TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Metals

In The

Harpeth River Watershed (HUC 05130204)

Cheatham, Davidson, Dickson, Hickman, Rutherford, & Williamson County, Tennessee

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LIST OF ABBREVIATIONS

BMP	Best Management Practices
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
DWPC	Division of Water Pollution Control
EPA	Environmental Protection Agency
HUC	Hydrologic Unit Code
ITRC	Instream Total Recoverable Concentration
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
Rf3	Reach File v.3
RM	River Mile
TDEC	Tennessee Department of Environment & Conservation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USGS	United States Geological Survey
WCS	Watershed Characterization System
WLA	Waste Load Allocation

SUMMARY SHEET
Total Maximum Daily Load (TMDL) for Metals
Harpeth River Watershed

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1) Waterbody Information

State: Tennessee
County: Cheatham, Davidson, Dickson, Hickman, Rutherford, & Williamson

Major River Basin: Lower Cumberland River Basin
Watershed: Harpeth River (HUC 05130204)

Waterbody Name: Harpeth River

1998 303(d) List
Location: Harpeth River from West Fork Harpeth River to headwaters
Waterbody ID: TN05130204016
Impacted Stream Length: 37.3 miles
Constituent(s) of Concern: Antimony, Arsenic, Lead, Zinc

2002 Assessment
Location: Harpeth River – Unnamed Tributary downstream of Hwy. 31A to Unnamed Tributary upstream of College Grove
Waterbody ID: TN05130204018 - 2000
Impacted Stream Length: 2.7 miles
Constituent(s) of Concern: Metals & Lead

Designated Uses: Domestic Water Supply, Industrial Water Supply, Fish & Aquatic Life, Recreation, Livestock Watering & Wildlife, and Irrigation

Applicable Water Quality Standard: Numerical criteria for the Domestic Water Supply, Fish & Aquatic Life, and Recreation use classifications (Fish & Aquatic Life criteria are functions of hardness for some metals)

2. TMDL Development

Analysis Methodology:
- **Hardness dependent criteria based on Level IV ecoregion data**
- **Dry weather allowable concentrations based on acute & chronic criteria; loads based on 7Q10 low flow**
- **Wet weather allowable concentrations based on acute criteria**

Critical Conditions: Methodology addresses all flow conditions

Seasonal Variation: Methodology addresses all seasons

3. TMDL/Allocation

Margin of Safety (MOS): Implicit (conservative modeling assumptions)

Dry Weather Conditions:

TMDLs: See table for dry weather conditions
WLAs: None assigned
LAs: None assigned

TMDLs for Metals – Dry Weather Conditions

Metal (Total Recoverable)	TMDL – Dry Weather Conditions			
	Chronic		Acute	
	Concentration	Mass	Concentration	Mass
	[μg/l]	[lbs/day]	[μg/l]	[lbs/day]
Antimony	6	0.0384	—	—
Arsenic	50	0.3198	—	—
Cadmium	5	0.0063	32.74[b]	0.0295
Lead	5	0.0284	810.1[b]	0.7297
Zinc	710.1[a]	0.6396	777.7[b]	0.7005

a – 4-day average, once every three years.
b – 1-hour average, once every three years.

Wet Weather Conditions:

TMDLs: See table for wet weather conditions
WLAs: See table for wet weather conditions
LAs: See table for wet weather conditions

TMDLs, WLAs, & LAs for Metals – Wet Weather Conditions

Metal (Total Recoverable)	Wet Weather Conditions		
	TMDLs	WLAs	LAs
	[μg/l]	[μg/l]	[μg/l]
Antimony	12	12	10
Arsenic	100	100	5
Cadmium	32.74[a]	32.74[a]	1
Lead	810.1[a]	810.1[a]	5
Zinc	777.7[a]	777.7[a]	10

a – 1-hour average, once every three years.

TOTAL MAXIMUM DAILY LOAD (TMDL) FOR METALS HARPETH RIVER WATERSHED (HUC 05130204)

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. Listed 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 water bodies that are not meeting designated uses. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

2.0 WATERSHED DESCRIPTION

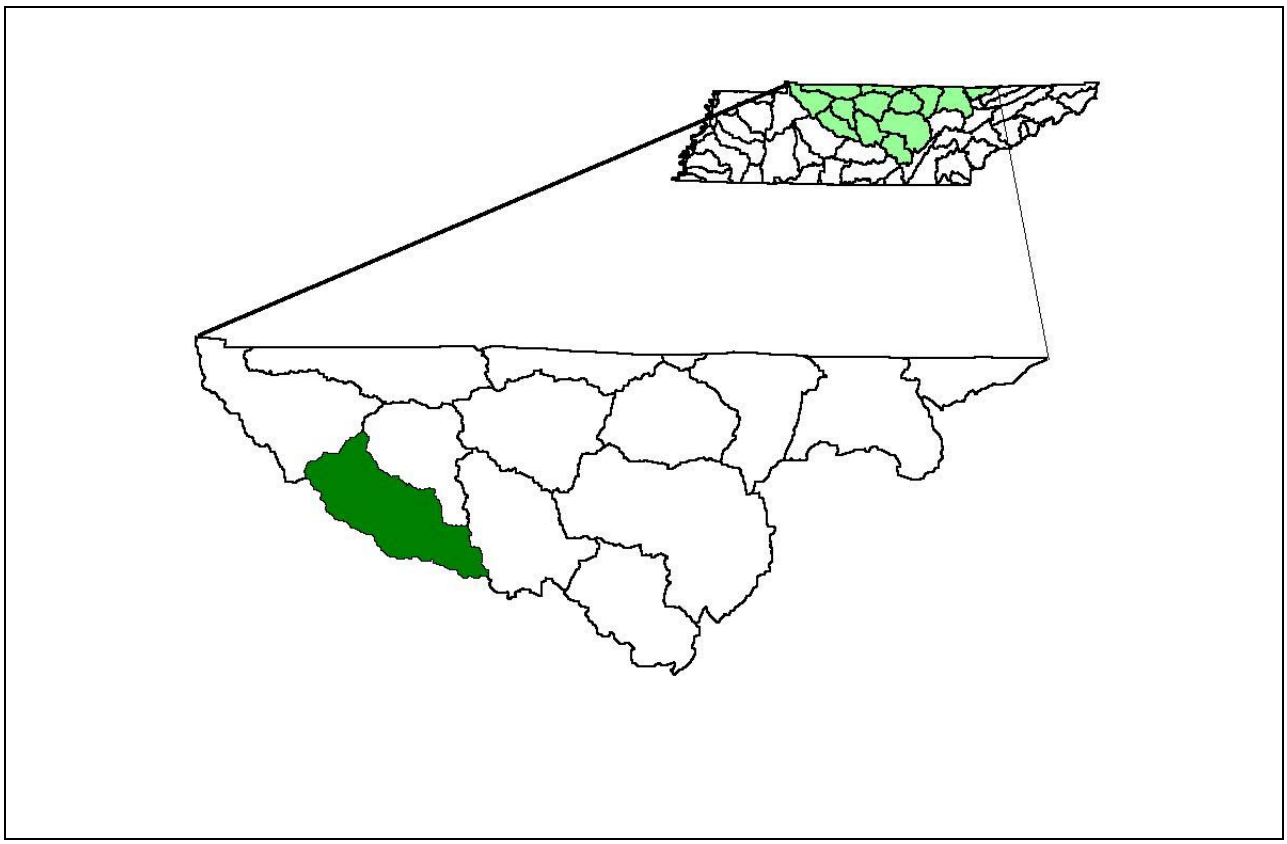
The Harpeth River watershed (HUC 05130204) is located in Middle Tennessee (Figure 1) and includes parts of Cheatham, Davidson, Dickson, Hickman, Rutherford, and Williamson Counties. The watershed lies within the Level III Interior Plateau (71) ecoregion and contains three Level IV subecoregions as shown in Figure 2 (USEPA, 1997):

- Western Highland Rim (71f) is characterized by dissected, rolling terrain of open hills, with elevations of 400 to 1000 feet. The geologic base of Mississippian-age limestone, chert, and shale is covered by soils that tend to be cherty, acidic and low to moderate in fertility. Streams are characterized by coarse chert gravel and sand substrates with areas of bedrock, moderate gradients, and relatively clear water. The oak-hickory natural vegetation was mostly deforested in the mid to late 1800's, in conjunction with the iron ore related mining and smelting of the mineral limonite, but now the region is again heavily forested. Some agriculture occurs on the flatter areas between streams and in the stream and river valleys: mostly hay, pasture, and cattle, with some cultivation of corn and tobacco.

- Outer Nashville Basin (71h) is a more heterogeneous region than the Inner Nashville Basin, with more rolling and hilly topography and slightly higher elevations. The region encompasses most all of the outer areas of the generally non-cherty Ordovician limestone bedrock. The higher hills and knobs are capped by the more cherty Mississippian-age formations, and some Devonian-age Chattanooga shale, remnants of the Highland Rim. The region's limestone rocks and soils are high in phosphorus, and commercial phosphate is mined. Deciduous forests with pasture and cropland are the dominant land covers. Streams are low to moderate gradient, with productive nutrient-rich waters, resulting in algae, rooted vegetation, and occasionally high densities of fish. The Nashville Basin as a whole has a distinctive fish fauna, notable for fish that avoid the region, as well as those that are present.

