Water Quality Analysis of Cadmium in Little Patuxent River, Anne Arundel County and Howard County, Maryland

FINAL

DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard, Suite 540
Baltimore MD 21230-1718

Submitted to:

Watershed Protection Division
U.S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

August 2008

EPA Submittal: July 24, 2008
EPA Approval: July 13, 2009

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AET	Apparent Effect Threshold
ANOVA	Analysis of Variance
AWQC	Ambient Water Quality Criteria
BDL	Below Detection Limit
Cd	Cadmium
COMAR	Code of Maryland Regulations
CWA	Clean Water Act
DNR	Maryland Department of Natural Resources
EPA	Environmental Protection Agency
HAC	Hardness Adjusted Criteria
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
mg/l	Milligrams per Liter
NRCS	National Resource Conservation Service
PEL	Probable Effects Lever
SCS	Soil Conservation Service
SD	Significant Difference
SHA	State Highway Administration
SQG	Sediment Quality Guideline
STATSGO	State Soil Geographic
TEL	Threshold Effects Level
TMDL	Total Maximum Daily Load
UET	Upper Effects Threshold
UMCES	University of Maryland Center for Environmental Sciences
USGS	United States Geological Survey
WQA	Water Quality Analysis
WQLS	Water Quality Limited Segment
µg/g	Micrograms per Gram
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 to either establish a Total Maximum Daily Load (TMDL) for the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

Little Patuxent River (basin code 02131105), located in Anne Arundel County and Howard County, Maryland, was identified on the State's list of WQLSs as impaired by cadmium (Cd) (1996), sediments (1996), nutrients (1996), and impacts to biological communities (2002 listing). The information used for listing Cd is suspect due in part to sampling and analysis methods available at the time, and assessment inconsistencies that led to the listing in 1996.

This report provides an analysis of recent monitoring data, which shows that the aquatic life criteria and designated uses associated with Cd are being met in the Little Patuxent River watershed, and that the 303(d) impairment listings associated with Cd are not supported by the analyses contained herein. The analyses support the conclusion that a TMDL for Cd is not necessary to achieve water quality standards. Barring the receipt of contradictory data, this report will be used to support a Cd listing change for the Little Patuxent River from Category 5 ("waterbodies impaired by one or more pollutants requiring a TMDL") to Category 2 ("Surface waters that are meeting some standards and have insufficient information to determine attainment of other standards"), when the Maryland Department of the Environment (MDE) proposes the revision of Maryland's 303(d) list for public review in the future. The listings for sediments, nutrients, and impacts to biological communities will be addressed separately at a future date.

Although the waters of the Little Patuxent River watershed do not display signs of toxic impairments due to Cd, the State reserves the right to require additional pollution controls in the Little Patuxent River watershed if evidence suggests that Cd from the basin is contributing to downstream water quality problems.

1.0 INTRODUCTION

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

A segment identified as a WQLS may not require the development and implementation of a TMDL if current information contradicts the previous finding of impairment. The most common factual scenarios obviating the need for a TMDL are as follows: 1) more recent data indicating that the impairment no longer exists (i.e., water quality criteria are being met); 2) more recent and updated water quality modeling demonstrates that the segment is now attaining criteria; 3) refinements to water quality criteria or the interpretation of standards, which result in standards being met; or 4) correction to errors made in the initial listing.

Little Patuxent River (basin code 02131105) was identified on the State's list of WQLSs as impaired by cadmium (Cd) (1996), sediments (1996), nutrients (1996), and impacts to biological communities (2002).

The informational basis (P. Jiapizian, personal communication, 2001) for this listing contended that mean levels of Cd exceeded both the EPA acute and chronic aquatic life criteria for Cd at the time of listing (1996). Although criteria were "exceeded", there were several methodological flaws in the monitoring and listing assessment applied in 1996. First, unfiltered (total metals) samples were compared to dissolved metals criteria. Second, current criteria for Cd rely on a hardness correction – since no hardness data existed, criteria thresholds using a 100 mg/l "default" hardness value were used for the assessment. Finally, station means for each analyte were calculated setting non-detects at half the detection limit. While this procedure may have been appropriately conservative at the time, the sensitivity of analytical instrumentation has improved dramatically, and samples taken currently for Cd have appropriate detection limits that are well below their respective criteria values.

A Water Quality Analysis (WQA) of Cd for Little Patuxent River was conducted by MDE using recent water column chemistry data and sediment toxicity data to determine if impairment currently exists. The listings for sediments, nutrients, and impacts to biological communities will be addressed separately at a future date.

The remainder of this report lays out the general setting of the waterbody within the Little Patuxent River watershed, presents a discussion of the water quality characterization process, and provides conclusions with regard to the characterization.

