

DEQ Certification Class Presentations

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August 2024

Exercise 4

Complexity

Exercise 4: Complexity

- Development sites can be complex on a variety of levels
 - Soil types
 - Treatment trains
 - Multiple outlets and drainage areas
- Complexities can sometimes be simplified, but should always be handled carefully to ensure they are accounted for

Differing Soils

Land Cover (acres)	A Soils	B Soils	C Soils	D Soils
Forest (acres) -- undisturbed, protected forest or reforested land			3.50	
Mixed Open (acres) -- undisturbed/infrequently maintained grass or				
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed			1.25	
Impervious Cover (acres)			1.95	

* Forest and Mixed Open areas must be protected in accordance with the Virginia Runoff Reduction Method

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)

1.15

Site soils should be accurately reflected on the spreadsheet

Incorrect soil types can drastically affect results

LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary

Forest Cover (acres)	3.50
Weighted Rv (forest)	0.04
% Forest	52%
Mixed Open (acres)	0.00
Weighted Rv (mixed open)	0.00
% Mixed Open	0%
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

Treatment Volume and Nutrient Loads

Treatment Volume (acre-ft)	0.1890
Treatment Volume (cubic feet)	8,231
TP Load (lb/yr)	2.89
TN Load (lb/yr)	38.88

Total phosphorous (TP) load = 1.15 lbs

Change Soils

Land Cover (acres)					
	A Soils	B Soils	C Soils	D Soils	Totals
Forest (acres) -- undisturbed, protected forest or reforested land			0.25	3.25	3.50
Mixed Open (acres) -- undisturbed/infrequently maintained grass or					0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed			0.25	1.00	1.25
Impervious Cover (acres)			0.45	1.50	1.95
* Forest and Mixed Open areas must be protected in accordance with the Virginia Runoff Reduction Method					6.70

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)

1.32

LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary

Forest Cover (acres)	3.50
Weighted Rv (forest)	0.05
% Forest	52%
Mixed Open (acres)	0.00
Weighted Rv (mixed open)	0.00
% Mixed Open	0%
Managed Turf Cover (acres)	1.25
Weighted Rv (turf)	0.24
% Managed Turf	19%
Impervious Cover (acres)	1.95
Rv (impervious)	0.95
% Impervious	29%
Site Area (acres)	6.70
Site Rv	0.35

Treatment Volume and Nutrient Loads

Treatment Volume (acre-ft)	0.1942
Treatment Volume (cubic feet)	8,458
TP Load (lb/yr)	3.06
TN Load (lb/yr)	41.10

TP load = 1.32 lbs

Change Soils

Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest (acres) -- undisturbed, protected forest or reforested land	3.25	0.25			3.50
Mixed Open (acres) -- undisturbed/infrequently maintained grass or					0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	1.00	0.25			1.25
Impervious Cover (acres)	1.50	0.45			1.95
					6.70

* Forest and Mixed Open areas must be protected in accordance with the Virginia Runoff Reduction Method

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)

0.76

LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary

Forest Cover (acres)	3.50
Weighted Rv (forest)	0.02
% Forest	52%
Mixed Open (acres)	0.00
Weighted Rv (mixed open)	0.00
% Mixed Open	0%
Managed Turf Cover (acres)	1.25
Weighted Rv (turf)	0.16
% Managed Turf	19%
Impervious Cover (acres)	1.95
Rv (impervious)	0.95
% Impervious	29%
Site Area (acres)	6.70
Site Rv	0.32

Treatment Volume and Nutrient Loads

Treatment Volume (acre-ft)	0.1771
Treatment Volume (cubic feet)	7,714
TP Load (lb/yr)	2.50
TN Load (lb/yr)	33.80

TP load = 0.76 lbs

Change Soils

	C Soils	C/D Soils	A/B Soils	
TP Load	1.15	1.32	0.76	
		15% ↑	34% ↓	

Multiple Drainage Areas

Multiple drainage areas
add to the complexity of the
spreadsheet entry

***Important
note:**

**Site area will not always match the entire
drainage area of the project**

**All drainage areas should be accounted
for when designing BMPs**

Multiple Drainage Areas

LEGEND:

- PROJECT LIMITS
- PROPOSED DRAINAGE AREA
- EXISTING CULVERT
- PROPOSED SITE BMP

PROPOSED PROJECT AREA DATA:

PROJECT AREA: 1.7 ACRES ±
OPEN SPACE (PROJECT LIMITS): 3.5 ACRES ±
MANAGED TURF (PROJECT LIMITS): 1.25 ACRES ±
IMPERVIOUS (PROJECT LIMITS): 1.95 ACRES ±
CURVE NUMBER: 73

