### Module 5f: Swales in WinSLAMM

#### **Problem Description**

You are the stormwater engineer for a commercial site that must reduce its pollution load by 40 percent. The site is fully developed with silty soils. Determine the site's pollution load if swales were used for drainage instead of curb and gutter. Instructions for modifying the file begin on page 2.

How much runoff and pollution does the site generate (Answers to be filled in throughout the example)?

- i. Runoff (cu ft):
- ii. TSS (mg/L): \_\_\_\_\_
- iii. TSS (lbs):
- iv. Total Copper (lbs):
- v. Particulate Lead (lbs):

What is the percent reduction of TSS (lbs)?

Steps:

- 1) Fill in the data regarding swales
- 2) Save the file as another name and update the site description
- 3) Enter the swale data
- 4) Run the model
- 5) View the output
- 6) Save the output

### Problem

1) Fill in the data regarding swales

Change the site's drainage from 100 percent curb and gutter to 100 percent swales. Enter data describing the swale. Assume soil is silt loam and site is classified as Shopping Center Commercial. Follow the steps starting on page 2 to enter the data. Some data has been filled in for you. The answers to (1) can be found on page 2.

Swale infiltration rate (in/hr):	
Swale density (ft/ac):	(Total Swale Length/Total Area of Site)
Total Swale Length (ft):	,
Total Area of Site (ac):	
Typical Bottom Width (ft): <u>3 fee</u>	<u>et</u>
Typical Swale Side Slope (H ft / V ft):	3:1
Typical Longitudinal Slope (ft/ft):	<u>0.01 ft/ft</u>
Swale Manning's n: 0.027	

-

<u>Answer</u>

Swale Data

Swale infiltration rate (in/hr): 0.15 inches/hr Swale density (ft/ac): 102 ft/ac Total Swale Length (ft): 757 ft Total Area of Site (ac): **7.39 acres** Typical Bottom Width (ft): **3 feet** Typical Swale Side Slope (H ft : V ft): **3:1** Typical Longitudinal Slope (ft/ft): **0.01 ft/ft** Swale Manning's n: **0.027** 

2) Save the file as another name and update the site description

Save Example 1a as "Example 1b". Save the File in the same location as Example 1a. Click **File**, then **Save As** to save the file with another name.

Click Current File Data to enter in swale data

SLAMM Data File	A	urce Irea No.	Source Area	Area (acres)	1	w	Р	0	s	B	Source Area Parameter:
Example 1b.DAT		61	Boots 1	1.48	-		-	-	-	-	Entered
and the second second		62	Boots 2	2.55							
Current Land Use: Co	mmercial	63	Roofs 3								
Current Land Ose, Ci		64	Boots 4								
Current Source Area	-	65	Roots 5								
Lurrent Source Alea		66	Paved Parking/Storage 1	2.56							Entered
		67	Paved Parking/Storage 2			1					
		68	Paved Parking/Storage 3								
Current File I	Data	69	Unpaved Prkng/Storage								
Contraction of the		70	Unpaved Prkng/Storage								
		71	Playground 1								
Current File S	Status	72	Playground 2								
		73	Driveways 1	2.35							Entered
Current File Dat	a Entered	74	Driveways 2								
Land Use A		75	Driveways 3								
Land Use /	ueas	76	Sidewalks/Walks 1	0.06							Entered
Residential Area:	0.00 Acres	77	Sidewalks/Walks 2								
Institutional Area:	0.00 Acres	78	Street Area 1	0.31							Entered
Commercial Area:	7.39 Acres	79	Street Area 2								
Industrial Area:	0.00 Acres	80	Street Area 3								
Other Urban Area:	0.00 Acres	81	Large Landscaped Area 1								
Freeway Area:	0.00 Acres	82	Large Landscaped Area 2								
Total Area:	7 29 Acres	83	Undeveloped Area								
Total Alea.		84	Small Landscaped Area 1	0.63							Entered
		85	Small Landscaped Area 2								
		86	Small Landscaped Area 3								
Exit Progr	am	87	Isolated Area							_	
		88	Other Pervious Area								
Press F1 fo		89	Other Dir Cnctd Imp Area								
		90	Other Part Cnctd Imp								

