COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF CLEAN WATER

SCM 3.4.5 SPREADSHEET
RETENTIVE GRADING BERM
INSTRUCTIONS

Draft, September 16, 2026

Introduction

The Department of Environmental Protection (DEP) has developed the SCM 3.4.5 Spreadsheet (Spreadsheet) to calculate volume and water quality management credits when a Retentive Grading Berm SCM is proposed for new land development or as a retrofit to implement Section 3.4.5 of the Pennsylvania Post-Construction Stormwater Management (PCSM) Manual. Disconnection means routing runoff from impervious surfaces into vegetated areas for infiltration and evapotranspiration (ET) benefits rather than directly into storm sewers or surface waters. The vegetated areas are called vegetated filter strips (VFSs).

The Spreadsheet was designed using the latest version of Microsoft Excel® and is in Excel macro workbook (XLSM) format.

Users should check DEP's website periodically for updates to the spreadsheet and instructions by visiting www.dep.pa.gov/constructionstormwater and selecting "E&S Resources". In general, DEP/CCD will accept older versions of the spreadsheet no more than 6 months following the revision date of the spreadsheet. DEP/CCD also reserves the right to request completion of the latest version of the spreadsheet for any project.

Questions on the use of the spreadsheet can be directed to the Bureau of Clean Water at **RA-EPCHAPTER102@pa.gov**.

General Information

It is important that the user follow these instructions carefully. Omission of data in any cell designed for data entry may result in the failure of important calculations.

If prompted by Excel after opening the spreadsheet, enable editing and macros. *Note that you may need to add additional Trusted Locations in the Trust Center Settings of Excel in order to run the macros*. These locations may include server drives and/or locations where you intend to save the file for use. The following steps may be taken:

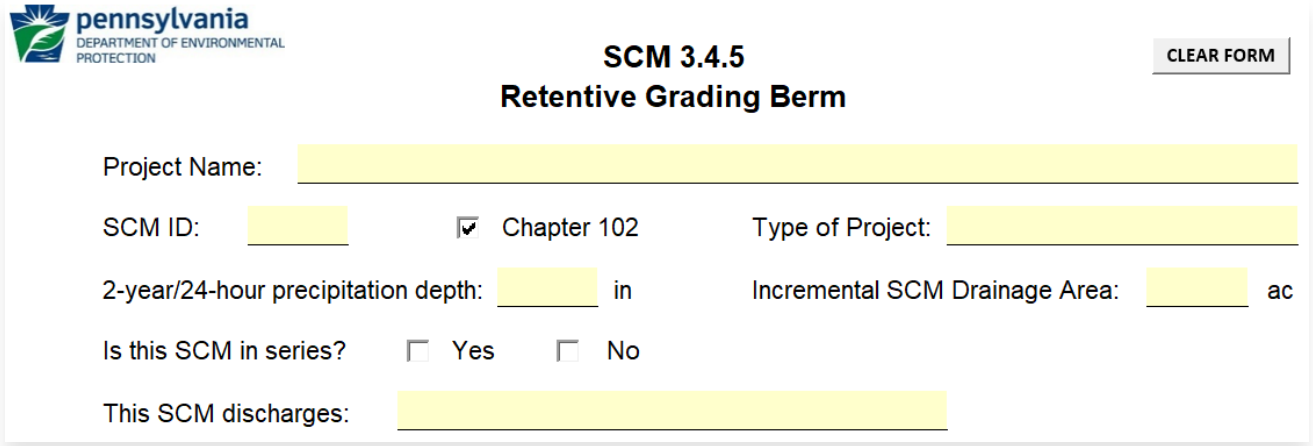
1. Excel Options > Trust Center > Trust Center Settings > Trusted Locations
2. Check the box to "Allow Trusted Locations on my network"
3. Select "Add new location"
4. Browse to select the folder (or server) where the file will be saved, check the "Subfolders of this location are also trusted" box, and then OK.

