

## Release Addendum: FWC-EMC Calculator ShinyApp

The purpose of this addendum is to document the updates to the flow-weighted compositing and event mean concentration (FWC-EMC) calculator developed at SCCWRP from the initial QA process through the beta reviewer improvements and initial release. Updates to the application following the release are documented through the “Issues” tab on Github.

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Application URL: [https://sccwrp.shinyapps.io/FWC EMC Calculator/](https://sccwrp.shinyapps.io/FWC_EMC_Calculator/)

Github Source: <https://github.com/SCCWRP/FWCCalculator>

QA date: 02/14/2023

Release date: SCCWRP Symposium 05/24/2023

### Beta Reviewers

A Microsoft survey was used to elicit feedback from a handful of expert reviewers.

Survey Link:

[https://forms.office.com/Pages/DesignPageV2.aspx?origin=NeoPortalPage&subpage=design&id=PfKopOEaHEuZAuqhUwKBkNb1vpfauizNit2g-l\\_MjnRUNVJWVFIFRzdLOVVPODIYMIILNjE3RU44Vy4u](https://forms.office.com/Pages/DesignPageV2.aspx?origin=NeoPortalPage&subpage=design&id=PfKopOEaHEuZAuqhUwKBkNb1vpfauizNit2g-l_MjnRUNVJWVFIFRzdLOVVPODIYMIILNjE3RU44Vy4u)

Reviewers: Joshua Steele (SCCWRP), Bridget Wadzuk (Villanova), Jon Hathaway (University of Tennessee), Ryan Winston (Ohio State), Karine Borne (NIWA, New Zealand), Isabella Colpo (San Diego County, Public Works), Rachel Biller (Los Angeles County, Public Works)

Major Changes:

- Added user control over Start-End Time in date/time format. User can specify the start and end date/times for the flow-weighted compositing or event mean concentration analysis. Times must be within the total time boundary of the submitted input file.
- Added Methodology Documentation. A narrative tab was created that describes the mathematical approach of the FWC-EMC calculator.
- Doubled-down on single storm analysis. Despite requests from beta reviewers, the scope of the calculator is to analyze one (1) storm event. Instructions on the application were amended to emphasize that the input data out to be from a single storm event. A data check was developed to ensure that the flow datetime stamps from the input file are consistent (e.g., all in 5-minute resolution).

Start-End Time Control – red circled area is where the user specifies the start and end datetimes, the greyed-out area on the hydrograph is NOT included in the analysis.



Methods Tab – purpose, background, calculation methodology, and supplemental documentation are provided.

Instructions Methods Flow-Weighting Event Mean Concentration Contact Us

### Flow-Weighting and Event Mean Concentration Calculation

**Purpose**

This web application has been developed to enable consistent, transparent, easily applied calculations for post-storm flow-weighting and compositing and/or to generate an Event Mean Concentration (EMC) from a pollutograph. The web app provides flow-weighted compositing instructions based on a user-uploaded hydrograph and times of sample collection, or returns an EMC based on a user-uploaded hydrograph and pollutograph. Total hydrograph volume is also returned so that users may determine a mass load from the EMC.

**Background**

The "gold standard" of stormwater control measure (SCM) performance monitoring is to collect and analyze water quality data as flow-weighted event mean concentrations (EMCs). EMCs may be generated by post-storm compositing of discrete samples as an alternative to collecting flow-weighted composite samples using automated equipment with integrated flow meters. Coincidentally, a standard procedure is not documented in industry-relevant literature to perform the requisite post-storm flow-weighting calculations. Lack of a documented procedure may deter data collection for agencies new to monitoring, or for complicated site conditions. It also leads to different approaches to post-storm flow-weighting that may influence resultant EMCs and mass loads.

The EMC parameter, fundamentally a pollutant concentration, is the ratio of the mass of pollutant to the volume of water flowing through the system in a given storm event. Storm water volume is calculated as the integral of the hydrograph with time. Total pollutant mass is obtained through the time integral of the product of the pollutograph (concentration with respect to time) and hydrograph functions. The ratio of these integrals is given as the continuous definition of the EMC.

$$EMC = \frac{M}{V} = \frac{\int_0^t C_i Q_i dt}{\int_0^t Q_i dt}$$

Equation 1

Pollutant mass,  $M$ , is equal to the integral of instantaneous concentration,  $C_i$ , multiplied by flow,  $Q_i$ , while total volume,  $V$ , is the time integral of flow. The application returns the total volume calculated by the integral of the hydrograph with time; the user can multiply the EMC by the total storm volume to yield mass loading.

**Method**

The practical problem of solving for an EMC using real world data is evaluating the integrals in Equation 1 using discrete data points. Commonly, the continuous definition of EMC is recast in a discrete form, written as

$$EMC = \frac{\sum_{i=1}^n C_i Q_i \Delta t}{\sum_{i=1}^n Q_i \Delta t} \approx \frac{\sum_{i=1}^n C_i V_i}{\sum_{i=1}^n V_i}$$

Equation 2

Single Storm Resolution Checker – ensures that the input file doesn't have multiple storms worth of data by searching for breakpoints in the flowrate datetime stamps.

155	6/12/09 14:38	0.037508791
156	6/12/09 14:40	0.021595971
157	6/12/09 14:42	0.01363956
158	6/12/09 14:44	0.00795641
159	6/12/09 14:46	0.00340989
160	6/12/09 14:48	0
161	6/12/09 14:50	0
162	6/12/09 14:52	0
163	6/12/09 14:54	0
164	6/12/09 14:56	0
165	6/12/09 14:58	0
166	6/17/09 5:17	0.00340989
167	6/17/09 5:19	0.00795641
168	6/17/09 5:21	0.01363956
169	6/17/09 5:23	0.021595971
170	6/17/09 5:25	0.037508791
171	6/17/09 5:27	0.065924542
172	6/17/09 5:29	0.103433333
173	6/17/09 5:31	0.175041026
174	6/17/09 5:33	0.283020879
175	6/17/09 5:35	0.472838095
176	6/17/09 5:37	0.756995604
177		

## Flow-Weighting & Compositing Calculator (v1.0.1)

This web application has been developed to enable consistent, transparent, easily applied calculations for post-storm flow-weighting and compositing and/or to generate an Event Mean Concentration (EMC) from a pollutograph. The web app provides flow-weighted compositing instructions based on a user-uploaded hydrograph and times of sample collection, or returns an EMC based on a user-uploaded hydrograph and pollutograph. Total hydrograph volume is also returned so that users may determine a mass load from the EMC.

### Step 1: Download Template

Overwrite the template with your data. See Data Requirements section below.

[Download](#)

### Step 2: Submit Data

If pollutant data is provided, concentrations must be exclusively numeric values.

Only one storm event can be analyzed at a time. Please confirm you are submitting data for only one storm. Possible new storm(s) on row(s) 166, 168, 169, 170, 171, 172, 173, 174, 175, 176

[Instructions](#) [Methods](#) [Contact Us](#)

### Using this Calculator

This calculator will produce a table of aliquot volume values, a hydrograph, and, if pollutant data is provided, a table of pollutant concentrations. timestamps of a single storm event.