Change File Description to reflect swale drainage – Select Edit next to "Site Descrip:" – Enter swales to reflect drainage system – Click **OK** 

C V85086 UW Wins	SLAMM/Minn Cou	urse\Exampl	e 1\Example 1b	hob.det		
-	Site Description	Ë			×	
dit Ste Descript:	Enter the Site De	scription (230 cl	varachers maximum)		OK. Cancel	
dat   Rain File:	Example To swal					
dat Start Date: dat End Date:	10.01.00	Winter Sea	NY 1975		End of Winter In	n/44
da Polutant Probat	ality Distribution File.	C'Program Få	n://winsilamm//wi	GEO01	ppd	
dat   Runot Coefficie	et File:	C: VProgram Fil	n//westamm//wi	_SL01 xr	e	
da Particulate Sold	ls Concentration File:	C VProgram File	n:\\winSLAMM\\wi	_AVG01	peç	
dat   Particulate Resi	due Delivery File:	C:VProgram Fé	NS'(WIRST, AMM'(W)	DLV01	pin	
Git Street Delivery F		C: VProgram File	es//wie/SLAMM//wi	_Con Ins	t Indust May05 std	8
C Institutional LU	C Other Urban LU	_0	hange all Steet De	livery File	s to Match the Cum	ent File
Use Cost	Cost Data File					

3) Enter the swale data

Select Edit next to "Drainage System" – Enter "1" by "Grass Swales" and "0" by "Curb and Gutters, Valleys or Sealed Swales in fair condition" – Click Continue

dit Site Descript :	Example 1a - Commercial Site, Directly Connected	Drainage, Silly Solls, Swale	Dvainage
NELON AND DO COLUMN	rainage System		
dit Seed.	Enter the fraction of each type of drainage		
dit Rain File:	system serving the study area:		
dit   Start Date:	1. Grass Swales	1.000	-
dit End Date:	Enter swale data immediately		Review
	2. Undeveloped Roadside:	0.000	
dit Pollutant Pic	3. Curb and Gutters, Valleys, or Sealed Swales in poor condition or very flat	0.000	
dit Runoff Coelt	4. Curb and Gutters, Valleys, or Sealed Swales in fair condition	0.000	
dit Particulate S	5. Curb and Gutters, Valleys, or Sealed Swales in good condition or very steep	0.000	
dit Particulate F	Continue The total must equal 1. T	otal: 1.000	
dit Steet Delivery	rantometricos Consignational Consignational Consignation of Co	WI_STRU4.00	
Residential LU	C Industrial LU		
C Institutional LU	C Other Urban LU Change all Street	Delivery Files to Match the	Current File

Enter the data describing the swales – Click **Continue** Ignore the "For Cost Analysis Only" section. We will be working with that later in the course.

1. Swale infiltration rate (in/hr)	0.15	2. Swale density (ft/ac):	102
	Contractory of		1 102
		WIDTH (constant for all events)	
3. Wet	ed swale	width (ft):	
		OR AL SWALE GEOMETRY M each event based on expected (lows)	-
Typical Swale Geometry 4. Typical Bottom Width (ft):	3	6. Typical Longitudinal Slope (ft/ft):	0.010
5. Typical Swale Side Slope {_ft H : 1 ft V};	3	7. Swale Manning's n	0.027
Select swale density by land ( C Low density residential - 160 N/ac Medium density residential - 350 h High density residential - 375 h/ac Shogoing center - 280 h/ac Shogoing center - 280 h/ac C Shogoing center - 280 h/ac C Ereeways (center and shoulder) - Area served by swales (acres): 7	/ac sc 110 fV/ac	<ul> <li>Select infiltration rate by</li> <li>Sand - 4 in/hr</li> <li>Loany sand - 1.25 in/hr</li> <li>Sandy loam - 0.5 in/hr</li> <li>Sandy loam - 0.15 in/hr</li> <li>Silt loam - 0.15 in/hr</li> <li>Sandy silt loam - 0.11 in/hr</li> <li>Silty clay loam - 0.025 in/hr</li> <li>Silty clay - 0.025 in/hr</li> <li>Silty clay - 0.025 in/hr</li> <li>Silty clay - 0.025 in/hr</li> <li>Clay clay - 0.025 in/hr</li> <li>Clay clay - 0.021 in/hr</li> </ul>	
For Cost Analysis Only: Typical Swale Depth (h): Typical Bottom Width (h): 3	-	Delete Cancel (	Continue

