Cost Analysis Workshop

Problem Description

You are the stormwater engineer for a new commercial development that must reduce its pollution load by 80 percent. The site has sandy soils and will be fully developed. Your task is to determine the most cost-effective pollution load reduction. The most cost-effective solution is defined by the least expensive option, expressed in $/lb removed, that achieves the 80% reduction goal. You may use the following practices:

1. Grass swales treating the entire drainage area for the project
2. Porous pavement applied to 20 percent or 50 percent of the paved parking area
3. Wet detention pond treating the entire project area at the outfall.
4. A combination of grass swales and a wet detention pond.

The general cost analysis procedure is as follows:
1. Begin by creating a "Cost Analysis – Base Condition No Controls.dat" file to describe the site without controls.
2. Add various control devices to the base condition file (saving each control in a separate file) to evaluate different control practices from both a pollution reduction and a cost-effective perspective.
3. Create a project-specific cost data file to reflect the expected costs for the practices at your site.
4. Run the set of .dat files that you created with the cost data file.
5. Review the results from all the .dat files, which will be combined in one text file.

Create the .dat Files with Control Practice Alternatives

To Create a Cost Example – Base Condition No Controls.dat file, use the parameter files you applied to Example 1. Start with your Example 1a.dat file and do the following:
1. Delete the commercial land use source areas. To do this, double-click on each area value in the commercial land use, and enter a 0. If you have any control devices applied to the source area, you must remove those first.
2. Change the fraction of each type of drainage system serving the study area to: *Curb and Gutters, Valleys, or Sealed Swales in good condition or very steep*.' To do this, enter a '1' for drainage system type 5.
3. Enter the following source area data in the Commercial Land Use screen
   a. Roofs 1: 10.0 ac, flat roof, directly connected
   b. Paved Parking/Storage 1: 50.0 ac, directly connected
   c. Driveways 1: 2.0 ac, directly connected
   d. Small Landscaped Area 1: 3.0 ac, sandy soils
   The total should be 65.0 acres.
4. Go to current file data and change the Site Description to: "Cost Analysis – Base Condition No Controls".
5. Change the output option to Output Option 1.
6. From the main menu, select 'Pollutants' and then select the 'Clear All' button to remove any pollutants other than particulate solids from the analysis.
7. Save the file as "Cost Example – Base Condition No Controls.dat".

To Create a Cost Example – G.dat file (for the grass swale analysis), start with the "Cost Example – Base Condition No Controls.dat" file and do the following:

1. Select the 'Current File Data' button, and then select the 'Edit' button for the drainage system.
2. Place a 1.0 for grass swales and 0.0 for everything else because 100% of the area drains to a grass swale drainage system.
3. Swale infiltration rate (in/hr) for sandy loam soils.
4. Swale density (ft/ac) for Shopping Centers.
5. Typical bottom width (ft): 5 ft
6. Typical swale side slope (H ft / V ft): 3:1
7. Typical Longitudinal Slope (ft/ft): 0.010
8. Swale Manning's n: 0.030
9. Typical Swale Depth (ft): 3.0
10. Change the Site Description to: "Cost Example – Grass Swales"
11. Save the file as "Cost Example - G.dat"

To Create a Cost Example – P 20 percent.dat file (for porous pavement on 20% of the paved parking area), start with the "Cost Example – Base Condition No Controls.dat" file and do the following:

1. From the main menu, go to Commercial land use.
2. Double-click on the grid cell intersecting P (Porous Pavement) and source area 66, Paved Parking/Storage 1.
3. Infiltration rate: 0.50 in/hr.
4. Porous pavement area: 10.0 acres.
5. Change the Site Description in Current File Data to: "Cost Example – 20 percent Porous Pavement in parking area."
6. Save the file as "Cost Example – P 20 percent.dat"

To Create a Cost Example – P 50 percent.dat file (for porous pavement on 50% of the paved parking area), start with the "Cost Example – Base Condition No Controls.dat' file and do the following:

1. From the main menu, go to Commercial land use.
2. Double-click on the grid cell intersecting P (Porous Pavement) and source area 66, Paved Parking/Storage 1.
3. Infiltration rate: 0.50 in/hr.
4. Porous pavement area: 25.0 acres.
5. Change the Site Description in Current File Data to: "Cost Example – 50 percent Porous Pavement in parking area."
6. Save the file as "Cost Example – P 50 percent.dat"

To Create a Cost Example – W.dat file (for the wet detention pond analyses), start with the "Cost Example – Base Condition No Controls.dat" file and do the following:

1. From the main menu, go to Land Use/Outfall/Wet Detention.
2. Critical particle size file: c:\program files\winslamm\nurp.cpz
3. Initial stage elevation: 3.0 ft.
4. Peak to Average ratio: 3.80

5.   Stage-Area data:

Row Number	Stage (ft)	Area (acres)
0	0.0	0.0
1	0.10	0.60
2	1.00	0.80
3	2.00	1.50
4	3.00	2.00
5	4.00	2.50
6	5.00	3.00

6.   Outlet 1 – Broad Crested Weir:
   a. Weir crest length: 50 ft
   b. Weir crest width: 3.0 ft
   c. Use default discharge coefficients
   d. Height of weir opening: 0.5 ft
   e. Height from datum to bottom of weir opening: 4.5 ft
7.   Outlet 2 – V-Notch Weir
   a. Weir angle: 30 degrees
   b. Height from bottom of weir opening to top of weir: 2.0 ft
   c. Height from datum to bottom of weir opening: 3.0 ft
8.   Outlet 3 – V-Notch Weir
   a. Weir angle: 30 degrees
   b. Height from bottom of weir opening to top of weir: 2.0 ft
   c. Height from datum to bottom of weir opening: 3.0 ft
9.   Change the Site Description in Current File Data to: "Cost Example – Wet detention at outfall."
10.   Save the file as "Cost Example – W.dat"