The top of the worksheet contains a "Clear Form" button. The user may click on the "Clear Form" button at any time to delete **all** data from the current worksheet. All cells available for data entry or selection from a drop-down menu are highlighted. **The user may use the Tab, arrow, or Enter keys to move from cell to cell. Using the mouse to click from cell to cell may result in validation errors**.

Care must be taken to enter the data in the correct order identified in these instructions to avoid potential errors with the calculations and logic. For example, skipping a cell may prevent a calculation or produce an error message. The spreadsheet is protected. Formulas are not visible but are explained in this document. Validation that exists in the spreadsheet is highlighted and explained in this document.

Completing the Spreadsheet

General Section



- **Project Name** – Enter the Project (Site) Name as reported on the NOI, application, and/or plan submitted to DEP/CCD.

- **SCM ID** – Enter the SCM ID as is identified on plan drawings and PCSM Module 2. A legal instrument, easement or other recording will be needed to ensure long-term protection.

- **Chapter 102** – Check the box next to "Chapter 102" if the SCM is being implemented to comply with Chapter 102 PCSM requirements, otherwise uncheck the box.

- **Type of Project** – Select "Residential" or "Non-Residential" from the dropdown list to characterize the type of project. Select "Residential" for residential subdivisions or single-family residential projects. All other projects (including non-Chapter 102 projects) should select "Non-Residential."

- **2-Year/24-Hour Precipitation Depth** – Enter the 90th upper confidence interval statistic for the 2-year/24-hour precipitation depth using NOAA Atlas 14 or other published sources, in inches.

- **Incremental SCM Drainage Area** – Enter the drainage area to the ponding area (i.e., vegetated treatment area upslope of the berm) of the SCM. The ponding area should not be included in the Incremental SCM Drainage Area value. If the SCM is downstream of another SCM and receives flows from that SCM, do not include the drainage area of the other SCM.

- **Is this SCM in series?** – Check the appropriate box (Yes or No). If Yes, select whether the SCM ("SCM 1") is upstream or downstream of another SCM ("SCM 2"). Then select the SCM type for "SCM 2". The options are PCSM Objective B, PCSM Objective C, and PCSM Objective D (refer to Table 3-1 of the draft PCSM Manual). For example, if the Retentive Grading SCM is upstream of a wet basin used for rate control, select "PCSM Objective D." Then enter the SCM ID for "SCM 2", as identified in the PCSM Plan.

- **This SCM discharges** – If the SCM is ***downstream*** of another SCM in series, select from the dropdown list the location where the SCM discharges to. The options are Off-Site and to a downstream (Objective A, B, C, or D) SCM. If the SCM is ***upstream*** of another SCM this question is not displayed.

Drainage Area Characterization Section

☑ ***Drainage Area Characterization***

Post-Construction Drainage Area Rows: ☑ ***Calculate runoff automatically***

Post-Construction Drainage Area Cover Type	Area (ac)	HSG	Off-Site	2-Year/24-Hour Runoff (CF)
Ponding Area				

	Post-Construction Values		
	Total	**Off-Site**	**Project Site**
Runoff Volume (CF):			

- **Post-Construction Drainage Area** – Enter the area associated with the Ponding Area, in acres, and select the HSG Soil Type from the dropdown list. The Curve Number (CN) for the Ponding Area is 100 (regardless of the HSG that is selected). However, the actual HSG for the Ponding Area should be selected. The HSG of the Ponding Area determines whether infiltration testing is necessary for residential projects (see below).

  In subsequent rows, select the Post-Construction Drainage Area Cover Types from the dropdown lists and enter their areas and HSG Soil Types for the SCM's drainage area to calculate the post-construction 2-year/24-hour runoff. If the area is located outside of the project site boundary check the box in the "Off-Site" column. If the user prefers to calculate runoff for each Land Cover / Soil Type combination separately, uncheck the "Calculate runoff automatically" box and enter the values into the column for "2-Year/24-Hour Runoff (CF)."

  Post-construction runoff volumes are calculated for the total drainage area (including Ponding Area), any off-site areas, and the project site (the difference between total drainage area and off-site area). This information is used to determine credits.

