

Dilution Factor and Effluent Limitation Calculations for Massachusetts

Prior to completing the NOI requirements for the Remediation General Permit (RGP), the State must be contacted to confirm the critical low flow (7Q10) of the receiving water, dilution factor (DF), other appropriate hydrologic conditions, or to confirm site-specific limiting factors, including additional water quality-based effluent limitations (WQBELs). See Part 4.6 of the RGP for contact information.

I. Dilution Factor

A DF for sites that discharge to freshwater receiving waters in Massachusetts is calculated using the equation below. Alternate calculation methods for DFs may be acceptable if approved by the State. A DF for sites that discharge to saltwater receiving waters in Massachusetts is assumed to be 1:1, unless otherwise approved on a case-by-case basis by the State.

A. Determine 7Q10:

1. Using DFLOW: DFLOW 4.0 is an EPA-developed tool for calculating flow statistics. Version 4.0 is contained within the larger watershed planning tool BASINS 4.1. The BASINS program can be downloaded from EPA's website at: <https://www.epa.gov/exposure-assessment-models/basins>.
2. Using StreamStats: This online application is appropriate for determining drainage area ratios for nearby gages, and uses the 7Q10s for available gages from the U.S. Geological Gazetteer reports (1984 Wandle et al.). StreamStats is available at: <http://water.usgs.gov/osw/streamstats/massachusetts.html>.

B. Calculate Dilution Factor:

1. The equation used to calculate the dilution factor is:

$$\frac{Q_S + Q_D}{Q_D}$$

Where:

Q_S = 7Q10 in million gallons per day (MGD)

Q_D = Discharge flow in MGD

II. Effluent Limitation Calculations

The calculation instructions provided below are used in calculating WQBELs for discharges to freshwater receiving waters in Massachusetts (for saltwater receiving waters, skip to II.A.3). The following calculations are required for a parameter that applies to an activity category for which a WQBEL is specified in Part 2.1.1 of the RGP if the given parameter is known or believed present. A suggested electronic format for the calculations required in this Appendix can be downloaded from EPA's website available at: <https://www.epa.gov/region1/npdes/rgp.html>.

A. Calculate Water Quality Criterion:

This calculation must be completed to: 1) convert the WQBELs expressed in terms of dissolved metal to total recoverable metal; and 2) adjust the WQBEL for metals that are hardness-dependent. Use the equations and appropriate factors for each parameter as specified in 314 CMR 4.05(5)(e) (or as revised), and calculate criteria as follows:

1. When the receiving water is a freshwater waterbody, calculate downstream hardness as:

$$C_r = \frac{Q_d C_d + Q_s C_s}{Q_r}$$

Where:

- C_r = Downstream hardness in mg/L
- Q_d = Discharge flow in MGD¹
- C_d = Discharge hardness in mg/L²
- Q_s = Upstream flow (i.e., 7Q10) in MGD
- C_s = Upstream hardness in mg/L³
- Q_r = Downstream receiving water flow in MGD⁴

2. When a given metal is hardness-dependent (e.g., copper, lead, zinc), calculate the total recoverable water quality criteria adjusted for hardness as:

$$\text{WQC in } \mu\text{g/L} = \exp\{m_c [\ln(h)] + b_c\}$$

Where:

- m_c = Pollutant-specific coefficient⁵
- b_c = Pollutant-specific coefficient⁶
- \ln = Natural logarithm
- h = Hardness calculated in Step 1

3. When the receiving water is a saltwater waterbody and the WQC for a metal must be converted to total recoverable, or when the receiving water is a freshwater waterbody but a given metal is not hardness-dependent (e.g., arsenic, chromium VI), calculate the total recoverable water quality criteria as:

$$\text{WQC in } \mu\text{g/L} = \frac{\text{dissolved WQC in } \mu\text{g/L}^7}{\text{dissolved to total recoverable factor}^8}$$

¹ Equal to the effluent flow limitation, either the design flow of the discharge or 1.0 MGD, whichever is less.

² For sample sizes less than 10, the maximum value is used for C_d . For samples sizes of 10 or greater, the 95th percentile of the values may be used.

