BAE 590-601: DRAINMOD Spring 2011

Homework 9: Simulating Hydrology of Bioretention Areas

Due by 5PM EST on Friday, April 15, 2011

FILES TO SUBMIT

- Report in .doc or .docx format and named as shown below. Replace LastName with your last name.
  - ✓ LastName.590.2011.HW10
  - ✓ Include final OUT and WET output in appendix
  - ✓ Include 4 month calibration RAI and TEM file data in appendix

- Spreadsheet in .xls, .xlsx, .xlsm format and named as shown below.
  - ✓ LastName.590.2011.HW10

- Zip file(s) including DRAINMOD inputs (PRJ, GEN, SIN, RAI, and TEM). Name your PRJ and GEN file as shown below.
  - ✓ YourInitials_hw10

    - For example, my PRJ file would be named: bdp_hw10.prj
    - If you use different project files for each drain depth, label similar to the following scheme:
      1. bdp_hw10_90cm.prj
      2. bdp_hw10_120cm.prj
      3. Etc…
    - As long as your PRJ and GEN files begin with YourInitials_hw10, a naming scheme is up to you
    - If you use the *Backup* button from within DRAINMOD to zip your project, the zip file generated should reside in your inputs folder.

- PDF's of any referenced material not distributed in the course (when possible)

HW INFORMATION

- Total possible points: 150
- Use the report template – Include All Sections
- Post questions to the *Homework Q & A* forum

PROBLEM STATEMENT

Runoff from the roof of a market near Plymouth, NC flows through a small parking lot to a bioretention area (BRA). The roof is 60 ft. wide and 120 ft. long; the parking lot is impervious and is 30 ft. wide and 50 ft. long. The BRA is 20 ft. wide and 80 ft. long. The soil profile of the BRA consists of 90 cm of planting soil (12% organic matter, K=10 cm/hr) over a sand and gravel mix that is 90 cm thick and has K=30 cm/hr. Parallel drains (4-inch in diameter) are placed 120 cm form the surface and 10 ft. apart. The bottom of the retention cell (>180 cm deep) is a marine silty clay that is assumed impermeable. The drains outlet to a single 4-inch corrugated plastic pipe that extends 200 ft to a free outlet to a stream. Slope of the pipe is 0.5% and it has a Manning's roughness of 0.015. The pipe has a flow capacity of 0.11 cfs. The surface of the BRA is 9 inches below the surface of the parking lot. Runoff will not enter the BRA if surface ponding is 9 inches deep.

Simulate the performance of the BRA over a **30-year period (1971-2000)** using DRAINMOD. Include answers the following five questions within your Discussion section.

1. What percentage of runoff from the roof and parking lot can be treated with the BRA described above (parallel drains)? Long term average?, 5 and 10 year recurrence interval?

2. Under the design described above, will the BRA have wetland hydrologic conditions? (show why or why not)

3. How could you manage it so that it would satisfy wetland hydrologic criteria? (show work)

4. Are two drains necessary? What percentage of runoff could be treated if there were only <u>one drain</u> in the BRA? Long term average?, 5 and 10 year recurrence interval?

5. How long is required after a large storm for the water table to 100 cm deep? With two drains? With one drain?

Note: Problem 4 requires analysis of a Bioretention area with a single drain tube at a depth of 120 cm. If the drain is at the center of the retention area it would have an effective spacing of the width of the retention area, which, in this case is 20 ft. Think about it. The vertical walls at the sides of the area may be assumed impermeable, so they would represent conditions at the midplane between parallel drains spaced 20 ft apart.

Below are from Previous BRA Example and may not fully reflect your HW. It is given as a guide.

1. Open WCW.prj
2. Save as BRCA1.prj
3. Change ET correction factors to those currently used for eastern NC
4. Change soil file to Parklot.sin (provided). Note values in this file (nearly zero infiltration, no upflux)
5. Change drainage system input parameters to reflect parking lot—i.e., assumes more than 90% of rainfall lost as surface runoff.
    - Drain depth = 10 cm
    - Drain spacing = 15000 cm
    - Effective radius = 1 cm
    - Depth impermeable layer = 150 cm
    - Surface storage = 0.5 cm? (may need to change to get % runoff in ball park)
6. Run DM and check predicted surface runoff as % of rainfall
7. Check box in lower left hand part of main screen, "Hourly surface runoff/water loss" also check surface runoff
8. Run DM to create BRCA1.SRO file. View it in the output Q
9. Convert BRCA1.SRO to BRCA1.OVR using the Utilities program in DRAINMOD. Follow directions for contributing area method.
10. Input T_c=0.5 hr, 0.2 Ac.= 0.081 ha, IUH=1.67
11. Click on "Create" to run the utility. Results will be in the "inputs" directory
12. Run DRAINMOD for Bioretention area. Save BRCA1. prj as BRA1.prj
13. Change soil to Portse.sin
14. Check box for runoff file in the "Hydrology" inputs; add BRCA1.OVR
15. Change drainage system parameters to reflect the Bioretention area.

- Spacing = 10 ft. = 305 cm
- Depth = 120 cm
- Depth impermeable layer = 180 cm
- DC = 2.5 cm – Does this seem reasonable?
- Change K values to 10 and 30 cm/hr for layer 1and 2, respectively
- Change root depths to 30 cm

16. Run the simulation

- Examine yearly results
- Annual average rainfall vs. runoff
- For above example, predicted average of 1741 cm of runoff (never entered the BRA—or went directly through it) VS 2614 cm of rainfall.
- Therefore treated 2614 – 1741 = 873 cm of runoff on average, or 873/2614 = 33% of rainfall that fell on parking lot.
- Examine day file, water table depth

17. Change DC to 5.0, re-examine results.

- Treated 46% of rainfall applied to site (i.e., 46% of rainfall that fell on parking lot did not leave as surface runoff)
- Examine day file, water table depth
- What happens after big storm event.
- Now average runoff is 1416 cm

18. Change DC to 25 cm/day (is this possible??)

- Now predicted treatment is 62% of rainfall
- Day file, water table depth