  NOTE 1 – For non-Chapter 102 projects (e.g., MS4 projects), at least 20% of the drainage area must be impervious in order to generate volume management credit.

Design Standards Section

☑ ***Design Standards***

Parameter	Standard	Design Value
Retentive Grading Berm Height, minimum (in)	6	
Retentive Grading Berm Width, maximum (ft)	100	
Upslope 45-Degree Berm Extension Length, minimum (ft)		
Ponding Area Land Cover		
Ponding Area Slope, maximum (%)	10.0%	
Ponding Area Length, minimum (ft)	10	
The berm(s) will be mowed		
Retentive Grading Berm Slope, maximum (%)		

- **Retentive Grading Berm Height, minimum (in) –** Enter the planned height of the berm, in inches, from toe to crest of berm. The minimum height is 6 inches. For residential projects, the maximum height is 12 inches. For non-residential projects, the maximum height is 18 inches. Users cannot enter values less than the minimum height or greater than the maximum height.

- **Retentive Grading Berm Width, maximum (ft)** – Enter the planned width of the berm. The maximum width is 100 feet. If wider berms are desired, individual berms and ponding areas may be placed in parallel as long as the upslope extensions of the berms overlap and grading is completed between ponding areas to ensure runoff remains within the designated ponding areas up to the 2-year/24-hour storm event. Widths greater than 100 feet can be entered; however, a deduction will be applied to volume and water quality management credits, as follows:

  Deduction (%) = Design Berm Width – (Standard * 110%) / (Standard * 110%)

- **Upslope 45-Degree Berm Extension Length, minimum (ft)** – An upslope extension of the berm must be implemented on both sides of the berm to reduce the possibility of short-circuiting. The berm extension should be oriented at a 45-degree angle in relation to the berm with a length at least 10% of the berm width with a minimum length of 5 feet. A deduction is applied if the minimum extension length is not met, as follows:

  Deduction (%) = (Standard * 90%) – Design Berm Extension Length / (Standard * 90%)

- **Ponding Area Land Cover** – Select “Meadow”, “Woods” or “Open Space” from the dropdown list. Ponding Area Land Cover is used to calculate pollutant loads that are captured and treated within the SCM.

