Appendix A

E. coli Bacteria Allocations and Daily Loads for Kingman Lake

February 2013

Contents

Introduction

The purpose of this document is to revise the original 2003 *Final Total Maximum Daily Load for Fecal Coliform Bacteria in Kingman Lake* (DDOH 2003) and the *Decision Rationale Total Maximum Daily Loads for Fecal Coliform Bacteria in Kingman Lake* (USEPA 2003). 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 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 2003 *Final Total Maximum Daily Load for Fecal Coliform Bacteria in Kingman Lake* (Paragraph 24c of the complaint).

Applicable Water Quality Standards

Kingman Lake was listed on the District's 1998 303(d) lists 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 2003 fecal coliform bacteria TMDL was developed for Kingman Lake, 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 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 Kingman Lake was designated as a Class A water, which has a more restrictive bacteria standard, the 200 MPN for Class A designation was used as the not-to-exceed criterion in the original 2003 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. Kingman Lake, which is part of the Anacostia River system, is 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 waterbody addressed by this revision is the same one that received allocations under the original TMDL and EPA's October 31, 2003, Decision Rationale for Kingman Lake.

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.

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

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 monthly fecal coliform loads into equivalent monthly *E. coli* loads. The October 2003 TMDL together with EPA's Decision Rationale provides loads for the MPN of colonies of fecal coliform calculated for stormwater sources. The original TMDL was developed based on the assumption that water in Kingman Lake reflects implementation of the Anacostia River bacteria TMDL and thus, already meets water quality criteria. Therefore,

[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*.

only stormwater loads were assigned an allocation in the original TMDL. 61 percent of the storm water flow was categorized as the WLA and 39 percent as the LA. (See EPA's *Decision Rationale Total Maximum Daily Loads For Fecal Coliform Bacteria In Kingman Lake*). Average existing loads were provided by month for a wet year, a dry year, and an average year and were calculated using an assumed stormwater concentration of fecal coliform of 17,300 # / 100 mL. The maximum monthly TMDL load was calculated by reducing the maximum monthly existing load by 50 percent and assigning 10 percent as the MOS. Table 2 provides the original existing and TMDL monthly loads of fecal coliform based on the original TMDL and Decision Rationale. Note that these are for stormwater loads entering Kingman Lake.

Table 2. Kingman Lake Original Stormwater Fecal Coliform TMDL Components (#/month)

Existing Load	TMDL	WLA	LA	MOS
6.31E+11	3.15E+11	1.73E+11	1.11E+11	3.15E+10

The original analysis did not provide the average monthly flow volume but it can be calculated from the average monthly load and the assumed fecal coliform stormwater concentration value of 17,300 # / 100 mL. The revised *E. coli* TMDL for Kingman Lake was developed as follows:

1) Calculated the average monthly flow volume based on the existing fecal coliform load and assumed fecal coliform stormwater concentration.
2) Used Equation 1 to translate the existing fecal coliform stormwater concentration (17,300 / 100 mL) to the existing *E. coli* stormwater concentration (6,841.02 / 100 mL).
3) Used Equation 1 to translate the TMDL fecal coliform stormwater concentration (8,636.29 / 100 mL calculated as TMDL load / flow volume) to the TMDL *E. coli* stormwater concentration (3,566.14 / 100 mL).[2]
4) Multiplied the TMDL *E. coli* stormwater concentration by the monthly flow volume to identify the *E. coli* TMDL.
5) Distributed the TMDL load among the various components according to the same distribution used in the original analysis (ten percent MOS, 39 percent LA, 61 percent WLA).

Allocations

Table 3 identifies the fecal coliform monthly maximum TMDL components and provides a translation to the *E. coli* allocation.

[2] Under the TMDL, *E. coli* concentrations in Kingman Lake are predicted to be approximately 80 # / 100 mL. This is determined by dividing the monthly TMDL load (1.30E+11) by the known volume of Kingman Lake (given in the original TMDL as 1.63E+11 mL) and multiplying by a conversion factor.

Table 3. Monthly fecal coliform and *E. coli* (translator derived) stormwater allocations

Average monthly load	Existing (MPN)	TMDL (MPN)	WLA (MPN)	LA (MPN)	MOS (10%)
Fecal coliform	6.31E+11	3.15E+11	1.73E+11	1.11E+11	3.15E+10
E. coli	2.50E+11	1.30E+11	7.05E+10	4.51E+10	1.45E+10

Daily Loads

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 Kingman Lake described in **Error! Reference source not found.** 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.

Calculation Approach for Kingman Lake Stormwater

EPA's draft guidance document, Options for Expressing Daily Loads in TMDLs (USEPA 2007), recommends a statistical approach an appropriate way to develop daily maximum load values, specifically when long periods of continuous simulation data are not available. EPA's *Technical Support Document for Water Quality-Based Toxics Control* (TSD) (USEPA 1991) describes a statistical approach to identifying a maximum daily load in such circumstances. The statistical

daily load expression incorporates acceptable variability in loading under the long-term loading allocation.

The equation below relates the maximum daily load (*MDL*) to the long-term average (*LTA*) as

$$MDL = LTA \cdot \exp\left(Z_p \sigma_y - 0.5\sigma_y^2\right),$$

where

Zp = *p*th percentage point of the standard normal distribution, as above
CV = coefficient of variation of the untransformed data

$$\sigma_y = \sqrt{\ln\left(CV^2 + 1\right)}.$$

Table 5-2 of the TSD provides precalculated multipliers for the LTA depending on the coefficient of variation and the Z-statistic used. The 99th percentile was used, and the default coefficient of variation of 0.6 was assumed on the basis of recommendations in the TSD.

For the Kingman Lake loads, the LTA was calculated by dividing the monthly *E. coli* load allocation by 30 and multiplying the LTA by the multiplier found in Table 5-2 of the TSD using the 99th percentile Z-statistic and a CV of 0.6. The specific steps are summarized below:

1. The *E. coli* allocated monthly load was divided by 30 to yield the average daily load.
2. The average daily load was multiplied by 3.11 (the 99th percentile Z-statistic from Table 5-2 in the TSD) to derive the corresponding maximum daily load.

E. coli Daily Loads

Error! Reference source not found. presents the stormwater daily load values for Kingman Lake.

Table 4. Maximum and average daily *E. coli* loads by source for Kingman Lake

***E. coli* Source**	**Daily Load (MPN)**	
Wasteload Allocation	Max daily	7.31E+09
	Avg daily	2.35E+09
Load Allocation	Max daily	4.67E+09
	Avg daily	1.50E+09
Total Load	Max daily	1.35E+10
	Avg daily	4.34E+09

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*.

References

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