

Appendix B

E. coli Bacteria Allocations and Daily Loads for Rock Creek

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Introduction

The purpose of this document is to revise the original 2004 *Final Total Maximum Daily Load for Fecal Coliform Bacteria in Rock Creek* (DDOH 2004). The revision incorporates a new water quality standard (WQS) for *Escherichia coli* (*E. coli*) that the District of Columbia (District) promulgated in October 2005 after the approval of the original total maximum daily loads (TMDLs). The allocations specified in the original TMDL are still in effect; this revision provides a translation of those loads to *E. coli*, the parameter on which the existing standard is based. The translation was performed using a translator equation developed from analysis of paired fecal coliform/*E. coli* sampling data collected from waters in the District.

In addition, daily loading expressions for the new *E. coli* allocations are also provided. This has been done to comply with the U.S. Environmental Protection Agency (EPA) obligations under the 2006 court case, *Friends of the Earth vs. the Environmental Protection Agency*, 446 F.3d 140, 144 (D.C. Cir. 2006) which requires establishment of a daily loading expression in TMDLs in addition to any annual or seasonal loading expressions previously established in the TMDL.

Anacostia Riverkeepers, Friends of the Earth, and Potomac Riverkeepers filed a complaint (Case No.: 1:09-cv-00098-JDB) on January 15, 2009, because certain District TMDLs did not have a daily load expression established. EPA settled the complaint by agreeing to an established schedule that both the court and the plaintiffs to the case approved. The settlement agreement requires establishment of daily loads in District bacteria TMDLs referenced in Paragraphs 24a, 24c, 24g, 24i, 24j, and 24l of the plaintiffs' complaint by December 2014. This TMDL revision satisfies that requirement for the 2004 *Final Total Maximum Daily Load for Fecal Coliform Bacteria in Rock Creek* (Paragraph 24g of the complaint).

Applicable Water Quality Standards

Rock Creek was on the District's 1998 303(d) list because of fecal coliform bacteria counts that exceeded the District's WQS. The District WQS, Title 21 of the District of Columbia Municipal Regulations (DCMR) Chapter 11, 49 D.C. Reg. 3012 and D.C. Reg. 4854, specifies the categories of beneficial uses as

1. Class A. primary contact recreation
2. Class B. secondary contact recreation
3. Class C. protection and propagation of fish, shellfish, and wildlife
4. Class D. protection of human health related to consumption of fish and shellfish
5. Class E. navigation

WQS are derived from EPA recommendations on the basis of risk levels associated with swimming. Under the WQS that were in place at the time of the original TMDL, Class A and Class B waters were required to achieve or exceed the WQS for bacteria as measured by fecal coliform as the indicator organism. Fecal coliforms are microbes that live in the intestinal tracts of warm-blooded animals, whose presence indicates the potential for pathogens in the water.

When the original 2004 fecal coliform bacteria TMDL was developed for Rock Creek, the standard for Class A waters was a maximum 30-day geometric mean of 200 MPN, where *MPN*

is a statistically derived estimate of the Most Probable Number of bacteria colonies in a 100 milliliter sample. This statistical estimate is often called a *count*, although it is represented as a concentration. The geometric mean is based on a minimum of five samples within the 30-day period. The standard for Class B waters was a 30-day geometric mean of 1,000 MPN. However because Rock Creek was designated as a Class A water, which was subject to the more restrictive bacteria standard, the 200 MPN for Class A designation was used as the not-to-exceed criterion for all the waterbodies in the original 2004 TMDL.

Effective January 1, 2008, the District bacteriological WQS changed from fecal coliform to *E. coli*. The current Class A water standards are a geometric mean of 126 MPN and 410 MPN for a single-sample value. The geometric mean is based on a minimum of five samples within the 30-day period and is used in both water quality trend assessments and permits. The single-sample value is valid for use only in assessing water quality trends. Class B and Class C waters do not have an *E. coli* standard. All waters subject to this TMDL including Rock creek and its tributaries are designated as Class A waters (DCMR, WQS, 21-1101.2), see Table 1.

