

**PROPOSED  
TOTAL MAXIMUM DAILY LOADS (TMDLs)**

**For  
Dioxins  
In  
Wolf River**

**Wolf River Watershed (HUC 08010210)**

**Shelby County, Tennessee**

**FINAL**

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## LIST OF ABBREVIATIONS

ADB	Assessment Database
BCF	Bioconcentration Factor
BMP	Best Management Practices
CFR	Code of Federal Regulations
EFO	Environmental Field Office
GIS	Geographic Information System
HRT	Hydraulic Retention Time
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
NPS	Non-point Source
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated Biphenyl
RM	River Mile
SWPPP	Storm Water Pollution Prevention Plan
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TEF	Toxic Equivalent Factor
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLA	Waste Load Allocation
WWTF	Wastewater Treatment Facility

**SUMMARY SHEET**

**WOLF RIVER**

**Total Maximum Daily Load for Dioxins as**

**Identified on the State of Tennessee's *Proposed Final 2010 303(d) List***

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**Impaired Waterbody Information:**

State: Tennessee

Counties: Shelby

Watershed: Wolf River Watershed (HUC 08010210)

Constituents of Concern: Dioxins

<b>Waterbody ID</b>	<b>Impaired Waterbody</b>	<b>Miles</b>
TN08010210001_1000	Wolf River	12.8
TN08010210002_1000	Wolf River	6.3

Designated Uses: Fish & aquatic life, industrial water supply, irrigation, livestock watering & wildlife, and recreation.

Applicable Water Quality Standard Most stringent numerical criteria applicable to recreation use classification

Total Dioxin:  $1 \times 10^{-6}$  µg/L

Toxic Substances The waters shall not contain toxic substances, whether alone or in combination with other substances, that will render the waters unsafe or unsuitable for water contact activities including the capture and subsequent consumption of fish and shellfish, or will propose toxic conditions that will adversely affect man, animal, aquatic life, or wildlife. Human health criteria have been derived to protect the consumer from consumption of contaminated fish and water. The water and organisms criteria should only be applied to those waters classified for both recreation and domestic water.

## **TMDL Development**

### General Analysis Methodology:

- Composite fish tissue samples are collected and analyzed for constituents of concern. Existing loads of dioxins in the water column are estimated from the fish tissue concentrations using the Bioconcentration Factors defined by the U.S. Environmental Protection Agency.
- The TMDLs are expressed in lbs/day as a function of flow. To assist with implementation, the TMDLs are also expressed as a maximum water column concentration ( $\mu\text{g/L}$ ) and as a maximum fish tissue concentration ( $\text{mg/kg}$ ), which are equivalent to the target criteria.
- Waste Load Allocations (WLAs) are derived for point source dischargers of dioxins.
- Load Allocations are established for non-point sources using a mass-balance approach.
- Fish tissue monitoring data indicate that levels of dioxins are below the target criteria. Since most of the monitoring data for dioxins is more than 10 years old, TDEC recommends additional fish tissue monitoring. At this time, a TMDL has been provided for dioxins. If more recent data confirms concentrations below the target level, TDEC recommends de-listing of Wolf River for dioxins.

### Critical Conditions and Seasonal Variation:

The methodology takes into account that the pollutants are contained in the sediment. The methodology addresses all seasons.

### Margin of Safety:

5% (Explicit)

### Summary of TMDLs, WLAs, and LAs

Waterbody ID	Pollutant	WLAs	LAs <sup>1</sup>	MOS <sup>1</sup>	TMDLs		
					Maximum Load <sup>1</sup>	Maximum Water Column Concentration <sup>2</sup>	Maximum Fish Tissue Concentration <sup>2</sup>
					(lbs/day) <sup>3</sup>	(µg/L)	(mg/kg)
TN08010210001_1000	Dioxins	0	Q * 5.12E-09	Q * 2.70E-10	Q * 5.39E-09	1.0E-06	5.0E-06
TN08010210002_1000	Dioxins	0	Q * 5.12E-09	Q * 2.70E-10	Q * 5.39E-09	1.0E-06	5.0E-06

1 The LA, MOS, and the Maximum Load TMDL are expressed as a function of flow ( $Q_1$ ), where  $Q_1$  represents the annual average flow of the Wolf River at the pour point of the segment.

2 The TMDL is also expressed in terms of maximum allowable water column concentration and maximum fish tissue concentration because TDEC recognizes that these values provide information that potentially will be more useful regarding TMDL implementation efforts than the values that are expressed in terms of an allowable load.

3 Daily load, in lbs/day, is expressed as an annual average.

## **TOTAL MAXIMUM DAILY LOADS (TMDLs) FOR WOLF RIVER**

### **1.0 INTRODUCTION**

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology-based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Impaired waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those waterbodies that are not attaining water quality standards. State water quality standards consist of designated use(s) for individual waterbodies, appropriate numeric and narrative water quality criteria protective of the designated uses, and an antidegradation statement. The TMDL process establishes the maximum allowable loadings of pollutants for a waterbody that will allow the waterbody to maintain water quality standards. The TMDL may then be used to develop controls for reducing pollution from both point and non-point sources in order to restore and maintain the quality of water resources (USEPA, 1991).

### **2.0 WATERSHED DESCRIPTION**

The Wolf River Watershed is located in Mississippi and Southwestern Tennessee (ref.: Figure 1). The watershed includes parts of Fayette, Hardeman, and Shelby counties in Tennessee. The Tennessee portion of the Wolf River Watershed, HUC 08010210 has approximately 1026 miles of streams and drains approximately 569 square miles. The entire Wolf River Watershed drains approximately 805 square miles.

The Wolf River Watershed lies within three Level III ecoregions (Southeastern Plains, Mississippi Alluvial Plain, and Mississippi Valley Loess Plains) and contains three Level IV ecoregions as shown in Figure 2 (USEPA, 1997).

Watershed land use distribution is based on the Multi-Resolution Land Characteristic (MRLC) databases derived from Landsat Thematic Mapper digital images from approximately 2001. Although changes in the land use of the Lower Tennessee River watershed have occurred since 2001 as a result of rapid development, this is the most current land use data available. Table 1 summarizes land use for the Lower Tennessee River watershed, as shown in Figure 3.

