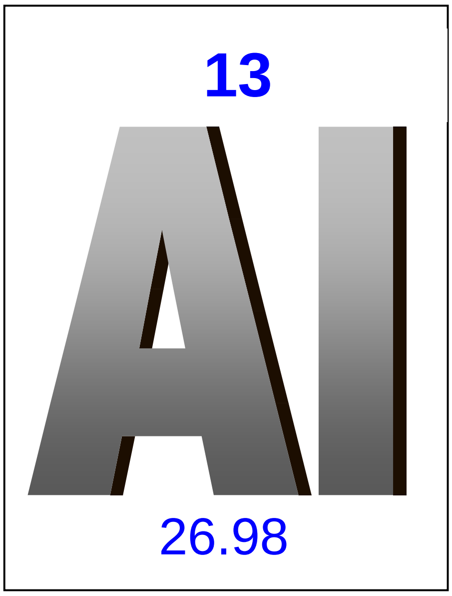
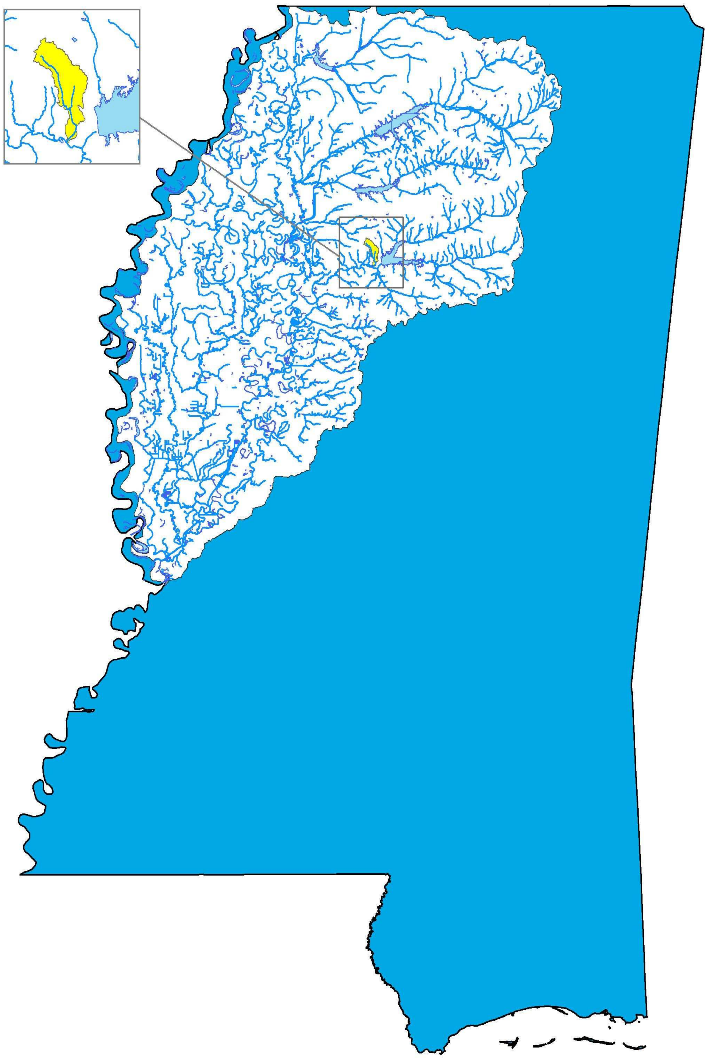
FINAL REPORT
June 2008
ID: 908063043

Total Maximum Daily Load For Aluminum In Riverdale Creek,

Yalobusha, Grenada Counties, Mississippi Yazoo River Basin





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FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. *(Sierra Club v. Hankinson, No. 97-CV-3683 (N.D> Ga.))* The report contains one or more Total Maximum Daily Loads (TMDLs) for water body segments found on Mississippi's 1996 Section 303(d) List of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The segments addressed are comprised of segments that have sporadic data indicating impairment. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	D	10	Deka	da
10^{-2}	centi	C	10^{2}	Hecto	h
10^{-3}	milli	M	10^{3}	Kilo	k
10^{-6}	micro	µ	10^{6}	Mega	M
10^{-9}	nano	N	10^{9}	Giga	G
10^{-12}	pico	P	10^{12}	Tera	T
10^{-15}	femto	F	10^{15}	Peta	P
10^{-18}	atto	A	10^{18}	Exa	E