- Inner Nashville Basin (71i) is less hilly and lower than the Outer Nashville Basin. Outcrops of the Ordovician-age limestone are common, and the generally shallow soils are redder and lower in phosphorus than those of the Outer Basin. Streams are lower gradient than surrounding regions, often flowing over large expanses of limestone bedrock. The most characteristic hardwoods within the Inner Basin are a maple-oak-hickory-ash association. The limestone cedar glades of Tennessee, a unique mixed grassland/forest/cedar glades vegetation type with many endemic species, are located primarily on the limestone of the Inner Nashville Basin. The more xeric, open characteristics and shallow soils of the cedar glades also result in a distinct distribution of amphibian and reptile species.

Figure 1 Location of Harpeth River Watershed



The Harpeth River watershed has approximately 1,364 miles of streams (Rf3) and drains a total area of 863 square miles. The mouth of the Harpeth River is at Cumberland River (Cheatham Lake) mile 152.9. Watershed land use distribution is based on the Multi-Resolution Land Characteristic (MRLC) databases derived from Landsat Thematic Mapper digital images from the period 1990-1993. Land use for the Harpeth River watershed is summarized in Table 1 and shown in Figure 3.

Figure 2 Level IV Ecoregions in the Harpeth River Watershed

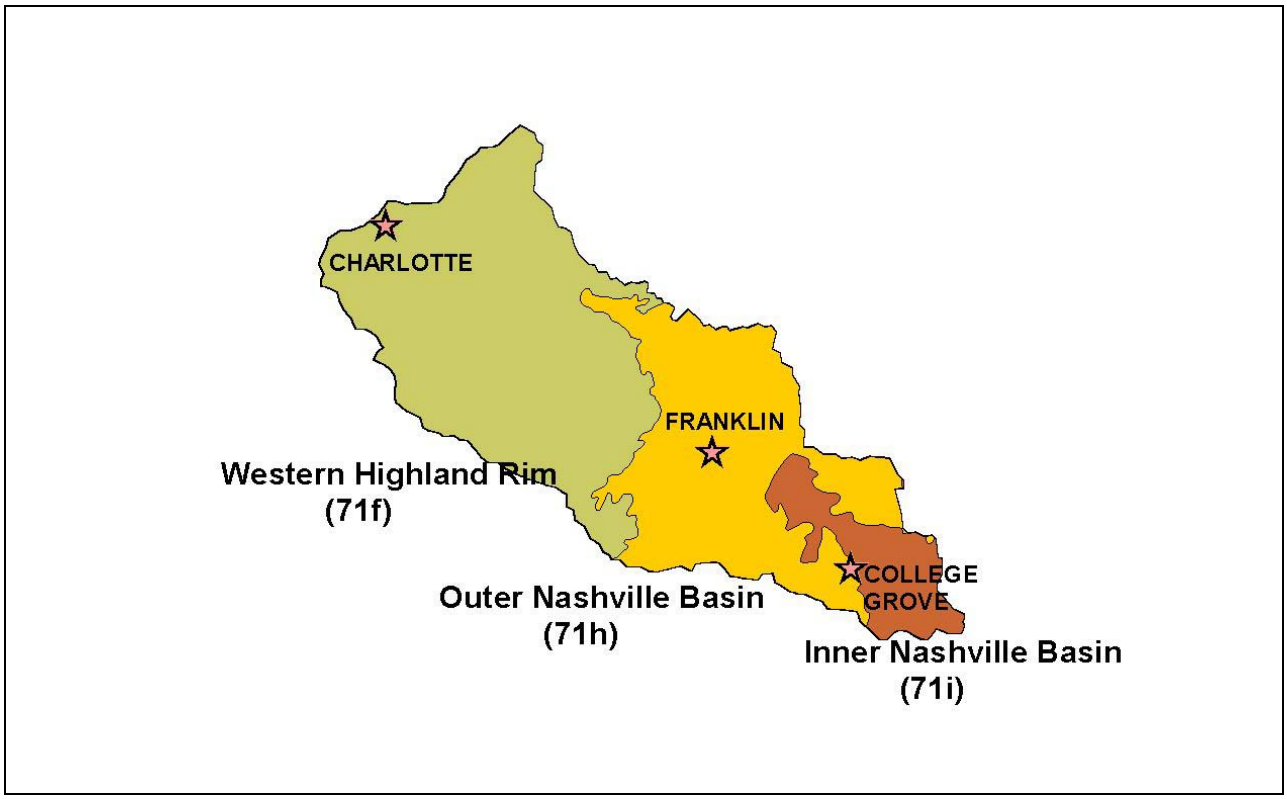


Figure 3 MRLC Land use Distribution in the Harpeth River Watershed

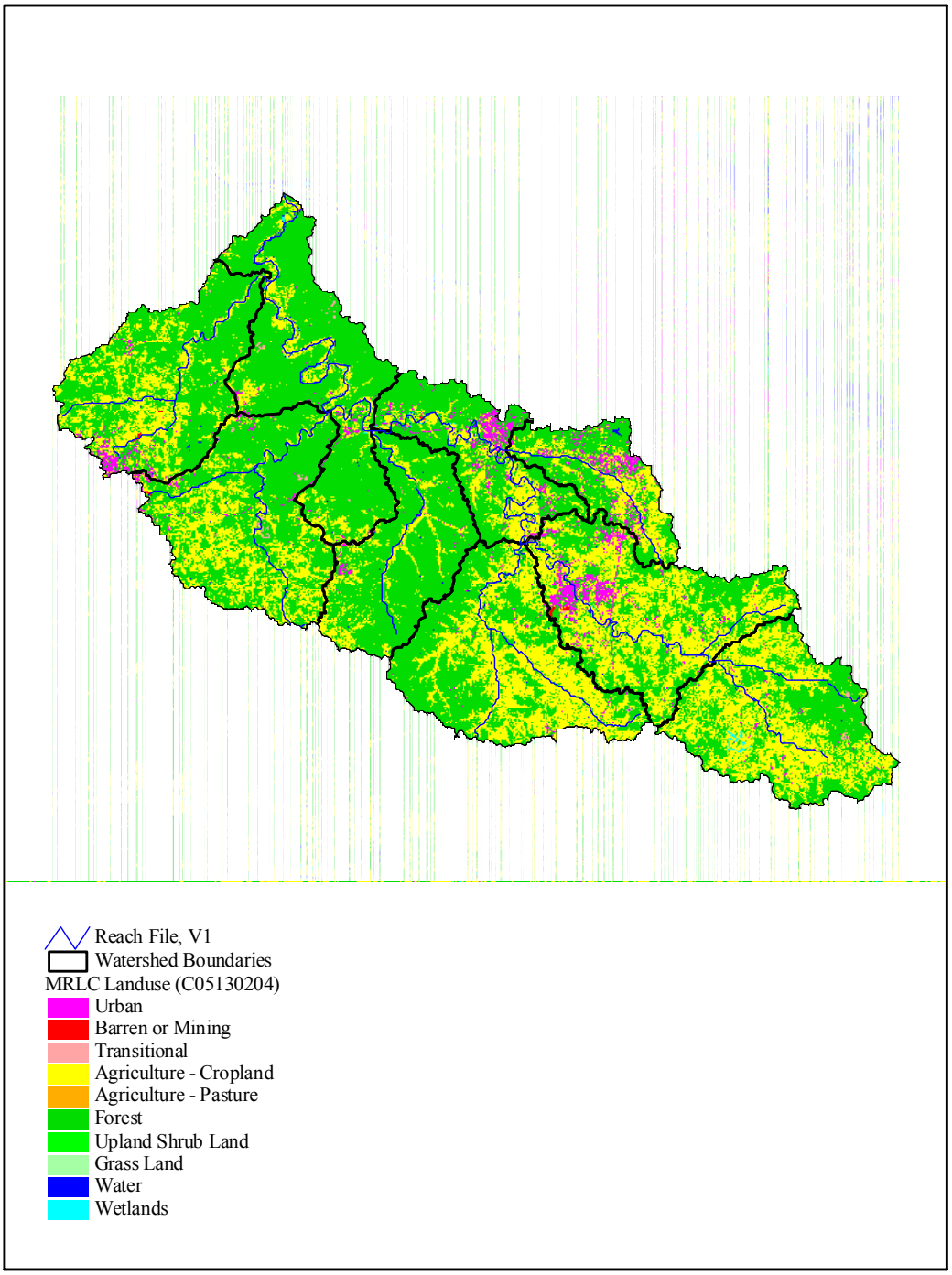


Table 1 Land Use Distribution - Harpeth River Watershed

LAND COVER/LAND USE	AREA [sq. mi.]	AREA [%]
Open Water	3.2	0.4
Low Intensity Residential	15.9	1.9
High Intensity Residential	1.9	0.2
High Intensity Commercial /Industrial/Transportation	7.5	0.9
Bare Rock/Sand/Clay	0	0
Transitional	1.6	0.2
Deciduous Forest	429.3	50.2
Evergreen Forest	21.6	2.5
Mixed Forest	84.6	9.9
Pasture/Hay	200.0	23.4
Row Crops	75.1	8.8
Other Grasses (Urban/Recreational)	12.5	1.4
Woody Wetlands	1.1	0.1
Emergent Herbaceous Wetlands	0	0
Quarries/Strip Mines/Gravel Pits	0.5	0.1
Total	**854.8**	**100.0**

3.0 PROBLEM DEFINITION

The State of Tennessee's final 1998 303(d) list (TDEC, 1998) was approved by the U.S. Environmental Protection Agency (EPA), Region IV on September 17, 1998. The list identified 37.3 miles of the Harpeth River (Waterbody ID TN05130204016), from the confluence with the West Fork Harpeth River to the headwaters, as not fully supporting designated use classifications due, in part, to metals (antimony, arsenic, lead, and zinc) associated with an industrial point source (see Table 2). These metals were listed based on their presence in battery casings in the stream bank near the General Smelting facility (~RM 113), not on water quality data. The designated use classifications for the listed portion of the Harpeth River includes fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. The Harpeth River upstream of river mile (RM) 85.2 is also classified for industrial water supply and domestic water supply.