**Figure 1 Location of Wolf River Watershed**

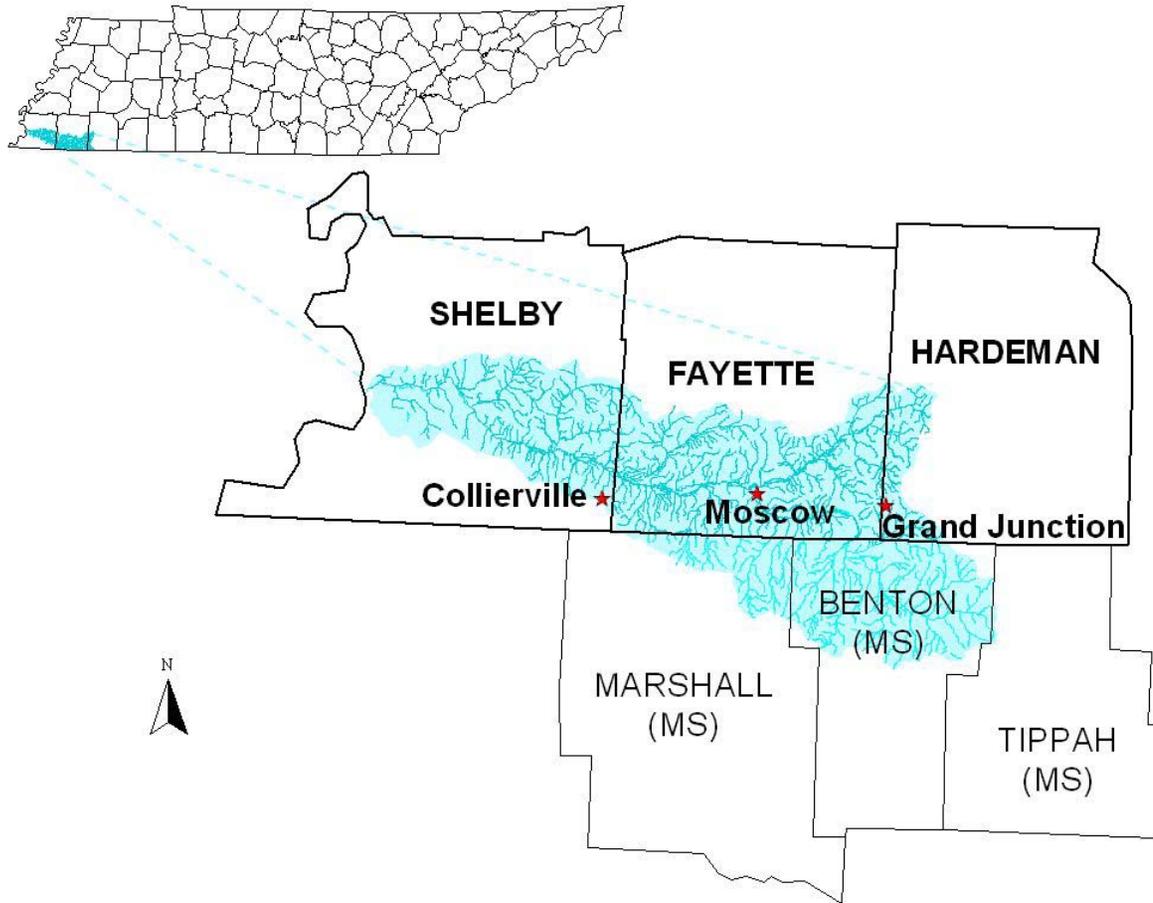


Figure 2 Level IV Ecoregions in the Wolf River Watershed

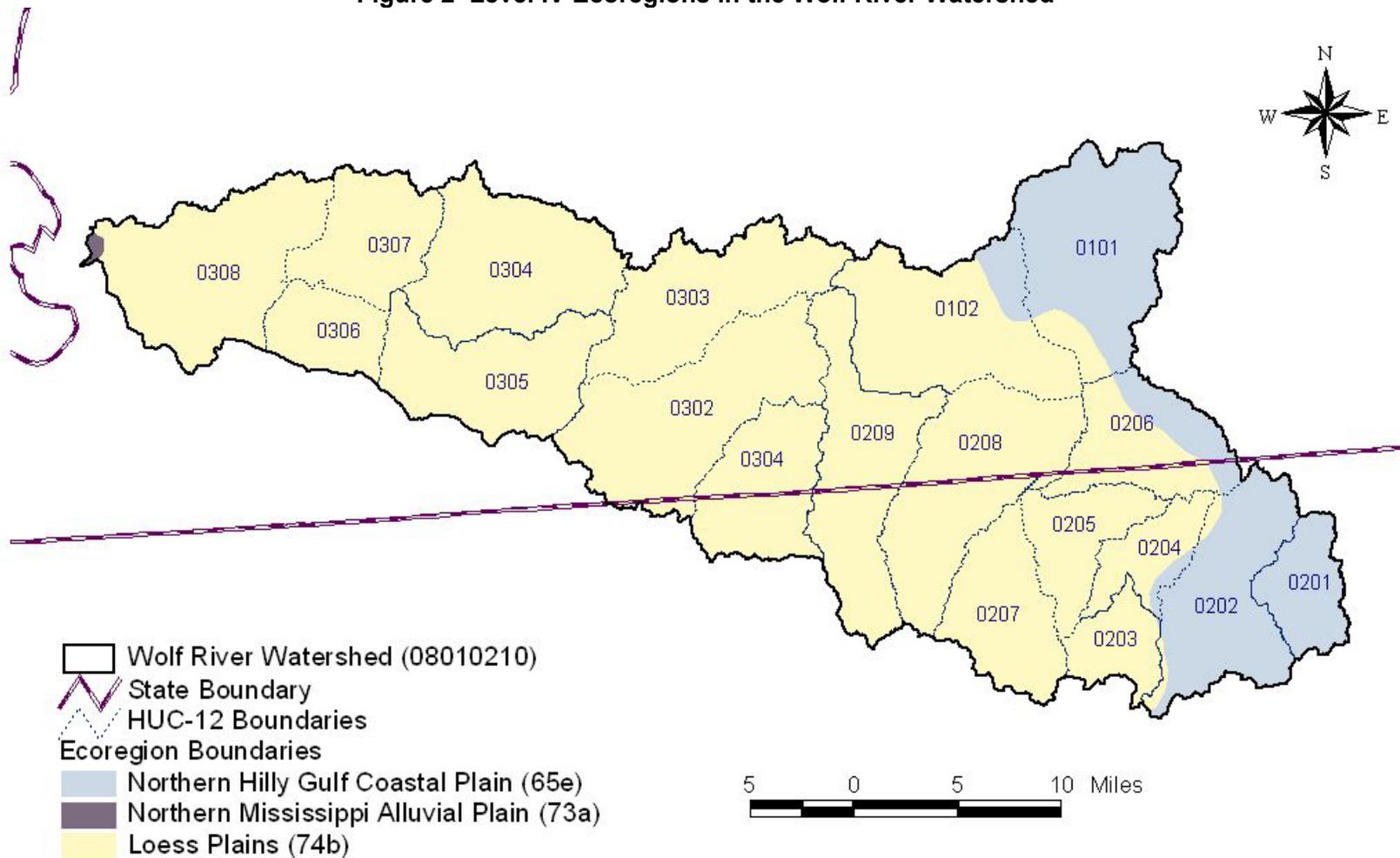
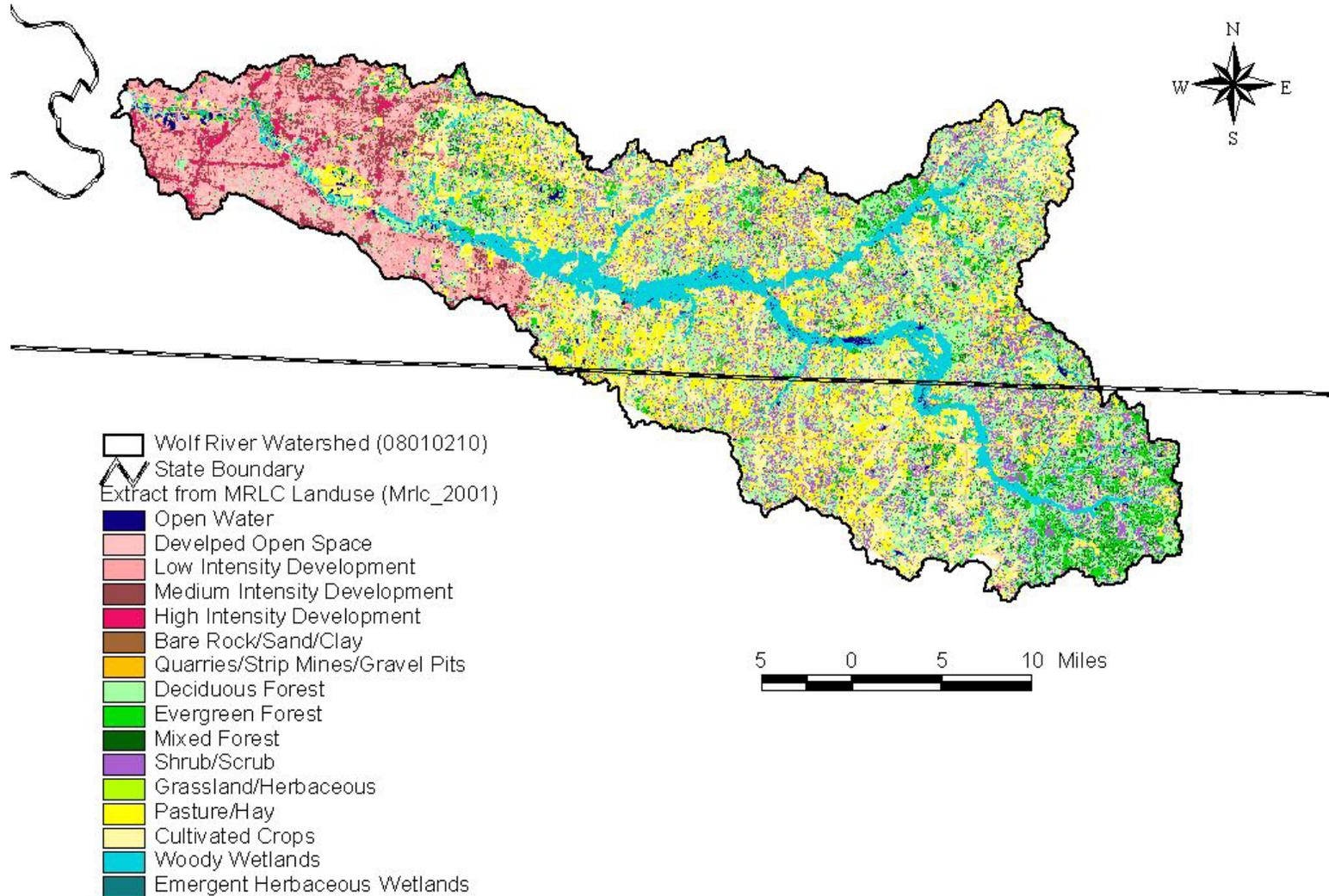


Figure 3 Land Use in the Wolf River Watershed



**Table 1. MRLC Land Use Distribution – Wolf River Watershed (08010210)**

Land use	Wolf River Watershed (TN & MS)		Wolf River Watershed (TN only)	
	[acres]	[%]	[acres]	[%]
Open Water	5,242	1.0	4,115	1.1
Developed Open Space	43,977	8.4	39,366	10.8
Low Intensity Development	33,441	6.4	31,791	8.7
Medium Intensity Development	16,878	3.2	16,715	4.6
High Intensity Development	4,613	0.9	4,588	1.3
Barren Land (Rock/Sand/Clay)	0	0.0	0	0.0
Deciduous Forest	104,518	19.9	63,400	17.4
Evergreen Forest	20,128	3.8	9,322	2.6
Mixed Forest	16,301	3.1	8,376	2.3
Shrub/Scrub	64,262	12.3	36,999	10.2
Grassland/Herbaceous	1,992	0.4	1,347	0.4
Pasture/Hay	74,011	14.1	50,181	13.8
Cultivated Crops	93,615	17.9	62,126	17.1
Woody Wetlands	43,086	8.2	34,340	9.4
Emergent Herbaceous Wetlands	2,201	0.4	1,529	0.4
Total	524,265	100.0	364,196	100.0

Note: A spreadsheet was used for this calculation and values are approximate due to rounding.

