APPENDIX 8
DILUTION FACTOR AND EFFLUENT LIMITATION CALCULATIONS FOR MASSACUSETTS

Prior to completing the Notice of Intent (NOI) requirements for the AQUAGP, the applicant must contact the State to confirm the critical low flow (7Q10) of the receiving water, dilution factor (DF), other appropriate hydrologic conditions, and to confirm site-specific limiting factors, including additional water quality-based effluent limitations (WQBELs). See Part I.C.2 of Appendix 4 (Suggested NOI Format and Instructions) 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 SWToolbox: SWToolbox is a desktop application that builds upon past tools, such as SWSTAT and DFLOW, which have historically been used to estimate low flow statistics from stream gage data. SWToolbox allows users to compute n-day frequency analyses (i.e., 1Q10 or 7Q10) and biologically based flows. It also facilitates the use of USGS National Water Information System (NWIS) streamflow data, as well as user-provided data files. The SWToolbox desktop application can be downloaded at: https://water.usgs.gov/osw/swtoolbox/.

2. Using StreamStats: StreamStats is a web application that provides access to an assortment of geographic information system (GIS) analytical tools that are useful for water resources planning and management, as well as engineering and design purposes. StreamStats can be used for mapping and exploring the drainage area and stream gages near a discharge location of interest. StreamStats is available at: https://www.usgs.gov/mission-areas/water-resources/science/streamstats-streamflow-statistics-and-spatial-analysis-tools.

B. Calculate Dilution Factor:

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

$$Dilution\ Factor = \frac{Q_S + Q_D}{Q_D}$$

Where:

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

II. Effluent Limitation Calculations

Applicants applying to discharge to receiving waters in Massachusetts shall utilize the calculation instructions provided below to calculate effluent limitations for formaldehyde, hydrogen peroxide, and copper, as specified in Part 1.1 and 1.3 of the AQUAGP. A suggested electronic format for the calculations required in this appendix can be downloaded from EPA's website available at: https://www.epa.gov/npdes-permits/draft-aquaculture-general-permit.

A. Calculate Water Quality Criterion for Copper

This calculation must be completed to: 1) convert the WQBELs expressed in terms of dissolved copper to total recoverable copper; and 2) adjust the WQBELs based on the site-specific receiving water hardness. Use the equations and appropriate factors as specified in 314 CMR 4.05(5)(e) (or as revised), and calculate the criteria as specified in Parts II.A.1 and 2 for freshwater and Part II.A.3 for saltwater:

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 MGD[1]
C_d = Discharge hardness in mg/L[2]
Q_s = Upstream flow (i.e., 7Q10) in MGD
C_s = Upstream hardness in mg/L[3]
Q_r = Downstream receiving water flow in MGD[4]

2. Calculate the total recoverable water quality criterion adjusted for hardness as:

$$WQC\ in\ \mu g/L = exp\{0.9422\ [ln(h)] - 1.700\}$$

Where:

ln = Natural logarithm
h = Downstream hardness in mg/L, as calculated in Step 1

3. When the receiving water is a saltwater waterbody, calculate the total recoverable water quality criterion as:

[1] Equal to the effluent flow limitation.
[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.

$$WQC\ in\ \mu g/L = \frac{dissolved\ WQC\ in\ \mu g/L}{dissolved\ to\ total\ recoverable\ factor} = \frac{4.8\ \mu g/L}{0.83} = 5.8\ \mu g/L$$

B. Calculate WQBELs:

If no dilution applies, skip this step. In this case, the acute water quality criterion for copper calculated in Part II.A, above, shall be applied as the WQBEL and the WQBELs specified in Part 1.1 of the AQUAGP for formaldehyde and hydrogen peroxide shall be applied directly, without credit for dilution.

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_d = Discharge concentration (i.e., WQBEL) in µg/L
Q_r = Downstream receiving water flow in MGD[5]
C_r = Downstream concentration (i.e., water quality criterion) in µg/L[6]
Q_s = Upstream flow (i.e., 7Q10) in MGD
C_s = Upstream concentration in µg/L[7]
Q_d = Discharge flow in MGD[8]

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

$$C_d = \left(\frac{Q_r}{Q_d}\right) \times C_r$$

[5] Equal to the sum of the upstream 7Q10 and the discharge flow. If available, a downstream 7Q10 may be used.
[6] Use the water quality criterion as calculated in Part II.A of this appendix for copper or the water quality criteria listed in Part 1.1 of the AQUAGP for formaldehyde and hydrogen peroxide.
[7] If the sample size is greater than 1, the median value may be used.
[8] Equal to the effluent flow limitation.