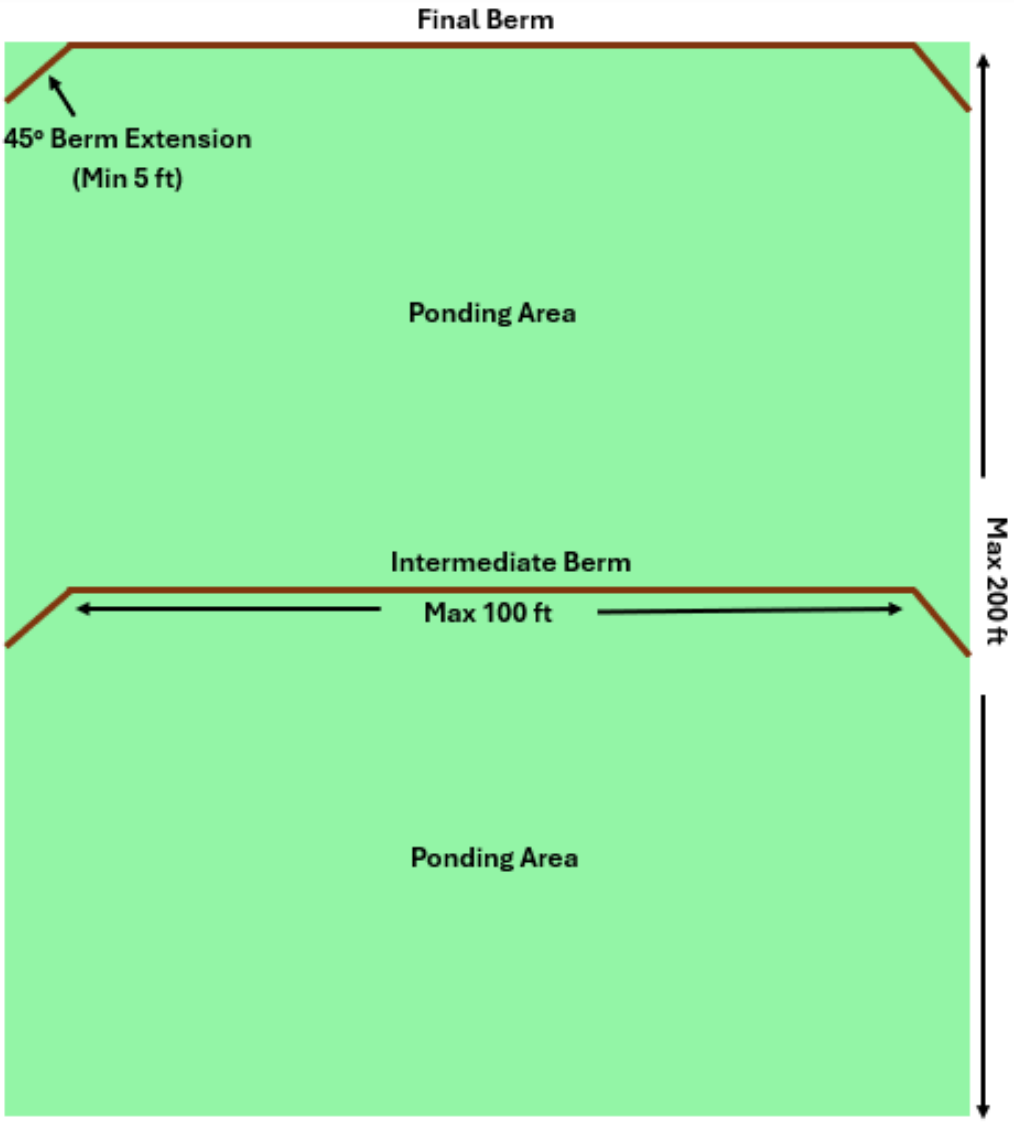
- **Ponding Area Slope, maximum (%)** – Enter the slope (%) of the Ponding Area across its length in the direction of runoff. The standard is 10%. A maximum of 15% may be entered; however, a deduction applies when slope exceeds 10%, as follows:

  Deduction (%) = Design Ponding Area Slope – (Standard * 110%) / (Standard * 110%)

- **Ponding Area Length, minimum (ft)** – The length of the Ponding Area in the direction of runoff, in feet, is calculated from the area entered in the Drainage Area Characterization Section for Ponding Area (in acres, multiplied by 43,560 SF/ac) divided by the berm width. The minimum standard is 10 feet. If the length of the Ponding Area is less than 10 feet, a deduction applies, as follows:

  Deduction (%) = (Standard * 90%) – Design Ponding Length / (Standard * 90%)

  The maximum Ponding Length is 200 feet if one (or more) intermediate berm(s) are implemented. See schematic below. The intermediate berm should be located at approximately one-half the Ponding Area length.



If Ponding Area Length exceeds 200 feet, a deduction is applied as follows:

Deduction (%) = Design Ponding Area Slope – (Standard * 110%) / (Standard * 110%)

- **An intermediate berm will be installed** – If Ponding Area length exceeds 100 feet, this standard will be displayed. Select TRUE from the dropdown list if one or more intermediate berms will be installed, otherwise select FALSE. A 50% deduction applies when an intermediate berm is needed but will not be provided.

- **The berm(s) will be mowed** – Enter TRUE if the berm(s) will be planted in turf grass or other vegetation that will be mowed, otherwise select FALSE.

