CE 585

Construction Site Erosion Control

The University of Alabama

Tuscaloosa, AL

New Chevrolet and Cadillac Dealership

Jasper, AL

Andrew Kennedy

Homework #6

July 24, 2007

Table of Contents

List of Tables

List of Figures

1.0 Introduction

This exercise is for the purpose of practicing channel and slope stability analysis on construction sites. The author has chosen the new Chevrolet and Cadillac dealership in Jasper, AL was chosen by the author to use for a class project in Construction Site Erosion, CE 585. The site is located in the southwest corner of the I-22 exit onto Industrial Blvd in Jasper, AL. This document contains a brief description of the drainage channels onto the site, across the site, and below the site. There are three such drainage channels (see Figure 1a). On the eastern side of the project a channel crosses a portion of the project, continues through a box culvert for a distance then into a short segment of stream which will flow into a drainage pond before leaving the site (Outlet A). In the middle portion of the site a road culvert empties an up-slope drainage area from the North into a very short segment of stream which will pick up some runoff from the East and some from the West before passing into a pipe culvert which will flow underneath the site emptying into a sediment pond and then exiting the site to the South (Outlet B). On the westernmost edge of the project stream passes nearby in which the western portion of the site will drain into (Outlet C). For this exercise only the drainage area flowing to the eastern most outlet is analyzed.

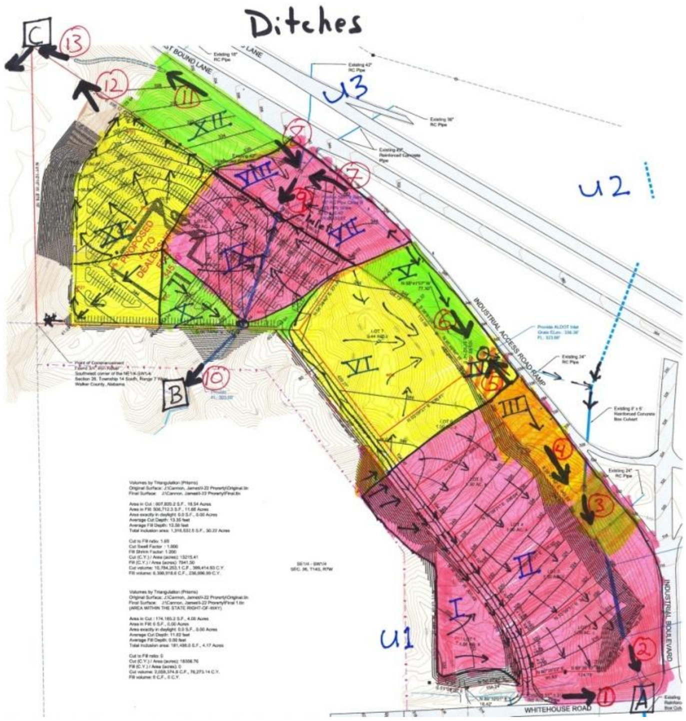

Figure 1-1: Drainage Areas, Ditches, and Outlets

2.0 The Assignment

For assignment #5 we are asked to:

1. Design an appropriate temporary sediment pond for the site.

a. Include sufficient water quality storage, sacrificial storage for sediment accumulation for the anticipated construction period.
b. Use WinTR55 to calculate the peak flow rate for the 50-yr rain event and size an appropriate emergency spillway or outfall to safely discharge this runoff rate.
c. Show sketches of the pond location on the site, and drainage area.
d. Provide a cross-section sketch of the pond showing the side slopes and elevations of the outlet devices plus pond depth.

2. Design perimeter filter fences for the site.
    a. Include all side- and down-slopes.
    b. Sketch drainage areas for each fence segment.
    c. Show the slopes and flow lengths for the land drainage to the fences.
    d. Limit the slope flow length to a maximum of 100 ft for the fences.
    e. If slopes are greater than this, terraces and diversions will be needed.
    f. Sketch terraces and diversions, if needed.
    g. Use WinTR55 to calculate the peak flow rates for the diversion pipes (assuming a 10-year design storm)
    h. Size the diversion pipes.

