DEQ Certification Class Presentations

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August 2024

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Exercise 2B

Energy Balance Equation

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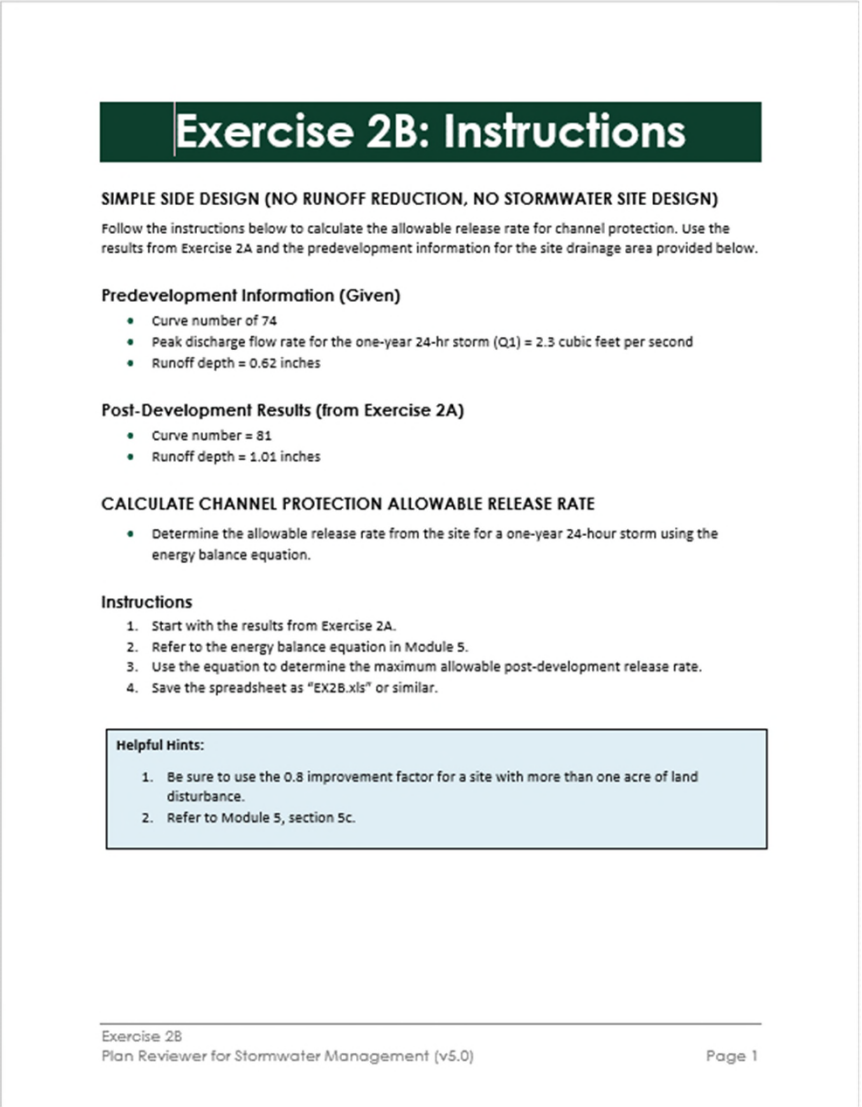
Exercise 2B Materials

In your participant guide:

- Exercise 2B Instructions
  - Use this sheet to jot down your results and notes
- See Module 5 for the energy balance equation



Exercise 2B: Instructions

SIMPLE SIDE DESIGN (NO RUNOFF REDUCTION, NO STORMWATER SITE DESIGN)

Follow the instructions below to calculate the allowable release rate for channel protection. Use the results from Exercise 2A and the predevelopment information for the site drainage area provided below.

Predevelopment Information (Given)

- Curve number of 74
- Peak discharge flow rate for the one-year 24-hr storm (Q1) = 2.3 cubic feet per second
- Runoff depth = 0.62 inches

Post-Development Results (from Exercise 2A)

- Curve number = 81
- Runoff depth = 1.01 inches

CALCULATE CHANNEL PROTECTION ALLOWABLE RELEASE RATE

- Determine the allowable release rate from the site for a one-year 24-hour storm using the energy balance equation.

Instructions

1. Start with the results from Exercise 2A.
2. Refer to the energy balance equation in Module 5.
3. Use the equation to determine the maximum allowable post-development release rate.
4. Save the spreadsheet as "EX2B.xls" or similar.

Helpful Hints:

1. Be sure to use the 0.8 improvement factor for a site with more than one acre of land disturbance.
2. Refer to Module 5, section 5c.