Waterbodies in the Harpeth River watershed were reassessed in 2000 using more recent data and a revised waterbody identification system. As documented in *The Status of Water Quality in Tennessee, Year 2000 305(b) Report* (TDEC, 2000), the Harpeth River, represented as a single section in the 1998 3030(d) List (confluence with the West Fork Harpeth River to the headwaters), was subdivided into five segments (see Table 3). Only one six mile long segment was identified as impaired due to metal and lead (Waterbody ID TN05130204018_1000 in Table 3). The waterbody

listings in Table 3 represent smaller watersheds than those listed in the 1998 303(d) list. All of the waterbody segments listed on the 2000 reassessment fall within the larger watershed on the1998 303(d) list. The last column in Table 3 provides the link between the 2000 assessment and the 1998 303(d) list.

The 2000 assessment was subsequently further refined and the six mile long segment impaired for metals subdivided into two segments. Only one of these segments (Harpeth River from unnamed tributary downstream of Highway 31A to an unnamed tributary upstream of College Grove) was identified as impaired due to lead only (see Table 4). The assessment information shown in Table 4 is considered to be the most accurate representation of metals impairment in the Harpeth River to date and is part of the 2002 303(d) List proposed by the Division of Water Pollution Control in July, 2002. The information in Table 4 is referred to as the "2002 assessment" in the remainder of this TMDL document. It should be noted that although the total mileage listed for the Harpeth River segments in Tables 2, 3, & 4 are not the same, all three represent the main stem from the West Fork Harpeth River to the headwaters.

This TMDL addresses antimony, arsenic, cadmium, lead, and zinc loading for the 2.7 mile segment of the Harpeth River from an unnamed tributary downstream of Highway 31A to an unnamed tributary upstream of College Grove (Waterbody ID TN05130204018_2000 in Table 4). Although cadmium was not cited as a cause of impairment in the 1998 303(d) list, a TMDL was also developed for this metal based on the specification of discharge limits for cadmium in the NPDES permits issued to the General Smelting facility in 1995 and 2001. Both permit rationales indicate that cadmium concentrations in the facility discharge had the potential to exceed allowable instream concentrations (ref: Section 6.1).

4.0 TARGET IDENTIFICATION

Target values for metals in the Harpeth River are based on the criteria established in *State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, October, 1999* for applicable use classifications. Criteria for the protection of fish & aquatic life for certain metals (including cadmium, lead, and zinc) are a function of water hardness (as $CaCO_3$). Criteria for these metals, as well as the instream total recoverable concentrations (ITRCs) required to comply with these criteria, were calculated in accordance with *State of Tennessee Water Quality Standards* using the methodology described in *The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From a Dissolved Criterion*, EPA 823-B-96-007, June 1996 (USEPA 1996). The hardness and TSS used in the calculations were derived from the average of samples collected at the reference monitoring sites for Level IV ecoregions 71h and 71i between April 1996 and September 2000. Calculations and ecoregion data are shown in Appendix A. The Harpeth River, from the confluence with the West Fork Harpeth River (RM 78.7) to Arno Pike (RM 97.5), lies within Level IV ecoregion 71h. The Harpeth River, from Arno Pike to the headwaters, is in Level IV ecoregion 71i.

In accordance with the guidance in *Technical Support Document For Water Quality-based Toxics Control* (USEPA, 1991a), fish & aquatic life criteria are interpreted to mean that the 1-hour average exposure should not exceed the Criterion Maximum Concentration (CMC) and the 4-day average exposure should not exceed the Criterion Continuous Concentration (CCC). Excursions of CMCs & CCCs should not exceed a frequency of once every three years.

Table 2 1998 303(d) List with Respect to Metals – Harpeth River From West Fork Harpeth River to Headwaters

Waterbody ID	Segment Name	Size [mi.]	Impairment Due To Metals?	Cause/Source	Comments
TN05130204016	Harpeth River – West Fork Harpeth River to Watson Branch	37.3	Yes	Metals (As, Pb, Zn, Sb) Industrial Point Source	Legacy chemicals from General Smelting causes contaminated sediment upstream of Franklin

Table 3 2000 Assessment with Respect to Metals– Harpeth River From West Fork Harpeth River to Headwaters

Waterbody ID	Segment Name	Size [mi.]	Impairment Due To Metals?	Cause/Source	Reference to 1998 303(d) List Waterbody ID
TN05130204016 - 1000	Harpeth River – West Fork Harpeth River to Watson Branch	10.7	No		TN05130204016
TN05130204016 - 2000	Harpeth River – Watson Branch to Mayes Creek	9.0	No		TN05130204016
TN05130204016 - 3000	Harpeth River – Mayes Creek to Wilson Branch	7.5	No		TN05130204016
TN05130204018 - 1000	Harpeth River – Nelson Creek to Unnamed Tributary upstream of College Grove	6.0	Yes	Metals & Lead due to industrial point source and contaminated sediment	TN05130204016
TN05130204018 - 2000	Harpeth River - Unnamed Tributary upstream of College Grove to headwaters	7.4	No		TN05130204016

Table 4 2002 Assessment with Respect to Metals– Harpeth River From West Fork Harpeth River to Headwaters

Waterbody ID	Segment Name	Size [mi.]	Impairment Due To Metals?	Cause/Source	Reference to 1998 303(d) List Waterbody ID
TN05130204016 - 1000	Harpeth River – West Fork Harpeth River to Watson Branch	10.7	No		TN05130204016
TN05130204016 - 2000	Harpeth River – Watson Branch to Mayes Creek	9.0	No		TN05130204016
TN05130204016 - 3000	Harpeth River – Mayes Creek to Wilson Branch	7.5	No		TN05130204016
TN05130204018 - 1000	Harpeth River – Nelson Creek to Unnamed Tributary downstream of Hwy. 31A	4.7	No		TN05130204016
TN05130204018 - 2000	Harpeth River – Unnamed Tributary downstream of Hwy. 31A to Unnamed Tributary upstream of College Grove	2.7	Yes	Lead due to industrial point source and contaminated sediment	TN05130204016
TN05130204018 - 3000	Harpeth River - Unnamed Tributary upstream of College Grove to headwaters	7.4	No		TN05130204016

The target values in each Level IV ecoregion are summarized in Table 5:

Table 5 Metal Target Values for Level IV Ecoregions 71h & 71i

Level IV Ecoregion	Metal (Total Recoverable)	Most Stringent ITRC *		Applicable Use Classification w/ Most Stringent ITRC
		Chronic	Acute	
		[µg/l]	[µg/l]	
71h	Antimony	6	—	Domestic Water Supply
	Arsenic	50	—	Domestic Water Supply /Recreation
	Cadmium	4.97	19.7	Fish & Aquatic Life
	Lead	5	498	Domestic Water Supply (Chronic) Fish & Aquatic Life (Acute)
	Zinc	485	531	Fish & Aquatic Life
71i	Antimony	6	—	Domestic Water Supply
	Arsenic	50	—	Domestic Water Supply/ Recreation
	Cadmium	5	32.7	Domestic Water Supply (Chronic) Fish & Aquatic Life (Acute)
	Lead	5	810	Domestic Water Supply (Chronic) Fish & Aquatic Life (Acute)
	Zinc	710	777	Fish & Aquatic Life

* Instream total recoverable concentration. This value is equal to criteria for the domestic water supply and recreation use classifications and is calculated for the fish and aquatic life use classification (see Appendix A).

5.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

The Harpeth River, from the confluence with the West Fork Harpeth River to the headwaters, was identified in the 1998 303(d) list as partially supporting its designated uses due, in part, to contaminated sediment caused by the presence of legacy materials from the General Smelting & Refining (GSR) facility at RM 110.3. Antimony, arsenic, lead, and zinc were identified on the 1998 303(d) list due to the presence of these metals in battery casings found in the stream bank near RM 113, not on water quality monitoring data.

