

DEQ Certification Class Presentations

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August 2024



Exercise 2C

Runoff Reduction and Stormwater Site Design

Exercise 2C Materials

In your participant guide:

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

Exercise 2C: Instructions

RUNOFF REDUCTION AND STORMWATER SITE DESIGN (EXERCISE 1C SPREADSHEET)

Using the saved spreadsheet from Exercise 1C, follow the instructions below to calculate the allowable release rate for channel protection. Use the drainage area and predevelopment information given below.

Drainage Area Information (Given)

- Post-development land cover and treatment (from Exercise 1C):
 - Forest = 3.25 acres
 - Mixed open = 0.25 acres
 - Managed turf = 1.25 acres
 - Impervious cover = 1.95 acres
 - Assume "C" soils throughout
 - Entire site (one drainage area) is treated by treatment train (Compost-Amended Grass Channel Draining to Extended Detention Level 2)
- One-year rainfall = 2.6 inches (from Exercise 2A)

Predevelopment Information (Given from Exercise 2B)

- 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

CALCULATE CHANNEL PROTECTION ALLOWABLE RELEASE RATE

- Determine the post-development runoff depth (in inches) and the adjusted CN (with runoff reduction).
- Calculate 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 1C.
2. Enter the one-year 24-hour rainfall depth (2.6 inches) into the Runoff Volume and Curve Number tab.
3. Use the adjusted curve number, the post-development runoff volume (with runoff reduction), and the energy balance equation to calculate the allowable release rate for the site again.
4. Save the spreadsheet as "EX2C.xls" or similar.

Helpful Hints: Be sure to use the 0.8 improvement factor for a site with more than one acre of land disturbance.

Exercise 2C Materials

VRRM 4.1

New Development Spreadsheet

- Open Exercise 1C spreadsheet
- Final (third) treatment configuration (III. CAGC to EDL2)

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

Project Name:

Date:

CLEAR ALL
(Ctrl+Shift+R)

BMP Design Specifications List: 2024 Stds & Specs

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			3.25		3.25
Mixed Open (acres) -- undisturbed/in frequently maintained grass or			0.25		0.25
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed			1.25		1.25
Impervious Cover (acres)			1.95		1.95
<small>* Forest and Mixed Open areas must be protected in accordance with the Virginia Runoff Reduction Method</small>					6.70

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)	1.23
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LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary		Treatment Volume and Nutrient Loads	
Forest Cover (acres)	3.25	Treatment Volume (acre-ft)	0.1908
Weighted Rv (forest)	0.04	Treatment Volume (cubic feet)	8,313
% Forest	49%	TP Load (lb/yr)	2.97
Mixed Open (acres)	0.25	TN Load (lb/yr)	38.97
Weighted Rv (mixed open)	0.13		
% Mixed Open	4%		
Managed Turf Cover (acres)	1.25		
Weighted Rv (turf)	0.22		
% Managed Turf	19%		
Impervious Cover (acres)	1.95		
Rv (impervious)	0.95		
% Impervious	29%		
Site Area (acres)	6.70		
Site Rv	0.34		

Exercise 2C

Post-Development Curve Number

Pre-Development	Post-Development (Exercise 1C)
Curve number of 74	Forest = 3.25 acres
Peak Q1 = 2.3 cfs	Mixed open = 0.25 acres (EDL2 surface area)
Runoff depth = 0.62 in	Managed turf = 1.25 acres
	Impervious cover = 1.95 acres

Determine:

- ❑ Post-development runoff depth with runoff reduction
- ❑ Adjusted curve number with runoff reduction
- ❑ Allowable discharge from site for the one-year 24-hour storm using energy balance equation

Solution

Exercise 2C

Using Exercise 1C (III. CAGC to ED2)

1 Open Exercise 1C spreadsheet and enter land cover summaries in the Site tab and Drainage Area tab

Land Cover ("C" Soils)	Site Tab	Drainage Area Tab
Forest:	<i>3.25 acres</i>	<i>3.25 acres</i>
Mixed open:	<i>0.25 acres</i>	<i>0.25 acres</i>
Managed turf:	<i>1.25 acres</i>	<i>1.25 acres</i>
Impervious cover:	<i>1.95 acres</i>	<i>1.95 acres</i>