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	Sq. miles	0.0015625	Days	Seconds	86400
Cubic feet	Cu. Meter	0.028316847	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805195	Gallons	Cu feet	0.133680555
Cubic feet	Liters	28.316847	Hectares	Acres	2.4710538
cfs	Gal/min	448.83117	Miles	Meters	1609.344
cfs	MGD	.6463168	Mg/l	ppm	1
Cubic meters	Gallons	264.17205	µg/l * cfs	Gm/day	2.45

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Table 1. Listing Information

Name	ID	County	HUC	Impaired Use	Causes
Riverdale Creek	MS341E	Yalobusha, Grenada	08030205	Aquatic Life Support	Aluminum
Near Grenada from headwaters to the Yalobusha River					

Table 2. Water Quality Criteria*

Parameter	Beneficial use	Water Quality Criteria	
Aluminum	Aquatic Life Support	Acute (CMC) 750 µg/l	Chronic (CCC) 87 µg/l

* Criteria based on *National Recommended Water Quality Criteria*, United States Environmental Protection Agency (EPA, 2006)

Table 3. Total Maximum Daily Load for Riverdale Creek

	WLA lbs/day	LA lbs/day	MOS	TMDL lbs/day
Total Aluminum	0.12	0.66	Implicit	**0.78**

Table 4. Identified NPDES Permitted Facilities

Name	NPDES Permit	Permitted Discharge (MGD)	Receiving Water
Grenada Manufacturing	MS0000671	0.16	Riverdale Creek

EXECUTIVE SUMMARY

Riverdale Creek (MS341E) was placed on the Mississippi 2006 Section 303(d) List of Evaluated Water bodies as potentially impaired due to aluminum. Riverdale Creek, shown in figure 1, is in the Yazoo Basin just northwest of Grenada in Grenada County. Riverdale Creek flows for 10 miles in a southernly direction from its headwaters to its confluence with the Yalobusha River. For this water body segment, the applicable chronic criteria specifies that the concentration of total aluminum shall not exceed 87 μg/l. Recent monitoring indicate this criteria is violated in Riverdale Creek. There is one NPDES permitted discharge, Grenada Manufacturing, located in the watershed and included as a point source in this report. A reduction in total aluminum from this facility is recommended.