Click Continue again to get back to the main screen

C185086 UW WinSLAMM/Minn C	ourse\Example 1\Example 1b dat
Edit Site Descript. Example 1e swale	8
Edit Seed 42	
Edit Rain File:	C:/Program Files/WinSLAMM/Rain Files/MSN1981.RAN
Edit Start Date: 01/01/81 Edit End Date: 12/31/81	Winter Season Range Start of Winter (mm/dd) End of Winter (mm/dd)
Edit   Pollutant Probability Distribution File	C-VProgram Files/WinSLAMM/WI_GE001.ppd
Edit   Runolf Coefficient File:	C.VProgram Files/WinSLAMM/WI_SL01.nv
Edit Particulate Solids Concentration Fil	C.Vhogram Files/WinSLAMM/WL/AVG01.pcc
Edit Particulate Residue Delivery File:	C-VProgram Files/WinSLAMM/W1_DLV01.pr
Edit Street Delivery File (Select LU)	C VProgram Files /WinSLAMM /WI_Com Inst Indust May05 std
C Institutional LU C Other Urban LU C Commercial LU C Freeways	U Change all Street Delivery Files to Match the Current File
Use Cost Estimation Option Select Cost Data File	1

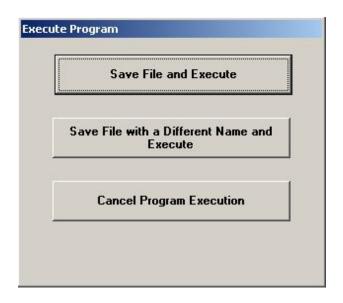
Save your changes

File Land Use Pollutar	ts Options Run	Utilities	Help		
New					
Open					
Save					
Save As					
Save Input Data					
Output Options					
L:\group\WaterResou	rces\WinSLAMM_Win rces\WinSLAMM_Win	DETPON	nple1a.dat D(Standard Land Use Files(No Conto D(Standard Land Use Files(No Conto sed BMPs(STR Clay site.dat		
Exit					
	2000-01	n	riayground i	1111	
Current File	Status	72	Playground 2		
Current File Dat	a Entered	73	Driveways 1	2.35	Entered
1 Content rue Dat	a Lineleu	74	Driveways 2		
Land Use /	Areas	75	Driveways 3 Sidewalks/Walks 1	0.06	Entered
Residential Area:	0.00 Acres	77	Sidewalks/Walks 1 Sidewalks/Walks 2	0.06	Entered
Institutional Area:	0.00 Acres	78	Street Area 1	0.31	Entered
Commercial Area:	7.39 Acres	79	Street Area 2	0.31	Entered
		80	Street Area 3		
Industrial Area:	0.00 Acres	81	Large Landscaped Area 1		
Other Urban Area:	0.00 Acres	82	Large Landscaped Area 2		
Freeway Area:	0.00 Acres	83	Undeveloped Area		
Total Area:	7.39 Acres	84	Small Landscaped Area 1	0.63	Entered
		85	Small Landscaped Area 2		100000000
		86	Small Landscaped Area 3		
Exit Prog	am	87	Isolated Area		
	3307/	88	Other Pervious Area		
Press F1 fo	r Help	89	Other Dir Cnctd Imp Area		
		90	Other Part Crictd Imp		