The Harpeth River watershed was reassessed in 2000, and further refined in 2002, using more recent data and a revised waterbody identification system. Although five of the six segments of the Harpeth River, from the confluence with the West Fork Harpeth River to the headwaters, were assessed as still impaired, the only segment identified as impaired due to metals is the 2.7 mile section in the vicinity of the GSR facility (reference Table 4, segment TN05130204018_2000). The four other segments were listed as impaired due to siltation, habitat alteration, and/or organic enrichment/low dissolved oxygen.

5.1 Water Quality Monitoring Data Downstream of GSR Facility

Water quality monitoring data collected at several sites on the Harpeth River, downstream of the GSR facility, support the finding of the 2002 assessment that the Harpeth River, from the confluence with West Fork Harpeth River to the unnamed tributary downstream of Highway 31A, are not impaired due to metals. The water quality data are summarized in Table 6. All sample concentrations are below target concentrations.

5.2 1998 EPA Study

In July, 1998, the United States Environmental Protection Agency (EPA) Science and Ecosystem Support Division (SESD) conducted a Case Development Investigation Evaluation at the GSR facility (USEPA, 1998). During the course of this study, soil, water, and sediment samples were obtained from the Harpeth River in proximity to the GSR facility and downstream for approximately one mile. The study concluded:

> Based on the lead concentrations in the sediment and soil in the Harpeth River bed immediately adjacent to, and downstream from the GRS site, the Harpeth River has been contaminated with elevated concentrations of lead from the GRS facility. The river bank adjacent to the GRS facility is highly contaminated. In fact, the soil and sediment from two samples collected from the bank directly below the facility failed the TCLP test. Although this test was designed for determining the leachability of hazardous waste, the environmental samples were so saturated with lead that they exceeded the regulatory limits.
>
> The extensive number of XRF determinations and the laboratory analytical results conclusively show that approximately one-mile of the Harpeth River, adjacent to, and downstream from the GRS property is highly contaminated with lead.

Water sample data for relevant metals collected during the study is summarized in Table 7.

Table 6 Harpeth River Monitoring Data for Metals

Level IV Ecoregion	Monitoring Station	RM	Date	Total Arsenic		Total Cadmium		Total Lead		Total Zinc	
				Target Concen.	Sample	Target Concen.	Sample	Target Concen.	Sample	Target Concen.	Sample
				[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]
71h	HARPE079.8WI	79.8	10/10/01	50	—	4.97	U1	5	U1	485	9
			11/29/01	50	—	19.7	U1 [R]	498	11 [R]	531	41 [R]
			12/18/01	50	—	4.97	U1	5	1	485	3
71h	HARPETH085.2	85.2	7/30/92	50	—	4.97	<1	5	<4	485	4
			8/30/92	50	—	4.97	<1	5	<4	485	4
			6/7/94	50	—	4.97	<1	5	<3	485	8
			6/12/95	50	—	4.97	<5	5	3	485	<20
			6/24/96	50	—	4.97	<1	5	<1	485	3
			6/19/97	50	—	4.97	1	5	2	485	1
71h	HARPE092.4WI	92.4	10/10/01	50	—	4.97	U1	5	U1	485	2
			11/29/01	50	—	19.7	U1 [R]	498	13 [R]	531	35 [R]
			12/18/01	50	—	4.97	U1	5	U1	485	2
71i	HARPE105.7WI	105.7	1/24/00	50	U1	5	U1	5	U1	710	U1
			5/3/00	50	U1	5	U1	5	U1	710	U1
			7/13/00	50	1	5	U1	5	U1	710	2
			10/31/00	50	3	5	U1	5	U1	710	52
			5/9/01	50	2	5	U1	5	U1	710	6
			10/9/01	50	1	5	1	5	U1	710	3
			12/12/01	50	U1	5	U1	5	U1	710	4

Note: U1 – Undetected at 1 μg/l
R – Sample collected during a storm event on 11/29/01. Target reflects acute ITRC.

Table 7 Water Monitoring Data – U.S. EPA Region IV RCRA Case Development Investigation/Evaluation

Mon. Site	Location	Date	Antimony [μg/l]	Arsenic [μg/l]	Cadmium [μg/l]	Lead [μg/l]	Zinc [μg/l]
Minimum Quantitation Limit →			0.10	1.0	0.20	0.50	
GW1	Approx. 1 mile u/s of GSR facility	7/7/98	ND	ND	ND	ND	4.4
GW2	Hwy. 31A bridge – Approx. 400 ft. d/s of GSR facility	7/8/98	0.39	ND	ND	3.3	5.3
GW3	Approx. 2.1 miles d/s of GSR facility	7/8/98	0.44	ND	0.21	3.2	5.2

ND – material was analyzed for but not detected

5.3 1997–1999 ARC Surveys

One of the provisions of Tennessee Department of Environment and Conservation (TDEC) Commissioner's Order 97-0364, issued on October 2, 1997, was that GSR shall conduct a sediment and aquatic biological integrity survey of river mile 110.3 of the Harpeth River for a period of 24 months to "ascertain the condition of the receiving and stream sediment and to determine whether the unauthorized discharges have resulted in accumulation of metals and other pollutants in water, sediment, and aquatic and biological life in the Harpeth River" (TDEC 1997). The results of the water and sediment survey are summarized in Tables 8 and 9 (ARC, 2000). The benthic invertebrate surveys concluded that " because there is little difference among the benthos at either site during the sampling effort, there appears to be no deleterious effects occurring between Site 1 upstream and Site 2 downstream during these two 1999 surveys" (ARC, 2000a).

Table 8 Water Quality Monitoring Data from 1997-1999 ARC Survey

Metal	Flow	First Quarter *			Second Quarter *			Third Quarter *			Fourth Quarter *		
		SW	S1	S2	SW	S1	S2	SW	S1	S2	SW	S1	S2
		[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]
Antimony	Storm	81	U	U	90	U	U	58	U	U	*	*	*
	Normal	—	U	U	—	U	U	—	U	U	—	U	U
Arsenic	Storm	U	U	U	7.6	U	U	U	U	U	*	*	*
	Normal	—	U	U	—	U	U	—	U	U	—	U	U
Cadmium	Storm	500	U	0.86	86	U	U	110	U	U	*	*	*
	Normal	—	U	U	—	U	U	—	U	U	—	U	U
Lead	Storm	410	U	U	370	17	13	99	U	14	*	*	*
	Normal	—	U	U	—	U	6.4	—	U	7.6	—	U	U
Zinc	Storm	570	U	U	33	U	U	38	U	U	*	*	*
	Normal	—	U	U	—	U	U	—	U	U	—	U	U

Notes: 1) SW- Former GSR facility storm water outfall
Site 1 – Harpeth River, upstream of Bellafont Road Bridge
Site 2 – approximately 400 feet downstream of GSR outfall, upstream of Highway 31A bridge
2) U = below reporting limits. Reporting limits are: Antimony – 10 μg/l, Arsenic – 5 μg/l, Cadmium – 1 μg/l, Lead – 5 μg/l, Zinc – 10 μg/l.
* No storm event samples collected during the fourth quarter.

Sample dates:

	Storm	Normal
1st Quarter	1/8/99	3/26/99
2nd Quarter	6/14/99	6/9/99
3rd Quarter	9/21/99	7/28/99
4th Quarter	No Sample	11/9/99

Table 9 Sediment Sampling Data from 1997-1999 ARC Survey

Metal	Site 1		Site 2	
	High Flow [mg/kg Dry Wt.]	Low Flow [mg/kg Dry Wt.]	High Flow [mg/kg Dry Wt.]	Low Flow [mg/kg Dry Wt.]
Antimony	U	U	U	12
Arsenic	75	24	U	26
Cadmium	U	U	U	2.2
Lead	88	34	12,000	1,900
Zinc	120	52	U	71

Note: 1) Site 1 – Harpeth River, upstream of Bellafont Road Bridge
2) Site 2 – approximately 400 feet downstream of GSR outfall, upstream of Highway 31A bridge
U = below reporting limits. High flow in March, low flow in July. Reporting limits (in mg/kg dry weight)for sediment are:

Metal	Site 1		Site 2	
	March	June	March	June
Antimony	66	4.0	640	4.2
Arsenic	33	2.0	320	2.1
Cadmium	6.6	0.40	64	0.42
Lead	33	2.0	320	2.1
Zinc	66	4.0	640	4.2

6.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories of siltation in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or nonpoint sources. A point source can be defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources include all other sources of pollution.