2.0 GENERAL SETTING

Location

The Little Patuxent River originates just north of Route 70 near the Howard County Landfill. The River flows southeast through the heavily suburbanized area of Columbia crossing under Route 29 just south of Lake Kittamaqundi. The Little Patuxent River continues southeast crossing under Route 32 where the Middle Patuxent River joins the Little Patuxent River in the town of Savage. The Little Patuxent River, now larger due to the influx of the Middle Patuxent River, continues flowing southeast crossing under Route 295 and flowing through the southwest corner of the Fort Meade Military Reservation and the northeast section of the Patuxent Research Refuge. The Little Patuxent River joins the Patuxent River just southeast of the Patuxent Research Refuge between the towns of Bowie and Crofton just before the Routes 3 and 450. The drainage area of the Little Patuxent River watershed is 65,947 acres. The location of the watershed is depicted in Figure 1.

Geology/Soils

The Little Patuxent River watershed is situated within the Northern Piedmont and Northern Coastal Plain Provinces in central Maryland. Sedimentary and igneous rocks that have been metamorphosed characterize the surficial geology of the Northern Piedmont Province. Most of the Northern Piedmont Province is located above the “fall line” on the east coast. Unconsolidated sand, silt, and clay sediments underlie the Northern Coastal Plain Province. The Coastal Plain Province sediments are a source of groundwater for nearby cities. The topography in the watershed is mostly characterized by rolling hills, gently sloping terrain, and broad valleys with small streams.

The Little Patuxent River watershed is comprised of several different soil series including the Chester, Beltsville, and Collington. The Chester series consists of very deep, well-drained soils on upland divides and upper slopes in the Northern Piedmont Province. Saturated hydraulic conductivity is moderately high to high. The Chester soils formed in materials weathered from micaceous schist. The Beltsville soil series consist of very deep, moderately well drained soils in the Northern Coastal Plain Province on uplands and coastal plain landscapes. Saturated Hydraulic Conductivity is high above the fragipan to moderately low or low in the fragipan. The Collington series consist of very deep well drained soils in the Northern Coastal Plain Province on a coastal plain landscape. Saturated Hydraulic Conductivity is low to moderate.

Land use

The land use in the Little Patuxent River watershed is predominantly forested. There are 66,214 total acres in the watershed. Forested lands encompass 27,535 acres (41.6%) in the watershed. Urban land use comprises 26,373 acres (39.8%) of the watershed mixed between low density, medium density, high density residential housing, commercial/industrial, institutional, and open urban land. The watershed contains 12,158 acres (18.4%) of agricultural used land distributed between cropland, pasture, orchard/horticulture, garden crops, and feed operations. The remaining acreage of 148 (0.2%) is water and wetlands. The land use distribution is based on

2002 Maryland Department of Planning (MDP) land use/land cover data. The Little Patuxent River land use percentages are displayed in Figure 2 and the watershed land use coverage is displayed in Figure 3.