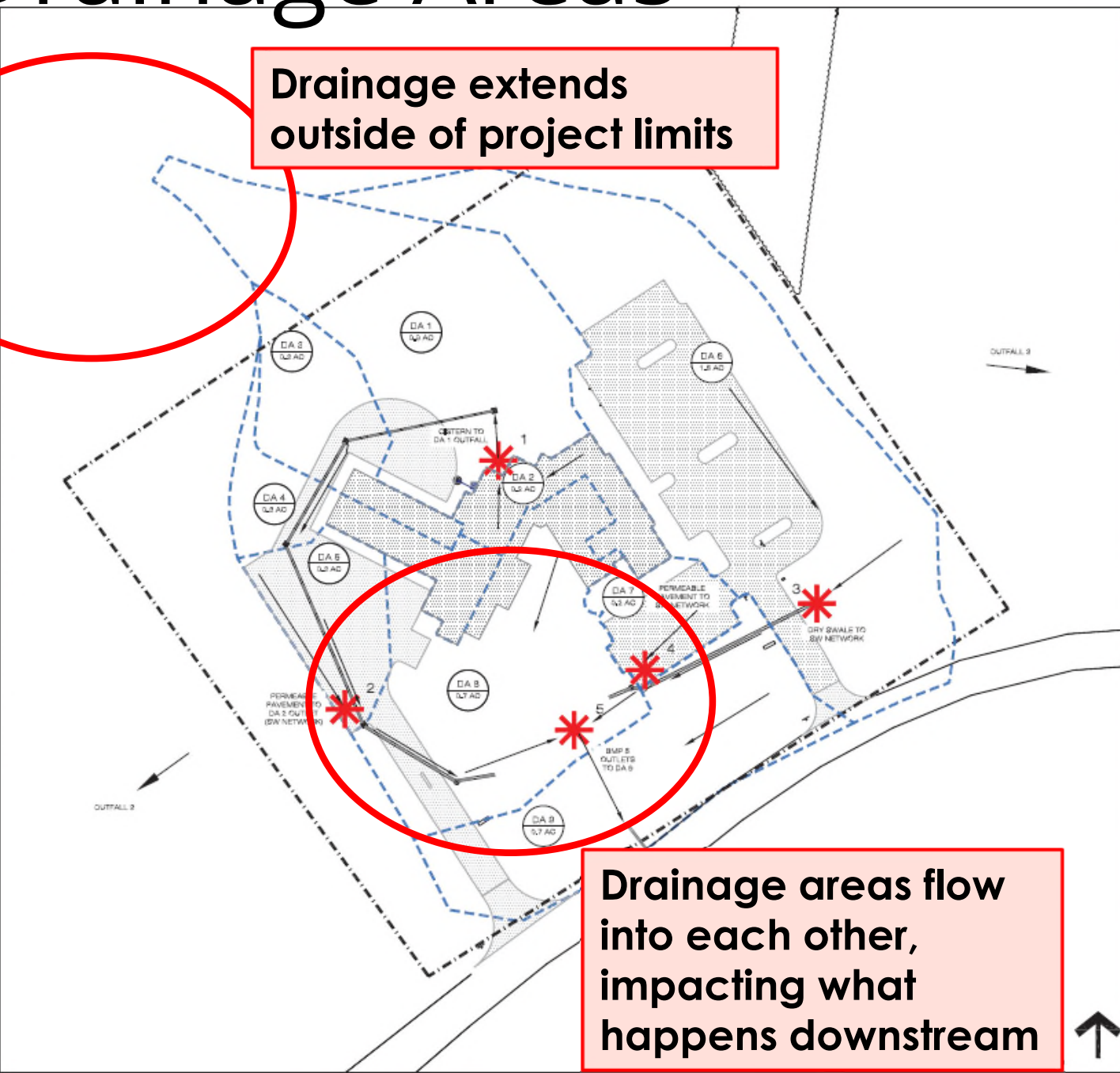
PROPOSED SITE DATA

DA	AREA (AC)	TREATED IN DAY	TREATMENT	IMPERVIOUS AREA (AC)	OPEN SPACE (AC)	MANAGED TURF (AC)
1	0.0	NO	-	0.10	0.75	0.05
2	0.2	YES	CISTERN	0.20	0.00	0.00
3	0.3	NO	-	0.1	0.20	0.00
4	0.3	NO	-	0.15	0.07	0.05
5	0.3	YES	PERM. PAVEMENT	0.3	0.00	0.00
6	1.5	YES	DRY SWALE	0.65	0.65	0.20
7	0.2	YES	PERM. PAVEMENT	0.2	0.00	0.00
8	0.7	YES*	EXTENDED DETENTION	0.2	0.00	0.50
9	0.7	NO	-	0.05	0.45	0.15
TOTAL	5.4	-	-	1.95	2.13	1.25

NOTE: ASSUME 5 MINUTES FOR TIME OF CONCENTRATION FOR EACH WATERSHED. ASSUME ALL SOILS ARE NO. 1.
*RETENTION IN DA 8 CAPTURES DRAINAGE FROM DAs 1-7 AS WELL, THESE ADDITIONAL AREAS ARE NOT INCLUDED IN THE DA 8 AREA.

