50	0.012
EVI0118	9/11/2000	8.8	0.87	0.41	0.012
EVI0118	10/11/2000	9.8	1.79	0.35	0.011
EVI0118	11/2/2000	10.2	7.90	0.40	0.009
EVI0118	12/11/2000	11.8	0.60	0.48	0.009
EVI0118	1/17/2001	11.6	1.64	0.47	0.021
EVI0118	2/13/2001	11.3	1.50	0.57	0.011
EVI0118	3/8/2001	11.5	0.90	0.53	0.013
EVI0118	3/13/2001	10.7	1.50	0.59	0.010
EVI0118	3/26/2001	11.9	1.79	0.62	0.014
EVI0118	4/3/2001	11.2	1.94	0.63	0.011
EVI0118	4/11/2001	8.4	2.99	0.84	0.030
EVI0118	5/8/2001	8.6	0.90	0.97	0.016
EVI0118	6/12/2001	8.1	1.20	0.68	0.013
EVI0118	7/17/2001	8.6	0.90	0.61	0.011
EVI0118	8/14/2001	8.3	1.20	0.63	0.008
EVI0118	8/21/2001	8.5	1.20	0.58	0.008
EVI0118	8/27/2001	6.5	0.90	0.77	0.017
EVI0118	9/6/2001	9.1	0.60	0.53	0.009
EVI0118	9/11/2001	8.2	0.60	0.64	0.014
EVI0118	10/10/2001	10.1	0.45	0.32	0.006
EVI0118	11/14/2001	11.5	0.60	0.31	0.005
EVI0118	12/11/2001	11.1	1.20	0.42	0.008
EVI0118	1/15/2002	11.1	0.75	0.41	0.009
EVI0118	2/12/2002	11.9	0.15	0.37	0.005
EVI0118	3/12/2002	11.8	0.75	0.35	0.007
EVI0118	4/9/2002	9.9	1.50	0.42	0.011
EVI0118	5/7/2002	9.4	1.94	0.46	0.014
EVI0118	6/18/2002	7.8	0.90	0.71	0.024
EVI0118	7/16/2002	8.2	0.75	0.52	0.013
EVI0118	8/13/2002	8.6	0.30	0.53	0.016
EVI0118	9/17/2002	8.2	0.45	0.48	0.016
PVR0001	3/8/2001	12.4	1.35	1.19	0.017

Station	Sampling Date	DO (mg/l)	Chlorophyll *a* (µg/l)	TN (mg/l)	TP (mg/l)
PVR0001	3/26/2001	12.8	0.45	0.88	0.007
PVR0001	4/3/2001	11.9	1.05	0.72	0.007
PVR0001	8/21/2001	7.4	1.64	0.39	0.019
PVR0001	8/27/2001	6.1	1.20	0.53	0.018
PVR0001	9/6/2001	10.0	1.94	0.26	0.016
RKG0001	3/8/2001	13.1	3.14	0.20	0.021
RKG0001	3/26/2001	12.7	5.08	0.24	0.018
RKG0001	4/3/2001	11.7	4.93	0.22	0.020
RKG0001	8/21/2001	8.9	0.45	1.10	0.062
RKG0001	8/27/2001	7.3	0.60	1.26	0.061
RKG0001	9/6/2001	9.4	0.30	0.79	0.059
RKG0041	3/29/1999	10.8		0.33	0.004
RKG0041	4/15/1999	11.0		0.26	0.002
RKG0041	5/19/1999	8.9	1.20	0.31	0.005
RKG0041	6/2/1999	8.1		0.83	0.006
RKG0041	7/13/1999	9.0	0.30	0.44	0.002
RKG0041	8/31/1999	8.8		0.50	0.003
RKG0041	9/21/1999	9.3		0.35	0.003
RKG0041	10/27/1999	10.2		0.24	0.003
RKG0041	11/18/1999	12.1			
RKG0041	12/14/1999	11.2	2.62	1.00	0.075
RKG0041	1/11/2000	12.2		0.35	0.006
RKG0041	2/8/2000	13.3		0.22	0.004
RKG0041	3/8/2001	12.1		0.21	0.012
RKG0041	3/26/2001	12.8		0.22	0.005
RKG0041	4/3/2001	10.6		0.23	0.004
RKG0041	8/21/2001	9.0	1.50	0.30	0.003
RKG0041	8/27/2001	6.7	0.75	0.38	0.005
RKG0041	9/6/2001	9.0	0.90	0.30	0.006

Table A-2: MBSS Water Quality Data

Station	Stream	Date	DO (mg/l)	TN (mg/l)	TP (mg/l)
WILL-102-C-2000	Evitts Creek UT1	4/12/2000		0.67	0.017
WILL-102-C-2000	Evitts Creek UT1	6/1/2000	7.5		
EVIT-101-R-2004	Evitts Creek UT1	3/4/2004		1.52	0.032
EVIT-108-R-2004	Willow Brook	3/4/2004		1.69	0.017
EVIT-109-R-2004	Willow Brook	3/4/2004		2.21	0.015
EVIT-112-R-2004	Rocky Gap Run	3/4/2004		0.76	0.069
EVIT-113-R-2004	Evitts Creek UT2	3/4/2004		0.99	0.015
EVIT-204-R-2004	Rocky Gap Run	3/4/2004		0.34	0.030
EVIT-102-R-2004	Pea Vine Run	3/15/2004		0.84	0.012
EVIT-303-R-2004	Evitts Creek	3/15/2004		0.86	0.015
EVIT-311-R-2004	Evitts Creek	3/15/2004		0.84	0.014
EVIT-110-R-2004	Evitts Creek UT3	3/25/2004		1.52	0.014
EVIT-101-R-2004	Evitts Creek UT1	6/28/2004	9.1		
EVIT-112-R-2004	Rocky Gap Run	6/28/2004	7.5		
EVIT-204-R-2004	Rocky Gap Run	6/28/2004	6.9		
EVIT-102-R-2004	Pea Vine Run	7/7/2004	5.8		
EVIT-110-R-2004	Evitts Creek UT3	7/13/2004	7.2		
EVIT-113-R-2004	Evitts Creek UT2	7/13/2004	6.0		
EVIT-108-R-2004	Willow Brook	7/21/2004	8.1		
EVIT-109-R-2004	Willow Brook	7/21/2004	6.9		
EVIT-303-R-2004	Evitts Creek	8/23/2004	7.9		
EVIT-311-R-2004	Evitts Creek	8/23/2004	7.9		