Dilution Determination Worksheet for use with the RIPDES General Permit for Non-Contact Cooling Water Discharges

Dilution Factor (DF)

A DF for sites that discharge to freshwater receiving waters in Rhode Island is calculated using the procedures as noted below. Alternate calculation methods for DFs may be acceptable if approved by the DEM. A DF for sites that discharge to saltwater receiving waters or non-flowing freshwater bodies (ponds or lakes) in Rhode Island is assumed to be 1:1, unless otherwise approved on a case-by-case basis by the DEM.

- **Determine 7Q10 (7 Day 10 Year Low Flow) using the 'RIPDES 7Q10 Policy':**

When determining the 7Q10 for calculating water quality-based effluent limits in a RIPDES permit, the following order of operations is required:

1. Determine if the discharge is to a stream with an active, inactive, or partial record USGS gauge station. This includes streams with impoundments or that are affected by groundwater pumping.
    a. If the stream has an active, inactive, or partial record gauge, use the list below to find the 7Q10.

USGS Station no.	Station Name	Water Year	7Q10 (cfs)	Drainage Area (sq. miles)
ACTIVE STATIONS				
01109403	Ten Mile River @ East Providence	1988-2018	9.7	53.1
01111300	Nipmuc River Near Harrisville	1965-2018	0.05	16
01111500	Branch River @ Forestdale	194-20181	11.48	91.2
01112500	Blackstone River @ Woonsocket	1930-2018	83.9	416
01113895	Blackstone River at Roosevelt Street @ Pawtucket, RI	2004-2018	84.3	474
01114000	Moshassuck River @ Providence	1965-2018	4.1	23.1
01114500	Woonasquatucket River @ Centerdale	1943-2018	6.1	38.3
01115098	Peeptoad Brook at Elmdale Rd. near North Scituate, RI	1995-2018	0.039	4.96
01115170	Moswansicut Stream near North Scituate, RI	2009-2018	0.08	3.25
01115187	Ponaganset River at South Foster, RI	1994-2018	0.062	14.4
01115265	Hemlock Brook at King Road near Foster, RI	2009-2018	0.04	8.72
01115276	Westconnaug Stream at Plainfield Pike, RI	2009-2018	1.2	5.18
01115630	Nooseneck River @ Nooseneck	2007-2018	1.3	8.23
01116000	South Branch Pawtuxet River @ Washington	1942-2018	16.1	63.8

USGS Station no.	Station Name	Water Year	7Q10 (cfs)	Drainage Area (sq. miles)
01116500	Pawtuxet River @ Cranston	1941-2018	59.9	200
01116905	Hunt River, 250 ft downstream of Fry Brook at Frenchtown, RI	2007-2018	1.5	16
01117000	Hunt River Near East Greenwich	1942-2018	1.5	23
01117350	Chipuxet River @ West Kingston	1973-2018	0.82	9.99
01117370	Queen River at Liberty Rd. at Liberty, RI	2007-2018	2.5	19.6
01117420	Usquepaug River Near Usquepaug	1975-2018	5.8	36.1
01117430	Pawcatuck River at Rt. 2 at Kenyon, RI	2007-2018	7.9	72.7
01117468	Beaver River Near Usquepaug	1976-2018	1.8	8.87
01117500	Pawcatuck River @ Wood River Junction	1942-2018	21.9	100
01117800	Wood River Near Arcadia	1965-2018	6.7	35.2
01118000	Wood River @ Hope Valley	1942-2018	17.8	72.4
01118500	Pawcatuck River @ Westerly	1942-2018	58	295
DISCONTINUED STATIONS				
01106000	Adamsville Brook at Adamsville, RI	1941-1978	0.06	8.01
01111400	Chepachet River at Chepachet, RI	1966-1972	2.28	17.4
01115630	Nooseneck River @ Nooseneck	1965-1981	1.32	8.23
01115770	Carr River Near Nooseneck	1965-1979	1.32	6.73
01117600	Meadow Brook Near Carolina	1967-1974	0.11	5.53
01126200	Bucks Horn Brook @ Greene	1967-1974	0.5	5.52
PARTIAL GAUGE STATIONS				
01111330	Clear River at Oakland, RI* (Burrillville WWTF)	1993-2003	2.4	45.4

* Note that the gauge station was downstream of the WWTF, the 7Q10 was calculated from upstream of the WWTF.

b. Use the 7Q10 from the list and the drainage area ratios between the gauge station and the point of discharge to determine the 7Q10 for WQBEL calculations (to get the dilution factor).

This would be done with the following equation:

$$7Q10_{At\ your\ facility} = \left(\frac{Drainage\ Area_{At\ your\ facility}}{Drainage\ Area_{At\ your\ gauge}}\right) * 7Q10_{At\ the\ gauge}$$

For example, if your facility was located on the Woonasquatucket River near Centerdale, and the drainage area for the watershed upstream of your facility was found to be 30 square miles, the 7Q10 would be calculated as follows:

$$7Q10_{At\ your\ facility} = \left(\frac{30\ Sq.Mi.}{38.3\ sq.Mi.}\right) * 6.1\ cfs$$

Which is equal to 4.8 cfs.

c. If a facility with significant flow is upstream of the gauging station, subtract the average flow from the facility from the 7Q10 value calculated in Step 1.b.