BMP LIST

ID	TYPE
1	CISTERN (80% EFFICIENT)
2	PERMEABLE PAVEMENT L1
3	DRY SWALE L2
4	PERMEABLE PAVEMENT L1
5	EXTENDED DETENTION L1



Water Quantity Compliance

**Energy balance
for each site
drainage point**

Water Quality Compliance

**Demonstrated at
site level**

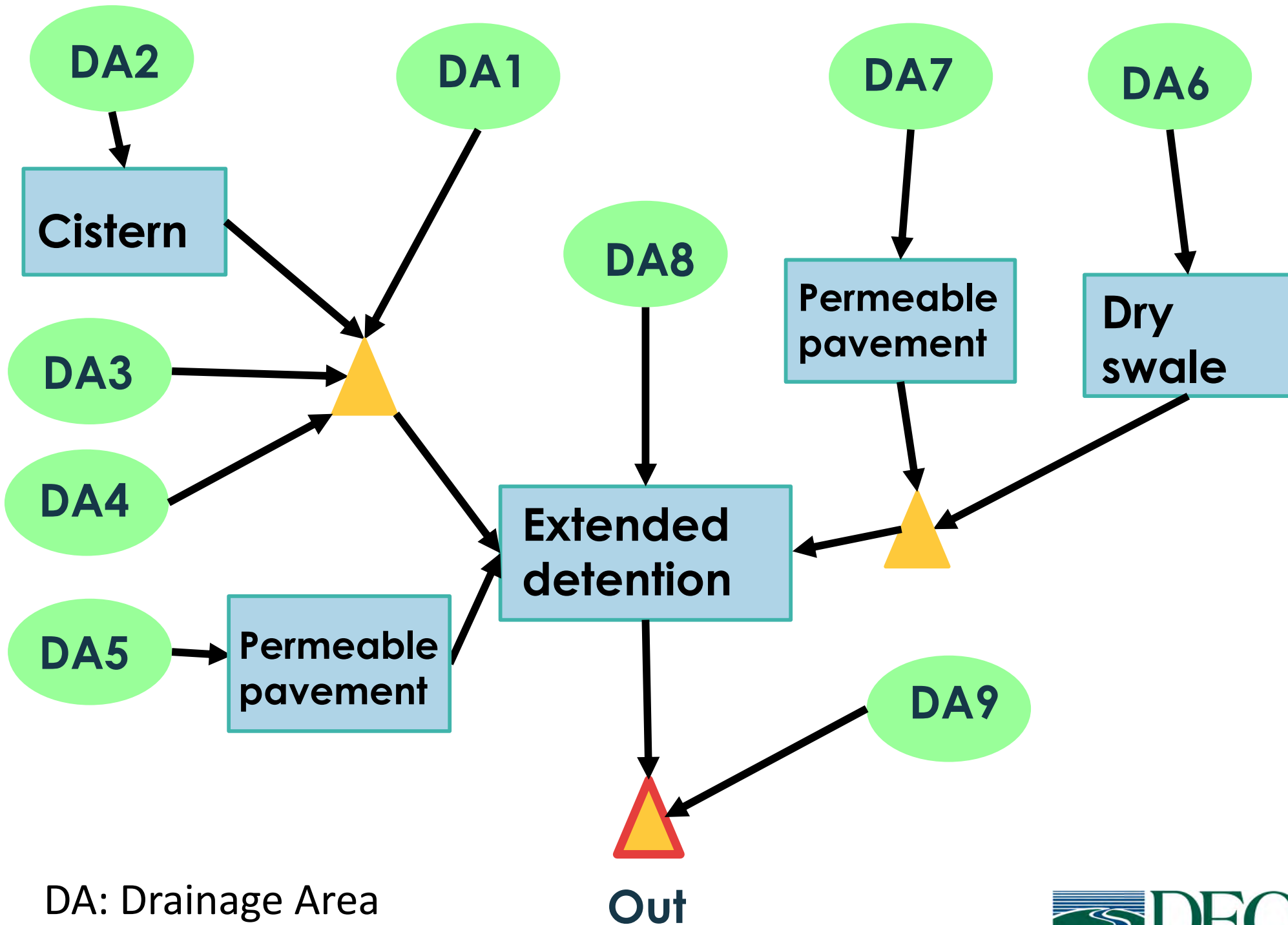
Many site discharge points:

**More complex
analysis**

**Calculations
typically not
affected**

Complex Treatment Trains

- When several BMPs treat the same runoff, the complexity of the spreadsheet entry increases
- There are several different correct ways to enter information to get the same result



Exercise 4

Complexity

Evaluate:

- ☐ Can some drainage areas be grouped together? How?
- ☐ How would you input the system into the VRRM spreadsheet?
- ☐ What is the total drainage area to BMP5? The credit area?
- ☐ What is the treatment volume for BMP5?
- ☐ Would the site satisfy the water quality requirements?

