CE 591
Stormwater Management

Final Exam

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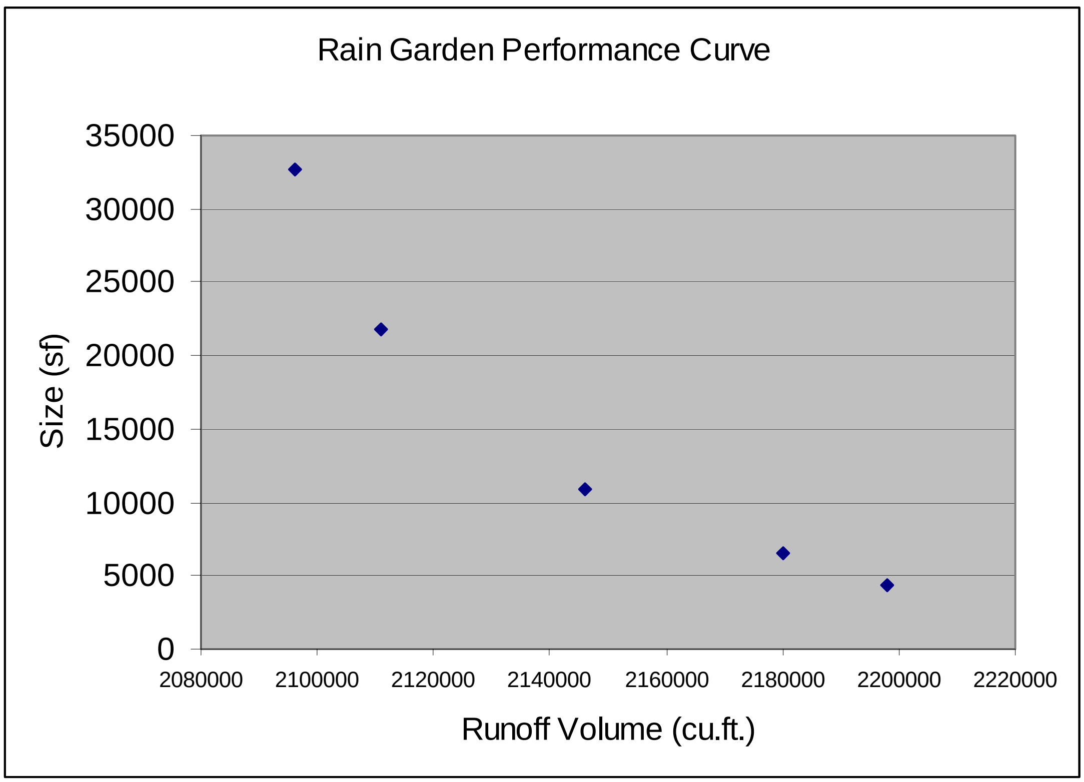
Introduction and background information

The area that I chose to study is the engineering buildings MIB and Bevil Hall, and the surrounding parking lots and landscape. This area is approximately 16.8 acres. The land use break down for this area is approximately 17% flat roof, 34% landscaped, 4% sidewalks, 4% streets, and 41% high density parking. This particular picture comes from the website http://terraserver.microsoft.com/image.aspx. and is provided by TerraServer USA.

1. Rain Garden

There are no good sizing criteria for sizing rain gardens, so a simple performance curve was developed using WinSLAMM. The rain file Tuscaloosa5899 for the year 1976 was used for my institutional area. There are certain limitations associated with my small landscaped area in regard to sizing. My largest small landscaped area available for a rain garden is 0.75 acres or 32,670 ft^2; this was used as the upper limit.

Size (acres)	Size (sf)	Runoff Volume (cu.ft.)	Runoff Coefficient Rv
0.75	32670	2096000	0.56
0.5	21780	2111000	0.56
0.25	10890	2146000	0.57
0.15	6534	2180000	0.58
0.1	4356	2198000	0.58



2. Wet Detention Pond Design

Using the pond sizer spreadsheet, I determined that an ideal side slope for my pond. The pond sizer spreadsheet says that a side slope between 10% and 25% is ideal, but given my particular set of circumstances the side slope increases until an average side slope of 4%, then the side slopes are negative for any pond storage depth greater than 1 ft. So a pond depth of 1 ft., with a side slope of 4%, a top area of .558 acres, and a top radius of 88 ft. was used to design the pond. Based on the side slope and the top area, all the stages were calculated.

stage (ft)	slope %	radius (ft)	area (acres)
1	4	88	0.5585054
2	4	113	0.9209136
3	4	138	1.3734732
4	4	163	1.916184
5	4	188	2.5490462
6	4	213	3.2720596
7	4	238	4.0852244
8	4	263	4.9885405
9	4	288	5.9820078

The stages and related areas were then entered into WinSLAMM. In the pond sizer spreadsheet the "delta" columns show the excess areas in the pond designs that meet these objectives. The V-notch weirs having a delta closest to zero (but still positive) and meets the slope criterion, is likely the best selection (Pitt, pond sizer spreadsheet). For my particular site the 22.5º V-notch weir has a "delta" value of 0.09, which is closest to zero. Initially only 5 stages were added to WinSLAMM, but there were several overflows therefore more stages needed to be added. One stage was added then the model was run again until the overflows were eliminated. A total of 9 stages were needed to eliminate excessive overflows. A 99.77% reduction of particulate solids was achieved. A pond this size based on the WinSLAMM cost file would cost around $500,000. Although a sizable solids reduction was achieved, the excessive size and cost associated with this pond design would be unacceptable for this particular site.