For example, the Smithfield WWTF is located on the Woonasquatucket River, just upstream of the Centerdale gauge. Therefore, the average WWTF flow is subtracted from the value at the gauge. In this case, the average WWTF flow is 3.2 cfs, making the 7Q10 flow at your facility 1.6 cfs.

If there is no facility impacting the 7Q10 of the gauge, then the 7Q10 value from step 1.b does not need to be adjusted to account for this, and step 1.c is skipped.

2. If the stream is ungauged and/or not included on the list above, use StreamStats per the procedure below to determine the 7Q10 flow.

3. The above active gauge station 7Q10s are current including data through water year 2018. RIPDES policy states these values shall be updated every 10 years. Therefore, this list must be updated for more recent 7Q10 values in 2029, when data through water year 2028 becomes available.

    a. In addition to updating the list for 7Q10 values, the USGS website should be consulted for the most up-to-date list of continuous active gauges in Rhode Island. Some gauges may now have at least 10 years of data to be included in this list that had been excluded previously.

- **Determine 7Q10 using StreamStats:**

1. 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

2. Follow the instructions in StreamStats. The location chosen must be where the NCCW discharges to the receiving water body. When the location has been chosen and the basin delineated, select the "Low-Flow Statistics" for the Regression Based Scenario. Then click Continue. This will bring up the Build a Report section. Again, click Continue.

3. Include a printout or otherwise attach the StreamStats Report with the NOI. An example StreamStats Report is included on the following page. The report should contain the 7 Day 10 Year Low Flow value for the selected location.

- **Calculate the Dilution Factor:**

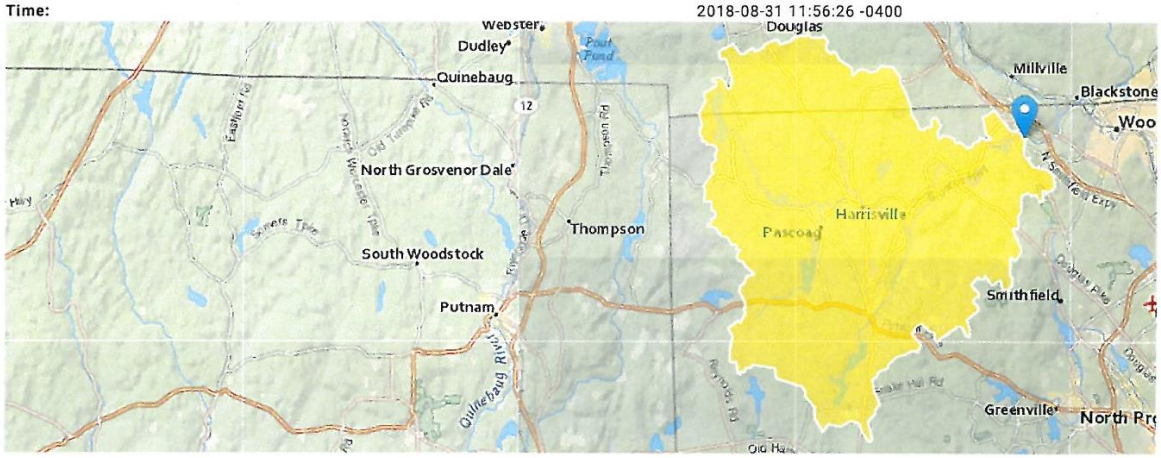
1. Calculate the dilution factor. The 7Q10 was calculated in equation 1,b above using the RIPDES 7Q10 Policy or as printed on the StreamStats Report. Use the following formula:

$$DF = \frac{\{(7Q10) + (\text{Total Combined System Design Flow})\}}{\{\text{Total Combined System Design Flow}\}} =$$

EXAMPLE STREAMSTATS REPORT

StreamStats Report

Region ID:	RI
Workspace ID:	RI20180831155611140000
Clicked Point (Latitude, Longitude):	41.99838, -71.57297
Time:	2018-08-31 11:56:26 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	89.8	square miles
STRDENED	Stream Density -- total length of streams divided by drainage area, edited from NHD	2.21	miles per square mile

Low-Flow Statistics Parameters [100 Percent (89.8 square miles) Statewide Low Flow 2014 5010]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	89.8	square miles	0.52	294
STRDENED	Stream Density Edited	2.21	miles per square mile	0.94	3.49

Low-Flow Statistics Flow Report [100 Percent (89.8 square miles) Statewide Low Flow 2014 5010]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu
7 Day 2 Year Low Flow	18.9	ft^3/s	4.08	87.4
7 Day 10 Year Low Flow	9.15	ft^3/s	1.17	71.3

Low-Flow Statistics Citations

Bent, G.C., Steeves, P.A., and Waite, A.M.,2014, Equations for estimating selected streamflow statistics in Rhode Island: U.S. Geological Survey Scientific Investigations Report 2014–5010, 65 p. (http://dx.doi.org/10.3133/sir20145010)