Figure 1. Riverdale Creek site photograph

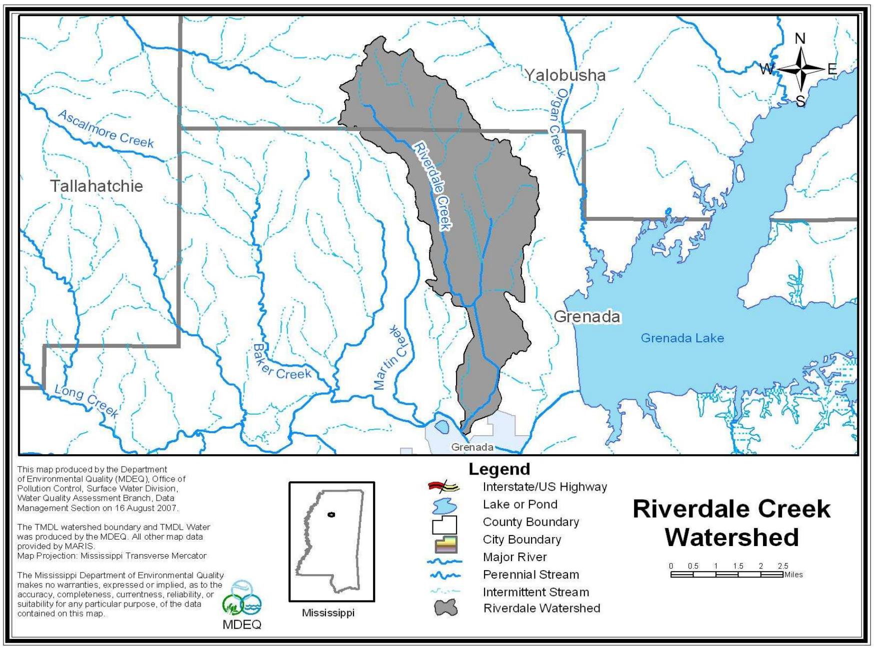
INTRODUCTION

1.1 Background

The identification of waterbodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those waterbodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired waterbodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is aluminum. The TMDL process can be used to establish water quality based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of water resources.

Mississippi Department of Environmental Quality (MDEQ) identified Riverdale Creek as potentially impaired by aluminum levels elevated above the aluminum toxicity chronic criteria for fresh water streams (USEPA National Water Quality Criteria). Riverdale Creek is in Yalobusha and Grenada Counties. This is a 10 mile long segment which begins northwest of Grenada and ends at the confluence with the Yalobusha River. The watershed is shown in Figure 2.

Figure 2. Riverdale Creek Watershed



1.2 Applicable Water body Segment Use

Designated beneficial uses and water quality criteria are established by the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. The designated use for Riverdale Creek as defined by the regulations is Fish and Wildlife.

1.3 Applicable Water body Segment Standard

The water quality standard applicable to the use of the water body and toxicity is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2007). The standard states:

“Toxic Substances:

A. Aquatic Life and Human Health Standards

(1) Aquatic Life - The concentration of toxic substances shall not result in chronic or acute toxicity or impairment of the uses of aquatic life. Any levels in excess of these values will be considered to result in chronic or acute toxicity, or the impairment of the uses of aquatic life. Regardless of direct measurements of chronic or acute toxicity, the concentrations of toxic substances shall not exceed the chronic or acute values, except as provided for in Sections 10.F.(1) and 10.F.(2).

(2) Human Health - The concentration of toxic substances shall not exceed the level necessary to protect human health through exposure routes of fish (and shellfish) tissue consumption, water consumption, or other routes identified as appropriate for the water body.”

No numeric criteria for aluminum have been adopted by the State of Mississippi. However, *The National Recommended Water Quality Criteria* indicates that the values in Table 5 are protective of aquatic life (EPA, 2006).

Table 5. Criteria for Total Aluminum (EPA, 2006)

Parameter	Fresh Water		Human Health	
	Acute	Chronic	Organisms Only	Water & Organisms
Aluminum	750 g,i	87 g,i,l	--	--

g = This value is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*,**PB85-227049**, January 1985) and was issued in one of the following criteria documents: Aluminum (**EPA 440/5-86-008**); Chloride (**EPA 440/5-88-001**); Chloropyrifos (**EPA 440/5-86-005**).

i = This value for aluminum is expressed in terms of total recoverable metal in the water column.

l = There are three major reasons why the use of Water-Effect Ratios might be appropriate. (1) The value of 87 μg/l is based on a toxicity test with the striped bass in water with pH= 6.5-6.6 and hardness < 10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 μg aluminum/ L, when either total recoverable or dissolved is measured.

TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The instream aluminum target for this TMDL is based on the fresh water chronic criterion of 87 μg/l.

2.2 Discussion of Aluminum

Five properties of aluminum affect the chemistry of surface water:

1. Aluminum is not as soluble in neutral solutions as it is in acidic or basic solutions.
2. Chloride, fluoride, nitrate, phosphate, and sulfate form soluble complexes with aluminum.
3. Some acids (fulvic and humic acids) form strong complexes with aluminum.
4. Soluble and insoluble polymers are formed when hydroxide ions connect aluminum ions.
5. Solutions of aluminum in water approach chemical equilibrium rather slowly under some conditions (EPA, 1988).

Toxicity due to aluminum has been shown to have effects on survival and reproduction in several species of freshwater fish. Two of these vulnerable species are brook trout and striped bass. Because of this sensitivity to aluminum, national criteria have been established. These criteria state that “Freshwater aquatic organisms and their uses should not be affected unacceptably, when the pH is between 6.5 and 9.0, if the four-day average concentration of aluminum does not exceed 87 μg/L more than once every three years on the average and if the one-hour average concentration does not exceed 750 μg/L more than once every three years on the average” (EPA, 1988).