### 3.0 PROBLEM DEFINITION

The designated use classifications for the Wolf River include industrial water supply, fish & aquatic life, irrigation, livestock watering & wildlife, and recreation. The State of Tennessee's *Proposed Final 2010 303(d) List* (TDEC, 2010) identified two segments of the Wolf River as not fully supporting designated use classifications due, in part, to elevated levels of dioxin in fish tissue samples. An excerpt from the *Proposed Final 2010 303(d) List* is presented in Table 2 and the impaired segments are shown in Figure 4. Assessment information excerpted from the Assessment Database (ADB) is also listed in Table 2. ADB information may be accessed at:

<http://tnmap.tn.gov/wpc/>

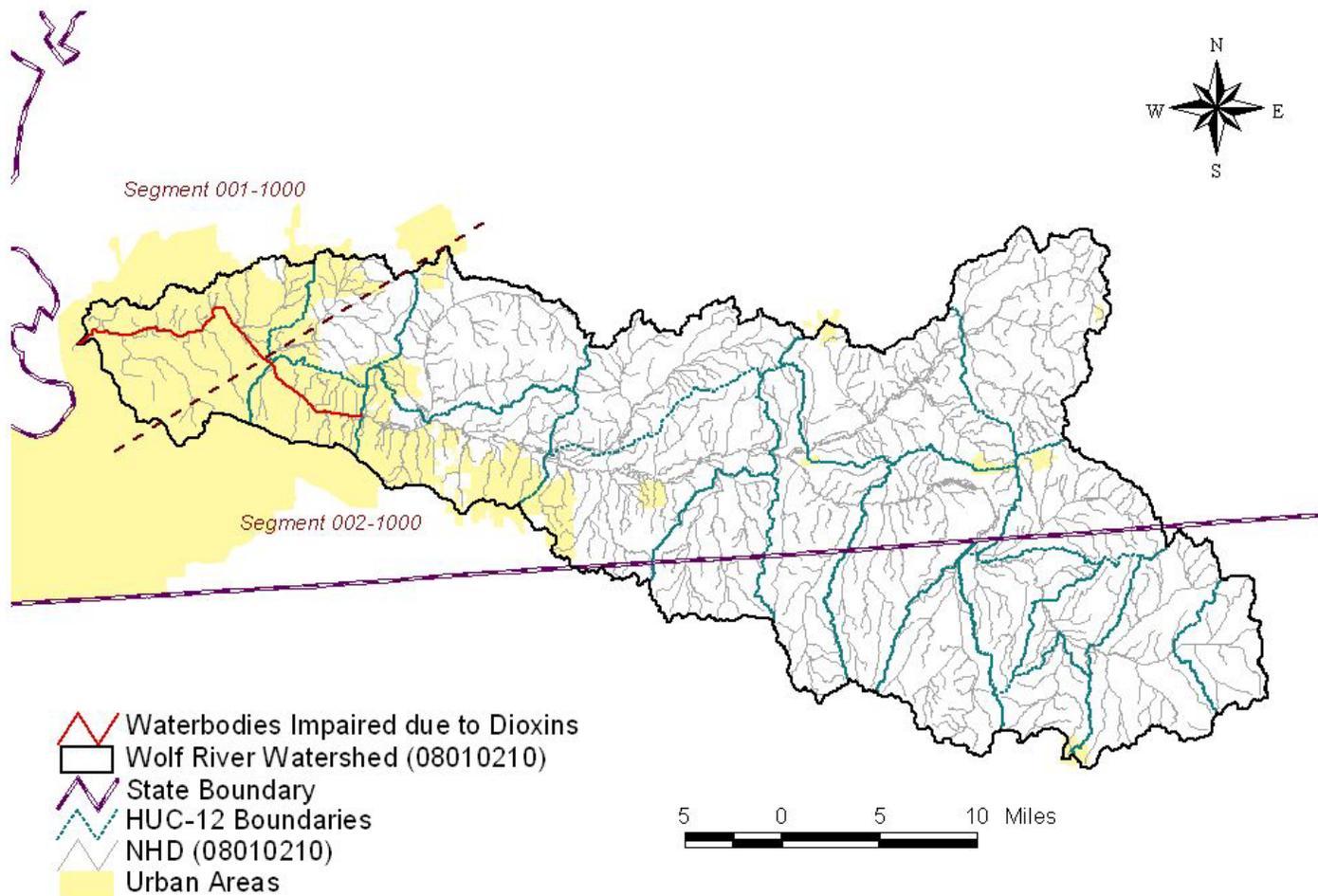
#### 3.1 Dioxins

Dioxins are a group of synthetic organic chemicals that contain 210 structurally related (congeners) chlorinated dibenzo-p-dioxins (CDD's) and chlorinated dibenzofurans (CDFs) (USEPA, 1999). Some polychlorinated biphenyls (PCBs) are also regarded as "dioxin-like" in nature. Each congener possesses different physical and chemical properties. As a result, there is a range of toxicity among these structurally related organics. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is the most toxic of any dioxins. Toxic Equivalent Factors (TEFs) were derived to express the toxicity of other dioxins "as a fraction of the toxicity attributed to 2,3,7,8-TCDD" (ATSDR, 1998).

Dioxins are largely created as unintentional by-products of incomplete combustion and various chemical processes, like chlorine bleaching in pulp and paper mills, and as contaminants during the production of some chlorinated organic chemicals such as chlorinated phenols (USEPA, 1999). These chlorinated hydrocarbons are persistent environmental contaminants, with environmental half-lives ranging from years to several decades. According to *An Inventory of Sources and Environmental Releases of Dioxin-Like Compounds in the United States for the Years 1987, 1995, and 2000*, "dioxin-like compounds enter surface water from atmospheric deposition, stormwater runoff erosion, and discharges of anthropogenic wastes" (USEPA, 2006).

Humans are predominately exposed to dioxins through dietary intake. Dioxins have been demonstrated to bioaccumulate in the aquatic food chain; therefore, contaminated fish and shellfish are a primary route of exposure. The exposure to any dioxins is associated with a number of adverse effects. EPA has classified dioxins as Group B2 (probable carcinogen). Furthermore, experiments "have shown toxic effects to the liver, gastrointestinal system, blood, skin, endocrine system, immune system, nervous system, and reproductive system" (USEPA, 1999).

**Figure 4** Location of Wolf River Dioxin Impairments (Documented on the Proposed Final 2010 303(d) List)



**Table 2 Proposed Final2010 303(d) List - Stream Impairment Due to Dioxin**

<b>Waterbody ID</b>	<b>Impacted Waterbody</b>	<b>Miles/ Acres</b>	<b>Cause (Pollutant)</b>	<b>Source (Pollutant)</b>
TN08010210001_1000	Wolf River (Mississippi River to Fletcher Creek)	12.8 mi	Mercury Lead Chlordane PCBs Dioxin Loss of biological integrity due to siltation Eschericia coli	Atmospheric Deposition Discharges from MS4 area RCRA Hazardous Waste Site Channelization Contaminated Sediments
TN08010210002_1000	Wolf River (Fletcher Creek to Highway 177)	6.3 mi	Mercury Chlordane PCBs Dioxin Lead Loss of biological integrity due to siltation Eschericia coli	Atmospheric Deposition RCRA Hazardous Waste Site Contaminated Sediment Channelization Discharges from MS4 area

#### 4.0 TARGET IDENTIFICATION

These TMDLs are being proposed for Wolf River, which is impaired because dioxins in fish tissue samples were detected at levels that exceed the applicable water quality criteria. In order for a TMDL to be established, a numeric “target” protective of the uses of the water must be identified to serve as the basis for the TMDL. Numerical criteria, applicable for dioxins, have been established in the *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, October 2007* (TDEC, 2007) to preserve the various use classifications. Fish tissue target criteria will be used in this TMDL because, in the State of Tennessee, assessment of waterbody segments for impairment due to dioxins is based on fish tissue concentration. A detailed discussion of the calculations involved in the development of fish tissue target criteria, and the relationship of fish tissue concentrations to published numerical water column criteria, is included in Appendix A. For the purpose of this TMDL, target criteria expressed as the fish tissue concentrations are summarized in Table 3. These values are based on the water quality criteria for the recreation designated use classification.

