



INTRODUCTION

Fecal indicator bacteria, such as *E. coli* (*Escherichia coli*), are used to determine whether streams and lakes are suitable for recreational use. Most *E. coli* bacteria are harmless, occur naturally in the environment, and naturally exist in the intestines of humans and warm-blooded animals. Basic information on Colorado stream standards, determination of stream impairments, total maximum daily loads (TMDLs), implications for municipal separate storm sewer system (MS4) permits, alternatives to TMDLs, and alternative stream standards are briefly summarized in this fact sheet. More detailed discussion on these topics can be found in the Colorado *E. coli* Toolbox.

HOW ARE STREAM STANDARDS ASSIGNED IN COLORADO?

The Colorado Water Quality Control Commission establishes use classifications and standards for waterbodies in Colorado. The Colorado Basic Standards (Regulation 31) establish recreational use classifications based on whether recreational primary contact use exists (E), is potentially present (P), not present (N) or undetermined (U). Numeric standards are assigned corresponding to the type of use. The purpose of these standards is to protect human health. Most urban streams in Colorado are assigned an Existing Primary Contact standard if there is potential for waterplay by children.





USE CLASSIFICATION	DESCRIPTION	STANDARD FOR <i>E. COLI</i> (CFU/100 ML) ¹
Class E - Existing Primary Contact	Surface waters used for primary contact recreation.	126
Class P - Potential Primary Contact	Surface waters that have the potential to be used for primary contact recreation. This classification is assigned when no use attainability analysis (UAA) has been performed demonstrating that a recreation class N classification is appropriate, if a reasonable level of inquiry has failed to identify any existing primary contact uses of the water segment, or where the conclusion of a UAA is that primary contact uses may potentially occur in the segment, but there is no existing primary contact.	205
Class N - Not Primary Contact	Surface waters that are not suitable or intended to become suitable for primary contact recreation uses. This classification is applied only where a UAA demonstrates that there is not a reasonable likelihood that primary contact uses will occur in the water segment in question within the next 20 years.	630
Class U - Undetermined	Surface waters that are to be protected at the same level of quality as Class E, but for which there has not been a reasonable level of inquiry about existing recreational uses and no recreation UAA has been completed. This is the default classification until inquiry or analysis demonstrates that another classification is appropriate.	126

TABLE 1. RECREATIONAL WATER QUALITY CRITERIA FOR COLORADO

¹Expressed as a 61-day rolling geometric mean. cfu/100 mL = colony forming units per 100 milliliters.

Additionally, Colorado has a “Natural Swimming Area” regulation (5 CCR 1003-5) that requires a swim beach to be closed and a public health notice posted if a single *E. coli* sample exceeds 235 cfu/100 mL. The swimming area must remain closed until sample results indicate that *E. coli* levels have returned below 235 cfu/100 mL. A natural swimming area is defined as a designated portion of a natural or impounded body of water in which the designated portion is devoted to swimming, recreative bathing, or wading and for which an individual is charged a fee for the use of such area for such purposes.





WHAT IS THE BASIS OF THE *E. COLI* STANDARD?

Colorado's primary contact standard is 126 cfu/100 mL, expressed as a not to be exceeded geometric mean value evaluated over a 61-day period. This standard was adopted based on EPA's 1986 Recreational Water Quality Criteria (RWQC).

DIFFERENCE BETWEEN FECAL INDICATOR BACTERIA (FIB) AND PATHOGENS

Fecal matter often contains pathogens, which are disease-causing organisms. Because of impracticality of testing for many pathogens associated with fecal waste, fecal indicator bacteria or "FIB" are used as indicators of fecal contamination. The FIB currently recommended by EPA include *E. coli* and/or enterococcus. Historically, fecal coliform bacteria were also recommended indicators. FIB are not necessarily disease-causing and may be present due to non-fecal sources such as decaying plant matter and other environmental sources.