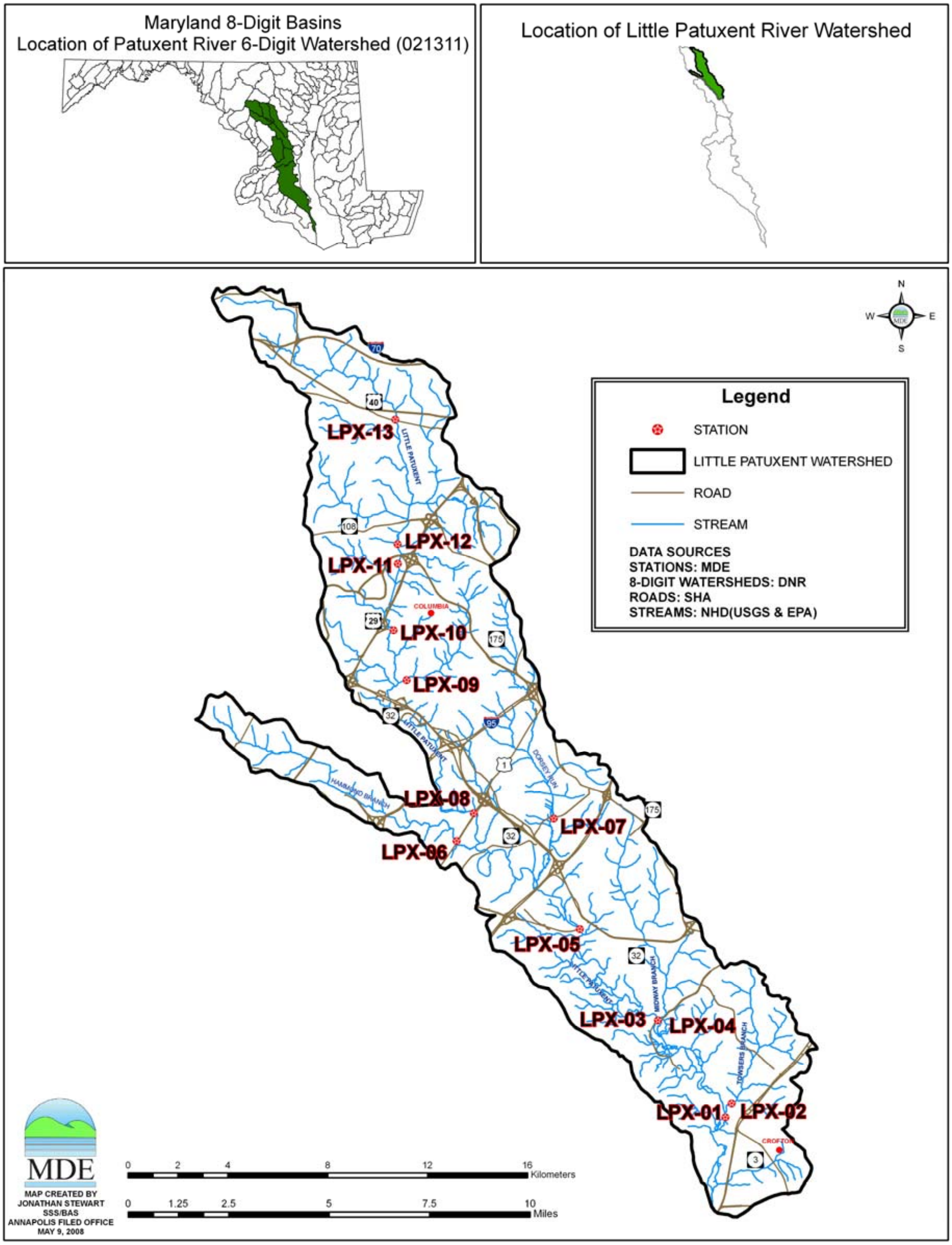

Figure 1: Little Patuxent Watershed Location Map

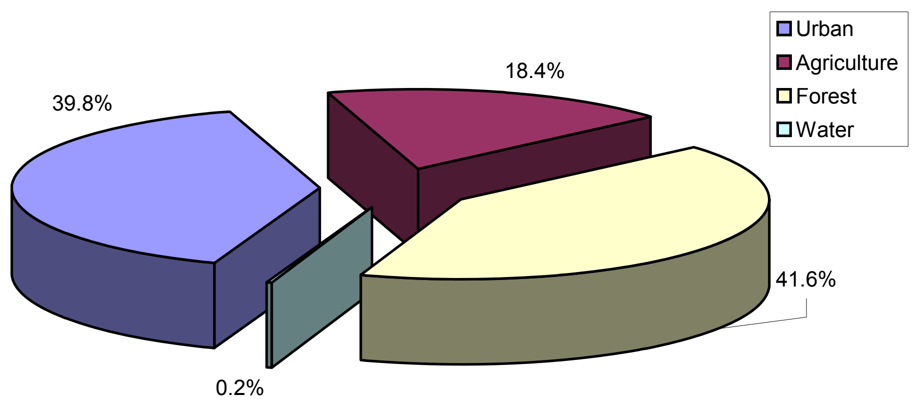

Figure 2: Proportions of Land Use in the Little Patuxent Watershed

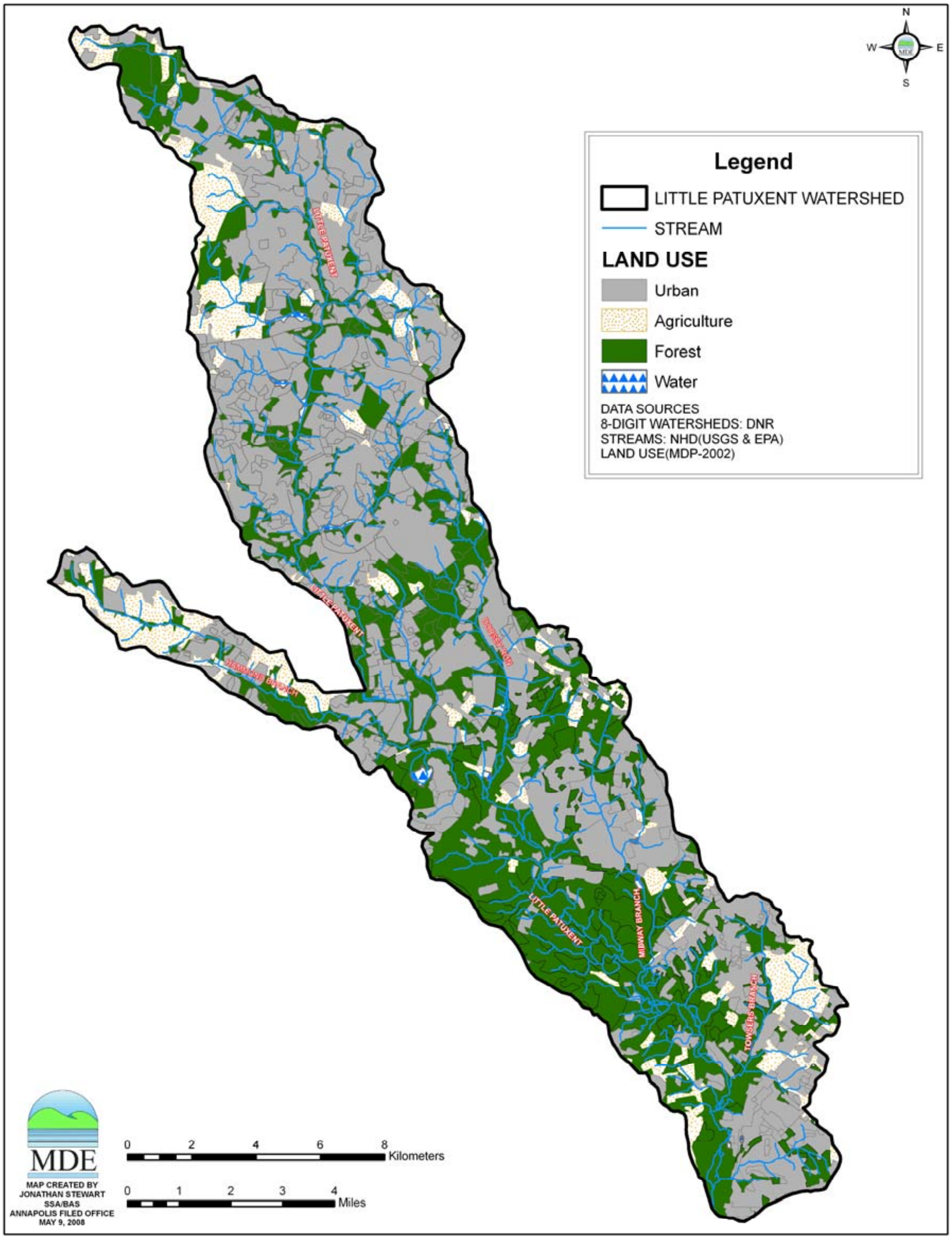

Figure 3: Land Use Distribution in the Little Patuxent River Watershed

3.0 WATER QUALITY CHARACTERIZATION

A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include 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 different designated uses may differ and are dependent on the specific designated use(s) of a waterbody. Maryland's water quality standards presently include numeric criteria for metals and other toxic substances based on the need to protect aquatic life, wildlife and human health. Water quality standards for toxic substances also address sediment quality to ensure the bottom sediment of a waterbody is capable of supporting aquatic life, thus protecting the designated uses.

The Maryland Surface Water Use Designation for the Little Patuxent River is Use I-P: *Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply*. (Code of Maryland Regulations (COMAR) 26.08.02.08 (M)(1)(a)). The aquatic life and human health criteria for Cd, which protect these uses, are displayed below in Table 1 (COMAR 26.08.02.03-2G).

Table 1: Numeric Water Quality Criteria

Criteria	Freshwater Aquatic Life* Acute (µg/l)	Freshwater Aquatic Life* Chronic (µg/l)	Human Health (Water + Organism) (µg/l) (10^{-5} risk level)	Human Health (Organism) (µg/l) (10^{-5} risk level)
Cd	2	0.25	5	-

*Aquatic Life Criteria based on default hardness of 100 mg/l

The University of Maryland Center for Environmental Sciences (UMCES-Solomons Island) conducted water column surveys, used to support this WQA, at 13 stations throughout the Little Patuxent River watershed in November 2005, June 2006, and May 2007. Sediment bulk samples were collected at six stations, LPX-1, LPX-3, LPX-5, LPX-8, LPX-10, and LPX-11 in June 2006. Sediments were