**Table 3 Fish Tissue Target Criteria**

Pollutant	Water Quality Criteria	Target Criteria
		(mg/kg)
Dioxins	$1 \times 10^{-6} \mu\text{g/L}$	$5 \times 10^{-6}$

#### 5.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

Fish tissue samples were collected and analyzed as defined in *The Results of Fish Tissue Monitoring in Tennessee 1992-1997* (TDEC). Fish tissue data were available from the sites shown in Figure 5. According to the methodology outlined in Section 7.1, the water column concentrations and the existing loads of dioxins in the water column were calculated from composite fish tissue data.

##### 5.1 Dioxins Water Quality Assessment and Deviation

The concentration of dioxins in the water column was estimated using fish tissue monitoring data from the sites shown in Figure 5 and the Bioconcentration Factor defined by the U.S. Environmental Protection Agency (ref.: Appendix A). This data is presented in Table 4.

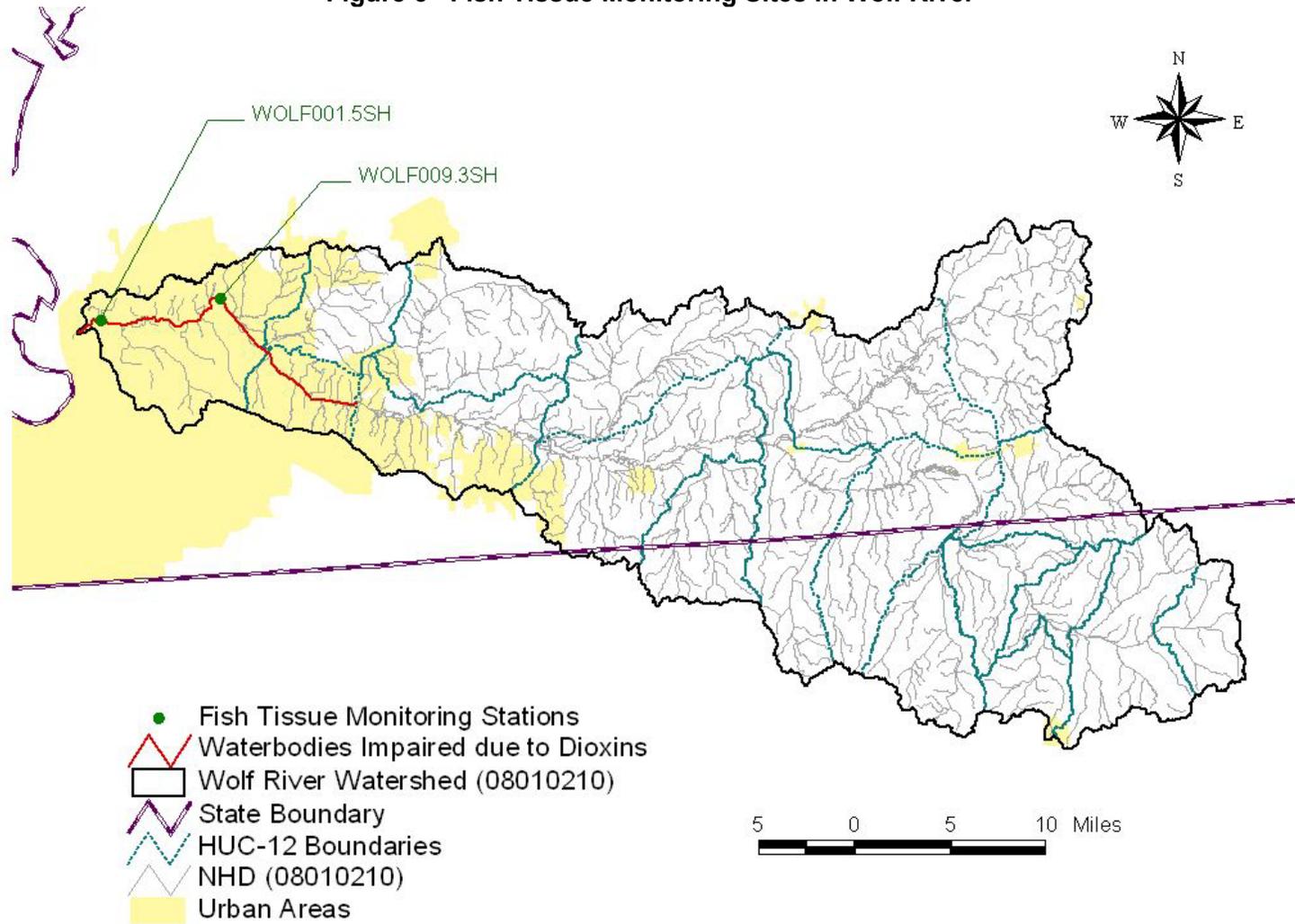
**Table 4 Existing Concentrations of Total Dioxin in the Wolf River  
 Calculated from Composite Fish Tissue Samples**

Fish Species	Sample Year	Sampling Site Location	Dioxins in Fish Sample (x10 <sup>-6</sup> ppm)	Calculated Water Column Concentration (x10 <sup>-6</sup> µg/L)
Bigmouth Buffalo	1997	RM 9.3	1.5823	
		<b>Geomean</b>	<b>1.5823</b>	<b>0.3165</b>
Carp	1997	RM 9.3	2.9903	
		<b>Geomean</b>	<b>2.9903</b>	<b>0.5981</b>
Carp sucker	1997	RM 1.5	0.7512	
	2006	RM 1.5	0.8845	
		<b>Geomean</b>	<b>0.8151</b>	<b>0.1630</b>
Channel Catfish	1996	RM 1.5	1.2938	
	1997	RM 1.5	3.2837	
	1997	RM 9.3	2.7934	
	2006	RM 1.5	0.3692	
		<b>Geomean</b>	<b>1.6502</b>	<b>0.3301</b>
Drum	1997	RM 1.5	0.2419	
		<b>Geomean</b>	<b>0.2419</b>	<b>0.0484</b>
Flathead Catfish	1996	RM 1.5	0.6982	
		<b>Geomean</b>	<b>0.6982</b>	<b>0.1396</b>
Largemouth Bass	1996	RM 1.5	0.2807	
		<b>Geomean</b>	<b>0.2807</b>	<b>0.0561</b>
White Bass	2006	RM 1.5	0.4481	
		<b>Geomean</b>	<b>0.4481</b>	<b>0.0896</b>