The U.S. Environmental Protection Agency's (EPA) 2012 RWQC replaced the 1986 bacteria criteria, which relied on a series of epidemiological studies that the EPA conducted in the late 1970s and early 1980s to derive protective values for culturable indicators of fecal contamination and illness in swimmers (*E. coli*, enterococci, and other fecal indicators such as fecal coliforms). The 2012 RWQC were based on the latest research and science including new epidemiology studies conducted in the 2000's yielding revised values for *E. coli* and enterococci designed to protect the public from exposure to harmful levels of pathogens while participating in water-contact activities in coastal and non-coastal recreational waters. The 2012 RWQC offer two sets of numeric concentration thresholds corresponding to two estimated illness rates, either of which would protect human health. Colorado's numeric standard of 126 cfu/100 mL for primary contact recreation is consistent with recommendations in EPA's 2012 RWQC corresponding to an allowable swimmer illness rate of 36 illnesses per 1,000 exposures. EPA's 2012 RWQC also include some additional components that have not been adopted in Colorado, but that may be considered as part of the triennial review process of state standards in the future.





HOW IS STANDARDS ATTAINMENT ASSESSED FOR *E. COLI*?

In Colorado, assessment of recreational stream standards is based on calculation of a rolling geometric mean of *E. coli* samples collected during a 61-day period. Assessment of standards is based on the most current version of Colorado's 303(d) Listing Methodology, which is updated every two years. The 2018 Listing Methodology assessment process depends on the number of samples on which the geometric mean is based. To be considered impaired, a stream segment would need the geometric mean of 5 or more samples during a 61-day period to exceed the stream standard. If "overwhelming evidence" of impairment is present for the geometric mean of 4 samples, then the segment would also be listed as impaired. If only 2 or 3 samples are available in a 61-day period and the geometric mean exceeds the standard, then the segment would be placed on the state's Monitoring and Evaluation List.

Streams can be delisted from the 303(d) List if the geometric mean of 5 samples over a 61-day period for same time period during which impairment was identified attains the stream standard for the most recent two years.

Regulation 93 is updated by the Colorado Water Quality Control Commission every two years and contains Colorado's 303(d) List of impaired waters, segments on the monitoring and evaluation list, and segments for which TMDLs have been completed.





WHAT ARE TMDLS AND HOW DO THEY AFFECT MS4 PERMITS?

A total maximum daily load (TMDL) is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet and maintain water quality standards, along with an allocation of that amount to the pollutant's sources. TMDLs consider both volume of discharge and pollutant concentration to calculate pollutant loads. The basic components of a TMDL include: wasteload allocations (WLAs) for point sources, load allocations (LAs) for non-point sources, and a margin of safety (MOS). A reserve allocation may also be identified to allow capacity for addition of new discharges. Wastewater treatment plant (WWTP) discharges and MS4s are considered point source discharges, with TMDL-related wasteload reductions enforceable under Colorado Discharge Permit System (CDPS) permit requirements. For non-point sources (e.g., agriculture, natural background), load allocations are implemented on a voluntary basis.

The basic formula for a TMDL is expressed as:

$$\text{TMDL} = \Sigma \text{WLA} + \Sigma \text{LA} + \text{MOS}$$

Where:

WLA = the sum of wasteload allocations
(point sources such as permitted wastewater and stormwater discharges)

LA = the sum of load allocations (nonpoint sources and background)

MOS = the margin of safety

FORMULA FOR A TMDL

Colorado utilizes a variety of approaches for development of TMDLs. The most common basic approach is the use of Load Duration Curves, which can be completed using a spreadsheet of stream flow and water quality data. As of 2018, several TMDLs for *E. coli* have been completed in Colorado, including portions of the South Platte River in the metro-Denver area, a portion of Boulder Creek, Big Dry Creek below Standley Lake, and Wildhorse Creek in the Pueblo area. Development of additional TMDLs is underway or planned because the Water Quality Control Division prioritized addressing *E. coli* impairments with particular focus on areas where primary contact is likely happening. As of 2018, nearly 90 stream segments in Colorado were listed as impaired or on the monitoring and evaluation list for *E. coli*, so additional TMDLs for *E. coli* are anticipated in the future.