sub sampled twice with one sub sample being frozen. The sub samples were used for analysis of trace metals present in the sediments. The remaining sediment was shipped to the University of Maryland System – Agricultural Experiment Station (Wye Research and Education Center) to be analyzed for toxicity using a standard EPA freshwater 10-day amphipod test and dissolved metals in the porewater. Table 2 shows the list of stations with their geographical coordinates (See Figure 1 for locations).

Table 2: Sample Stations for the Little Patuxent River

Station ID	Latitude	Longitude	Station Description
LPX-1	39.024	76.701	Conway Rd. overpass of LPR mainstem downstream of outlet from Towsers Run
LPX-2	39.029	76.698	Evergreen Rd. or Capitol Raceway Rd. west of MD 3 at Towsers Run
LPX-3	39.059	76.732	Patuxent Rd. overpass of LPR mainstem; north of Midway Branch outlet
LPX-4	39.059	76.732	Unnamed Rd. north of rail line at Midway Branch
LPX-5	39.092	76.768	MD 198 west of MD 32 at LPR mainstem
LPX-6	39.124	76.825	US 1 0.6 miles north of Whiskey Bottom Rd. at overpass of Hammond Branch
LPX-7	39.132	76.780	Brock Bridge Rd. at Dorsey Run
LPX-8	39.134	76.817	US 1 at Savage Mill 0.8 miles south of MD 32, LPR mainstem
LPX-9	39.182	76.848	Unnamed tributary to LPR at Broken land Pkwy., downstream of unnamed lake
LPX-10	39.200	76.854	LPR mainstem at Broken Land Pkwy., directly east of US 29
LPX-11	39.224	76.852	LPR mainstem at Little Patuxent Pkwy. (MD 175)
LPX-12	39.231	76.852	Plumbtree Branch at Columbia Rd. (western crossing)
LPX-13	39.276	76.853	LPR mainstem at Frederick Rd. (US 40)

For the water column evaluation, a comparison is made between Cd dissolved water column concentrations and the freshwater aquatic life chronic criterion, the most stringent of the numeric water quality criteria for Cd. Water hardness concentrations were obtained for each station to adjust the freshwater aquatic life criteria that were listed based on a default hardness of 100 mg/l.

