WQCD Policy Concerning *Escherichia coli* versus Fecal Coliform Effluent Limitations

**Background**

In a Regulation No. 31 rulemaking hearing (RMH) in June of 2000, the Colorado Water Quality Control Commission (WQCC) adopted dual fecal coliform and *Escherichia coli* (*E. coli*) pathogen indicator criteria in anticipation of a transition from reliance on the former, to reliance on the latter indicator. In a June 15, 2005 Regulation No. 31 RMH, the WQCC changed the pathogen indicator criteria to solely *E. coli*, removing the fecal coliform criteria. To complete the transition from fecal coliform to *E. coli*, the fecal coliform standards in each of the Basin Regulations will also be dropped as each Basin Classifications and Standards next RMH occurs (see Table 1 below).

![WQCC Regulation Boundaries](image)

**Table 1**

<table>
<thead>
<tr>
<th>Regulation No.</th>
<th>Expected Effective Date of <em>E. coli</em> Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 (Upper Co. Basin)</td>
<td>Jan., 2009</td>
</tr>
<tr>
<td>34 (San Juan Basin)</td>
<td>Jan., 2007*</td>
</tr>
<tr>
<td>35 (Gunnison Basin)</td>
<td>Jan., 2007*</td>
</tr>
<tr>
<td>36 (Rio Grande Basin)</td>
<td>Jan., 2008</td>
</tr>
<tr>
<td>37 (Lower Co. Basin)</td>
<td>Jan., 2009</td>
</tr>
<tr>
<td>38 (S. Platte Basin)</td>
<td>Jan., 2010</td>
</tr>
</tbody>
</table>

- Already decided by WQCC in June 2006 RMH.
Use of Ambient Pathogen Data in Effluent Limitation Calculations

Until the segment specific Basin Standards are changed, both ambient fecal coliform and *E. coli* data may be used where they are available. The statistic of the ambient level should be calculated by using the Geometric Mean of the available data.

**When Ambient Receiving Water Data are Limited to Fecal coliform**

Where only ambient fecal coliform data are available, this same data may be used to also estimate what the ambient *E. coli* levels are for effluent limit calculations. Because *E. coli* are a subset of fecal coliform, *E. coli* levels should normally be less than or equal to the fecal coliform levels in waters. If a site-specific correlation between fecal coliform and *E. coli* is available, this may be used to establish ambient *E. coli* levels. Barring no available correlation, ambient fecal coliform levels will be assumed to be equal to *E. coli* levels.

**When Ambient Receiving Water Data are Limited to *E. coli***

Where only ambient *E. coli* data are available, calculate effluent limits only for *E. coli*. *E. coli* standards have already been promulgated in all basin regulations, and will be the sole pathogen indicator standard for all surface waters in 4 years (see Table 1), within the next permit cycle. Setting appropriate effluent limits, based solely on *E. coli*, will put only the required limitations on a discharger. The *E. coli* standard already governs decisions on the microbiological quality of waters for 303(d) listing decisions.

**Calculation of Acute *E. Coli* Effluent Limits**

In the absence of acute pathogen indicator criteria, the Division’s current practice is to assign a value of two times the calculated chronic effluent limit for establishing “acute” pathogen indicator effluent limits. For establishing “acute” *E. coli* effluent limits the Division will continue using twice the chronic limit, unless and until acute *E. coli* standards are promulgated.

**Calculation of Technology Based Effluent Limits for Pathogen Indicators**

The fecal coliform criteria have been replaced with *E. coli* criteria, and the Division needs to change the “technology based” fecal coliform limits to be based on the new *E. coli* standards. The Division’s current policy for a “technology based” fecal coliform limit is based on a 1976 internal Memorandum and an associated “Procedure for Selection of Fecal Coliform Limitations, Permit Conditions.” This 1976 policy sets the maximum 30-day (chronic) limit at 6,000 fecal coliform #/100 ml and the 7-day (acute) limit at 12,000 fecal coliform #/100 ml.

The Division’s Policy on a “technology based” *E. coli* limit will use a simple conversion from fecal coliform to *E. coli*, based on the ratio of the two chronic Recreation 2 standards. Since the Recreation 2 standard for *E. coli* is 630 #/100 ml, and the standard for fecal coliform is 2,000 #/100ml, the ratio of the current chronic standards is 630/2000 = 0.32. This leads to the calculations of 6,000 X 0.32 = 1,920 and 12,000 X 0.32 = 3,840.