- **Retentive Grading Berm Slope, maximum (%)** – Enter the berm embankment slope, in percent. The standard is 25% if the berm(s) will be mowed and 33% if the berm(s) will not be mowed. The maximum slope standard is exceeded, a deduction applies as follows:

Deduction (%) = Design Berm Slope – (Standard * 110%) / (Standard * 110%)

Ponding Area Infiltration Rate Section

☐ ***Ponding Area Infiltration Rate***

Infiltration Test Method: _____ Minimum No. Tests: _____

Saturated Hydraulic Conductivity (Ksat) Results for SCM: Actual No. Tests: _____

Geometric Mean (in/hr): _____

- **Infiltration Test Method** – Select the infiltration testing method used from the dropdown list.
- **Minimum No. Tests** – If "Double Ring Infiltrometer" is selected as the Infiltration Test Method, 1 test per 1,000 SF of VFS area (1 minimum) is recommended as the minimum number of tests; if other methods are used, 2 tests per 1,000 SF of VFS area is recommended. For ponding areas exceeding 2,000 SF, the number of tests may be reduced by 50% if a soils scientist or other professional with soils expertise determines soil conditions can be characterized by the initial tests (as long as at least 1 test is completed).
- **Actual No. Tests** – Select the actual number of infiltration tests completed from the dropdown list.
- **Saturated Hydraulic Conductivity (Ksat) Results for SCM** – Enter the Test ID No., the Ksat result determined in the field (inches/hour), and the air temperature (or preferably water temperature) at the time of the test. A temperature-adjusted Ksat is calculated. If the field Ksat result is not zero (0), the "Ksat for Geomean" result is the same as the temperature-adjusted Ksat. If the field Ksat result is 0, the "Ksat for Geomean" is set to 0.1. A geometric mean of all "Ksat for Geomean" results is calculated and displayed.

  If the calculated geometric mean Ksat is less than 0.5 inch/hour (for berm heights 6-12 inches) or 1.0 inch/hour (for berm heights greater than 12 inches up to 18 inches), a checkbox and message are displayed: "Soils in the Ponding Area will be amended and/or restored to meet a minimum Ksat of 0.5 in/hr" (or "1.0 in/hr"). If the geometric mean is less than 0.5 inch/hour (for berm heights 6-12 inches) or 1.0 inch/hour (for berm heights greater than 12 inches up to 18 inches), and the box is not checked (i.e., amendment and/or restoration is not proposed), no volume management credit is provided.

☐ *Soils in the Ponding Area will be amended and/or restored to meet a minimum Ksat of 0.5 in/hr and retesting will be completed*

If the project type is residential and the HSG of the Ponding Area is Type A, B, or C (and the Infiltration Test Method and Actual No. Tests are not entered), a checkbox appears next to "Assume 0.5 inch/hour." When the box is checked the Geometric Mean Ksat is shown as 0.500 inch/hour, which is used to calculate credit. Infiltration testing may be completed if higher credit is being sought for these projects.

☑ Assume 0.5 inch/hour **Geometric Mean (in/hr):** 0.500

Volume and Water Quality Management Credit Section

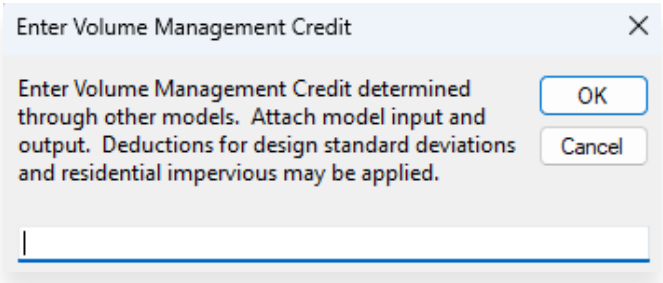
☑ ***Volume and Water Quality Management Credit***

Analysis Method: ◉ Default ○ Other Design Storm Model ○ Continuous Simulation

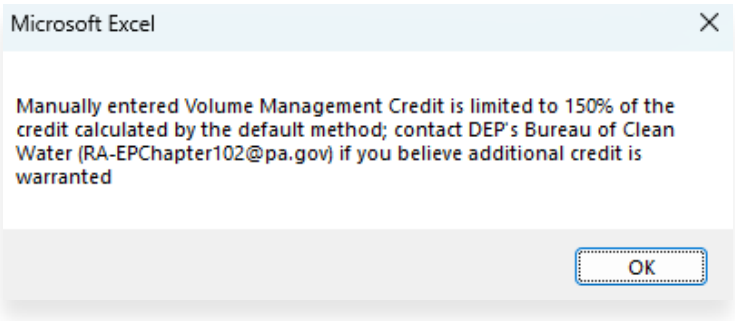
Total Volume Routed to SCM (CF)	Stored Volume (CF)	Infiltration Period (hrs)	Media Depth (ft)	Infiltration Credit (CF)	ET Credit (CF)
				0	0