MDE calculates freshwater aquatic life criteria as a function of a hardness adjustment formula for metals, where toxicity is a function of total hardness. According to EPA's National Recommended Water Quality Criteria (EPA, November 2002), allowable hardness values must fall within the range of 25 - 400 mg/l. When the measured hardness exceeds 400 mg/l, MDE will use this value as an upper limit when calculating the hardness adjusted criteria (HAC). EPA's Office of Research and Development does not recommend a lower limit on hardness for adjusting criterion (EPA, July 2002). A lower limit may result in criteria that are less protective of the water quality standard. In analyses where available hardness data indicates a value below 25 mg/l, MDE may perform additional analyses to insure data quality objectives for the assessments were met. When data are of questionable quality, MDE will take additional samples to establish the validity of the initial assessment.

The HAC equation for metals is as follows (EPA, November 2002):

$$HAC = e^{(m[\ln (Hardness(mg/l))]+b)} * CF$$

Where,
HAC = Hardness Adjusted Criteria (μg/l)
m = slope
b = y intercept
CF = Conversion Factor (conversion from totals to dissolved numeric criteria)

The chronic HAC parameters for Cd are presented in Table 3 (EPA, November 2002).

Table 3: HAC Parameters (Freshwater Aquatic Life Chronic Criteria)

Chemical	Slope (m)	y Intercept (b)	Conversion Factor (CF)
Cd	0.7409	-4.719	1.102 - ln(hardness)*0.0418

The water column evaluation and sediment quality evaluation are presented in Section 3.1 and 3.2, respectively.

3.1 Water Column Evaluation

MDE conducted a data solicitation for metals and considered all readily available data from the past five years in the WQA. The water column data are presented in Table 4 for each station and evaluated using the freshwater aquatic life chronic criteria (Heyes, 2007). Table 5 displays hardness (mg/l), dissolved Cd sample concentrations (μg/l) and Cd criteria (μg/l). The water column data are also displayed in Figure 4.

Concentrations of Cd in the water column are no greater than 0.12 μg/l. All concentrations are well below their associated freshwater aquatic life hardness adjusted chronic criteria for Cd, while some concentrations are below the method detection limit for Cd. The method detection limit for Cd is displayed in Table 4.

Table 4: Method Detection Limit

Metal	Method Detection Limit (μg/l)
Cd	0.048

Table 5: Little Patuxent River Water Column Data (Cd)

Station	Date	Hardness (mg/L)	Cd (µg/L)	Cd Criteria* (µg/L)
LPX-01	11/01/05	96	0.08	0.24
LPX-01	06/01/06	144	0.08	0.32
LPX-01	05/02/07	93.5	BDL	0.23
LPX-02	11/01/05	84	0.08	0.22
LPX-02	06/01/06	132	0.09	0.30
LPX-02	05/02/07	74.8	0.08	0.20
LPX-03	11/01/05	100	0.12	0.25
LPX-03	06/01/06	152	0.10	0.33
LPX-03	05/02/07	101.0	BDL	0.25
LPX-04	11/01/05	73	0.07	0.20
LPX-04	06/01/06	66	BDL	0.18
LPX-04	05/02/07	89.8	BDL	0.23
LPX-05	11/01/05	107	0.08	0.26
LPX-05	06/01/06	133	0.09	0.30
LPX-05	05/02/07	104.7	BDL	0.25
LPX-06	11/01/05	88	0.07	0.23
LPX-06	06/01/06	99	BDL	0.24
LPX-06	05/02/07	86.0	BDL	0.22
LPX-07	11/01/05	115	0.07	0.27
LPX-07	06/01/06	101	0.08	0.25
LPX-07	05/02/07	104.7	BDL	0.25
LPX-08	11/01/05	107	0.07	0.26
LPX-08	06/01/06	142	BDL	0.31
LPX-08	05/02/07	93.5	BDL	0.23
LPX-09	11/01/05	92	0.08	0.23
LPX-09	06/01/06	131	BDL	0.30
LPX-09	05/02/07	115.9	BDL	0.27
LPX-10	11/01/05	127	0.07	0.29
LPX-10	06/01/06	121	BDL	0.28
LPX-10	05/02/07	97.2	BDL	0.24
LPX-11	11/01/05	123	0.09	0.28
LPX-11	06/01/06	102	BDL	0.25
LPX-11	05/02/07	134.6	BDL	0.30
LPX-12	11/01/05	176	0.08	0.36
LPX-12	05/02/07	168.3	BDL	0.35
LPX-13	11/01/05	115	0.07	0.27
LPX-13	06/01/06	111	BDL	0.26
LPX-13	05/02/07	134.6	BDL	0.30
LPX-13 DUP	05/02/07	119.7	BDL	0.28

*Freshwater Aquatic Life Hardness Adjusted Chronic Criterion
** BDL Below Detection Limit