HOW WILL AN *E. COLI* TMDL AFFECT MY STORMWATER MS4 PERMIT?

When a waterbody is listed as impaired, there are already implications for permitted discharges even when an approved TMDL is not yet available. After a TMDL is approved, if additional MS4 *E. coli* reductions are necessary, the MS4 permit requirements may be affected in several ways:



- Continued implementation of existing permit conditions without additional requirements. This would occur if the Division determines that existing permit requirements are adequate to ensure compliance with the WLA. For example, Phase 2 MS4 permittees are already required to implement the “six minimum control measures” which include a variety of measures that can help to reduce *E. coli*. The Division will amend the permittee’s certification if necessary to address additional reporting or documentation requirements to demonstrate compliance with the WLA.
- Implementation of additional BMP-based requirements to reduce bacteria loading. If the Division determines that the conditions of the permit are not adequate to bring about compliance with the WLA, the Division may modify the permit or require the permittee to apply for and obtain an individual or alternate general CDPS permit. A compliance schedule and additional reporting requirements are also typically required if additional BMPs are warranted. Permits are scheduled for review on a five-year cycle, with requirements subject to change when the permit is reviewed.
- Monitoring. This may be required on a case-by-case basis if a stormwater-based TMDL and WLA have been put into place for any waterbody into which the permittee discharges.
- Implementation of numeric effluent limits at end of pipe. To date, this approach has not been implemented for stormwater discharges in Colorado and is not required by EPA. The South Platte River Segment 14 *E. coli* TMDL has numeric limits for dry weather discharges from the MS4. (Note: some of the most effective strategies for reducing *E. coli* loads include volume reduction, which are not necessarily reflected on a concentration basis.)





WHAT REGULATORY ALTERNATIVES EXIST FOR IMPAIRED WATERBODIES OTHER THAN A TMDL?¹

On a biennial basis, the Colorado Water Quality Control Division (Division) assesses whether waterbodies meet designated uses and stream standards. There are five “integrated reporting categories” used in this assessment. Impaired waterbodies are listed in either Category 4 or Category 5. (Category 5 listings are those stream segments requiring development of a TMDL.) Both of these listing categories include specifically-defined subcategories that may be implementation-oriented alternatives to development of a TMDL:

- **Category 4b:** Stream segments may be placed in Category 4 if available data indicates impairment, but a TMDL is not needed for specific allowable reasons, one of which is meeting Category 4b requirements. Category 4b is applicable when pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future. A Category 4b Plan must be completed, approved and implemented in order for this option to be viable.
- **Category 5-alt:** Category 5-alt is based on EPA’s recognition that “under certain circumstances there are alternative restoration approaches that may be more practicable to achieve water quality standards than pursuing the TMDL approach in the near future. An alternative restoration approach is a plan, or description of actions, with a schedule and milestones, pursued in the near-term that in their totality are expected to achieve water quality standards more rapidly.” This approach may also be referred to as the “straight to implementation” approach.

For both Category 4b and 5-alt, if monitoring does not demonstrate that the water quality standard is attained as expected within an appropriate timeframe, then a TMDL would likely still be needed for the segment. For both of these alternative regulatory categories, close coordination with the Division is needed.

¹*Information in this section is based on communication with the Colorado Water Quality Control Division Permits Unit.*





WHAT ARE THE OPTIONS FOR SITE-SPECIFIC STREAM STANDARDS?

Once local governments have identified and corrected controllable sources of *E. coli* to the “maximum extent practicable,” it is possible that streams and stormwater outfalls may continue to exceed recreational water quality standards. In such cases, regulatory adjustments to stream standards or discharge permit conditions may be appropriate. Because only a few *E. coli* TMDLs have been completed in Colorado to date, the Division is still gaining experience in such situations. Basic information on regulatory alternatives in Colorado is described below, followed by new guidance from EPA that provides additional detail on site-specific standards under EPA’s 2012 Recreational Water Quality Criteria.