Exercise 2B
Plan Reviewer for Stormwater Management (v5.0) Page 1

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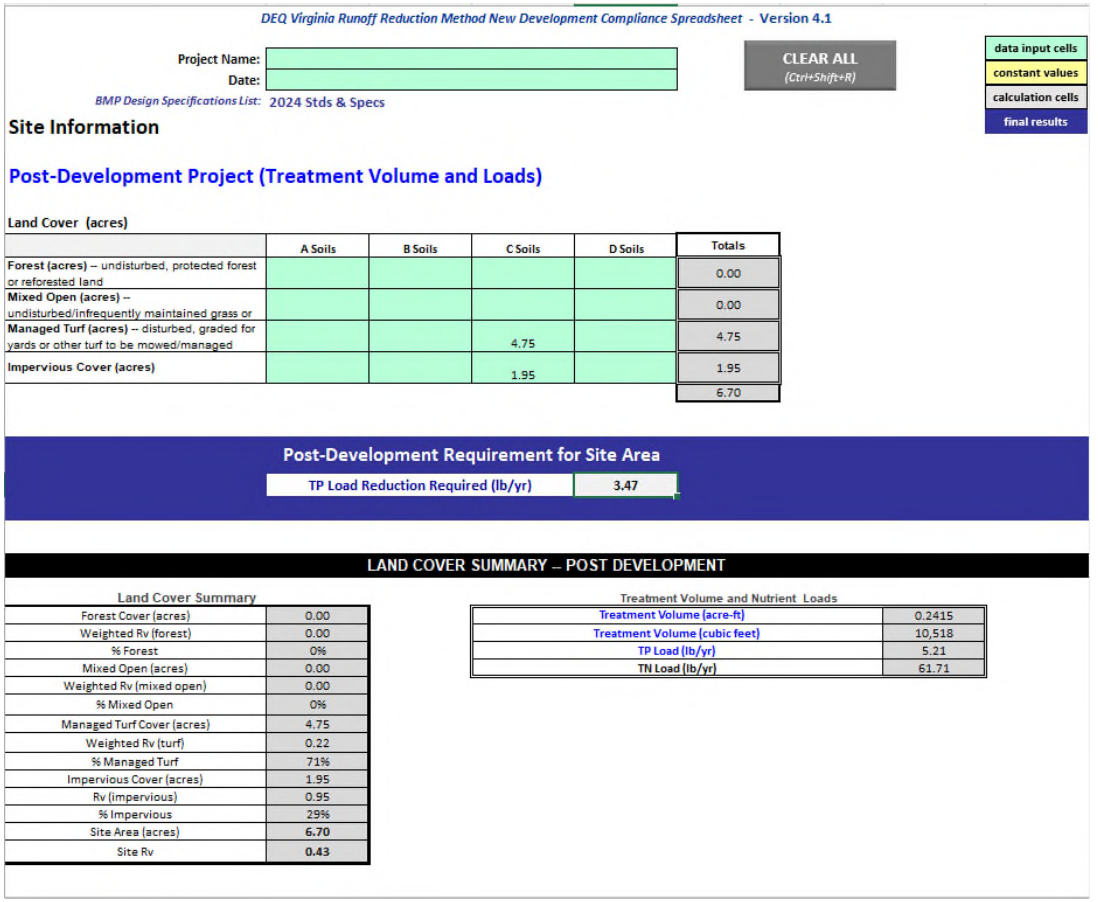
Exercise 2B Materials

VRRM 4.1 New Development Spreadsheet

- Still using Exercise 1A spreadsheet



DEQ Virginia Runoff Reduction Method New Development Compliance Spreadsheet - Version 4.1

Project Name:
Date:
BMP Design Specifications List: 2024 Stds & Specs

CLEAR ALL (Ctrl+Shift+R)

data input cells
constant values
calculation cells
final results

Site Information

Post-Development Project (Treatment Volume and Loads)

Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest (acres) -- undisturbed, protected forest or reforested land					0.00
Mixed Open (acres) -- undisturbed/infrequently maintained grass or					0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed			4.75		4.75
Impervious Cover (acres)			1.95		1.95
					6.70

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)	3.47

LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary

Forest Cover (acres)	0.00
Weighted Rv (forest)	0.00
% Forest	0%
Mixed Open (acres)	0.00
Weighted Rv (mixed open)	0.00
% Mixed Open	0%
Managed Turf Cover (acres)	4.75
Weighted Rv (turf)	0.22
% Managed Turf	71%
Impervious Cover (acres)	1.95
Rv (impervious)	0.95
% Impervious	29%
Site Area (acres)	6.70
Site Rv	0.43