# 4) Run the model

## Run the file

File Land Use Pollutants	Options Run	Utilities	Help							
	Ca	loulation	Module		-		-	21	1	
	Ru	n Batch B	ditor	Area		w	P	0 9	: 1	Source
SLAMM Data File:		No.		(acres)				°   '	1	Parameters
Example1e.DAT		61	Boofs 1	1.48		-	-	-	-	Entered
		62	Boofs 2							
Current Land Use: Con	Internet	63	Boofs 3							
Content Cana Orec. Con	assertional	64	Roofs 4							
Current Source Area		65	Roofs 5							
Current Source Area		66	Paved Parking/Storage 1	2.56						Entered
		67	Paved Parking/Storage 2							1 ANN 6502 STATE
THE COST CONTRACT		68	Paved Parking/Storage 3							
Current File Da	sta	69	Unpaved Prkng/Storage							
		70	Unpaved Prkng/Storage							
		71	Playground 1							
Current File St	atus	72	Playground 2							
		73	Driveways 1	2.35						Entered
Current File Data	Entered	74	Driveways 2					_	_	
Land Use Ar	eas	75	Driveways 3					_		And the second second
		76	Sidewalks/Walks 1	0.06	_	_		_	_	Entered
Residential Area:	0.00 Acres	77	Sidewalks/Walks 2					_		
Institutional Area:	0.00 Acres	78	Street Area 1	0.31	_	_		_	_	Entered
Commercial Area:	7.39 Acres	79	Street Area 2		_	_	_	_	_	
Industrial Area:	0.00 Acres	80	Street Area 3			_		_	-	-
Other Urban Area:	0.00 Acres	81	Large Landscaped Area 1		-			-	-	
Freeway Area:	0.00 Acres	82	Large Landscaped Area 2					_	-	
Total Area:	7.39 Acres	83	Undeveloped Area	0.00	-		-	-	+	
		84	Small Landscaped Area 1	0.63	-	-	-	-	+	Entered
		85	Small Landscaped Area 2		-		-	-	+	
	201	86	Small Landscaped Area 3 Isolated Area		-		-	+	+	
Exit Progra	m	87	Other Pervious Area		-		-	+	+	-
		89	Other Pervious Area		-	-	-	+	+	+
Press F1 for	Help	90	Other Part Cnctd Imp					_	-	



5) View the output

How much runoff and pollution does the site generate (fill in summary table on page 1)?

Runoff Volume	Particulate Solids	Pollutants	Output Summary
File Name: C:\85086 UW WinSL	AMM\Minn Course\Example 1\	Example 1b.dat	~
	Runoff Percent Volume Runoff (cu. ft.) Reduction	Particulate Solids Conc. (mg/L)	Percent Particulate Particulate Solids Yield Solids (lbs) Reduction
Total Before Drainage System	561484 Base	125.3	4390 Base
Total After Drainage System	540579 3.72 %	124.4	4195 4.44 %
Total After Outfall Controls	540579 3.72 %	124.4	4195 4.44 %
		Total A	wea Modeled (ac) 7.39
Total Control Practic	e Costs		
Capital Cost	N/A		Print Output Summary to
Land Cost	N/A		Comma Separated Value File
Annual Maintenance Cost	N/A		
Present Value of All Costs	N/A		Print Output Summary to Text File
Annualized Value of All Costs	N/A		T GM T PO

- i. Runoff (cu ft): 540,579 cu. ft.
- ii. TSS (mg/L): **124.4 mg/L**
- iii. TSS (lbs): 4,195 lbs

Runoff	Volume	Part	iculate Solids	Ĵ	Pollutants	Ľ	Output Summary				
(	Concentration	T		Yield (lbs)			Percent SA Contribution				
Data File: Ex	kample 1b.DAT										
Rain File: M	SN1981.RAN										
Date: 09-05-	05 Time: 1:26	33 PM									
Site Descript	ion: Example 1	e swales									
Total Area, w	with Drainage a	nd Outfall Con	trols - Yield of	TOTAL COPP	ER (lbs)						
Summary of F	Runoff Produci	ng Events									
	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls							
Minimum	0.01	6.691E-06	5.258E-06	5.258E-06				-11			
Maximum:	2.59	0.06604	0.06583	0.06583							
FI WI Ave:		0.02668	0.02699	0.02699							
Total:	32.10	0.6765	0.6615	0.6605	>						
Total Area, w	with Drainage a	nd Outfall Con	trols - Yield of	PARTICULAT	E LEAD (lbs)						
Summary of F	Runoff Produci	ng Events									
	Rain Total (inches)	Total Before Drainage Sustem	Total After Drainage System	Total After Outfall Controls							