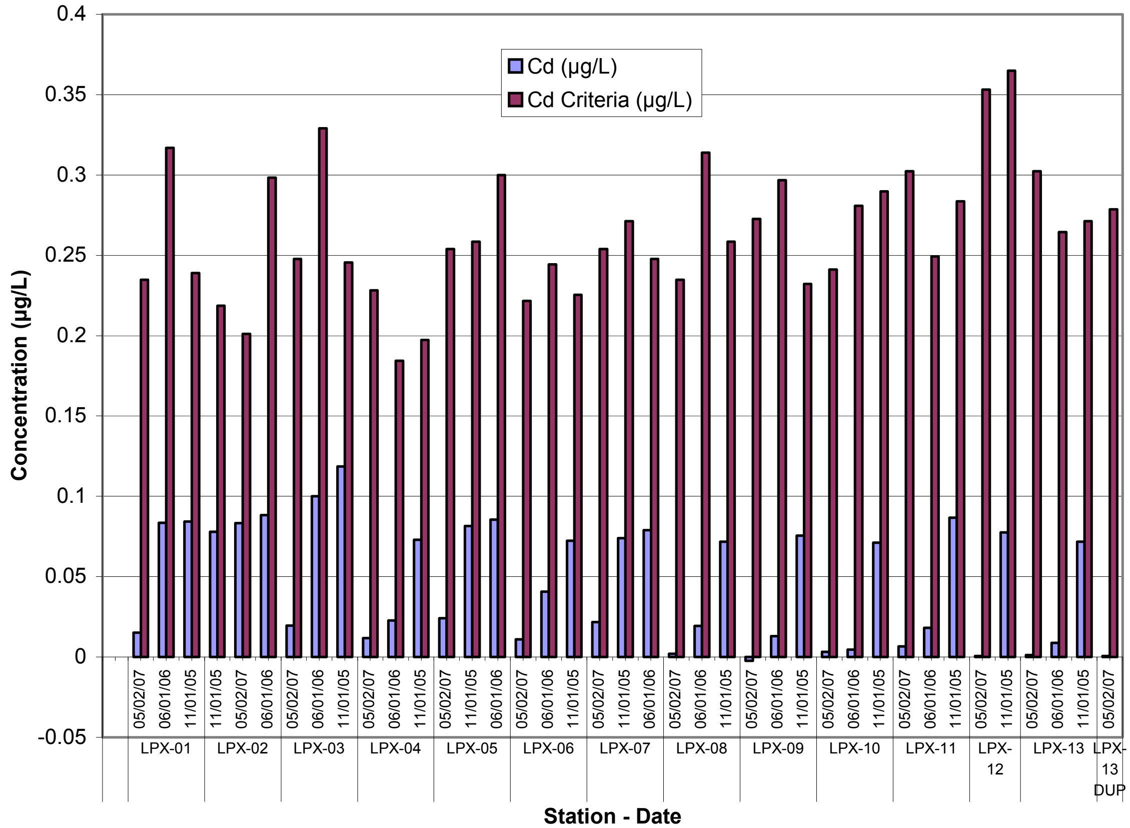

Figure 4: Little Patuxent River Water Column Data (Cd)

3.2 Sediment Quality Evaluation

Sediment quality in the Little Patuxent River watershed was evaluated using a 10-day whole sediment test with the freshwater amphipod *Hyalella azteca* (Fisher, 2007). This species was chosen because of its ecological relevance to the waterbody of concern. *Hyalella azteca* is an EPA-recommended test species for assessing the toxicity of freshwater (EPA, 2000). Six surficial sediment samples were collected in June 2006 using a petite ponar dredge (top 2 cm) in the Little Patuxent River watershed. Control sediments were collected from Bigwood Cove, Wye River, from a depositional area previously characterized as low in contaminants (Fisher, 2007). Refer to Figure 1 for the station locations. The results are presented in Table 6. Eight replicates containing ten amphipods each were exposed to the contaminated sediment samples, as well as a control sediment sample, for testing. The table displays average amphipod survival (%) and average amphipod growth (mg dry weight).

Table 6: Little Patuxent River Sediment Toxicity Test Results

Treatment REP	Amphipod Survival (#)	Amphipod Weight (mg)	Treatment % Survival (SD)	Treatment mg. dry wt. (SD)
Control A	10	0.21	93.8 (5.18)	0.20 (0.014)
Control B	9	0.18		
Control C	9	0.2		
Control D	10	0.18		
Control E	9	0.22		
Control F	10	0.19		
Control G	9	0.19		
Control H	9	0.2		
LPX-1 A	10	0.18	97.5 (4.63)	0.21 (0.020)
LPX-1 B	10	0.19		
LPX-1 C	9	0.19		
LPX-1 D	9	0.21		
LPX-1 E	10	0.23		
LPX-1 F	10	0.23		
LPX-1 G	10	0.22		
LPX-1 H	10	0.22		
LPX-3 A	10	0.12	97.5 (4.63)	0.15 (0.023)*
LPX-3 B	10	0.18		
LPX-3 C	10	0.13		
LPX-3 D	10	0.16		
LPX-3 E	10	0.13		
LPX-3 F	9	0.15		
LPX-3 G	9	0.18		
LPX-3 H	10	0.16		
LPX-5 A	10	0.16	97.5 (4.63)	0.22 (0.033)
LPX-5 B	10	0.17		
LPX-5 C	10	0.22		
LPX-5 D	9	0.22		
LPX-5 E	10	0.24		
LPX-5 F	10	0.25		
LPX-5 G	9	0.23		
LPX-5 H	10	0.24		