Treatment Volume and Nutrient Loads

Treatment Volume (acre-ft)	0.2415
Treatment Volume (cubic feet)	10,518
TP Load (lb/yr)	5.21
TN Load (lb/yr)	61.71

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Exercise 2B
Post-Development Curve Number

Pre-development:

- Curve number of 74
- Peak Q1 = 2.3 cfs
- Runoff depth = 0.62 in

Post-Development:

- Curve number of 81
- Runoff depth = 1.01 in

Determine:

- Allowable discharge from site for one-year storm using the energy balance equation

IF = Improvement factor
0.8 for sites > 1 acre
0.9 for sites ≤ 1 acre

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Solution

Results

1 Recall S and Q from Exercise 2A

$$S = \frac{1000}{CN} - 10 = \frac{1000}{81} - 10 = 2.35\ in$$

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} = \frac{[2.6 - (0.2 \times 2.35)]^2}{2.6 + (0.8 \times 2.35)} = 1.01\ in$$

***Remember: RV in VRRM curve number adjustment (Runoff Volume and Curve Number tab) same as Q in the TR-55 Runoff Equation**

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Results

1 Recall S and Q from Exercise 2A

$$S = \frac{1000}{CN} - 10 = \frac{1000}{81} - 10 = 2.35\ in$$

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} = \frac{[2.6 - (0.2 \times 2.35)]^2}{2.6 + (0.8 \times 2.35)} = 1.01\ in$$

2 Calculate pre- and post-runoff volume

$$Vr_{post1} = Q \times A \times \frac{1}{12}$$

$$Vr_{pre1} = Q \times A \times \frac{1}{12}$$

Volume = Area × Depth

Vr in TR-55 represents the runoff volume (cubic feet or acre-feet) that we need for the Energy Balance equation.

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Results

1 Recall S and Q from Exercise 2A

$$S = \frac{1000}{CN} - 10 = \frac{1000}{81} - 10 = 2.35\ in$$

Equivalent to RV in VRRM CN adjustment

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} = \frac{[2.6 - (0.2 \times 2.35)]^2}{2.6 + (0.8 \times 2.35)} = 1.01\ in$$

2 Calculate pre- and post-runoff volume

$$Vr_{post1} = Q \times A \times \frac{1}{12} = 1.01\ in \times 6.7\ Ac \times \frac{1ft}{12\ in}$$

$$Vr_{pre1} = Q \times A \times \frac{1}{12} = 0.62\ in \times 6.7\ Ac \times \frac{1ft}{12\ in}$$

Given

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Results

1 Recall S and Q from Exercise 2A

$$S = \frac{1000}{CN} - 10 = \frac{1000}{81} - 10 = 2.35\ in$$

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} = \frac{[2.6 - (0.2 \times 2.35)]^2}{2.6 + (0.8 \times 2.35)} = 1.01\ in$$

2 Calculate pre- and post-runoff volume

$$Vr_{post1} = Q \times A \times \frac{1}{12} = 1.01\ in \times 6.7\ Ac \times \frac{1ft}{12\ in} = 0.56\ Acre - ft$$

$$Vr_{pre1} = Q \times A \times \frac{1}{12} = 0.62\ in \times 6.7\ Ac \times \frac{1ft}{12\ in} = 0.35\ Acre - ft$$

Given

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Results

3 Calculate allowable peak discharge

$$q_{1\,post} \leq q_{1\,pre}\left(\frac{Vr_{\,pre\,1}}{Vr_{\,post\,1}}\right)(IF)$$

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Results

3 Calculate allowable peak discharge

$$q_{1\,post} \leq q_{1\,pre}\left(\frac{Vr_{\,pre\,1}}{Vr_{\,post\,1}}\right)(IF) \leq 2.3 \times \left(\frac{0.35}{0.56}\right) \times 0.8$$

Given

Site > 1 ac, IF = 0.8

Pre- and post-development volumes calculated in previous step

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Results

3 Calculate allowable peak discharge

$$q_{1\,post} \le q_{1\,pre}\left(\frac{Vr_{\,pre\,1}}{Vr_{\,post\,1}}\right)(IF) \le 2.3 \times \left(\frac{0.35}{0.56}\right) \times 0.8$$

$$\le 1.1\ cfs$$

Post-development release rate <u>cannot</u> exceed 1.1 cubic feet per second (cfs)

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Questions?

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