Dated 1/12/2007
Because of normal variability expected in *E. coli* analysis, and to simplify calculations, the new “technology based” *E. coli* effluent limits will be rounded to the nearest whole thousand (see Table 2 below). This rounding leads to a less than 5% difference between the rounded number and the number based on the ratio. This is well within normal measurement error.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Technology Based Effluent Limits for Pathogen Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chronic</td>
</tr>
<tr>
<td>Fecal Coliform (#/100 ml)</td>
<td>6,000²</td>
</tr>
<tr>
<td><em>Escherichia coli</em> (#/100 ml)</td>
<td>2,000</td>
</tr>
</tbody>
</table>

1 - Based on the acute effluent limit policy above.
2 – Based on WQCD Permits Policy #1 (1976)

**Calculation of Antidegradation Based Implicit Non-Impact Limits**

Where there is a discharge of *E. coli* located (in place before 9/30/2000) on a Reviewable segment and there are no available effluent data on *E. coli*, an Implicit Non-Impact Limit (NIL) for *E. coli* may be calculated using available effluent fecal coliform data. It has shown that in normal domestic effluent, *E. coli* levels are less than fecal coliform levels. Since *E. coli* is a subset of fecal coliform, a simple ratio of the *E. coli* to fecal coliform will be used barring site-specific data showing otherwise. This ratio will be calculated from the current Recreation 2 coliform standards of 630 (*E. coli*/100 ml) to 2000 (fecal coliform/100 ml). This will be 630/2000 = 0.32. This is a default ratio, and will suffice until other site-specific data become available.

**Analysis Methods for *E. coli***

The Federal EPA proposed “Guidelines Establishing Test Procedures for the Analysis of Pollutants; Analytical Methods for Biological Pollutants in Wastewater and Sewage Sludge; Proposed Rule” August 16, 2005. The final rule was signed by the EPA Administrator on September 28, 2006, and was accepted by the Office of the Federal Register on October 4, 2006. The rule became officially final in April of 2007. As a suggestion the discharger might use the easiest proposed EPA method, utilizing the Quantitray® with Colilert® media.
Memorandum

To: Fred Matter

From: Paul Williamson

Subject: Fecal Coliform Limitations

Date: April 7, 1976

The attached draft "Procedure for Selection of Fecal Coliform Limitations, Permit Conditions" was developed by the Water Quality Control Division to conform with the requirements of "Colorado Department of Health, Water Quality Control Commission Effluent Limitations, adopted March 18, 1975." Section 300, Specific Limitations for the Discharge of Wastes states for the Fecal Coliform parameter: "Parameter Limitation - as determined by the Division of Administration of the State Health Department to protect public health in the stream classification to which the discharge is made."

Comments were solicited from the Water Quality Control field and administrative personnel, and from the EPA. The original draft separated unclassified streams into two categories, those readily accessible to humans, and those not readily accessible. Definite limitations were imposed for each category. Many comments were in opposition to these categories, and that if certain unclassified streams are so used for bodily contact sports, they should be so classified. The final draft was revised to include these viewpoints.

One comment was concerned with adequate mixing of the receiving waters and the discharge. This should be more properly addressed by the Technical Services Section of Water Quality Control.

The procedure utilizes, through careful control, some of the significant assimilative capacity of the natural water systems. Available data are rather sketchy; the techniques used are imprecise and are on the conservative side. Actual fecal coliform concentrations in the receiving bodies of water may be considerably less than those calculated for permit conditions. Thus, care must be used to prevent conservative estimations from accumulating unnecessary design and operational costs to the permittees.

It is further suggested that a more intensive search of the literature be made on:

1. Bacterial die-off rates
2. Viral survivals in streams and effluents
3. Outfall design
4. Irrigation use
Mr. Fred Matter  
April 7, 1978  
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Studies of fecal coliform concentrations above and below outfalls should be made an integral part of the on-going stream and standing bodies of water studies being conducted by all agencies.

Paul E. Williamson, P.E.  
Sr. Public Health Engineer

PH:ef  
Attachment
PROCEDURE FOR SELECTION OF FECAL COLIFORM LIMITATIONS
PERMIT CONDITIONS

1. STREAMS

The method is based on stream classification, flow of the receiving stream, and flow of the effluent of the permittee.

First, the following ratio is determined:

\[ R \text{ (flow ratio)} = \frac{\text{stream flow (10 yr-7 day low flow or equivalent)}}{\text{maximum design or maximum effluent flow}} \]

If the 10 year-7 day low flow data are not readily available, an equivalent flow will be developed by the Planning Section of the Water Quality Control Division, based on the best available data. Whenever sufficient data for determining the 10 year-7 day low flow are available, that value will be determined, and the ratio R recalculated.

The table below (Table 1) is based on no fecal coliform background in the receiving stream. Values will be adjusted to include background data as indicated in the paragraphs following the table.