How many Drainage Area tabs do you need to use for water quality?

Exercise 4

Complexity

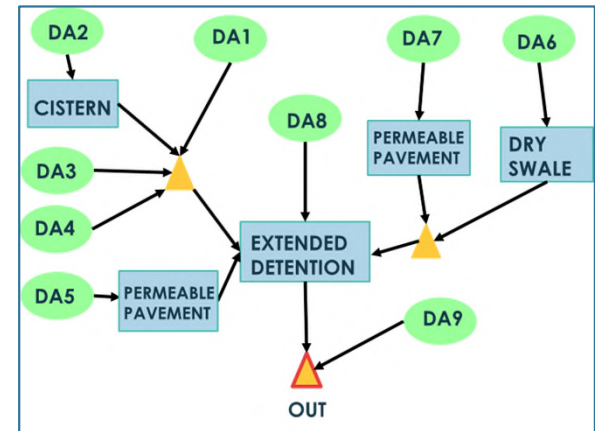
Evaluate:

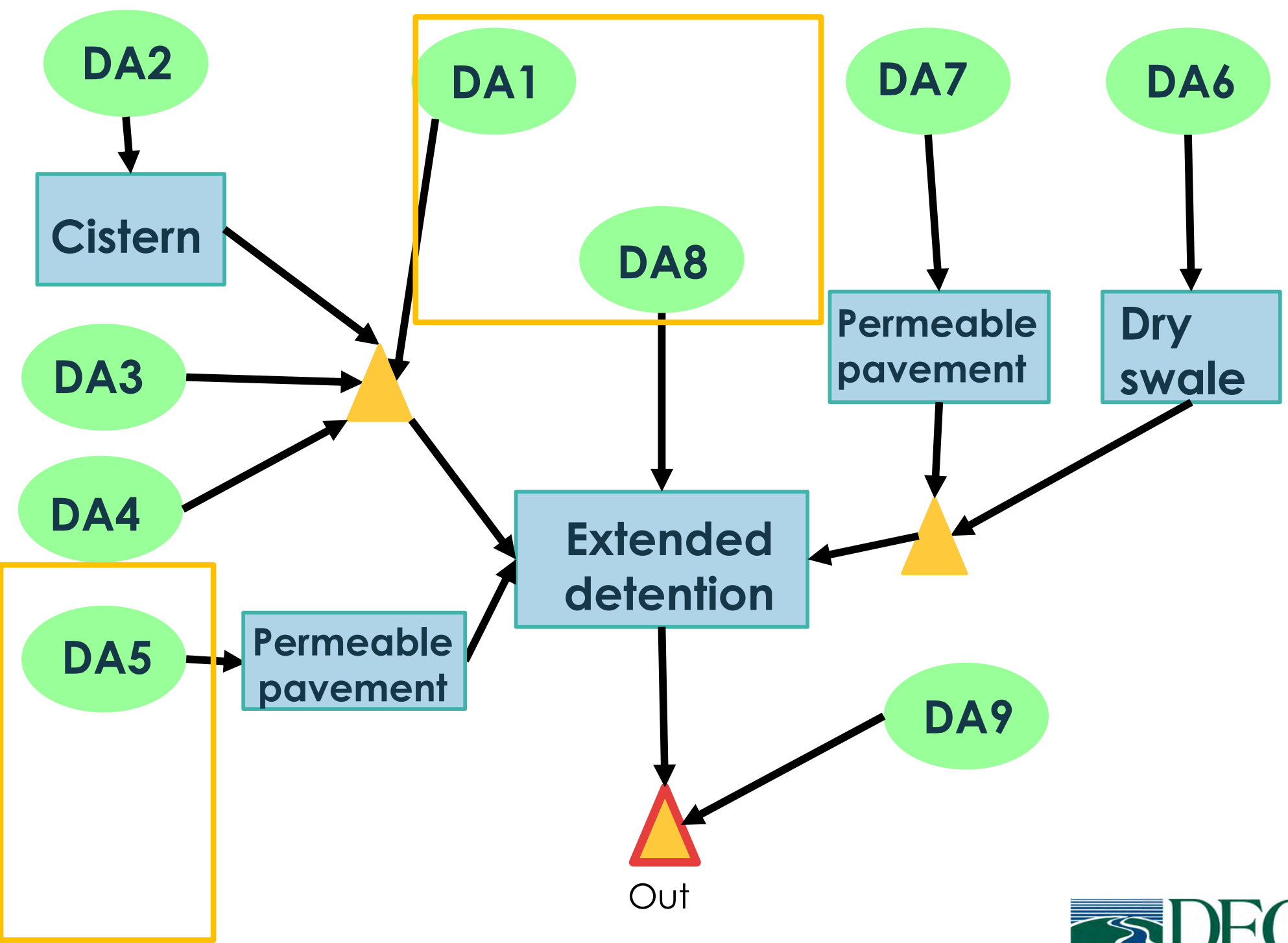
- ☐ Can some drainage areas be grouped together? How?
- ☐ How would you input the system into the VRRM spreadsheet?