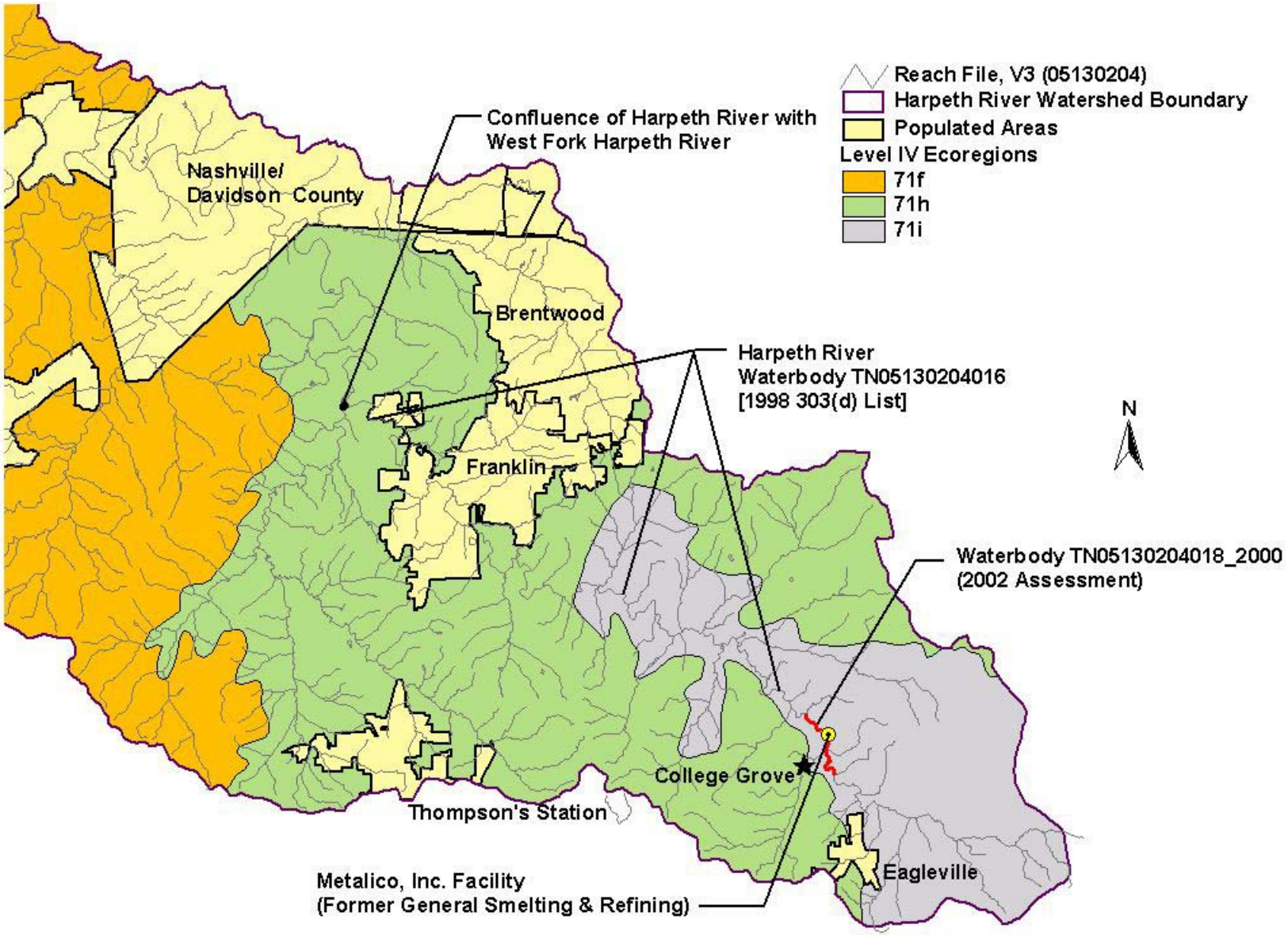
6.1 Point Sources

The General Smelting & Refining, Inc. (GSR) facility is the only permitted point source discharging to the Harpeth River segment identified in the 2002 assessment (waterbody ID: TN05130204018-2000) as impaired due to metals (see Figure 4). A secondary lead smelting facility has occupied the site since 1953. The company has changed ownership several times since its inception, but has retained the same name. GSR was sold to Metalico, Inc on, or about, November 21, 1997.

As stated in the 1998 EPA Case Development Investigation Evaluation:

> The standard operating procedure for the secondary lead smelting operation prior to the passage of the Clean Water Act was to allow waste streams, which included lead contaminated spent battery acid, to flow untreated into the Harpeth River. Also, the indiscriminate disposal of battery casings in and around the facility introduced another significant source of environmental lead contamination. One steady source of lead and heavy metals contamination originated from air emissions

Figure 4 Location of Metalico, Inc. Facility (Former General Smelting & Refining)



exiting the blast and reverberatory furnaces. Air pollution control equipment was later installed to reduce the lead emissions, but lead had already been deposited around the area.

Another source of past lead contamination was furnace slag. The slag was buried in a landfill or spread about as fill material. The various migration pathways mentioned above have allowed lead an opportunity to accumulate in the Harpeth River sediment and soil in the vicinity of the GRS plant (USEPA, 1998).

A summary of the recent compliance history of the GSR facility includes the following:

- The GSR facility was reissued National Pollution Discharge Elimination System (NPDES) permit TN0001384 on September 29, 1995 to discharge treated process wastewater and storm water runoff to the Harpeth River. As part of the Watershed Program, the permit was revoked an reissued on October 31, 1996 to expire on October 31, 2001. None of the permit provisions were modified during the reissue.

- During the period from October 1, 1995 through July 31, 1997, GSR violated permit limits for antimony, ammonia, cadmium, lead, biochemical oxygen demand (BOD), and total suspended solids (TSS) on at least 52 occasions. GSR also failed to submit the results of required quarterly biomonitoring on four occasions. Notices of Violations for permit non-compliance were issued to GSR four times during this period. A Compliance Review meeting was held on July 1, 1997.

- In a letter dated August 21, 1997, GSR stated that it would commence shipment of its waste stream to a permitted treatment/disposal facility by September 21, 1997. After that time, the facility no longer had a process wastewater discharge.

- Commissioner's Order No. 97-0364 was issued to GSR on October 2, 1997 requiring: 1) to cease discharge of process wastewater until the successful implementation and completion of all activities specified in an approved remedial action plan; 2) submittal of a remedial action plan to identify the remedial action necessary to permanently eliminate all violations of its permit; 3) implementation and completion of remedial activities set forth in the remedial action plan within 12 months of receipt of the order; 4) to conduct a 24-month sediment and aquatic, biological integrity survey of the Harpeth River in the vicinity of RM 110.3; and 5) payment of a civil penalty of $144,000.

- A review of compliance with the Commissioner's Order in July, 1998 indicated that: 1) there was no discharge of process wastewater with excess water hauled off by Laidlaw Environmental Services; 2) the remedial action plan was submitted and implementation was underway; 3) a new facility was under construction with no new discharge of process wastewater planned; 4) GSR retained Aquatic Resources Center (ARC) to conduct the required sediment and aquatic, biological integrity survey.

NPDES Permit No. TN0001384 was reissued to Metalico, Inc. (former GSR) on November 30, 2001 authorizing the discharge of storm water runoff only. The application for this permit stated

that the facility received its post-closure permit and ceased operations on November 24, 1997. Facility structures were decontaminated and demolished between May 27, 2000 and September 15, 2000. Only concrete foundations and two closed waste disposal units remained at the facility site. A remedial action plan was to be prepared to remediate any remaining impacted site soils. The closed waste disposal sites contain hazardous wastes from former battery chip, ash, and slag piles, as well as impacted material from former surface impoundments. A barrier retaining wall and gravel berm minimize runoff from former operational areas of the site. Although surface structures have been decontaminated and demolished, metal impacted soils remain which may come into contact with storm water. The reissued permit specifies a Daily Maximum limit of 0.015 mg/l for total cadmium and 0.35 mg/l for total lead for storm water discharges. No limits were specified for total antimony, total arsenic, or total zinc. The permit rationale stated that there was no reasonable potential for exceedance of instream water quality standards for these metals.

The facility has reported no process wastewater discharges since July, 1997. Storm water discharges of metals through Outfall SW1 for the period from 4th quarter, 1996 through 4th quarter, 2001 are summarized in Table 10.

Table 10 GSR Storm Water Discharges of Metals

Monitoring Period End Date	Total Antimony	Total Arsenic	Total Cadmium	Total Lead	Total Zinc
	[μg/l]	[μg/l]	[μg/l]	[μg/l]	[μg/l]
12/31/96					
3/31/97	130	26	2,160	1,680	1,910
6/30/97	120	14	1,660	660	790
9/30/97	67	8	171	494	153
12/31/97	BDL	BDL	4	25	21
3/31/98	14	14	1,890	1,550	1,200
6/30/98	37	7	1,580	1,530	1,290
9/30/98					
12/31/98	66	BDL	438	165	225
3/31/99	46	7	311	389	249
6/30/99	90	7.6	86	370	33
9/30/99	58	5	110	99	38
12/31/99					
3/31/00	ND	ND	ND	ND	ND
6/30/00	190	<4,000	6.3	240	290
9/30/00	52	<5	1,000	590	670
9/15/00	**Decontamination & demolition of surface structures complete**				
12/31/00	52	13	24	610	28
3/31/01	51	7.4	41	290	37
6/30/01	99	5.4	64	240	42
9/30/01	110	10	40	590	31
12/31/01	39	8.7	17	140	15

6.2 Nonpoint Sources

There are no known nonpoint sources of metals loading to the 2.7 mile segment of the Harpeth River identified as impaired in the 2002 assessment, other than water column background and loading from legacy metals in sediments. Background concentrations of metals are not well defined. Except for zinc, monitoring data upstream of the GSR facility from the EPA Case Development Investigation Evaluation (ref: Table 7) were reported as "analyzed for but not detected". Data from the ARC survey (ref: Table 8) indicate that background levels of antimony, arsenic, cadmium, lead, and zinc were reported as "below reporting limits" during both dry and wet weather conditions (the 2nd quarter wet weather sample for lead was reported as 17 μg/l). For four of the five metals listed, the reporting levels noted in Table 8 were higher than the Required Detection Levels (RDLs) specified in *State of Tennessee Water Quality Standards 1200-4-3-.05(8)* (TDEC, 1999).