3. **Grass Swale**

The runoff volume is not significantly decreased with a grass swale. 2,198,000 cu. ft. of annual runoff occurs with the addition of a grass swale. There is a 19.98% reduction of particulate solids associated with the addition of a single grass swale alone. The cost of the swale is around $38,000 based on the WinSLAMM cost data. The use of a grass swale on this particular site was of little help in concern for volumetric runoff, reduction of particulate solids, or runoff quality. This control would not be worth the cost for this particular site.

4. **Infiltration as an outfall**

Infiltration as Control Device

Area (acres)	Area (sf)	Runoff Vol. (cu.ft.)	Rv	% reduction
0.25	10890	2385000	0.63	47.86
0.5	21780	2210000	0.59	50.59
0.75	32670	2046000	0.54	52.98
1	43560	1889000	0.5	54.99
1.5	65340	1616000	0.43	60.46
3.44	149846.4	810560	0.21	65.16

As shown on the above table the more land that can be devoted to infiltration the more effective the device will be. I would recommend if .75 acres is going to be used, just add a half acre and get much better control. No cost data was available for this device. If the parking lot between Paty Hall and MIB (3.44 acres) is changed from impervious asphalt to an infiltration device there are very effective results.

5. **Combinations**

Rain Garden with Detention Pond

When a .25 acre rain garden is used with the designed detention pond for this site there is a high level of control. Although these two controls are very expensive for a site this small, at $612,830 you can achieve 99.99% reduction in particulate solids, an Rv=0.03, and a total annual runoff volume of 105,938 cu. ft.

Biofiltration as an Outfall structure

Rain Garden as an Outfall structure

Area (acres)	Area (sf)	Runoff Vol. (cu.ft.)	Rv	% reduction	Cost $
0.75	32670	471639	0.12	82.76	329960
0.5	21780	554904	0.15	79.61	232912
0.25	10890	660447	0.17	75.59	135864
0.15	6534	730897	0.19	73.02	97047
0.1	4356	768235	0.2	71.69	77634

I tried using a biofiltration as an outfall structure. This control device proved to be effective in controlling runoff volume and reducing particulates. This device is very cost effective for the job that it does. The 0.25 acre rain garden is the most efficient and effective size for the least amount of money. A reduction of 75% can be achieved for less than $150,000, while spending another $100,000 would only achieve an increased reduction of 4%.

Grass Swale with 0.25 acre Rain Garden

It was determined that a 0.25 acre rain garden is the most effective and efficient size for this area. With the addition of a grass swale to the small rain garden would cost approximately $173,000 according to WinSLAMM cost data. Annual runoff volume would decrease 70% to 753,772 cu.ft. Rv = 0.20. There are significant runoff improvements with the addition of a grass swale, but the reduction of particulate solids only increases from 75.59% to 76.36%. I would have expected the particulate solids improvement to be more significant with the addition of a grass swale.

Grass Swale with Detention Pond

When a grass swale is added with a detention pond, the reduction of particulate solids is 99.99% but the size of pond is still not really suitable for this site. The runoff quantity is improved with the addition of the grass swale to 1,076,000 cu.ft. with a Rv = .44, but this is still on the high side compared to the improvements made from infiltration devices.

Replacing MIB parking lot with Infiltration Device

In the area of controlling quantity of runoff, the parking lot is the specific area of concern. The parking lot between Paty Hall and MIB could be turn into pervious green space; similar to the Quad this would greatly reduce the amount of storm water runoff by replacing an impervious parking lot with landscaped pervious green space. If the 3.44 acre parking lot is changed from an impervious parking space to large landscape area and then used as an infiltration outfall device in WinSLAMM, this proves to be an excellent storm water management approach. The runoff volume is decreased by 59% to 810,560 cu. ft., the Rv value is 0.21, and there is a 65.16% reduction in particulate solids. Although this would be very expensive, the parking issue could be greatly improved by adding more levels to the parking deck south of Paty Hall. This would be a very expensive solution, but it would be much more aesthetically pleasing, and could also solve some parking issues if more spaces were added to the parking deck than had previously existed in the parking lot. To help with some of the extensive construction costs, a parking plan similar to the existing plan at the business school could be implemented. In this plan students pay extra for a parking pass for that particular deck with the assurance that the school didn't sell more passes than there are spaces. This plan could greatly reduce the quantity of runoff as well as improve the quality of runoff.