How many Drainage Area tabs do you need to evaluate for water quality?

Exercise 4: Complexity

Can some Drainage Areas be grouped together?



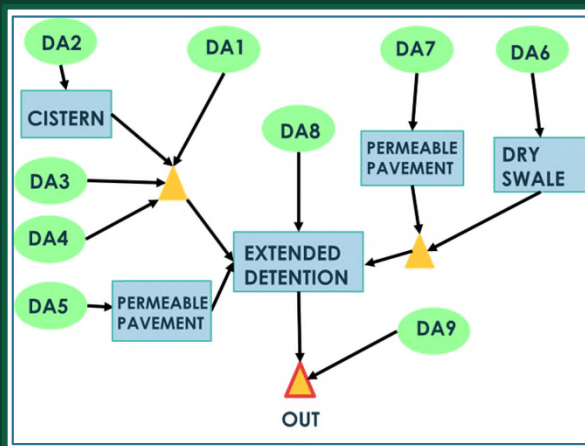


Exercise 4

Complexity

Evaluate:

- ✓ Can some drainage areas be grouped together? How?
- ✓ How would you input the system into the VRRM spreadsheet?
- ❑ What is the total drainage area to BMP5? The credit area?



Site Information

Project Name: 2013 Draft Site & Space

Date: 10/10/2013

Site Information: ENTER AREAS IN DATA INPUT CELLS FOR RESULTS

Post-Development Project (Treatment Volume and Loads)

Land Cover (acres)

	A	B	C	D	Total
Forest/Open Space (acres) - undisturbed	0.00	0.00	0.00	0.00	0.00
Forest/Open Space (acres) - disturbed	0.00	0.00	0.00	0.00	0.00
Forest/Open Space (acres) - total	0.00	0.00	0.00	0.00	0.00
Forest/Open Space (acres) - total	0.00	0.00	0.00	0.00	0.00
Forest/Open Space (acres) - total	0.00	0.00	0.00	0.00	0.00

Runoff Coefficients (C)

	A	B	C	D	Total
Forest/Open Space (acres) - undisturbed	0.00	0.00	0.00	0.00	0.00
Forest/Open Space (acres) - disturbed	0.00	0.00	0.00	0.00	0.00
Forest/Open Space (acres) - total	0.00	0.00	0.00	0.00	0.00
Forest/Open Space (acres) - total	0.00	0.00	0.00	0.00	0.00
Forest/Open Space (acres) - total	0.00	0.00	0.00	0.00	0.00