iv. Total Copper (lbs): 0.6605 lbs

Runoff	Volume	Part	iculate Solids	I	Pollutants	Ľ	Output Summary
(	Concentration	The second secon		Yield (lbs)	γ	Perce	ent SA Contribution
Data File: Ex	ample 1b.DAT						
	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls			
Minimum:	0.01	6.691E-06	5.258E-06	5.258E-06			
Maximum:	2.59	0.06604	0.06583	0.06583			
FI WI Ave:		0.02668	0.02699	0.02699			
Total:	32.10	0.6765	0.6605	0.6605			
	with Drainage a		trols - Yield of	PARTICULA	TE LEAD (lbs)		
Summary of I	Runoff Produci	and front of the second second second second					
	Rain Total (inches)	Total Before Drainage System	Total After Drainage System	Total After Outfall Controls			
Minimum:	0.01	5.156E-06	1.034E-05	1.034E-05		1	
Maximum:	2.59	0.1098	0.1090	0.1090			
FI Wt Ave:		0.04444	0.04457	0.04457			
Total:	32.10	1.128	1.081	1.081			

v. Particulate Lead (lbs): 1.081 lbs

- [D] X]

Concentration     C Printer       Data File: Example1e.DAT     © Eile       Maximum: 259     0.06       FIVM Ave: 0.02     Select Item(s) to Print       Total Area, with Drainage and Outlal     Image: Select Item (cult)       Total Area, with Drainage and Outlal     Image: Select Item (cult)       Summary of Runotf Producing Event     Particulate Select	
Data File: Example1e.DAT       Maximum:     2.59       Otal File: Example1e.DAT       Maximum:     2.59       Otal File: Example1e.DAT       Filwit Ave:     0.02       Total Area, with Drainage and Outfal       Total Area, with Drainage and Outfal	
FI Wt Ave:     0.02       Total:     32.10       Total Area, with Drainage and Outfal         Total Area, with Drainage and Outfal         Select (tem(s) to Frink         Bunoff Volume       Image: Select (tem(s) to Frink         Bunoff Volume         Image: Select (tem(s) to Frink         Bunoff Volume         Image: Select (tem(s) to Frink         Bunoff Volume         Image: Select (tem(s) to Frink	-
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Total Area, with Drainage and Outfal	- 111
Total Area, with Dranage and Outfal	- 111
Total Area, with Drainage and Outfal	
	- 11
Rain Total	- 111
Total Before 🔽 Concentration	
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Minimum 0.01 5.156E C SA Yield Contribution	- 111
Maximum: 2.59 0.1	
FIWt Ave: 0.04 Pollutants	-11
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Vield (lbs)	- 111
Percent SA Contribution	- 11
Cancel QK	all
Press F1 for Help 89 Uther Dir Crictid Imp Area 90 Other Part Crictid Imp	

6) Save the output

WinSLAMM Data File: [C:\85086 UW WinSLAMM Eng\Wi

What is the percent reduction from swales of TSS(%)? 4.44 %

Alternative Scenarios (if available time)

a. Question: You have chosen to use engineered soil with an infiltration rate of 2 in/hr. What happens to the runoff and pollution results? Why?

Answer: Runoff and pollution are decreased. The engineered soil has a higher infiltration rate than the native soil, thus allowing additional runoff to infiltrate.

b. Question: You have chosen to increase the swale bottom width by 2 feet using the native soil. What happens to the runoff and pollution results? Why?

Answer: Runoff and pollution are decreased. The wider swale allows for more surface area for runoff to spread out and infiltrate. The decrease is not a linear relationship because the smallest storms are infiltrated completely – only the slightly larger storms and above are affected by the wider bottom width.