An * indicates a treatment significantly < the control (= 0.05).
SD - Standard Deviation

Table 6: Little Patuxent River Sediment Toxicity Test Results (cont'd)

Treatment REP	Amphipod Survival (#)	Amphipod Weight (mg)	Treatment % Survival (SD)	Treatment mg. dry wt. (SD)
LPX-8 A	Rep not loaded		92.9 (9.51)	0.18 (0.031)
LPX-8 B	10	0.15		
LPX-8 C	8	0.16		
LPX-8 D	10	0.19		
LPX-8 E	10	0.19		
LPX-8 F	8	0.15		
PX-8 G	10	0.21		
LPX-8 H	9	0.23		
LPX-10 A	10	0.13	88.8 (9.91)	0.13 (0.014)*
LPX-10 B	10	0.13		
LPX-10 C	7	0.12		
LPX-10 D	9	0.13		
LPX-10 E	9	0.12		
LPX-10 F	9	0.14		
LPX-10 G	8	0.12		
LPX-10 H	9	0.16		
LPX-11 A	10	0.15	95.0 (7.56)	0.20 (0.020)
LPX-11 B	10	0.19		
LPX-11 C	8	0.21		
LPX-11 D	10	0.21		
LPX-11 E	9	0.2		
LPX-11 F	10	0.2		
LPX-11 G	10	0.21		
LPX-11 H	9	0.19		

n * indicates a treatment significantly < the control (= 0.05).
SD - Standard Deviation

The test considers two performance criteria: survival and growth. For the test to be valid the average survival of control sediment samples must be greater than 80% and there must be measurable growth.

Survival of amphipods in the field sediment samples was not significantly less than the average survival demonstrated in the control sediment sample. The average survival for the control sediment sample was 94.9%. The average survival for all field sediment samples ranged between 88.8% and 97.5%. The control sediment sample exhibited an average final dry weight of 0.11 mg, in contrast to a range of 0.12 mg to 0.16 mg average final dry weight for field sediment samples. Only sediment from two of the eight stations in the Little Patuxent River (LPX-3 and LPX-10) proved to be toxic. Both sediments caused a significant reduction in *H.*

azteca growth (dry weight) when compared to control amphipod growth (dry weight). (Fisher 2007).

Ambient sediment bioassays are only capable of establishing the existence of sediment toxicity, therefore further chemical analyses were required to determine whether Cd contamination was a source of observed sediment toxicity. Bulk sediment chemistry analysis was conducted in order to measure total Cd concentrations within the sediment (Heyes, 2007).

EPA Ambient Water Quality Criteria (AWQC) was used in the absence of sediment quality criteria to predict the likelihood of impacts to sediment biota given a specific contaminant concentration observed in the sediment. Numerous organizations have established AWQCs for sediment management and ecological risk assessment purposes. Generally, each guideline consists of three levels: a threshold value below which effects are expected to occur only rarely (TEL); a value at or above which impacts are frequently expected (PEL); and a threshold value at or above which impacts are definitive (UET). In this analysis, bulk sediment concentrations were compared to various AWQCs (TEL, PEL, UET) to determine the likelihood for a role in the observed toxicity for Cd. The Threshold Effects Level (TEL) is calculated as the geometric mean of the 15th percentile concentration of the toxic effects data set and the median of the no-effect data set. The Probable Effects Level (PEL) is the geometric mean of the 50th percentile of impacted, toxic samples and the 85th percentile of the non-impacted samples. The TEL and PEL are based on benthic community metrics and toxicity results. The Upper Effects Threshold (UET) is derived as the lowest Apparent Effect Threshold (AET) from a compilation of endpoint analogous to the marine AET endpoints (Buchman, 1999). The impact values for cadmium are shown in Table 7.

Table 7: Ambient Water Quality Criteria for Cadmium Table

	TEL (µg/g)	PEL (µg/g)	UET (µg/g)
Cd	0.596	3.53	3.00

Although the average Cd concentrations in the bulk sediment are above the TEL in four of the six stations sampled, they are below the PEL and UET in all six stations. If cadmium were the source of the impaired growth, one would expect to see this effect at LPX-8 (0.89 µg/g) and LPX-11 (1.09 µg/g); LPX-11 was the second highest observed concentration. The sediment concentrations (µg/g dry weight) are presented in Table 8.