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr) =

LAND COVER SUMMARY - POST DEVELOPMENT

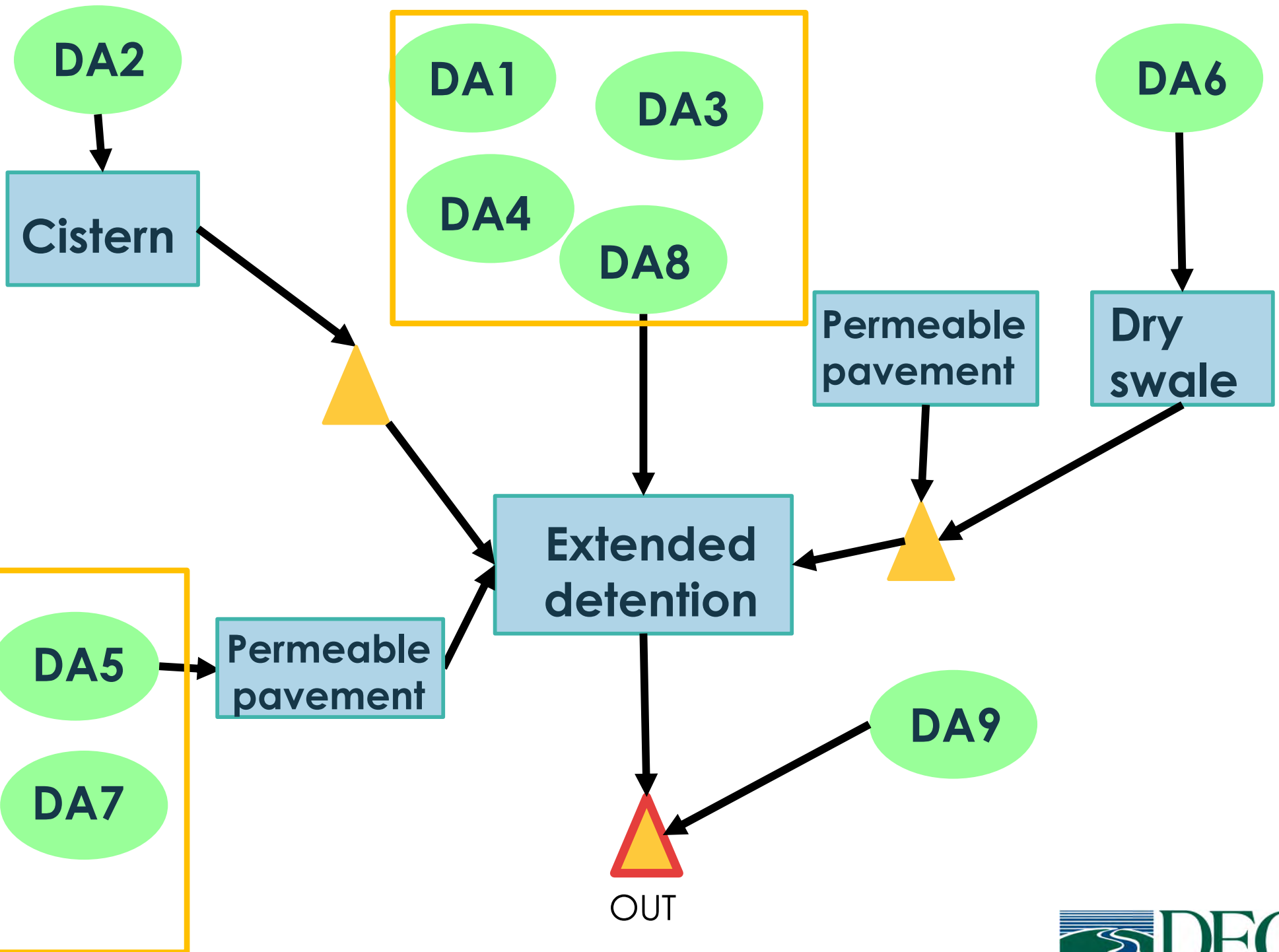
Land Cover Summary	Treatment Volume (acre-ft)	TP Load Reduction (lb/yr)
Forest/Open Space (acres)	0.00	0.0000
Forest/Open Space (acres)	0.00	0.0000
Forest/Open Space (acres)	0.00	0.0000
Forest/Open Space (acres)	0.00	0.0000
Forest/Open Space (acres)	0.00	0.0000

PROPOSED SITE DATA						
DA	AREA (AC)	P-BMP IN DA?	TREATMENT (use P-BMP List)	IMPERVIOUS COVER (AC)	FOREST (AC)	MANAGED TURF (AC)
1	0.9	NO	-	0.10	0.75	0.05
2	0.2	YES	CISTERN	0.20	0.00	0.00
3	0.3	NO	-	0.10	0.20	0.00
4	0.3	NO	-	0.15	0.07	0.05
5	0.3	YES	PP L1	0.30	0.00	0.00
6	1.8	YES	DS L2	0.65	0.65	0.50
7	0.2	YES	PP L1	0.20	0.00	0.00
8	0.7	YES*	ED L1	0.20	0.00	0.50
9	0.7	NO	-	0.05	0.46	0.15
TOTAL	5.4	-	-	1.95	2.13	1.25

Exercise 4

Total Drainage Area to BMP5?

PROPOSED SITE DATA						
DA	AREA (AC)	P-BMP IN DA?	TREATMENT (use P-BMP List)	IMPERVIOUS COVER (AC)	FOREST (AC)	MANAGED TURF (AC)
1	0.9	NO	-	0.10	0.75	0.05
2	0.2	YES	CISTERN	0.20	0.00	0.00
3	0.3	NO	-	0.10	0.20	0.00
4	0.3	NO	-	0.15	0.07	0.05
5	0.3	YES	PP L1	0.30	0.00	0.00
6	1.8	YES	DS L2	0.65	0.65	0.50
7	0.2	YES	PP L1	0.20	0.00	0.00
8	0.7	YES*	ED L1	0.20	0.00	0.50
9	0.7	NO	-	0.05	0.46	0.15
TOTAL	5.4	-	-	1.95	2.13	1.25



Exercise 4

Total DA to BMP5?