According to the geometric mean of dioxin concentrations, the existing water column concentration was calculated to be 0.5981 x 10<sup>-6</sup> µg/L, which is less than the 1x10<sup>-6</sup> µg/L target value. Note that the geomean of the dioxin concentrations for each fish species was calculated using all of the available monitoring data because (1) more recent monitoring data was limited, and (2) the more recent data did not show a clear trend.

Since the most recent monitoring data for dioxins is limited, with most of the monitoring data being more than 10 years old, TDEC recommends additional fish tissue monitoring. At this time, a TMDL will be provided for dioxins. If more recent data confirms concentrations below the target level, TDEC recommends de-listing of the Wolf River for dioxins.

Figure 5 Fish Tissue Monitoring Sites in Wolf River



## 6.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories of pollutants in the watershed and the amount of pollutant loading contributed by each of these sources. According to the Clean Water Act, sources are broadly classified as either point or non-point sources. Under 40 CFR §122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Regulated point sources include: 1) municipal and industrial wastewater treatment facilities (WWTFs); 2) storm water discharges associated with industrial activity (which includes construction activities); and 3) certain discharges from Municipal Separate Storm Sewer Systems (MS4s). For the purposes of these TMDLs, all sources of pollutant loading not regulated by NPDES are considered non-point sources.

### 6.1 Point Sources

There are numerous permitted dischargers in the Wolf River watershed. However, there are currently no permitted point source dischargers with existing allocations for dioxins in the Wolf River watershed.

### 6.2 Non-point Sources

Assessments have determined that contaminated sediment is the source of dioxin impairments in the Wolf River. There are two hazardous waste sites located in the Wolf River Watershed. Ross Metals Inc. hazardous waste site (TND096070396) is located upstream of these impaired segments, while North Hollywood Dump (TND980558894) is located in Shelby County. According to references compiled by the U.S. Environmental Protection Agency, the sites have not been associated with dioxin contamination (USEPA, 2008).

This TMDL will consider contaminated sediment as the primary source of dioxin contamination in Wolf River. According to the U.S. Environmental Protection Agency, these pollutants have a very low solubility in water and low volatility and they are contained in sediments that serve as reservoirs from which these pollutants may be released over a long period of time (USEPA 1999).

## 7.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations) and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma \text{WLAs} + \Sigma \text{LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure.

### 7.1 Critical Conditions and Seasonal Variation

Critical conditions were incorporated into the TMDL analysis by using the entire period of record (1996-2006) for the fish tissue monitoring data. Fish tissue data were collected during a variety of seasons. Dioxin concentrations are not expected to fluctuate very much due to the fact that these pollutants are contained mainly in the sediment

### 7.2 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) in TMDL analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In these TMDLs, a 5% explicit MOS was incorporated to account for uncertainties.

### 7.3 Determination of TMDLs

In this document, the TMDLs are daily loads expressed as a function of the annual average flow (daily loading function). The daily load is calculated by multiplying the water quality criterion by the annual average flow (represented by Q) and the required unit conversion factor.

Example:           Water quality criterion for dioxins =  $1.0 \times 10^{-6}$   $\mu\text{g/L}$   
                      Conversion Factor =  $5.39 \times 10^{-3}$  (lbs-L-sec/ $\mu\text{g-ft}^3$ -day)  
                      Daily Load =  $Q * 5.39 \times 10^{-9}$  lbs/day

For implementation purposes, the TMDLs are also expressed as maximum water column concentrations and maximum fish tissue concentrations (as determined in Appendix A).

**Table 5 TMDLs, WLAs, and LAs for the Wolf River Watershed**

Waterbody ID	Pollutant	WLAs	LAs <sup>1</sup>	MOS <sup>1</sup>	TMDLs		
					Maximum Load <sup>1</sup>	Maximum Water Column Concentration <sup>2</sup>	Maximum Fish Tissue Concentration <sup>2</sup>
					(lbs/day) <sup>3</sup>	(lbs/day) <sup>3</sup>	(lbs/day) <sup>3</sup>
TN08010210001_1000	Dioxins	0	Q * 5.12E-09	Q * 2.70E-10	Q * 5.39E-09	1.0E-06	5.0E-06
TN08010210002_1000	Dioxins	0	Q * 5.12E-09	Q * 2.70E-10	Q * 5.39E-09	1.0E-06	5.0E-06

- 1 The LA, MOS, and the Maximum Load TMDL are expressed as a function of flow ( $Q_1$ ), where  $Q_1$  represents the annual average flow of the Wolf River at the pour point of the segment.
- 2 The TMDL is also expressed in terms of maximum allowable water column concentration and maximum fish tissue concentration because TDEC recognizes that these values provide information that potentially will be more useful regarding TMDL implementation efforts than the values that are expressed in terms of an allowable load.
- 3 Daily load, in lbs/day, is expressed as an annual average.

#### 7.4 Determination of WLAs & LAs

There are currently no permitted point source dischargers with existing allocations for dioxins. Waste load allocations (WLAs) of zero are being provided.

The load allocation requires the contribution from non-point sources to be less than or equal to the TMDL target value. In the absence of point sources:

$$LA = TMDL - MOS$$

TMDLs, WLAs, and LAs are summarized in Table 5.

### 8.0 IMPLEMENTATION PLAN

#### 8.1 Non-point Sources

The Tennessee Department of Environment & Conservation (TDEC) has no direct regulatory authority over most non-point source discharges. Voluntary, incentive-based mechanisms will be used to implement non-point source management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the impaired waterbody.

Two segments of the Wolf River was listed as impaired on the *2010 303(d) List* because they were not fully supporting designated use classifications due, in part, to elevated levels of dioxins. Contaminated sediments were listed as the likely source for the contamination in the Wolf River.

There are generally two options to prevent dioxins contained in the sediment from being released to the reservoir: 1) avoid disturbing the sediment or 2) remediate contaminated sites. TDEC recommends using option one whenever possible. If the sediment must be disturbed, remediation efforts will be necessary to control the load of dioxins in the reservoir so that the water quality criteria are not exceeded. Strategies to identify sites with elevated levels of dioxins may be helpful for implementing controls to prevent the contaminants from being released into the river.