Table 1. Classification of the District's waters

Surface waters of the District	Use classes	
	Current use	Designated use
Potomac River	B, C, D, E	A, B, C, D, E
Potomac River tributaries (except as listed below)	B, C, D	A, B, C, D
Battery Kemble Creek	B, C, D	A, B, C, D
C&O Canal	B, C, D, E	A, B, C, D, E
Rock Creek	B, C, D, E	A, B, C, D, E
Rock Creek tributaries	B, C, D, E	A, B, C, D, E
Tidal Basin	B, C, D, E	A, B, C, D, E
Washington Ship Channel	B, C, D, E	A, B, C, D, E
Oxon Run	B, C, D	A, B, C, D
Anacostia River	B, C, D, E	A, B, C, D, E
Anacostia River tributaries (except as listed below)	B, C, D	A, B, C, D
Hickey Run	B, C, D	A, B, C, D
Watts Branch	B, C, D	A, B, C, D
Wetlands	C, D	C, D

Source: DCMR 1101.2

The waterbodies addressed by this revision are the same ones that received allocations under the original TMDL, Upper Rock Creek and Lower Rock Creek.

Translation of Fecal Coliform Values to *E. Coli*

A *translator* is a mathematical equation that allows one parameter to be translated into another consistently and in a scientifically defensible manner. To support the TMDL revision, EPA and the District of Columbia Department of the Environment developed a District-specific translator using the statistical relationship between paired fecal coliform and *E. coli* data collected in the District's waters (LimnoTech 2011 and 2012).¹ The data used to develop the DC translator was composed of paired fecal coliform and *E. coli* instream monitoring measurements for DC and adjacent waters collected by three agencies: DDOE, the Virginia Department of Environmental Quality (VDEQ), and the Maryland Department of the Environment (MDE). The dataset includes contains ambient instream water quality monitoring data as well as end-of-pipe data collected by DC Water at separate storm water system (SSWS) outfalls. CSO data was excluded from the dataset and was not used in the development of the translator. *E.coli* levels for CSO's were not calculated using the translator. (See Section CSO section below) The translator is representative of ambient and stormwater bacteria concentrations and was used to convert the original fecal coliform TMDL allocations into *E. coli* values. The District-specific translator equation is shown in Equation 1 below.

$$\text{Log2}(E. coli) = 0.9377[\text{Log2}(\text{fecal coliform})] - 0.4614 \quad [1]$$

Use of the translator allowed for converting original fecal coliform annual load allocations to the current WQS for *E. coli*, while still relying on the original modeling and analysis.

Compliance with Revised WQS

Using the District-specific translator, a fecal coliform value of 200 MPN (the original District standard for bacteria) is associated with an *E. coli* value of approximately 104 MPN, which is below the 126 MPN *E. coli* criteria.

It is important to consider that under the original modeling analysis, reductions to sources of fecal bacteria were made until the waterbodies met the fecal coliform geometric mean standard of 200 MPN at all times. Therefore, under the original modeling analysis, fecal coliform loads translated to *E. coli* loads will result in loads that are more protective than WQS. The *E. coli* reductions in this TMDL meet approximately a geometric mean of 104 MPN, while the current bacteria standard is 126 MPN.

Translation Methodology

This TMDL revision translates the original annual fecal coliform loads into equivalent annual *E. coli* loads. The original February 2004 TMDL divided Rock Creek into upper and lower segments, consistent with the District's 303(d) list, where the line of separation is at Pierce Mill Dam near Klinge Road above the National Zoo. The original TMDL provides load allocations

¹ Documentation related to development of the translator is in LimnoTech's 2011 Memorandum, *Final Memo Summarizing DC Bacteria Data and Recommending a DC Bacteria Translator (Task 2)* and Limno Tech's 2012 Memorandum, *Update on Development of DC Bacteria Translators*.

for the MPN of colonies of fecal coliform for various sources and identifies the necessary percentage reduction required for each source in order to meet the TMDL (Table 2). Associated modeling files are also available that provide daily fecal coliform concentrations and flows for existing conditions for the period 1988-1990. Allocations were made for the following sources: upstream, combined sewer overflow (CSO), separate storm water (SW), and direct storm runoff or lateral flow (LAT).

Table 2. Percent Reduction Required (Original Fecal Coliform TMDL)

Upper Rock Creek		Lower Rock Creek	
Upstream	95.05	Upstream	95.05
CSO	0.00	CSO	92.69
Separate Storm Water	95.05	Separate Storm Water	95.05
Direct Storm Runoff	95.05	Direct Storm Runoff	95.05
Total	95.00	Total	94.08

Information from the original TMDL and input files to the Rock Creek Model² were used to develop the revised *E. coli* allocations. The methodologies used to calculate the revised *E. coli* allocation for each source are more fully described below. For calculations and information supporting the translations, please see Appendix C.