³ If the sample size is greater than 1, the median value may be used.

⁴ Equal to the sum of the upstream 7Q10 and the discharge flow. If available, a downstream 7Q10 may be used.

⁵ Per 314 CMR 4.05(5)(e) (or as revised). For silver, use the acute coefficient, m_a , for m_c .

⁶ Per 314 CMR 4.05(5)(e) (or as revised). For silver, use the acute coefficient, b_a , for b_c .

⁷ Use the WQC listed in Part 2.1.1 of the RGP, per 314 CMR 4.05(5)(e) (or as revised).

⁸ Dissolved to total recoverable conversion factors per 314 CMR 4.05(5)(e) (or as revised).

B. Calculate WQBEL:

If no dilution applies, skip this step, as the WQBEL is as calculated in II.A, above, or is the WQBEL in Part 2.1.1 of the RGP, if II.A does not apply. Note that if a WQBEL is calculated to be lower than the criterion, then the WQBEL is set at the criterion. Calculate the WQBEL as follows:

1. Calculate the freshwater WQBEL for a parameter detected in the receiving water or for saltwater receiving waters for which MassDEP has approved a dilution factor on a case-by-case basis as:

$$C_d = \frac{Q_r C_r - Q_s C_s}{Q_d}$$

Where:

- C_r = Downstream concentration (i.e., WQC) in $\mu\text{g/L}$ ⁹
- Q_d = Discharge flow in MGD¹⁰
- C_d = Discharge concentration (i.e., WQBEL) in $\mu\text{g/L}$
- Q_s = Upstream flow (i.e., 7Q10) in MGD
- C_s = Upstream concentration in $\mu\text{g/L}$ ¹¹
- Q_r = Downstream receiving water flow in MGD¹²

2. Calculate the WQBEL for a parameter either not detected in the receiving water, or for which receiving water sampling is not required as:

$$C_d = (Q_r/Q_d) \times C_r$$

C. Determine if a WQBEL applies:

1. For a parameter detected in the receiving water, project the downstream concentration as:

$$C_r = \frac{Q_d C_d + Q_s C_s}{Q_r}$$

Where:

- C_r = Projected downstream concentration in $\mu\text{g/L}$
- Q_d = Discharge flow in MGD
- C_d = Discharge concentration in $\mu\text{g/L}$ ¹³
- Q_s = Upstream flow (i.e., 7Q10) in MGD
- C_s = Upstream concentration in $\mu\text{g/L}$
- Q_r = Downstream receiving water flow in MGD

⁹ Use the WQC as calculated in A of this appendix, when required for a parameter; for all other parameters, use the WQC listed in Part 2.1.1 of the RGP, per 314 CMR 4.05(5)(e) (or as revised).

¹⁰ Equal to the effluent flow limitation, either the design flow of the discharge or 1.0 MGD, whichever is less.

¹¹ If the sample size is greater than 1, the median value may be used.

¹² Equal to the sum of the upstream 7Q10 and the discharge flow. If available, a downstream 7Q10 may be used.

¹³ Note that for sample sizes less than 10, the maximum value is used for C_d . For samples sizes of 10 or greater, the 95th percentile of the values may be used.

The WQBEL applies if: 1) the projected downstream concentration of a parameter calculated above, and the discharge concentration are greater than the WQC calculated for that parameter in accordance with II.A, above; and 2) the WQBEL calculated in accordance with II.B, above, is less than the TBEL in Part 2.1.1 of the RGP for that parameter. Otherwise, the TBEL in Part 2.1.1 of the RGP for that parameter applies.

2. For a parameter either not detected in the receiving water, or for which receiving water sampling is not required, the WQBEL applies if: 1) the discharge concentration of a parameter is greater than the WQBEL determined for that parameter in accordance with this appendix; and 2) the WQBEL determined for that parameter in accordance with this appendix is less than the TBEL in Part 2.1.1 of the RGP for that parameter. Otherwise, the TBEL in Part 2.1.1 of the RGP for that parameter applies.