Create a Project-Specific Cost Data File

1.   From the main menu, select Options/Access Cost Data.
2.   Press the 'Select File' button and open the file: c:\program files\winslamm\Cost Template.csv, and immediately save the file as 'Example Cost Data File.csv'
3.   On the Summary Data tab:
   a. Commercial Land Cost: $40,000/acre
   b. Outfall and Drainage System Land Cost: $40,000/acre
   c. Interest Rate on Capital Debt: 5%
   d. Project Life: 20 years
   e. Use City Cost Index Values, select Minneapolis
   f. File Description: Cost Example Data File – Minneapolis Index
4.   On the Detention Pond tab:
   a. For Applicable Cost Range, select 'High"
   b. Land Cost Site Area Multiplier: 2.5
5.   On the Porous Pavement tab:
   a. For Applicable Cost Range, select 'Low"
   b. Land Cost Site Area Multiplier: 0
6.   On the Grass Swale tab:

a. Select the User Defined Costs, enter the following (note that the item 'Grass Swales' and the unit for grass swales, 'LF', are already entered for you):

Item	Unit	$/Unit	Quan.
Grass Swales	LF	4.50	18000
Seed & Mulch	SY	0.80	10000
E Mat	SY	0.80	36000

   b. Annual routine maintenance cost ($/LF): 0.50
   c. Land Cost Site Area Multiplier: 0
7. Go back to the Summary Data tab and press the 'Save File' button to save the file you just modified. Press the 'Exit' button. The program will ask you if you want to save the file. Press 'No' because you have already saved it.

Run the Set of .dat Files That You Just Created

To compare the control practices that you entered in the above .dat files, use the 'Run a Set of .dat Files' option in the batch editor. To do this, do the following:
1. From the main menu, select 'Run/Run Batch Editor . . .', press the 'Yes' button, and then press the 'Run a Set of .dat Files' button.
2. Use the 'Select Directory' button to show the .dat files that are in the directory you just created for the exercise.
3. To select the files you want to run, either double-click on the desired files listed in the Current Directory box or select the 'Add All Files to the Run List' button.
4. Check the 'Include Cost Estimates' box, press the 'Select Cost Data File' button, and select the cost file, 'Example Cost Data File.csv', that you just created.
5. Execute the program for the files on the list by pressing the 'Run Files in Run List' button.
6. To view the output, go to the directory that you had the cost files in and double-click on the output file 'DATSetOutput.csv'. This will open the comma-separated-value file in Microsoft Excel. The output should look similar to the table below. The last two columns were added to the table using Excel. The spreadsheet with the columns has been included with the program distribution disk. Note that 'DATSetOutput.csv' is created in the folder where your .dat files were.

File Name	Catchment Area (ac)	Runoff Volume (cf)	Particulate Solids Yield (lbs)	Sub Basin Capital Cost	Sub Basin Land Cost	Sub Basin Maintenance Cost	Sub Basin Total Annualized Cost	Sub Basin Total Present Value Cost	Percent Particulate Solids Reduction	Cost per lb Sediment Reduced per Year
Cost Example - Base Case No Controls	65	5246545	37412.91	0	0	0	0	0	0%	
Cost Example - G	65	3136146	22341.03	119109	0	9100	18658	232515	40%	$ 1.24
Cost Example - P 20 percent	65	4425257	30761.3	681686	0	3422	58122	724332	18%	$ 8.74
Cost Example - P 50 percent	65	3193328	20783.89	1704215	0	8555	145306	1810829	44%	$ 8.74
Cost Example - W	65	5204862	7496.197 7574.77	366536	300000	7125	60609	755328	80%	$ 2.03

Discussion

The output shows that the only practice that meets the goal of 80% reduction is a wet detention pond at the outfall. The porous pavement, although it has the potential to reach the 80% goal, appears to be much more expensive than the swales or pond options. However, the grass swale and the porous pavement options also reduce the runoff volume, which the outfall wet detention pond does not.

Question 1: The model results above show that the wet detention pond meets the sediment reduction requirements described in the problem statement. What other options might be available to reduce the cost of the project but still meet the goal of 80% sediment reduction?

Answer: One possibility would be to add grass swales to the site before the wet detention pond at the outfall, and then reduce the size of the wet pond to reduce the total cost. Below is the resulting analysis of such as strategy. The file that was used to generate this output is included in the distribution disk (Cost Example – W G.dat)

File Name	Catchment Area (ac)	Runoff Volume (cf)	Particulate Solids Yield (lbs)	Sub Basin Capital Cost	Sub Basin Land Cost	Sub Basin Maintenance Cost	Sub Basin Total Annualized Cost	Sub Basin Total Present Value Cost	Percent Particulate Solids Reduction	Cost per lb Sediment Reduced per Year
Cost Example - Base Case No Controls	65	5246545	37412.91	0	0	0	0	0	0%	
Cost Example - G	65	3136146	22341.03	119109	0	9100	18658	232515	40%	$ 1.24
Cost Example - P 20 percent	65	4425257	30761.3	681686	0	3422	58122	724332	18%	$ 8.74
Cost Example - P 50 percent	65	3193328	20783.89	1704215	0	8555	145306	1810829	44%	$ 8.74
Cost Example - W	65	5204862	7496.197	366536	300000	7125	60609	755328	80%	$ 2.03
Cost Example - W G	65	2840801	6824.588	360849	170000	14109	56706	706683	82%	$ 1.85