#### 8.2 Evaluation of TMDL Effectiveness

The effectiveness of these TMDLs will be assessed as data becomes available. As less of the contaminants become biologically available, the concentrations of dioxin measured in fish tissue samples should theoretically decline. Watershed monitoring and assessment activities will provide information by which the effectiveness of dioxin load allocations can be evaluated. Continued fish tissue sampling will be necessary to monitor the efficacy of the proposed TMDLs. These results will be reevaluated during subsequent water quality assessment cycles as required by the Clean Water Act.

## 9.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed TMDLs for dioxins in the Wolf River Watershed were placed on Public Notice for a 35-day period and comments solicited. Steps that were taken in this regard include:

- 1) Notice of the proposed TMDLs was posted on the Tennessee Department of Environment and Conservation website. The announcement invited public and stakeholder comment and provided a link to a downloadable version of the TMDL document.
- 2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings, which is sent to interested persons or groups who have requested this information.
- 3) A letter was sent to identified water quality partners in the Wolf River watershed advising them of the proposed dioxin TMDLs, stating the document's availability on the TDEC website, and inviting comments. These partners include:

Natural Resources Conservation Service  
Tennessee Department of Agriculture  
Tennessee Wildlife Resources Agency  
The Nature Conservancy  
United States Army Corps of Engineers  
United States Fish and Wildlife Service  
United States Geological Survey  
Tennessee Water Sentinels  
Wolf River Conservancy

- 3) A draft copy of the proposed TMDLs was sent to the following MS4s:

Shelby County (TNS075663)  
City of Memphis MS4 (TNS068276)  
Tennessee Dept. of Transportation (TNS077585)

## 10.0 FURTHER INFORMATION

Further information concerning Tennessee's TMDL program can be found on the Internet at the Tennessee Department of Environment and Conservation website:

<http://www.state.tn.us/environment/wpc/tmdl/>

Technical questions regarding these TMDLs should be directed to the following members of the Division of Water Pollution Control staff:

Vicki S. Steed, Watershed Management Section  
E-mail: [Vicki.Steed@tn.gov](mailto:Vicki.Steed@tn.gov)

Bruce R. Evans, P.E., Watershed Management Section  
Email: [Bruce.Evans@tn.gov](mailto:Bruce.Evans@tn.gov)

Sherry H. Wang, Ph.D., Watershed Management Section  
E-mail: [Sherry.Wang@tn.gov](mailto:Sherry.Wang@tn.gov)

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**APPENDIX A**

**Development of Fish Tissue Concentrations  
Equivalent to Water Quality Criteria for Dioxin**

In the State of Tennessee, assessment of waterbody segments for impairment due to dioxin are based on fish tissue concentrations. Public fishing advisories are also based upon fish tissue concentrations. Therefore, for the purpose of this TMDL, dioxin concentrations from fish tissue samples will be converted to their equivalent water column concentrations.

For dioxin, the fish tissue concentration requiring a fish advisory is based on the water quality criterion as established by *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, October 2007* (TDEC, 2007). The water quality criterion is based on a combination of EPA and USFDA assumptions and was approved by EPA in 1999. (For a more complete explanation, see *Dioxin Levels in Pigeon River Fish: 1996-2002* [TDEC, 2002]). The water criterion of 1 ppq is multiplied by the bioconcentration factor for dioxin and the appropriate conversion factor:

$$C_{\text{fish}} = [C_{\text{water}} * \text{BCF}] / \text{CF2} \quad (\text{Equation A-1})$$

where:

CF2 = Conversion Factor (1000  $\mu\text{g}/\text{mg}$ )  
BCF = Bioconcentration Factor (5,000 L/kg)

The resulting fish tissue concentration is:

$$C_{\text{fish}} = [(1 \times 10^{-6} \mu\text{g}/\text{L}) * (5000 \text{ L}/\text{kg})] / (1000 \mu\text{g}/\text{mg}) = 5 \times 10^{-6} \text{ mg}/\text{kg}$$

where:

$$1 \text{ ppq} = 1 \times 10^{-6} \mu\text{g}/\text{L}$$

Therefore, the fish tissue concentration calculated from Equation A-1 ( $5 \times 10^{-6} \text{ mg}/\text{kg}$ ) will be used as the target criterion for this TMDL.

Total dioxins were calculated as the sum of the concentrations of all polychlorinated dibenzo-p-dioxins (CDD) and polychlorinated dibenzofuran (CDF) isomers after multiplication by the appropriate Toxic Equivalent Factor (TEF):

$$C_{\text{dioxins}} = \sum [C_i \times \text{TEF}_i]$$

where:

$C_{\text{dioxins}}$  = Total dioxins measured in fish tissue samples (ppt)  
 $C_i$  = Concentration of isomer  $i$  in fish tissue samples (ppt)  
 $\text{TEF}_i$  = Toxic Equivalent Factor specific for isomer  $i$

The TEF approach compares the relative potential toxicity of each dioxin like compound in the mixture to the toxicity of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD), the most toxic member of the group. The TEF for 2,3,7,8-TCDD is defined as unity; and the TEFs for all other polychlorinated dibenzo-p-dioxins (CDDs), polychlorodibenzofurans (CDFs), and certain coplanar polychlorinated biphenyls (PCBs) are defined with values that are less than one which reflects their lower toxic potency relative to 2,3,7,8 TCDD (USEPA, 2006).

The TEFs used in this TMDL were recommended by the EPA (USEPA, 2007).

**APPENDIX B**

**Public Notice Announcement**

**STATE OF TENNESSEE  
DEPARTMENT OF ENVIRONMENT AND CONSERVATION  
DIVISION OF WATER POLLUTION CONTROL**

**PUBLIC NOTICE OF AVAILABILITY OF PROPOSED  
TOTAL MAXIMUM DAILY LOAD (TMDLS) FOR  
DIOXINS  
FOR THE  
WOLF RIVER WATERSHED (HUC 08010210), TENNESSEE**

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Loads (TMDLs) for dioxins for the Wolf River in the Wolf River Watershed, located in southwestern Tennessee. Section 303(d) of the Clean Water Act requires states to develop TMDLs for waters on their impaired waters list. TMDLs must determine the allowable pollutant load that the water can assimilate, allocate that load among the various point and nonpoint sources, include a margin of safety, and address seasonality.