Drainage Areas 1 through 8
drain to BMP 5

PROPOSED SITE DATA						
DA	AREA (AC)	P-BMP IN DA?	TREATMENT (use P-BMP List)	IMPERVIOUS COVER (AC)	FOREST (AC)	MANAGED TURF (AC)
1	0.9	NO	-	0.10	0.75	0.05
2	0.2	YES	CISTERN	0.20	0.00	0.00
3	0.3	NO	-	0.10	0.20	0.00
4	0.3	NO	-	0.15	0.07	0.05
5	0.3	YES	PP L1	0.30	0.00	0.00
6	1.8	YES	DS L2	0.65	0.65	0.50
7	0.2	YES	PP L1	0.20	0.00	0.00
8	0.7	YES*	ED L1	0.20	0.00	0.50
9	0.7	NO	-	0.05	0.46	0.15
TOTAL	5.4	-	-	1.95	2.13	1.25

Treatment Paths:

Drainage Area	Area	Treatment	Impervious Cover	Forest	Managed Turf
1,3,4,8	2.2	ED	0.55	1.02	0.60
5,7	0.5	PP to ED	0.50	0.00	0.00
2	0.2	RH to ED	0.2		
6	1.8	DS to ED	0.65	0.65	0.50
Total	4.7		1.9	1.67	1.1

**Total credit area to ED 1.9
+ 1.1 = 3.0 acres**

ED: Extended detention L1

PP: Permeable pavement L1

RH: Rainwater harvesting (90% efficiency)

DS: Dry swale L2

Treatment Paths:

Drainage Area	Area	Treatment	Impervious Cover	Managed Turf	Mixed	Forest
1,3,4,8	2.2	ED	0.55	0.60	0.25	1.02
5,7	0.5	PP to ED	0.50			
2	0.2	RH to ED	0.2			
6	1.8	DS to ED	0.65	0.50		0.65
Total	4.7		1.9	1.1		1.67

**Total credit area to ED 1.9
+ 1.1 = 3.0 acres**

**ED surface area can be
counted as mixed open (0.25
ac from previous exercise)**

ED: Extended detention L1

PP: Permeable pavement L1

RH: Rainwater harvesting (90% efficiency)

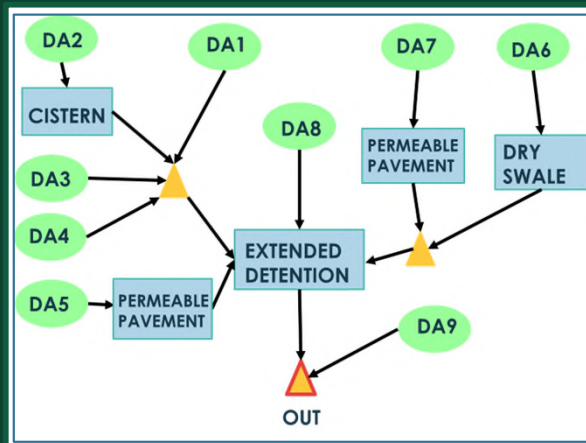
DS: Dry swale L2

Exercise 4

Complexity

Evaluate:

- ✓ Can some drainage areas be grouped together? How?
- ✓ How would you input the system into the VRRM spreadsheet?
- ✓ What is the total drainage area to BMP5? The credit area?
- What is the treatment volume for BMP5?



The screenshot shows the VRRM spreadsheet interface. The 'Project Name' field is set to 'BMP Design Spreadsheet (VRRM) 2013 Draft Study & Space'. The 'Site Information' section includes a table for 'Land Cover (acres)' with columns for A, B, C, and D, and a 'Total' column. The 'Runoff Coefficients (Cp)' table has columns for A, B, C, and D, and a 'Total' column. The 'Post-Development Requirement for Site Area' section shows a '10' Land Reduction Required (20/20) value. The 'LAND COVER SUMMARY - POST DEVELOPMENT' section shows a 'Land Cover Summary' table with columns for Land Cover, Treatment Volume, and Credit Volume.

Input to VRRM 4.1 Spreadsheet

Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest (acres) -- undisturbed, protected forest or reforested land			3.50		3.50
Mixed Open (acres) -- undisturbed/infrequently maintained grass or					0.00
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
					6.70

* Forest and Mixed Open areas must be protected in accordance with the Virginia Runoff Reduction Method

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)

1.15

LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary

Forest Cover (acres)	3.50
Weighted Rv (forest)	0.04
% Forest	52%
Mixed Open (acres)	0.00
Weighted Rv (mixed open)	0.00
% Mixed Open	0%
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

Treatment Volume and Nutrient Loads

Treatment Volume (acre-ft)	0.1890
Treatment Volume (cubic feet)	8,231
TP Load (lb/yr)	2.89
TN Load (lb/yr)	38.88