Regulation 31, The Basic Standards and Methodologies for Surface Water, outlines regulatory options for assigning stream standards in Colorado. The primary options for modifying a stream standard include a temporary modification to the standard, changing the designated use based on a Use Attainability Analysis, changing the standard based on a site-specific analysis, or adopting a discharger specific variance (DSV). A limitation of a DSV is that it only applies to dischargers with numeric effluent limits assigned in their CDPS permits.

Most MS4 permits in Colorado rely on BMP-based approaches implemented to the maximum extent practicable (MEP), as opposed to numeric effluent limits enforced at the end-of-pipe; therefore, DSVs may not provide regulatory relief for MS4s. Additionally, although DSVs can be renewed, they are considered temporary and require on-going attention to maintain.

EPA also identifies several alternatives for adoption of alternative standards in the 2012 Recreational Water Quality Criteria. EPA provided three alternatives for developing site-specific standards, which are further described in EPA’s Overview of Technical Support Materials: A Guide to the Site-Specific Alternative Recreational Criteria TSM Documents issued in 2014. Detailed Technical Support Materials (TSMs) to further explain and provide guidance on each of these alternatives are currently being developed by the EPA. EPA generally describes these approaches as:

1. *Alternative health relationships (“Epidemiological Studies”)*
2. *Non-human fecal sources (“Quantitative Microbial Risk Assessment”)*
3. *Alternative indicators and methods.*





From a practical perspective, epidemiological studies are extremely costly and likely beyond the financial means of many MS4s. To achieve regulatory modification to account for non-human sources of bacteria, QMRA is expected to hold the most promise and is described very briefly below.

QMRA is generally considered a potentially useful approach in moderately urbanized watersheds where significant compliance efforts have already been implemented and where initial source tracking results demonstrate an absence (or near absence) of human fecal contamination. The general premise of QMRA is based on concepts of equivalent risk and the fact that risk varies based on sources of FIB. EPA-sponsored studies have shown that some non-human sources of fecal contamination pose less risk to human health than human sources. If the sources of FIB are relatively low risk, then a higher (less restrictive) water quality standard for FIB can be implemented while still protecting human health. Risk is based on exposure and potency. Exposure includes concentration of pathogens and ingestion rate, whereas potency is based on documented dose-response rates of illness in published literature. Simply described, the key steps for a QMRA involve:

- 1. Monitoring for both FIB and pathogens to develop a data set suitable for conducting QMRA.*
- 2. Calculating expected illness rates associated with measured pathogen concentrations using QMRA methods.*
- 3. Comparing calculated illness rates to EPA's tolerable illness levels (TILs) (e.g., 36 illnesses/1,000 exposures).*

QMRA-based site-specific standards have not been implemented to date in Colorado but are a potential option that could be considered in the future. See EPA's Recreational Water Quality Criteria website for emerging guidance on QMRA.





WHERE CAN I FIND MORE INFORMATION ON *E. COLI*-RELATED REGULATORY ISSUES?

For a condensed discussion of regulatory issues, see:

- [Colorado *E. coli* Toolbox: A Practical Guide for Colorado MS4s](#)
- [Pathogens in Urban Stormwater Systems](#)

For regulatory information in Colorado, see:

- [Colorado Water Quality Control Commission Regulations \(particularly Regulation 31 and Regulation 93\)](#)
- [Colorado's 303\(d\) Listing Methodology \(updated every two years\)](#)
- [Colorado's TMDL webpage, including completed TMDLs by basin](#)

For information on EPA's 2012 Recreational Water Quality Criteria, research forming the basis of current criteria and guidance for alternative regulatory approaches for recreational standards, see:

- [EPA's 2012 Recreational Water Quality Criteria](#)