2.3 Inventory of Available Water Quality Monitoring Data

The Mississippi 1998 Section 303(d) List identified numerous water bodies as being impaired by metals based on evaluated assessments for which limited monitoring data were available. The available data were not collected using clean sampling techniques. Water samples that were not collected using clean sampling techniques have the potential to be incorrect due to the possibility of contamination during the sample collection process. It was evident that more samples were needed, and that clean sampling techniques should be followed as described in Section 8.1 of the standard operating procedure (SOP) provided by EPA (Method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels*, July 1996).

On September 29, 2006, a year long study began to accurately determine the aluminum concentration in Riverdale Creek. During this one-year period, 10 samples were collected during baseflow conditions. The samples were analyzed for metals content using clean sampling techniques. All samples were collected according to the SOP provided by EPA (Method 1669).

The location of the water quality monitoring station is shown in Figure 3. The sample results are listed in Table 6. All of the samples exceed the chronic criteria and TMDL target.

Figure 3. Location of Water Quality Monitoring Station

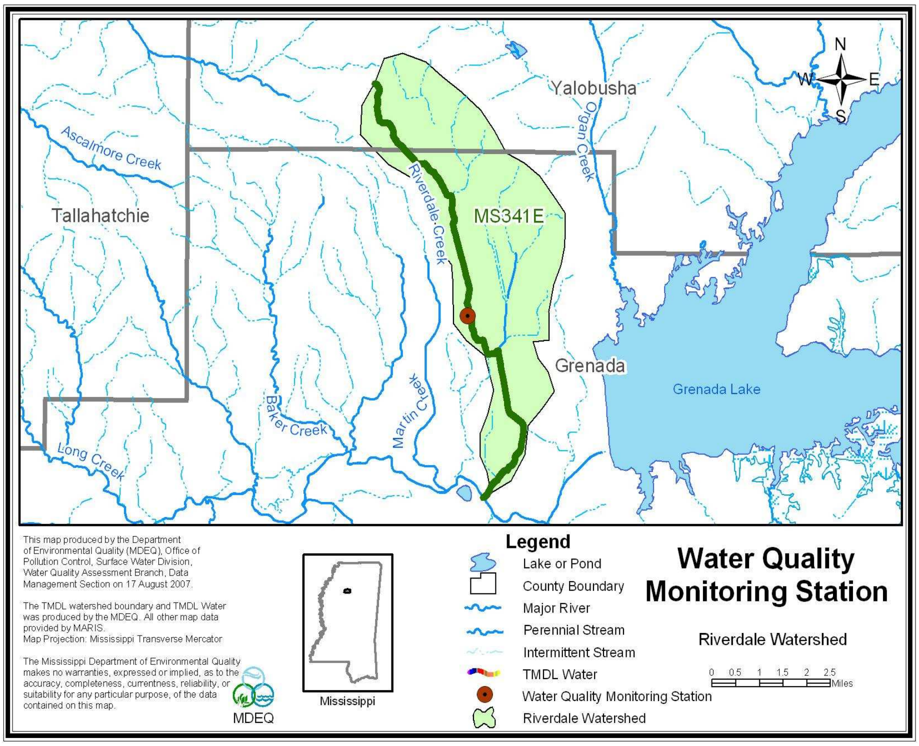


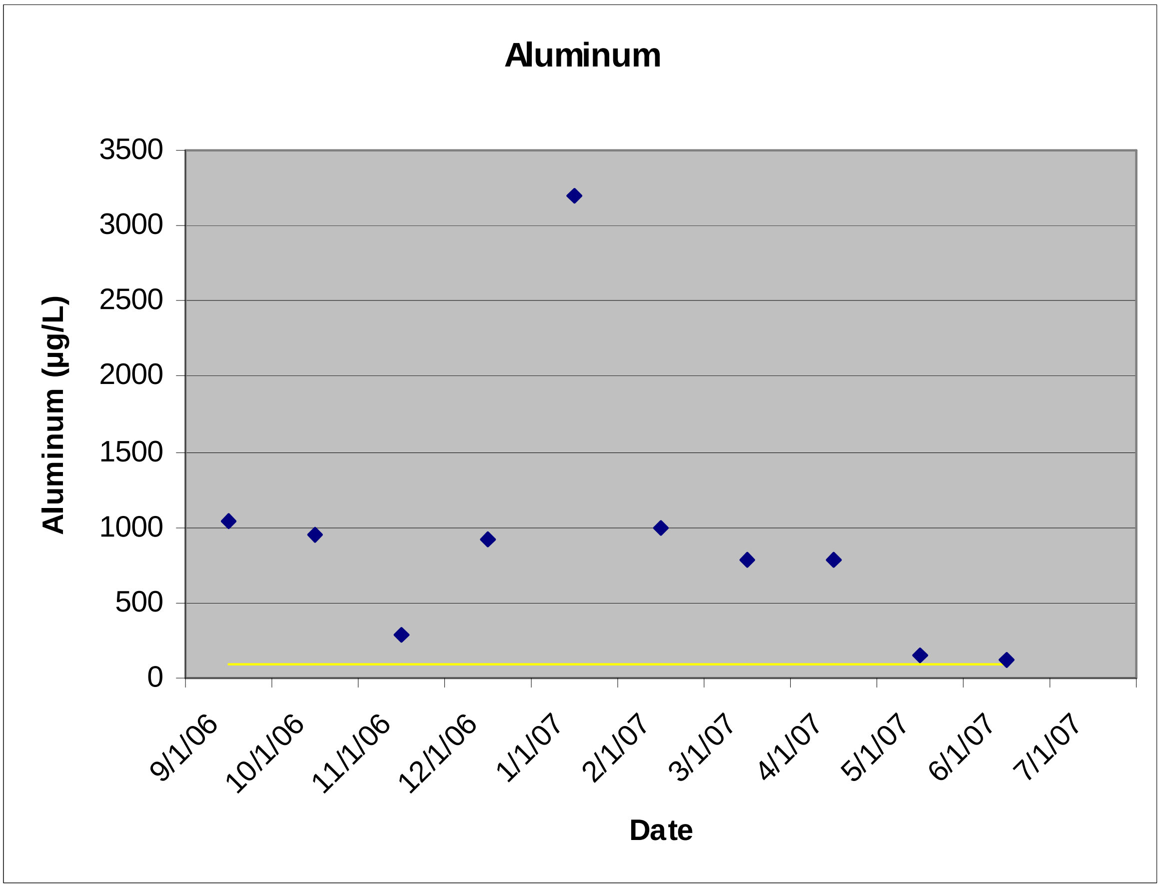
Table 6. Aluminum Loading for Riverdale Creek

Date	Total Aluminum (µg/l)
09/29/2006	1040
10/24/2006	947
11/21/2006	290
12/05/2006	921
01/10/2007	3200
02/20/2007	989
03/06/2007	785
04/03/2007	785
05/03/2007	158
06/04/2007	119

2.4 Analysis of Instream Water Quality Monitoring Data

The data from the 2006 study are shown in the graph in Figure 3. The blue points represent aluminum levels observed in Riverdale Creek . The yellow line represents the freshwater chronic aluminum toxicity criteria (87 µg/l).

Figure 4. Aluminum in Riverdale Creek



SOURCE ASSESSMENT

This TMDL notes the need for monitoring in the watershed to attempt to characterize the point and nonpoint sources of aluminum. The TMDL calculations will be based on the maximum allowed by the standard.