Table 8: Little Patuxent River Bulk Sediment Analysis Results

Station	Watershed	Date	Sediment Metals Concentration Cd (µg/g)
LPX-1	Little Patuxent River	6/1/2006	0.34
LPX-3	Little Patuxent River	6/1/2006	1.06
LPX-5	Little Patuxent River	6/1/2006	0.58
LPX-8	Little Patuxent River	6/1/2006	0.89
LPX-10	Little Patuxent River	6/1/2006	1.12
LPX-11	Little Patuxent River	6/1/2006	1.09

An analysis of porewater concentrations was also conducted in order to evaluate the concentrations of the readily bioavailable portion of Cd in the sediment matrix. The porewater data is presented in Table 8 for each of the six stations and is evaluated using the fresh water hardness adjusted chronic criteria (Heyes, 2007). This comparison is similar to what was done for the water column.

Table 9: Little Patuxent River Porewater Toxicity Results

Station	Date	Hardness (mg/L)	Cd (µg/L)	Cd Criteria (µg/L)
LPX-1	5/2/2007	144	0.11	0.32
LPX-3	5/2/2007	152	0.11	0.33
LPX-5	5/2/2007	133	0.11	0.30
LPX-8	5/2/2007	142	0.11	0.31
LPX-10	5/2/2007	121	0.21	0.28
LPX-11	5/2/2007	102	0.11	0.25

Concentrations of Cd in the porewater samples are no greater than 0.21 µg/l. All concentrations are below their associated freshwater aquatic life hardness adjusted chronic criteria for Cd.

4.0 CONCLUSION

The WQA establishes that the water quality standard for Cd is being met in the Little Patuxent River watershed. The water column data collected in November 2005, June 2006, and May 2007 at thirteen monitoring stations (presented in Section 3.1, Table 5) shows that concentrations of Cd in the water column do not exceed the water quality criterion. An ambient sediment bioassay conducted in the Little Patuxent River, by the University of Maryland Wye Research Center, established that there is toxicity in the sediment at two (LPX-3 & LPX-10) of the thirteen stations. Bulk sediment chemistry analysis done at six (LPX-1, LPX-3, LPX-5, LPX-8, LPX-10, LPX-11) of the thirteen stations show all six stations below the PEL and UET for Cd. Four of the stations (LPX-3, LPX-8, LPX-10, LPX-11) show Cd levels above the TEL, but two stations (LPX-8 & LPX-11) of the four stations show no growth rate reduction due to toxicity. If Cd were the contributing factor to toxicity in the Little Patuxent River, there would be a reduction in growth rates for all four stations that show an elevated Cd level in the bulk sediment samples. Therefore it is unlikely that Cd played a role in the growth rate reduction of *H. azteca* at the two stations. The porewater samples showed all concentrations of Cd below their associated aquatic life hardness adjusted chronic criteria. Therefore, Cd most likely does not impair the water column and sediment in the Little Patuxent River. Thus, the designated uses are supported and the water quality standard is being met.

Even though Cd is not responsible for the sediment toxicity, the issue still remains; therefore the State will list the segment for aquatic life use impairments due to sediment toxicity (unidentified contaminants) on the 303(d) list, and will remove Cd as an impairing substance in Little Patuxent River. The new listing will be available for public review. This will require the State to perform additional studies in this area to identify which contaminants are responsible for causing the observed sediment toxicity.

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

REFERENCES

COMAR 26.08.02.03-2G. *Numerical Criteria for Toxic Substances in Surface Waters*.

COMAR 26.08.02.08(M)(1)(a). *Stream Segment Designations.*

COMAR 26.08.02.02(B)(2). *Designated Uses***.**

Buchman, M. F. *NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1.* Seattle WA, Coastal Protection and Restoration Division – National Oceanic and Atmospheric Administration, 1999.

Fisher, D., Osborn, M., Ziegler, G. *Toxicity of Sediments from the 2006 Metals Monitoring Program to Hyalella azteca and Leptocheirus plumulosus: Bodkins Creek, Northeast River, Little Patuxent River, Middle Patuxent River, and Lower Susquehanna River*. University of Maryland System – Agricultural Experiment Station (Wye Research and Education Center), November 2007.

Heyes, A., Fisher, D., Baker, J. *Maryland Metals Contaminant Survey of the: Lower Susquehanna River, Bodkin Creek, Jones Falls, Lower North Branch of Patapsco, Litte Patuxent River and Middle Patuxent River conducted in 2005 and 2006.* University of Maryland Center for Environmental Science - Chesapeake Biological Laboratory, November 2007.

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

Maryland Department of the Environment. *2006 List of Impaired Surface Waters [303(d) List] and Integrated Assessment of Water Quality in Maryland: Submitted in Accordance with Sections 303(d) and 305(b) of the Clean Water Act.* April 2006.

Natural Resources Conservation Service (NRCS). *Soil Survey of Anne Arundel County, MD*, 1973.

Natural Resources Conservation Service (NRCS). *Soil Survey of Howard County, MD*, 1968.

U.S. Environmental Protection Agency. *Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates.* Second ed. EPA/600/R-99/064, Duluth, MN. 192 pp. 2000.

U.S. Environmental Protection Agency. *Consolidated Assessment and Listing Methodology: Toward a Compendium of Best Practices*. 1st edition. July 2002.

U.S. Environmental Protection Agency. *National Recommended Water Quality Criteria: 2002.* EPA-822-R-02-047. November 2002.