### TABLE 1 - EFFLUENT FECAL COLIFORM (no./100 ml)
(assuming stream background: zero/100 ml; 30 day concentration/7 day concentration)

<table>
<thead>
<tr>
<th>Flow Ratio Categories (Geometric Mean)</th>
<th>R value for category:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R ( \geq 10 )</td>
</tr>
<tr>
<td></td>
<td>10 &gt; R ( \geq 5 )</td>
</tr>
<tr>
<td></td>
<td>5 &gt; R ( \geq 2 )</td>
</tr>
<tr>
<td></td>
<td>2 &gt; R ( \geq 1 )</td>
</tr>
<tr>
<td></td>
<td>R &lt; 1</td>
</tr>
<tr>
<td>Stream Classification</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

| A1, A2                               | 2,200/4,400            |
|                                       | 1,200/2,400            |
|                                       | 600/1,200              |
|                                       | 400/800                |
|                                       | 200/400                |
| B1, B2                               | 6,000/12,000           |
|                                       | 6,000/12,000           |
|                                       | 3,000/6,000            |
|                                       | 2,000/4,000            |
|                                       | 1,000/2,000            |

The calculated concentrations of fecal coliforms in the stream, at the point of discharge, with adequate mixing (assuming no die-off from point of sampling to point of adequate mixing), are, for all ratios:
\( A_1, A_2 \) equal to or less than 200/400 per 100 ml

\( B_1, B_2 \) equal to or less than 1,000/2,000 per 100 ml

Discharges in close proximity will be considered as one point source, and the ratio \( R \) computed on the basis of the total effluent flow from all discharges in that stream stretch.

Stream background data shall be taken from Colorado Water Quality Stream Monitoring Data, at the nearest monitoring station upstream of the effluent discharge point. ** The geometric mean shall be used. Adjustment will be made according to the following formulae:

**A**<sub>1</sub>, **A**<sub>2</sub> Stream Classification

30 day concentration: \( C_1 = R \cdot (200-C_2) + 200 \)

7 day concentration: \( C_1 = R \cdot (400-C_2) + 400 \)

**B**<sub>1</sub>, **B**<sub>2</sub> Stream Classification

30 day concentration: \( C_1 = R \cdot (1,000-C_2) + 1,000 \)

7 day concentration: \( C_1 = R \cdot (2,000-C_2) + 2,000 \)

\( R = \) receiving stream: effluent ratio value for that particular category; see Table 1 for \( R \) values.

\( C_1 = \) effluent concentration in fecal coliforms per 100 ml

\( C_2 = \) stream background concentration in fecal coliforms per 100 ml

If \( C_2 \) is greater than 200/400 per 100 ml for a **A**<sub>1</sub>, **A**<sub>2</sub> classification, the effluent concentration will be limited to 200/400 per 100 ml.

Similarly, for **B**<sub>1</sub>, **B**<sub>2</sub> stream classifications, if \( C_2 \) is greater than 1,000/2,000 per 100 ml, the effluent concentration will be limited to 1,000/2,000 per 100 ml.

Fecal coliform limitations for discharges to unclassified streams and irrigation ditches will be determined on each specific discharge. In general, the following guidelines will be used:

1. **Location**

   **a. Unacceptable** for bodily contact activities; limitations of up to 6,000/12,000 per 100 ml may be assigned.
b. Areas accessible for bodily contact activities; stringent
limitations of 200/400 per 100 ml may be assigned, based
on the amount of activity involved. Those stream stretches
having considerable activities should be properly classified.

2. Flows - where discharges are to unclassified streams, including
intermittent streams, which in turn, discharge to classified
waters, the fecal coliform limits shall be set so that the
limitations of the classified waters will not be exceeded.

3. Irrigation ditches and use for irrigation
a. Effluents used for irrigation of tracts of land used for
bodily contact sports shall conform to the bacterial require-
ments of USPHS Drinking Water Standards.

b. The use of completely treated, well oxidized and reliably
disinfected wastewater effluents essentially conforming to
the bacterial requirements of the USPHS Drinking Water Standards
is allowed on all crops.

c. Limitations for discharges to irrigation ditches will be
determined by the types of crops irrigated.

d. General crop limitations are:

(1) Effluents that are not disinfected (no fecal
coliform limitation) - Industrial grain and fodder
crops, vegetables grown for seed purposes, ornamental
plants, plants and fruits to be eaten in the cooked
state, nut trees.

(2) 200/400 per 100 ml - All fruit trees and truck farm
crops to be consumed in the raw state, in addition
to (1) above.
II. STANDING BODIES OF WATER

Effective utilization of standing bodies of water for natural purification of wastewaters depends on methods of discharge, convection currents, diffusion, and bacterial die-off rates. These factors are highly variable and each discharge would require extensive data collection to establish reliable limits. Therefore, the effluent discharge limitations shall be those of the receiving body of water. Upon presentation of adequate data from the permittee, the fecal coliform limitations will be adjusted accordingly.

* Values used for permit conditions shall be no less stringent than those in Table I for each R category.

** If valid stream background data is available at a location downstream of the nearest monitoring station and upstream of the effluent zone of influence, that background data can be used instead of the monitoring station data.