3.1 Assessment of Point Sources

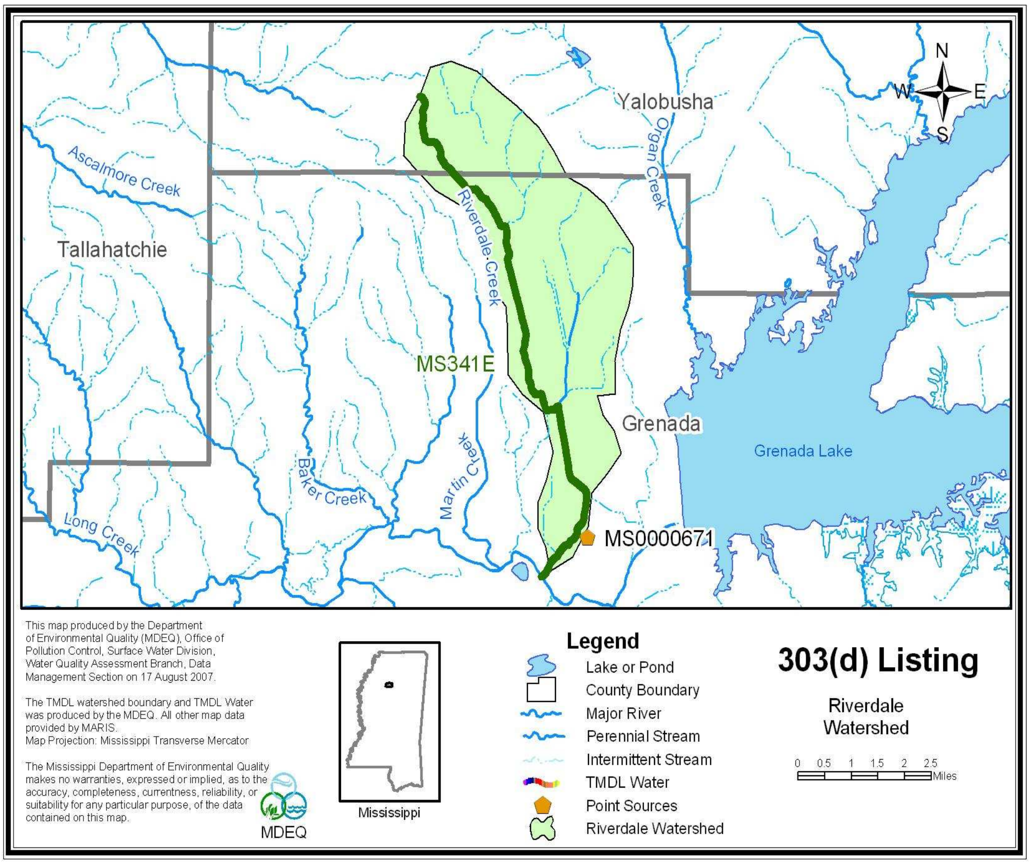
Point sources of aluminum have their greatest potential impact on water quality during periods of low flow. Thus, a careful evaluation of point sources that discharge aluminum is necessary in order to quantify the degree of impairment present during the low flow, critical condition period. Table 7 lists the permitted discharger in the watershed along with the NPDES Permit number and the receiving water body. Figure 4 shows the location of the point source in the Riverdale Creek watershed. The contribution of the discharger was based on the facility's discharge monitoring data and other records of past performance. As can be seen when comparing the monitoring location and the point source, the samples were collected above the discharge point. More investigation is needed to determine the source of aluminum in the water body.

Table 7. Inventory of Point Source Dischargers

Facility Name	NPDES Permit	Current Estimated Aluminum Concentration	Receiving Water body	Estimated Existing NPDES Load
Grenada Manufacturing LLC	MS0000671	240 µg/l	Riverdale Creek	0.32 lb/d

0.248 cfs (flow) * 0.240 mg/l (concentration) * 5.394 (conversion) = 0.32 lbs per day (Existing NPDES Load)

Figure 5. Location of Point Source for Riverdale Creek



3.2 Assessment of Nonpoint Sources

The 10,567-acre drainage area of the Riverdale Creek watershed contains many different landuse types, including urban, forests, cropland, pasture, and wetlands. The landuse information is based on data collected by the State of Mississippi's Automated Information System (MARIS), 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. This classification is based on a modified Anderson level one and two system with additional level two wetland classifications. Table 8 shows the landuse distribution in number of acres.