**Total phosphorous
(TP) load = 1.15 lbs**

Input to VRRM 4.1 Spreadsheet

Drainage Area A Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals	Composite
Forest (acres)			3.50		3.50	
Mixed Open (acres)					0.00	
Managed Turf (acres)			1.25		1.25	
Impervious Cover (acres)			1.95		1.95	
				Total	6.70	

Same data for
DA tab land
cover summary

Stormwater Best Management Practices (RR = Runoff Reduction)

Practice	Runoff Reduction Credit (%)	Mixed Open Credit Area (acres)	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	Volume from Upstream Practice (ft ³)	Runoff Reduction (ft ³)	Remaining Runoff Volume (ft ³)	Total BMP Treatment Volume (ft ³)
8. Extended Detention Pond (RR)								
8.a. ED #1 (P-BAS-03)	0		0.60	0.55	2,074	0	4,449	4,449
8.b. ED #2 (P-BAS-03)	15				0	0	0	0

Total BMP treatment volume = 4,449 cubic feet

Site

D.A. A

D.A. B

D.A. C

D.A. D

D.A. E

Water Quality Compliance

Runoff Volume and CN

Summary

Notes

Exercise 4

Complexity

Evaluate:

- ☒ Can some drainage areas be grouped together? How?
- ☒ How would you input the system into the VRRM spreadsheet?
- ☒ What is the total drainage area to BMP5? The credit area?
- ☒ What is the treatment volume for BMP5?
- ☐ Does the site satisfy water quality requirements?

Does the Site Comply with Water Quality Criteria?

Site Results (Water Quality Compliance) VRRM 4.1, 2024

Area Checks	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	AREA CHECK
FOREST (ac)	3.50	0.00	0.00	0.00	0.00	OK.
MIXED OPEN AREA (ac)	0.00	0.00	0.00	0.00	0.00	OK.
MIXED OPEN AREA TREATED (ac)	0.00	0.00	0.00	0.00	0.00	OK.
MANAGED TURF AREA (ac)	1.25	0.00	0.00	0.00	0.00	OK.
MANAGED TURF AREA TREATED (ac)	1.10	0.00	0.00	0.00	0.00	OK.
IMPERVIOUS COVER (ac)	1.95	0.00	0.00	0.00	0.00	OK.
IMPERVIOUS COVER TREATED (ac)	1.90	0.00	0.00	0.00	0.00	OK.
AREA CHECK	OK.	OK.	OK.	OK.	OK.	

Site Treatment Volume (ft³) 8,231

Runoff Reduction Volume and TP By Drainage Area

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	TOTAL
RUNOFF REDUCTION VOLUME ACHIEVED (ft ³)	2,981	0	0	0	0	2,981
TP LOAD AVAILABLE FOR REMOVAL (lb/yr)	2.60	0.00	0.00	0.00	0.00	2.60
TP LOAD REDUCTION ACHIEVED (lb/yr)	1.31	0.00	0.00	0.00	0.00	1.31
TP LOAD REMAINING (lb/yr)	1.29	0.00	0.00	0.00	0.00	1.29

NITROGEN LOAD REDUCTION ACHIEVED (lb/yr)	16.45	0.00	0.00	0.00	0.00	16.45
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Total Phosphorus

FINAL POST-DEVELOPMENT TP LOAD (lb/yr)	2.89
TP LOAD REDUCTION REQUIRED (lb/yr)	1.15
TP LOAD REDUCTION ACHIEVED (lb/yr)	1.31
TP LOAD REMAINING (lb/yr)	1.58
REMAINING TP LOAD REDUCTION REQUIRED (lb/yr)	0.00

** TARGET TP REDUCTION EXCEEDED BY 0.16 LB/YEAR **

Does the Site Comply with Water Quality Criteria?

Yes: the cistern, permeable pavement L1, dry swale L2, and extended detention L1 all work together to make the site water quality compliant.

Total Phosphorus

FINAL POST-DEVELOPMENT TP LOAD (lb/yr)	2.89
TP LOAD REDUCTION REQUIRED (lb/yr)	1.15
TP LOAD REDUCTION ACHIEVED (lb/yr)	1.31
TP LOAD REMAINING (lb/yr):	1.58

REMAINING TP LOAD REDUCTION REQUIRED (lb/yr): 0.00

**** TARGET TP REDUCTION EXCEEDED BY 0.16 LB/YEAR ****

Site

D.A. A

Sheet1

D.A. B

D.A. C

D.A. D

D.A. E

Water Quality Compliance

Runoff Volume and CN

Summary

Exercise 4

Complexity

FIND:

- ✓ Can some drainage areas be grouped together? How?
- ✓ How would you input the system into the VRRM spreadsheet?
- ✓ What is the total drainage area to BMP5? The credit area?
- ✓ What is the treatment volume for BMP5?
- ✓ Does the site meet the phosphorus load reduction requirement?

Questions?