The Wolf River was identified on Tennessee's Proposed Final 2010 303(d) list as not supporting designated use classifications due to elevated levels of dioxins in fish tissue samples. Contaminated sediments are the source of pollutant causes associated with these impairments. Using a mass-balance approach, the TMDLs utilize Tennessee's general water quality criteria, fish tissue sampling data collected from the Wolf River, fish advisory calculations, Bioconcentration Factors defined by the U.S. Environmental Protection Agency, and an appropriate Margin of Safety (MOS) to establish dioxin loading levels which will result in lower fish tissue concentrations and the attainment of water quality standards.

The proposed dioxin TMDLs may be downloaded from the Department of Environment and Conservation website:

<http://www.tennessee.gov/environment/wpc/tmdl/proposed.shtml>

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

Vicki S. Steed, P.E., Watershed Management Section  
Telephone: 615-532-0707

Sherry H. Wang, Ph.D., Watershed Management Section  
Telephone: 615-532-0656

Persons wishing to comment on the proposed TMDL are invited to submit their comments in writing no later than June 20, 2011 to:

Division of Water Pollution Control  
Watershed Management Section  
7<sup>th</sup> Floor, L & C Annex  
401 Church Street  
Nashville, TN 37243-1534

All comments received prior to that date will be considered when revising the TMDL for final submittal to the U.S. Environmental Protection Agency.

The TMDL and supporting information are on file at the Division of Water Pollution Control, 6<sup>th</sup> Floor, L & C Annex, 401 Church Street, Nashville, Tennessee. They may be inspected during normal office hours. Copies of the information on file are available on request.

**APPENDIX C**  
**Comments Received**



A C WHARTON, JR. - Mayor  
GEORGE M. LITTLE - Chief Administrative Officer  
**DIVISION OF PUBLIC WORKS**  
DWAN L. GILLIOM - Director  
Storm Water Program

RECEIVED  
JUN 20 2011

June 17, 2011

Ms. Sherry H. Wang, Ph.D., Manager  
Watershed Management Section  
Tennessee Department of Environment and Conservation  
Division of Water Pollution  
401 Church Street  
L&C Annex, Seventh Floor  
Nashville, Tennessee 37243

RE: Draft of Proposed Total Maximum Daily Load  
For Dioxins  
Wolf River Watershed, Tennessee

Dr. Wang:

The City of Memphis respectfully submits the attached comments to the referenced document for your review and comment.

Sincerely,

Bobby D. Allen, P.E.  
Storm Water Program Manager  
City of Memphis

**Comments on Draft Proposed Total Maximum Daily Load for Dioxins  
for Wolf River Watershed, Tennessee**

Summary Sheet Page V, TMDL Development, General Analysis Methodology,  
Bullet Five

This section states that “Fish tissue monitoring data indicate that levels of dioxins are below the target criteria. Since most of the monitoring data for dioxins is more than 10 years old, TDEC recommends additional fish tissue monitoring. At this time, a TMDL has been provided for dioxins. If more recent data confirms concentrations below the target level, TDEC recommends de-listing of Wolf River for dioxins.”

Section 5.1 Dioxins Water Quality Assessment and Deviation, Paragraphs 2 and 3

These paragraphs states that “According to the geometric mean of dioxin concentrations, the existing water column concentration was calculated to be  $0.5981 \times 10^{-6}$  ug/L, which is less than the  $1 \times 10^{-6}$  ug/L target value. Note that the geomean of the dioxin concentrations for each fish species was calculated using all of the available monitoring data because (1) more recent monitoring data was limited, and (2) the more recent data did not show a clear trend.

Since the most recent monitoring data for dioxins is limited, with most of the monitoring data being more than 10 years old, TDEC recommends additional fish tissue monitoring. At this time, a TMDL will be provided for dioxins. If more recent data confirms concentrations below the target level, TDEC recommends de-listing of the Wolf River for dioxins”

Section 6.2 Non-point Sources, First Paragraph

This paragraph states that “Assessments have determined that contaminated sediment is the source of dioxin impairments in the Wolf River.”

Section 7.1 Critical Conditions and Seasonal Variation

This paragraph states that “Critical conditions were incorporated into the TMDL analysis by using the entire period of record (1996-2006) for the fish tissue monitoring data. Fish tissue data were collected during a variety of seasons. Dioxin concentrations are not expected to fluctuate very much due to the fact that these pollutants are contained mainly in the sediment.”

**Comment:**

The Proposed Draft TMDL (Document) clearly states that the “levels of dioxins are below the target criteria”. In fact, the geometric mean analyses show the dioxin values to be approximately 40% below the target criteria. The Document further states that “contaminated sediment is the source of dioxin” and that dioxin concentrations are “not expected to fluctuate very much” because they are “contained mainly in the sediment”. Under present day regulations the potential for new sources of dioxins into the river is minimal (if any) and significantly less than historic contributions. Historic contributions have resulted in a concentration of 40% less than the target criteria. Therefore, future dioxin concentrations in the river are not expected to exceed the target criteria.

TDEC acknowledges that the dioxin data is “more than 10 years old” and “recommends additional fish tissue monitoring”. TDEC further states that if this new data “confirms concentrations below the target level”, TDEC will recommend the “de-listing of Wolf River for dioxins”.

Based on these facts, the City of Memphis believes that establishing a TMDL at this time contradicts accepted fundamental engineering practices. It is not justifiable, especially in today’s economy, to expend time and money addressing an unsubstantiated TMDL and then going through the de-listing process. The City believes that the TMDL should not be established until such time as valid data can be obtained and evaluated.

**APPENDIX D**

**Response to Comments Received**

TDEC thanks the City of Memphis for their interest in reviewing the draft version of this TMDL. TDEC's response to their comment is summarized below:

- As stated in Section 1, TMDLs must be developed for all waterbodies not attaining water quality standards as indicated by their inclusion on the 303(d) List. This is a requirement of the Clean Water Act.
- TMDLs are developed using the fish tissue data currently available. EPA's *Report of the Federal Advisory Committee on the Total Maximum Daily Load Program*, EPA 100-R-98-006 states "lack of certainty must not delay TMDL development" (USEPA, 1998). TDEC agrees that additional monitoring data would be desirable. However according to EPA's *Guidance for Water Quality-based Decisions: The TMDL Process*, EPA 440/4-91-001, "Lack of information about certain types of pollution problems (for example, those associated with nonpoint sources or with certain toxic pollutants) should not be used as a reason to delay implementation of water quality-based controls" (USEPA, 1991). As stated in Section 5.1, additional fish tissue sampling is recommended.
- Once more recent data has been obtained which confirms that the Wolf River is no longer impaired, it will be de-listed.