Figure 6. Riverdale Creek Landuse Distribution

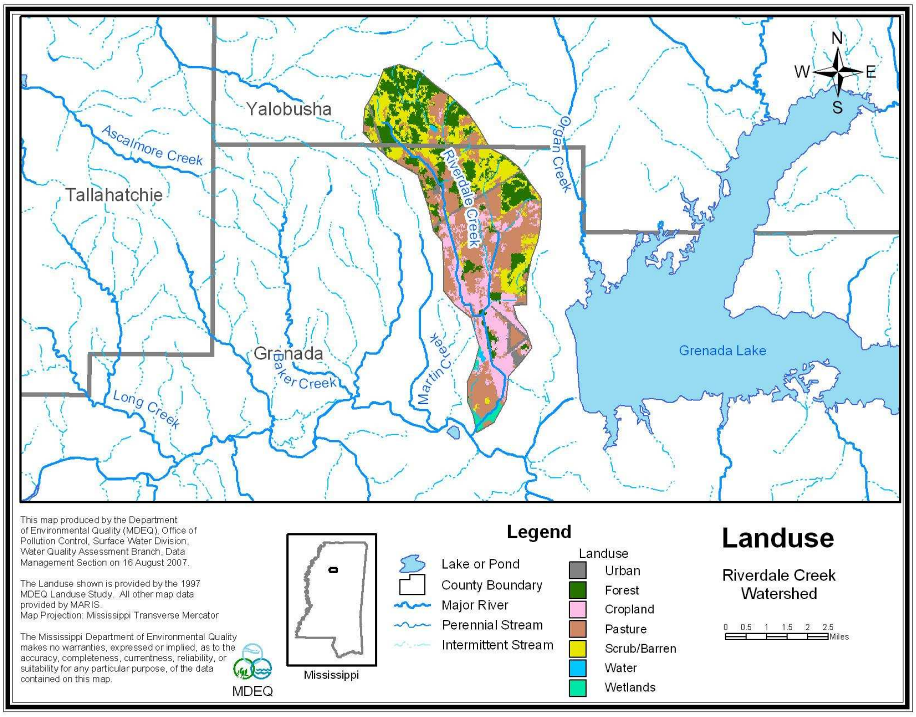


Table 8. Landuse Distribution in Number of Acres and Percentage of Total

	Water	Barren	Forest	Croplands	Pasture	Urban	Wetland	Total
Area (acres)	31.8	2200.8	2312.8	1864.4	3685.1	329.2	143.3	10567.4
Percentage	0.3 %	20.8 %	21.9 %	17.6 %	34.9 %	3.1 %	1.4 %	100 %

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for nonpoint sources necessary for attainment of water quality standards in segment MS341E. The Margin of Safety (MOS) is implicit based on conservative assumptions. The TMDL is based on the fresh water chronic aluminum toxicity criterion multiplied by the 7Q10 flow in the stream. The WLA and LA portions of the TMDL are allocated from the allowable daily load.

4.1 Calculation of the TMDL

The TMDL is calculated by multiplying the 7Q10 flow in Riverdale Creek by the fresh water chronic aluminum toxicity criterion. By using this mass balance calculation, the maximum safe value of the aluminum load was calculated. The 7Q10 flow was found using the Unit Map Method (USGS, 1992). This unit-7Q10 value was based on the 7Q10 for nearby gaged sites, and on the geology and topography of the basin.

1.651 cfs (7Q10 flow) * 0.087 mg/l (criterion) * 5.394 (conversion) = 0.78 lbs per day (TMDL)

4.2 Wasteload Allocations

Mass balance equations have been used to determine the aluminum TMDL. The aluminum loading rate for the point source was calculated with the permitted flow in cubic feet per second and the aluminum criteria of 87μg/l. As part of this TMDL, this facility will be required to meet water quality criteria limits. Table 9 lists the allocated point source contribution. The total WLA for this segment is 0.12 lb/day. This is a 64 % reduction of the estimated point source load so as not to allow point sources to contribute to the documented impairment of aluminum in Riverdale Creek.