Infiltration & ET Credit (CF):	
Deductions (CF):	
Volume Management Credit (CF):	-
WQM Credit, TSS (lbs):	-
WQM Credit, TP (lbs):	-
WQM Credit, TN (lbs):	-

- **Analysis Method** – Select the method used to analyze the SCM's performance by checking the appropriate box. If "Default" is checked, credit calculations are performed using the procedures explained in "Infiltration Credit" and "ET Credit" below. Check the box for "Other Design Storm Model" if a different model is used that evaluates the 2-year/24-hour storm precipitation depth but does not rely on the Curve Number method (e.g., Green-Ampt, Horton, others). Check the box for "Continuous Simulation" if a dynamic model is used to evaluate SCM performance through a long-term precipitation data set (e.g., EPA's SWMM). If a selection is made that is not "Default", Volume Management Credit must be manually entered, which must be supported by the submission of model inputs and outputs. An input box will be displayed for manual entry of the credit determined by modeling:

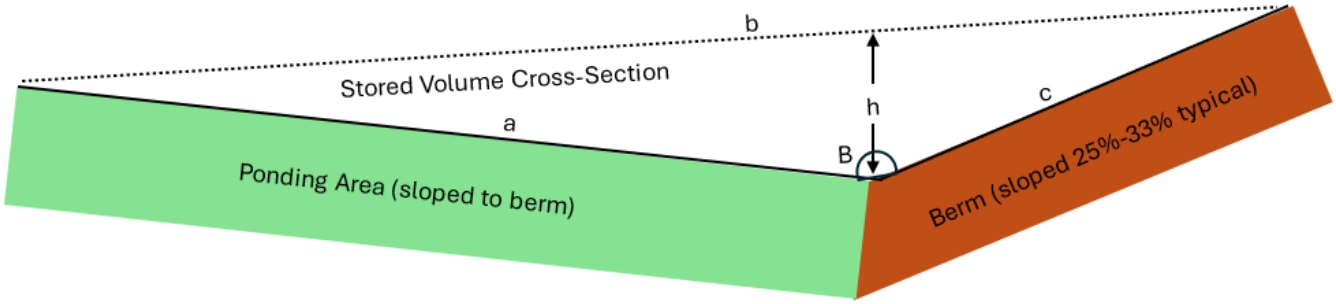


Enter a valid whole number and click "OK". The entered value will be displayed as Volume Management Credit, less any deductions for design standard deviations. If a number is entered that exceeds 150% of the credit calculated by the default method, a message is displayed and a value equal to 1.5 times the credit calculated by the default method is populated into the Volume Management Credit cell.



- **Total Volume Routed to SCM (CF)** – The Total Volume Routed to SCM (including off-site runoff) as calculated in the Drainage Area Characterization Section is displayed.

- **Stored Volume (CF)** – The Stored Volume, or surface storage capacity of the Ponding Area, is calculated by determining the cross-sectional area of the obtuse triangle formed by the Ponding Area and berm (see schematic below), multiplied by the berm width.



To find the base (b) of the triangle (i.e., the length of the water surface when runoff has completely filled the Ponding Area), the law of Cosines is used:

$b^2 = a^2 + c^2 – 2ac * \cos(B)$

Where:

a = Berm length from toe to crest;
c = Ponding Area length;
B = Obtuse angle formed between end of Ponding Area and the toe of the berm.

Once the base of the triangle is determined, the area is found by 0.5bh where h = berm height.