7.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

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), nonpoint 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:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

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 (e.g. pounds per day), toxicity, or other appropriate measure.

7.1 Determination of Total Maximum Daily Loads

Metals TMDLs are developed for, and apply to, the 2.7 mile segment of the Harpeth River identified as impaired in the 2002 assessment (ref: Section 4.0).

7.1.1 Dry Weather Conditions

Metal TMDLs during dry weather conditions are expressed in terms of both concentration and mass loading. These TMDLs correspond to the ITRCs and loads for Level IV ecoregion 71i and are summarized in Table 11 (see Appendix A, Section A.4 and Tables A-5 & A-6). In accordance with the guidance in *Technical Support Document For Water Quality-based Toxics Control* (USEPA, 1991a), fish & aquatic life ITRCs are interpreted to mean that the 1-hour average exposure should not exceed the acute ITRC and the 4-day average exposure should not exceed the chronic ITRC. Excursions of chronic and acute ITRCs should not exceed a frequency of once every three years.

Table 11 TMDLs for Metals – Dry Weather Conditions

Metal (Total Recoverable)	TMDL – Dry Weather Conditions			
	Chronic		Acute	
	Concentration	Mass	Concentration	Mass
	[μg/l]	[lbs/day]	[μg/l]	[lbs/day]
Antimony	6	0.0384	—	—
Arsenic	50	0.3198	—	—
Cadmium	5	0.0063	32.74[b]	0.0295
Lead	5	0.0284	810.1[b]	0.7297
Zinc	710.1[a]	0.6396	777.7[b]	0.7005

a – 4-day average, once every three years.
b – 1-hour average, once every three years.

7.1.2 Wet Weather Conditions

Metal TMDLs during wet weather conditions correspond to the acute ITRCs for Level IV ecoregion 71i and are summarized in Table 12 (see Appendix A, Section A.5 and Tables A-7 & A-8). Due to the variability of stream flow resulting from storm events, the TMDLs are only expressed in terms of concentration. Mass loads could, however, be determined for any specific flow regime. ITRCs derived from fish & aquatic life criteria are interpreted to mean that the 1-hour average exposure should not exceed the acute ITRC once every three years.

Table 12 TMDLs for Metals – Wet Weather Conditions

Metal (Total Recoverable)	TMDL – Wet Weather Conditions[a]
	Concentration
	[μg/l]
Antimony	12
Arsenic	100
Cadmium	32.74
Lead	810.1
Zinc	777.7

a – 1-hour average, once every three years.

7.2 Seasonal Variation

The TMDLs provide for year-round protection of applicable water quality standards and , therefore, account for seasonal variation.

7.3 Margin of Safety

There are two methods for incorporating a MOS in the 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, an implicit MOS was incorporated through the use of conservative modeling assumptions. These include:

- Target values based on average hardness and TSS data from Level IV ecoregion reference sites. These sites represent the least impacted streams in the ecoregion.
- Dry weather TMDLs were calculated at summer low flow conditions (7Q10).

7.4 Determination of WLAs, & LAs

As previously stated, the TMDL can be expressed as the sum of all Waste Load Allocations (WLAs), Load Allocations (LAs), and an appropriate margin of safety (MOS). Considering the conservative analysis (implicit MOS), the TMDL equation reduces to:

$$TMDL = \Sigma WLAs + \Sigma LAs$$

where: MOS =0

7.4.1 Dry Weather Conditions

At the present time, there are no NPDES permitted discharges during dry weather conditions. Therefore, the LA for each metal is considered to be equal to the TMDL concentrations and loads specified in Table 11 and is applicable to all stream flow conditions.

$$TMDL = \Sigma LAs = \text{Stream Background}$$

where: Σ WLAs =0

In the event that future dry weather discharges are proposed, WLAs & LAs will be established based on the TMDLs specified in Table 11 and a determination of stream background concentrations in accordance with the Required Detection Levels (RDLs) specified in Section 1200-4-3-.05(8) of *State of Tennessee Water Quality Standards* (TDEC, 1999).

7.4.2 Wet Weather Conditions

During wet weather conditions, the WLA for discharges from the Metalico facility for each metal is considered to be equal to the TMDL concentrations specified in Table 10. These WLAs, expressed as concentrations, apply to all wet weather flow regimes. LAs, representing stream background, are considered to be equal to the reporting limits used in the 1997-1999 ARC survey (see Table 6). Wet weather WLAs & LAs could be calculated in terms of mass for specific flow conditions. Wet weather WLAs & LAs are summarized in Table 13.

Table 13 WLAs & LAs for Metals – Wet Weather Conditions

Metal (Total Recoverable)	Wet Weather Conditions	
	WLAs	LAs
	[μg/l]	[μg/l]
Antimony	12	10
Arsenic	100	5
Cadmium	32.74[a]	1
Lead	810.1[a]	5
Zinc	777.7[a]	10

a – 1-hour average, once every three years.

8.0 IMPLEMENTATION PLAN

8.1 Point Sources

A WLA to an individual point source discharger does not necessarily result in a permit limit or monitoring requirement. Through the NPDES permitting process, a determination will be made whether the metals discharges from a point source have the reasonable potential of violating the allocated concentration and/or load. The results of this reasonable potential analysis will determine specific permit requirements for each metal.

8.1.1 Dry Weather Conditions

At the present time, there are no permitted point source discharges of antimony, arsenic, cadmium, lead, or zinc during dry weather conditions to the 2.7 mile segment of the Harpeth River identified as impaired in the 2002 assessment. Any future point source discharges of these metals will be expected to comply with the WLAs specified in Section 7.4.1.

8.1.2 Wet Weather Conditions

At the present time, Metalico, Inc. is the only permitted discharger of metals during wet weather conditions to the 2.7 mile segment of the Harpeth River identified as impaired in the 2002 assessment. NPDES Permit No. TN0001384 specifies daily maximum limits for storm water discharges from the Metalico facility of 15 μg/l for total cadmium and 350 μg/l for total lead. Both limits are more stringent than the wet weather WLAs for these metals. It is recommended that the Metalico permit be reviewed for compliance with the WLAs specified in Section 7.4.2.

8.2 Additional Monitoring

Additional monitoring will take place within the context of Tennessee's Watershed Management Approach. This approach specifies a five-year cycle for planning and assessment. Each watershed will be examined (or re-examined) on a rotating basis. Generally, in years two and three of the five-year cycle, water quality data are collected in support of water quality assessment. Based on this data, the TMDL will be re-evaluated and revised as necessary. Specific information regarding the Watershed Management Approach in the Harpeth River watershed may be found in the *Harpeth River Watershed Management Plan* (TDEC, 2002).

9.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed metals TMDLs for the Harpeth 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 notice invited comments from stakeholders and the public 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 the NPDES permit Public Notice mailings which was sent to approximately 90 interested persons or groups who have requested this information on September 9, 2002.

3) A copy of the public notice announcement and the proposed TMDL was sent to Metalico, Inc.

No written comments were received during the Public Notice period.

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:

www.state.tn.us/environment/wpc/tmdl.htm

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

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APPENDIX A

Calculation of Allowable Instream Concentrations For Several Metals in the Harpeth River

A.1 Introduction

The 1998 303(d) list identified the Harpeth River, from West Fork Harpeth River to the headwaters, as not fully supporting designated use classifications due, in part, to metals associated with industrial point source discharges. Three of the designated use classifications for the listed segment of the Harpeth River (domestic water supply, fish and aquatic life, and recreation) have numerical criteria for metals. Water quality criteria for applicable use classifications are established in *State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, October, 1999* (TDEC, 1999).

A.2 Numerical Criteria for the Drinking Water Supply & Recreation Use Classifications

Water quality criteria for the drinking water supply and recreation use classifications contain a single expression of allowable magnitude and are associated with the protection of human health from long-term (chronic) effects. Criteria for these use classifications are summarized in Table A-1.