CSO

The *E. coli* loads for CSO's were not calculated using the equation 1 translator but were developed using the Long Term Control Plan (LTCP) based event meant concentration (EMC) for *E. coli*, which was established from data gathered during the development of DC Water and Sewer Authority 's Combined Sewer System Long Term Control Plan (DC WASA 2002). The LTCP-based EMC for *E. coli* (686,429 MPN / 100 mL) and the predicted flow volume under full implementation of the LTCP were used to calculate the revised CSO *E. coli* allocation as follows.

1. Obtained the predicted flow volumes from the Rock Creek CSOs for 1988-1990 under the LTCP implementation scenario.
2. Multiplied the flow volumes by the LTCP-based *E. coli* EMC value of 686,429 MPN/ 100 mL to derive the daily CSO loads.
3. Summed the loads and divided by 3 to derive the average annual CSO allocation for the modeled 3-year period.

Upstream, Lateral, and Stormwater Sources

Equation 1 was applied to fecal coliform concentrations to develop the revised *E. coli* allocation for the upstream, LAT, and SW sources as follows.

² The Rock Creek TMDL was developed using a one-dimensional SWMM model (DCWASA 2002b).

1. From available original model files, obtained the time series of the flow and fecal coliform loads for the existing condition. Calculated the fecal coliform concentrations using the load and flow (concentration = load / flow).
2. Multiplied each fecal coliform concentration value by the percent reduction required for that source in the original TMDL (see Table 2) to derive the ‘TMDL’ condition daily fecal coliform concentrations.
3. Applied Equation 1 to the TMDL daily fecal coliform concentrations to derive the TMDL daily *E. coli* concentrations.
4. Multiplied the daily *E. coli* concentrations by the flow volumes to derive the *E. coli* TMDL daily load time series.
5. From the daily load time series, calculated the average annual *E. coli* TMDL load allocation by summing the daily loads and dividing the total by three to account for the three-year simulation period.

Allocations

The original February 2004 TMDL used a series of computer simulations to determine the level of annual load reductions needed to meet WQS. The WQS were considered to be met if no model segment in the District had a fecal coliform maximum 30-day geometric mean exceeding the 200 MPN Class A standards. Exceedance is expressed in the number of months exceeding the geometric mean. However, this revised TMDL considers standards to be met when all portions of the waterbody do not exceed the *E. coli* maximum 30-day geometric mean of 126 MPN Class A standard. Because the bacteria translator provides a means to calculate the equivalent *E. coli* load, under a given scenario that meets the fecal coliform standard, the equivalent *E. coli* standard will also be met with an additional margin of safety. The tables below present the TMDL expressed in equivalent *E. coli* annual loads.

The following *E. coli* allocations are made for Rock Creek.

Table 3. Rock Creek average annual allocation (MPN) (*E. coli*, translator derived)

Upper Rock Creek		Lower Rock Creek	
Upstream	2.66E+13	Upstream	5.68E+13
CSO	0.00E+00	CSO	9.94E+13
SW	2.87E+13	SW	1.01E+13
LAT	1.55E+12	LAT	2.03E+13
MOS 1%	5.74E+11	MOS 1%	3.07E+11
Total Allocated (sources minus MOS)	5.68E+13	Total Allocated (sources minus MOS)	1.866E+14
Total	5.74E+13	Total	1.869E+14

Bold text indicates sources from which MOS was calculated. From the February 2004 TMDL, 1% of non-CSO loads were allocated to the MOS.

Daily Loads Calculation Methodology

In November 2006, EPA issued the memorandum *Establishing TMDL Daily Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et. al., No. 05-5015 (April 25, 2006) and Implications for NPDES permits*, which recommends that all TMDLs and associated load allocations and wasteload allocations include a daily time increment in conjunction with other appropriate temporal expressions that might be necessary to implement the relevant WQS. In compliance with that recommendation, this section presents corresponding daily load expressions for the long-term load allocations for Rock Creek described in **Error! Reference source not found.** and Table 3 above. These daily loads were developed in a manner consistent with the following assumptions in EPA's *Draft Options for Expressions of Daily Loads in TMDLs* (USEPA 2007):