Table 9. Wasteload Allocations

Facility	Allocated Flow (cfs)	Water Quality Criteria (μg/l)	WLA (lb/day)
Grenada Manufacturing	0.248	87.0	0.12

0.248 cfs (flow) * 0.087 mg/l (concentration) * 5.394 (conversion) = 0.12 lbs per day (WLA)

4.3 Load Allocations

The load allocation developed for this TMDL is an estimation of the acceptable contribution of all nonpoint sources in the watershed. The calculated total of the allowable yield of aluminum for the Riverdale Creek watershed without exceeding the applicable water quality criteria is 0.664 lb/day.

4.4 Incorporation of a Margin of Safety

The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this TMDL model is implicit.

4.5 Seasonality

Seasonality was covered in this TMDL by gathering samples during each of the seasons, low-flow and high-flow.

CONCLUSION

Aluminum was addressed through a total aluminum target based on USEPA criteria. This TMDL recommends a 64% reduction of the aluminum load from the permitted facility to meet water quality criteria. This TMDL recommends further monitoring for aluminum using clean techniques and accurate testing methods to investigate the cause of the violation of water quality criteria upstream of the permitted facility and to try to identify upstream sources.

5.1 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper. The public will be given an opportunity to review the TMDLs and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list. Anyone wishing to become a member of the TMDL mailing list should contact Kay Whittington at Kay_Whittington@deq.state.ms.us.

All comments should be directed to Kay Whittington at Kay_Whittington@deq.state.ms.us or Kay Whittington, MDEQ, PO Box 10385, Jackson, MS 39289. All comments received during the public notice period and at any public hearings become a part of the record of this TMDL and will be considered in the submission of this TMDL to EPA Region 4 for final approval.

DEFINITIONS

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered water body may be based upon a similar, unaltered or least impaired, water body or on historical pre-alteration data.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving water body.

Critical Condition: hydrologic and atmospheric conditions in which the pollutants causing impairment of a water body have their greatest potential for adverse effects.

Daily discharge: the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: use specified in water quality standards for each water body or segment regardless of actual attainment.

Discharge monitoring report: report of effluent characteristics submitted by a NPDES Permitted facility.

Effluent standards and limitations: all State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: treated wastewater flowing out of the treatment facilities.

Evaluated Water body: The group of listings on the 1998 Mississippi Section 303(d) for which there are insufficient data to make an assessment call.

Geometric mean: the *n*th root of the product of *n* numbers. A 30-day geometric mean is the 30^{th} root of the product of 30 numbers.

Impaired Water body: any water body that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant. The load allocation is the value assigned to the summation of all cattle and land applied fecal coliform that enter a receiving water body. It also contains a portion of the contribution from septic tanks.

Loading: the total amount of pollutants entering a stream from one or multiple sources.

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

NPDES permit: an individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

Point Source: pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): a waste treatment facility owned and/or operated by a public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the decimal point is *b* places to the left of where it is shown.
For example: $2.7X10^{4}$ = 2.7E+4 =27000 and $2.7X10^{-4}$ = 2.7E-4=0.00027.

Sigma (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, (d_l, d_2, d_3) respectively could be shown as:

$$\sum_{i=1}^{3} d_i = d_1+d_2+d_3 = 24 + 123 + 16 = 163$$

Total Maximum Daily Load or TMDL: the calculated maximum permissible pollutant loading to a water body at which water quality standards can be maintained.

Regression Coefficient: an expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

Waste: sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload allocation (WLA): the portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant. It also contains a portion of the contribution from septic tanks

Water Quality Standards: the criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water quality criteria: elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

Waters of the State: all waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: the area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10.......................... Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period

BMP ....Best Management Practice

CWA ....Clean Water Act

DMR .... Discharge Monitoring Report

EPA ....Environmental Protection Agency

GIS ....Geographic Information System

HUC ....Hydrologic Unit Code

LA .... Load Allocation

MARIS .... State of Mississippi Automated Information System

MDEQ .... Mississippi Department of Environmental Quality

MOS .... Margin of Safety

NRCS ....National Resource Conservation Service

NPDES .... National Pollution Discharge Elimination System

USGS .... United States Geological Survey

WLA .... Waste Load Allocation

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