Table A-1 Metals Criteria for the Drinking Water Supply & Recreation Use Classifications

Metal (Total Recoverable)	Drinking Water Supply	Recreation	
		Water & Organisms	Organisms Only
	[µg/l]	[µg/l]	[µg/l]
Antimony	6	14	4300
Arsenic	50	50	50
Cadmium	5	—	—
Lead	5	—	—
Zinc	—	—	—

A.3 Numerical Criteria for the Fish & Aquatic Life Use Classifications

Water quality criteria for the fish & aquatic life use classification contain two expressions of allowable magnitude: a Criteria Maximum Concentration (CMC) to protect against short-term (acute) effects and a Criteria Continuous Concentration (CCC) to protect against long-term (chronic) effects. In accordance with the guidance in *Technical Support Document For Water Quality-based Toxics Control* (USEPA, 1991a), fish & aquatic life criteria are interpreted to mean that the 1-hour average exposure should not exceed the CMC and the 4-day average exposure should not exceed the CCC. Excursions of CMCs & CCCs should not exceed a frequency of once every three years.

CMCs & CCCs for certain metals (including cadmium, lead, and zinc) are a function of water hardness (as $CaCO_3$). In the toxicity tests used to derive metals criteria for aquatic life, some fraction of the metal was dissolved and some fraction bound to particulate matter. The criteria concentrations resulting from these tests were expressed as total recoverable metal. In consideration of the premise that the dissolved fraction of metal more closely approximates the biologically available fraction, conversion factors were developed to predict how different the criteria would be if they had been based on measurements of the dissolved concentrations in the toxicity

tests used to develop criteria.

As effluents from point and nonpoint source discharges mix with receiving water, the chemical properties of the mixture will determine the fraction of metal that is dissolved and the fraction that is in particulate form. Factors that influence the dissolved to total recoverable metal ratio include temperature , hardness, pH, concentration of binding sites (such as total suspended solids), and concentrations of other materials that compete for binding sites. Criteria (CMCs & CCCs) can be related to effluent discharges through the use of metals translators.

Cadmium, lead, and zinc criteria, as well as the instream total recoverable concentrations (ITRCs) required to comply with these criteria, were calculated in accordance with *State of Tennessee Water Quality Standards* using the methodology described in *The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From a Dissolved Criterion*, EPA 823-B-96-007, June 1996 (USEPA 1996). Corresponding effluent concentrations from point and nonpoint sources can be calculated from ITRCs if flow rates are known. The hardness and TSS used in the calculations were derived from the average of samples collected at the reference monitoring sites for Level IV ecoregions 71h and 71i between April 1996 and September 2000 (see Tables A-2 & A-3). The Harpeth River, from the confluence with the West Fork Harpeth River (RM 78.7) to Arno Pike (RM 97.5), lies within Level IV ecoregion 71h. The Harpeth River, from Arno Pike to the headwaters, is in Level IV ecoregion 71i.

Fish & aquatic life criteria and ITRCs for lead in Level IV ecoregion 71h were calculated using the following procedure (calculations for cadmium and zinc, as well as for metals in Level IV ecoregion 71i, are similar):

1) The total recoverable Criterion Maximum Concentration (CMC_{TR}) and Criterion Continuous Concentration (CCC_{TR}) at laboratory conditions are calculated using the equations:

$$CMC_{TR} = \exp\{m_A [\ln (\text{hardness})] + b_A\}$$

$$CCC_{TR} = \exp\{m_C [\ln (\text{hardness})] + b_C\}$$

for lead:

$$CMC_{TR} = \exp\{1.273 [\ln (134.1)] - 1.460\} = 118.6 \ \mu g/l$$

$$CCC_{TR} = \exp\{1.273 [\ln (134.1)] - 4.705\} = 4.622 \ \mu g/l$$

Table A-2 Level IV Ecoregion 71h Monitoring Data

Level IV Ecoregion Site	Date	Time	TSS	Hardness (as $CaCO_3$)
			[mg/l]	[mg/l]
ECO71H03	4/29/96	1100	10	114
	8/27/96	1200	10	127
	11/25/96	1330	10	112
	2/3/97	1200	96	101
	5/6/97	1200	10	121
	8/20/97	1410	10	117
	11/10/97	1030	10	122
	2/3/98	0915	10	120
	5/4/98	1000	10	109
	9/17/98	1115	10	154
	11/18/98	1405	10	107
	6/2/99	1015	10	115
	9/5/99	1055	10	138
ECO71H06	4/22/96	0900	10	117
	8/20/96	1130	11	130
	11/12/96	1205	10	153
	2/4/97	1130	10	128
	5/12/97	1030	10	105
	8/22/97	1020	10	117
	12/8/97	1230	10	126
	2/12/98	1135	10	97.1
	4/13/98	1430	10	111
	8/31/98	1415	10	155
	11/16/98	1030	10	127
	2/9/99	1200	10	110
	6/11/99	1230	10	113
ECO71H09	5/1/96	1131	10	158
	8/20/96	0945	10	170
	11/12/96	1210	10	192
	2/4/97	1000	10	148
	4/30/97	1015	10	154
	8/19/97	1230	10	150
	12/8/97	1100	10	181
	2/12/98	0940	10	142
	4/13/98	1145	10	145
	8/31/98	1050	10	211
	11/16/98	1230	10	152
	2/9/99	1000	10	142
	6/11/99	1015	10	140
Σ	**Average**		**12.2**	**134.1**

Note: In cases where multiple samples were collected on the same day, or on consecutive days, only the sample with the lowest hardness appears in the table.

Table A-3 Level IV Ecoregion 71i Monitoring Data

Level IV Ecoregion Site	Date	Time	TSS	Hardness (as $CaCO_3$)
			[mg/l]	[mg/l]
ECO71I03	5/2/96	1205	10	286
	9/3/96	1140	49	208
	11/25/96	0910	10	174
	2/6/97	1400	10	229
	4/23/97	1000	19	273
	10/1/97	1400	10	314
	11/24/97	1300	10	291
	2/25/98	1445	10	186
ECO71I09	5/1/96	0900	10	208
	9/3/96	0940	15	107
	11/25/96	1015	10	159
	2/6/97	1245	10	198
	4/23/97	1300	10	159
	10/01/97	1130	10	258
	11/13/97	1000	10	296
	2/25/98	1330	10	184
	4/27/98	1300	10	228
	9/1/98	1000	10	171
	12/2/98	1145	10	249
	2/16/99	1200	10	192
	6/3/99	1000	10	176
	1/11/00	0845	10	230
	4/19/00	1100	10	194
	7/25/00	1030	14	337
ECO71I10	5/20/96	1125	10	234
	9/3/96	1324	10	134
	11/20/96	1143	10	168
	2/10/97	1040	10	225
	4/28/97	1115	10	221
	10/9/97	1100	10	197
	11/13/97	1300	14	260
	2/25/98	1155	10	201
	4/27/98	1100	10	203
	12/2/98	1330	17	207
	2/16/99	1330	10	188
	6/8/99	1430	10	150
	11/9/99	1250	10	228
	1/6/00	1400	10	210
	1/25/00	0910	10	242
	4/6/00	1320	10	'--
	4/12/00	0930	10	193
	7/12/00	1035	10	155
Σ	**Average**		**11.6**	**212.8**

Note: In cases where multiple samples were collected on the same day, or on consecutive days, only the sample with the lowest hardness appears in the table.

2) The dissolved Criterion Maximum Concentration (CMC_{DIS}) and Criterion Continuous Concentration (CCC_{DIS}) at laboratory conditions are calculated for by applying the Acute Conversion Factor (ACF) and Chronic Conversion Factor (CCF) respectively: The conversion factors for lead are also a function of stream hardness.

$$CMC_{DIS} = (CMC_{TR})\ (ACF)$$

$$CCC_{DIS} = (CCC_{TR})\ (CCF)$$

for lead:

$$ACF = CCF = 1.46203 - \{[\ln(hardness)]\ (0.145712)\}$$

$$ACF = CCF = 1.46203 - \{[\ln(134.1)]\ (0.145712)\} = 0.7484$$

therefore:

$$CMC_{DIS} = (118.6)\ (0.748) = 88.76\ \mu g/l$$

$$CCC_{DIS} = (4.622)\ (0.748) = 3.459\ \mu g/l$$

3) The metals translator is defined as the fraction of total recoverable metal in the downstream water, after mixing with effluents, that is dissolved.

The metals translator is calculated using the equation:

$$Translator = \frac{1}{1 + \{\ [K_{po}]\ \ [TSS^{(1+a)}\ ]\ [10^{-6}]\ \}}$$

for lead:

$$Translator_{Pb} = \frac{1}{1 + \{\ [2.80 \times 10^{6}]\ [12.2^{(1\ -\ 0.8)}\ ]\ [10^{-6}]\ \}} = 0.178$$

4) The instream total recoverable concentration (ITRC) that corresponds to the dissolved criterion is expressed as:

$$ITRC = (\text{Water Quality Criterion})_{dissolved}\ \ (1/Translator)$$

The ITRCs are calculated by applying the translator to the CMC_{DIS} and the CCC_{DIS}:

$$ITRC_{acute} = \frac{CMC_{DIS}}{Translator}$$

$$ITRC_{chronic} = \frac{CCC_{DIS}}{Translator}$$

for lead:

$$ITRC_{acute} = \frac{88.76}{0.178} = 498.6\ \mu g/l$$

$$ITRC_{chronic} = \frac{3.459}{0.178} = 19.43\ \mu g/l$$

CCCs, CMCS, and ITRCs for protection of fish & aquatic life are summarized in Table A-4. No numerical criteria are specified for total arsenic or total antimony for the fish & aquatic life use classification (there are fish & aquatic life criteria for arsenic III).