Exercise 2C

2 Enter one-year rainfall in Runoff Volume and Curve Number tab

Runoff Volume and Curve Number Calculations, VRRM 4.1, 2024

Enter design storm rainfall depths (in):

1-year storm

2-year storm

10-year storm

2.60

Use NOAA Atlas 14 (<http://hdsc.nws.noaa.gov/hdsc/pfds/>)

Enter 2.6 for one-year storm

Site

D.A. A

D.A. B

D.A. C

D.A. D

D.A. E

Water Quality Compliance

Runoff Volume and CN

Summary

Constants

Notes

Runoff Volume and CN tab

Exercise 2C

Runoff Volume and Curve Number Calculations, VRRM 4.1, 2024

Enter design storm rainfall depths (in):

1-year storm

2.60

Use NOAA Atlas 14 (<http://www.nws.noaa.gov/hydro/atlas14/>)

3

Note adjusted curve number (CN) and runoff volume (RV) with runoff reduction (RR) in Runoff Volume and Curve Number tab

Drainage Area A		A Soils	B Soils	C Soils	D Soils
Forest -- undisturbed, protected forest or reforested land	Area (acres)	0.00	0.00	3.25	0.00
	CN	30	55	70	77
Mixed Open -- undisturbed/infrequently maintained grass or shrub land	Area (acres)	0.00	0.00	0.25	0.00
	CN	34	59	72	79
Managed Turf -- disturbed, graded for yards	Area (acres)	0.00	0.00	1.25	0.00
	CN	39	61	74	80
	Area (acres)	0.00	0.00	1.95	0.00
	CN	98	98	98	98

RV no RR = 0.91"
RV with RR = 0.80"
Adjusted CN = 77

CN_(D.A. A)

79

	1-year storm	2-year storm	10-year storm
RV _{Developed} (watershed-inch) with no Runoff Reduction	0.91	0.00	0.00
RV _{Developed} (watershed-inch) with Runoff Reduction	0.80	0.00	0.00
Adjusted CN*	77	100	100

*See Notes above

Site

D.A. A

D.A. B

D.A. C

D.A. D

D.A. E

Water Quality Compliance

Runoff Volume and CN

Summary

Constants

Notes

Final Answer

4 Calculate pre- and post-development runoff volumes (V_r) in acre feet

Use RV in VRRM CN adjustment

$$Vr_{post1} = Q \times A \times \frac{1}{12} = 0.80 \text{ in} \times 6.7 \text{ Ac} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.45 \text{ acre feet}$$

$$Vr_{pre1} = Q \times A \times \frac{1}{12} = 0.62 \text{ in} \times 6.7 \text{ Ac} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.35 \text{ acre feet}$$

Given

Final Answer

5 Calculate allowable peak discharge

$$Vr_{post1} = Q \times A \times \frac{1}{12} = 0.80 \text{ in} \times 6.7 \text{ Ac} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.45 \text{ acre feet}$$

$$Vr_{pre1} = Q \times A \times \frac{1}{12} = 0.62 \text{ in} \times 6.7 \text{ Ac} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.35 \text{ acre feet}$$

Final Answer

5 Calculate allowable peak discharge

$$Vr_{post1} = Q \times A \times \frac{1}{12} = 0.80 \text{ in} \times 6.7 \text{ Ac} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.45 \text{ acre feet}$$

$$Vr_{pre1} = Q \times A \times \frac{1}{12} = 0.62 \text{ in} \times 6.7 \text{ Ac} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.35 \text{ acre feet}$$

$$\text{Given } q_{1post} \leq q_{1pre} \left(\frac{Vr_{pre1}}{Vr_{post1}} \right) (IF)$$

$$\leq 2.3 \times \left(\frac{0.35}{0.45} \right) \times 0.8 \leq 1.4 \text{ cfs}$$

Site > 1 ac, IF = 0.8

Post-development release rate cannot exceed 1.4 cubic feet per second (cfs)

Comparison

Exercise	Runoff Reduction or Environmental Site Design?	Runoff Volume (acre feet)	Peak Discharge (cubic feet per second)
2B	None	0.56	1.1
2C	Both	0.45	1.4

Runoff reduction practices and stormwater site design allow developers to have a higher discharge rate leaving the site due to the reduction in runoff volume.

Questions?