1. Methods and information used to develop the daily load should be consistent with the approach used to develop the loading analysis.
2. The analysis should avoid added analytical burden without providing added benefit.
3. The daily load expression should incorporate terms that address acceptable variability in loading under the long-term loading allocation. Because many TMDLs are developed for precipitation-driven parameters, one number will often not represent an adequate daily load value. Rather, a range of values might need to be presented to account for allowable differences in loading due to seasonal or flow-related conditions (e.g., daily maximum and daily median).
4. The methodologies are applicable to a wide variety of TMDL situations; however, the specific application (e.g., data used, values selected) should be based on knowledge and consideration of site-specific characteristics and priorities.
5. The TMDL analysis on which the daily load expression is based fully meets the EPA requirements for approval, is appropriate for the specific pollutant and waterbody type, and results in attainment of water quality criteria in a manner that is consistent with the underlying analysis that was used to develop the original TMDLs.

Daily Load Calculation Approach for Rock Creek Sources

To develop the daily load values in this TMDL revision, input files to the original fecal coliform model were obtained for Rock Creek.³ Daily load allocations were developed on the basis of the translated *E. coli* daily load time series for the simulation period (1988-1990). From these time series, EPA identified the average and maximum daily load values for each source. The specific steps are summarized below:

1. Using the *E. coli* daily load time series for sources (CSOs⁴, upstream, direct storm runoff and tributary storm water) identified the maximum *E.coli* daily load over the 3 year simulation period. This maximum *E.coli* daily load represents the maximum daily load that Rock Creek can receive on a given day and still meet water quality standards.
2. Next, from the same time series, calculated the *E. coli* average daily load (for non-zero loading days) over the 3 year period of simulation for each source category. Average daily loads were calculated by summing all the simulated daily loads for each source and dividing the sum by the number of data points.

³ Representing existing conditions.

⁴ The daily load time series for CSOs is based on model files representing the LTCP scenario (CSO_D70P_RC).

E. coli Daily Loads

Table 4 presents the *E. coli* daily loads for Rock Creek by source.

Table 4. Rock Creek daily loads (*E. coli*)

Source		Upper	Lower
		<i>E. coli</i> (MPN)	
Upstream	Max	1.09E+12	3.43E+12
	Avg	7.35E+10	1.56E+11
Combined sewer overflow	Max	0.00E+00	9.73E+13
	Avg	0.00E+00	2.59E+12
Separate storm water	Max	2.92E+12	9.08E+11
	Avg	8.62E+10	3.45E+10
Direct (lateral) runoff	Max	8.39E+10	1.10E+12
	Avg	1.30E+10	1.70E+11

Other Sources

The February 2004 TMDL provides zero allocations of fecal coliform to boats, ships, houseboats, and floating residences. This TMDL revision also provides a zero allocation to these sources as part of the *E. coli* allocations.

Assurance of Implementation—Daily Loads

The approach used to calculate daily loads in this TMDL identifies a representative maximum daily or average daily load for the annual TMDL for each source identified in the original report. The approach does not presume that the maximum daily load provided could be discharged every day and still meet the in-stream WQS. While expressions of daily loading values are useful in illustrating the variability in loading that can occur under a TMDL scenario, the annual load must also be met to comply with the TMDL.

Note that federal regulations at Title 40 of the *Code of Federal Regulations* section 122.44(d)(1)(vii)(B) require that, for a National Pollutant Discharge Elimination System permit for an individual point source, the effluent limitations must be consistent with the assumptions and requirements of any available wasteload allocation for the discharge prepared by the jurisdiction and approved by EPA. There is no express or implied statutory requirement that effluent limitations in National Pollutant Discharge Elimination System permits be expressed in daily terms. The Clean Water Act definition of *effluent limitation* is quite broad (effluent limitation is “any restriction on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources ...”), see Clean Water Act section 502(11). Unlike the Clean Water Act’s definition of TMDL, the Clean Water Act

definition of *effluent limitation* does not contain a *daily* temporal restriction. National Pollutant Discharge Elimination System permit regulations do not require that effluent limits in permits be expressed as maximum daily limits or even as numeric limitations in all circumstances, and such discretion exists regardless of the time increment chosen to express the TMDL. For further guidance, see Benjamin H. Grumbles' memo of November 15, 2006, titled *Establishing TMDL Daily Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No. 05-5015 (April 25, 2006) and implications for NPDES Permits.*

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