Table A-4 Criteria & Instream Concentrations for the Fish & Aquatic Life Use Classifications

Level IV Ecoregion	Metal	Fish & Aquatic Life Criteria				$ITRC_{Chronic}$	$ITRC_{Acute}$
		CCC_{TR}	CMC_{TR}	CCC_{DIS}	CMC_{DIS}		
		[µg/l]	[µg/l]	[µg/l]	[µg/l]	[µg/l]	[µg/l]
71h	Cadmium	1.428	5.461	1.281	5.088	4.975	19.76
	Lead	4.622	118.6	3.459	88.76	19.43	498.6
	Zinc	135.9	150.1	134.0	146.7	485.4	531.6
71i	Cadmium	2.052	9.193	1.801	8.388	7.029	32.74
	Lead	8.321	213.5	5.666	145.4	31.57	810.1
	Zinc	201.0	221.9	198.2	217.0	710.1	777.7

A.4 Development of TMDLs for Dry Weather Conditions (Summer Low Flow)

State of Tennessee Water Quality Standards, Chapter 1200-4-3-.05(4), states that fish & aquatic life criteria shall be applied on the basis the 7Q10 low flow (unregulated streams) and domestic water supply/recreation criteria shall be applied on the basis of the 30Q2 low flow. ITRCs for all applicable use classifications in each Level IV ecoregion were compared (ITRCs for domestic water supply and recreation use classifications are equal to criteria). The ITRC which, when applied at the specified low flow, results in the lowest mass loading rate was selected as the TMDL for each metal.

Estimates of 7Q10 and 30Q2 low flows in the vicinity of the GSR facility (~RM110.3) were based on the flows at USGS Station 03432350, a continuous gaging station located on the Harpeth River at the Highway 96 bridge in Franklin, Tennessee (~RM 88.1), and the ratio of the respective drainage areas.

$$Q_{RM\ 110.3} = (Q_{USGS}) \times \frac{[\text{Drainage Area}]_{RM\ 110.3}}{[\text{Drainage Area}]_{USGS}} \times (UCF)$$

where: $[\text{Drainage Area}]_{RM\ 110.3} = 55.6\ mi^2$
$[\text{Drainage Area}]_{USGS} = 191\ mi^2$
Q_{USGS} = 0.573 cfs (7Q10); 4.074 cfs (30Q2) for the period 1975-2001
UCF = 0.6464 (Unit conversion factor)

therefore: $Q_{RM\ 110.3}$ = 0.108 MGD (7Q10)
0.767 MGD (30Q2)

Mass loads are calculated by:

$$\text{Mass} = (\text{ITRC}) \times (Q_{RM\ 110.3}) \times UCF$$

where: Mass [lbs/day]
ITRC [μg/l]
$Q_{RM\ 110.3}$ [MGD]
UCF = Unit conversion factor = 0.00834

Metals ITRCs and calculated mass loads associated with each use classification for Level IV ecoregions 71h & 71i during dry weather conditions are summarized in Table A-5. The most stringent mass load for each metal in each ecoregion is indicated. The lower concentrations and loads for Level IV ecoregion 71i were considered to be the appropriate TMDLs since they would be protective for waters in both ecoregions and the impaired waterbody segment identified in the 2002 assessment is also located in 71i. TMDLs for dry weather conditions include both concentrations and associated loads and are summarized in Table A-6.

Table A-5 Comparison of Mass Loads Associated with ITRCs

Level IV Ecoregion	Metal (Total Recoverable)	Human Health (30Q2)			Fish & Aquatic Life (7Q10)				Most Stringent	
		Most Stringent ITRC (Chronic)	Use Classif.	Mass Load (Chronic)	ITRC (Chronic)	ITRC (Acute)	Mass Load (Chronic)	Mass Load (Acute)	Mass Load (Chronic)	Mass Load (Acute)
		[µg/l]	[µg/l]	[lbs/day]	[µg/l]	[µg/l]	[lbs/day]	[lbs/day]	[lbs/day]	[lbs/day]
71h	Antimony	6	DWS	0.0384	—	—	—	—	0.0384	—
	Arsenic	50	DWS/Rec.	0.3198	—	—	—	—	0.3198	—
	Cadmium	5	DWS	0.0320	4.975	19.76	0.0045	0.0178	0.0045	0.0178
	Lead	5	DWS	0.0320	19.43	498.6	0.0175	0.4491	0.0175	0.4491
	Zinc	—	—	—	485.4	531.6	0.4372	0.4788	0.4372	0.4788
71i	Antimony	6	DWS	0.0384	—	—	—	—	0.0384	—
	Arsenic	50	DWS/Rec.	0.3198	—	—	—	—	0.3198	—
	Cadmium	5	DWS	0.0320	7.029	32.74	0.0063	0.0295	0.0063	0.0295
	Lead	5	DWS	0.0320	31.57	810.1	0.0284	0.7297	0.0284	0.7297
	Zinc	—	—	—	710.1	777.7	0.6396	0.7005	0.6396	0.7005

Note: ITRC = Instream total recoverable concentration. This value is equal to criteria for the domestic water supply and recreation use classifications and is calculated for the fish and aquatic life use classification.

Table A-6 TMDLs for Metals - Dry Weather Conditions

Metal (Total Recoverable)	TMDL – Dry Weather Conditions			
	Chronic		Acute	
	Concentration	Mass	Concentration	Mass
	[μg/l]	[lbs/day]	[μg/l]	[lbs/day]
Antimony	6	0.0384	—	—
Arsenic	50	0.3198	—	—
Cadmium	5	0.0063	32.74[b]	0.0295
Lead	5	0.0284	810.1[b]	0.7297
Zinc	710.1[a]	0.6396	777.7[b]	0.7005

a – 4-day average, once every three years.
b – 1-hour average, once every three years.

A.5 Development of TMDLs for Wet Weather Conditions

The development of allowable metals loading during wet weather conditions is problematical for several reasons. Both stream flow and loading due to runoff are dependent on such factors as storm volume, storm frequency, storm intensity, storm duration, time between storm events, and imperviousness of drainage areas. Since loading associated with storm events is of a relatively short duration, application of acute criteria (one hour average exposure, once every three years) is considered to be more appropriate than chronic criteria. . For metals with no acute criteria specified, two times the most stringent chronic ITRC was used. Wet weather ITRCs for Level IV ecoregions 71h & 71i are summarized in Table A-7.

Table A-7 Summary of Acute ITRCs for Wet Weather Conditions

Level IV Ecoregion	Metal (Total Recoverable)	Target Wet Weather ITRC	Basis for Target ITRC
		[μg/l]	
71h	Antimony	12	2 x Most stringent chronic criteria
	Arsenic	100	2 x Most stringent chronic criteria
	Cadmium	19.76	Fish & Aquatic life acute criteria
	Lead	498.6	Fish & Aquatic life acute criteria
	Zinc	531.6	Fish & Aquatic life acute criteria
71i	Antimony	12	2 x Most stringent chronic criteria
	Arsenic	100	2 x Most stringent chronic criteria
	Cadmium	32.74	Fish & Aquatic life acute criteria
	Lead	810.1	Fish & Aquatic life acute criteria
	Zinc	777.7	Fish & Aquatic life acute criteria

For the same reasons cited in Section A.4, wet weather TMDLs were, therefore, considered to be equal to acute ITRCs ecoregion 71i. Wet weather TMDLs are summarized in Table A-8.

Table A-8 TMDLs for Metals – Wet Weather Conditions

Metal (Total Recoverable)	TMDL – Wet Weather Conditions[a]
	Concentration
	[μg/l]
Antimony	12
Arsenic	100
Cadmium	32.74
Lead	810.1
Zinc	777.7

a – 1-hour average, once every three years.

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 LOADS (TMDLs) FOR METALS IN THE HARPETH RIVER WATERSHED (HUC 05130204), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Loads (TMDLs) for metals in the Harpeth River Watershed located in middle 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.

Portions of the Harpeth River are listed on Tennessee's final 1998 303(d) list and proposed 2002 303(d) list as not supporting designated use classifications due, in part, to metals associated with an industrial point source and contaminated sediment. The TMDLs utilize Tennessee's general water quality criteria, ecoregion reference site data, and an appropriate Margin of Safety (MOS) to establish allowable metals loading, during dry and wet weather conditions, which will result in reduced in-stream concentrations and the attainment of water quality standards.

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

http://www.state.tn.us/environment/wpc/tmdl.htm

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

Bruce R. Evans, P.E., Watershed Management Section
Telephone: 615-532-0668

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

Persons wishing to comment on the TMDLs are invited to submit their comments in writing no later than October 14, 2002 to:

Division of Water Pollution Control
Watershed Management Section
6th 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, 6th 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.