- **Infiltration Period (hrs)** – Infiltration Period is used to determine Infiltration Credit (default method only) and is determined by the following equation:

Infiltration Period = (Maximum Infiltration After Storm (CF) / Ponding Area (SF)) / Ksat (inches/hour) x 0.9 / 12 inches/foot) + 12 hours during storm event

Where Maximum Infiltration After Storm (CF) = The lesser of 1, 2 or 3:

1 = (Ksat (inches/hour) x 0.9 / 12 inches/foot) x 60 hours x Ponding Area (SF) – Off-Site Volume

2 = Volume routed to SCM @ 2-year/24-hour storm – Infiltration Credit During Storm – Off-Site Volume

3 = Stored Volume (as long as it is greater than Off-Site Volume)

- **Media Depth (ft)** – Select the depth of amended soils or, if soils are not amended, the average rooting depth of the planned vegetation, in feet.

- **Infiltration Credit (CF)** – Infiltration Credit is calculated by determining the infiltration that occurs during the storm (assumed 12 hours) and up to 60 hours following the storm, and adding the results.

  - *Infiltration Credit During Storm (CF)* = The lesser of 1 or 2:

    1 = ((Ksat (inches/hour) x 0.9 (10% factor of safety) / 12 inches/foot) x 12 hours (infiltration during storm) x Ponding Area (square feet (SF))) – Off-Site Volume

    2 = Volume routed to SCM @ 2-year/24-hour storm – Off-Site Volume

  - *Infiltration Credit After Storm (CF)* = (Ksat (inches/hour) x 0.9 / 12 inches/foot) x (Infiltration Period (hours) – 12 hours) x Ponding Area (SF))

  Infiltration Credit is not calculated where 1) a method other than the default is used; 2) the geometric mean Ksat requirements are not met; and 3) when the Incremental SCM Drainage Area contains less than 20% impervious surfaces (non-Chapter 102 projects only).

- **ET Credit** – When meadow vegetation or trees (not turf grass) are planted in the Ponding Area, ET credit may be claimed as follows:

  If (MD x VSC x PA) is less than V– IC, then ET credit is (MD x VSC x PA); otherwise, ET credit is V – IC.

  Where:

MD	=	Media Depth (ft)
VSC	=	Void Space Credit (%) (see Appendix D of the **PCSM Manual**)
PA	=	Ponding Area (SF)
V	=	Total Volume Routed to SCM (minus off-site runoff, if applicable) (CF)
IC	=	Infiltration Credit (CF)

- **Infiltration & ET Credit (CF)** – When the default method is used, this is the sum of Infiltration Credit and ET Credit. When a method other than the default is used, this is the user-entered credit from other models (up to 150% of the credit calculated by the default method).

- **Water Quality Management (WQM) Credit (lbs)** – WQM Credit is calculated when the following are true: 1) the Chapter 102 indicator is checked; 2) the SCM discharges off-site or to a downstream Objective D SCM; 3) when Volume Management Credit has been calculated or entered; and 4) when the Design Standards section has been completed. The steps for calculating WQM Credit are as follows:

  1. Land cover-based loads for Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) are calculated using the equation below:

     Event Mean Concentration (EMC) for land cover and pollutant (see Appendix G of the draft **PCSM Manual**) x runoff volume per land cover at 2-year/24-hour storm x 6.24 x 10^{-5} (conversion factor)

  2. Total Volume Management Credit is subtracted from Total Volume Routed to SCM (minus off-site runoff, if applicable) to determine the SCM outflow volume.

  3. The pollutant loads associated with the outflow volume are determined as follows:

SCM Outflow Volume x Median Outflow Concentration (MOC) (i.e., 10 mg/L, 0.24 mg/L, and 0.96 mg/L for TSS, TP and TN, respectively) x 6.24 x 10^{-5} (conversion factor)

4. The difference between land cover-based loads and outflow loads represents the pollutant load captured and treated by the SCM, i.e., WQM Credit.

The user of the spreadsheet should enter their name and company after reading the certification statement.

Revision History

Date	Version	Revision Reason
9/16/2026	1.0	Revised Draft