3.0 Design Sediment Pond

The site will require three detention ponds. However for this exercise only the most eastern pond will be designed. The pond is to be located at outlet A as shown in the bottom-right corner of figure 1a. Nine sub-watersheds flow into this particular detention pond. Two of the watersheds are up-slope areas which will remain undisturbed. These two areas (U1 and U2) will remain undisturbed and constitute 85% of the areas draining to this pond. Normally the runoff from such large undisturbed areas would be diverted around the construction site and would not drain into construction site detention ponds. However due to the constraints of this site it is not feasible to divert the runoff from these areas. As a result the size of the detention pond is much larger than it would be if only runoff from the construction site were allowed to flow into the pond.

Five different zones were calculated for the detention pond: water quality "live" storage, scour protection, sediment storage, emergency spillway, and freeboard.

3.1 Water Quality Storage

The detention pond is designed to have a performance of 90% suspended-solid removal for 5μm particle size. Table 3-1 shows the calculation of the pond surface area and water quality volume for a runoff from the sub-areas as shown in Figure 1-1 and 1.25 inches of rainfall.

Site Sub Area	Land Use	Area (acre)	% Area for 5µ removal	Pond Surface Area (acre)	Pond WQ Volume Factor	Water Quality "LIVE" Volume (acre-ft)
U1	undisturbed wooded	7.1	0.6%	0.043	0.3	0.18
U2	undisturbed wooded	94	0.6%	0.564	0.3	2.35
I	active construction	2.92	1.5%	0.044	0.6	0.15
II	active construction	5.71	1.5%	0.086	0.6	0.29
IIA	active construction	0.98	1.5%	0.015	0.6	0.05
III	active construction	1.78	1.5%	0.027	0.6	0.09
IV	active construction	0.44	1.5%	0.007	0.6	0.02
V	active construction	1.35	1.5%	0.020	0.6	0.07
VI	active construction	5.09	1.5%	0.076	0.6	0.25
Total		**119.37**		**0.881**		**3.44**

Table 3-1 Pond Surface Area and Water Quality Volume for 1.25 inches of Rainfall

The calculation of the top surface area of the water quality "live" storage is shown in Table 3-2. Due to limitations of the site the depth of 3.0 ft will be used giving a side slope of 10.16%.

Under Surface Area (acre)	Volume (acre-ft)	Depth (ft)	Top Area (acre)	Radius of Surface (ft)	Radius top (ft)	Slope (%)
0.88	3.44	0.5	12.88	110	423	0.16
0.88	3.44	1.0	6.00	110	288	0.56
0.88	3.44	1.5	3.71	110	227	1.29
0.88	3.44	2.0	2.56	110	188	2.57
0.88	**3.44**	**3.0**	**1.41**	**110**	**140**	**10.16**

Table 3.2 Calculation of Top Surface Area of the Water Quality "Live" Storage for the Detention Pond

At the top of the Water Quality "Live" storage volume, this pond will have provided 2 ft of stage and 1.41 acres of maximum pond area.

According to tables 6.9 thru 6.11 in the text, a 45^0 V-notch weir requires at least 2.8 acres of pond surface at three feet of stage in order to provide about 90% control of sediment. A 30^0 V-notch weir requires only 1.8 acres and a 60^0 V-notch weir requires 3.9 acres. None of the rectangular weirs are suitable due the smallest two foot weir requires 5.7 acres at the 3 ft stage. An 18 inch vertical riser outlet requires 1.1 acres at the 3 ft stage. **For this application the 18 inch vertical riser is selected.**

3.2 Scour and Sediment Storage

A dead storage "scour protection" zone is required to minimize scour. The dead storage zone is three feet deep with side slopes of 25%. The calculations for the dead storage zone are shown in Table 3.3.

Top Surface Area (acre)	Radius Top (ft)	Depth (ft)	Slope (ft/ft)	Under Surface Area (acre)	Radius Under Surface (ft)	Volume (acre-ft)
0.88	110	3	0.25	0.70	98	2.37

Table 3.3: Dead Storace Area Calculation

The sediment loss for the complete construction period for the site is calculated using the Revised Universal Soil Loss Equation (RUSLE). The results are shown in Tables 3.4a through 3.4c.

Table 3.4a: 4/17/07 - 7/2/07 Clearing Through Grading Operations							
Area Description	**Land Area (acres)**	**R for phase period**	**K soil factor**	**LS slope length factor**	**C cover factor**	**Calculated unit area soil loss (tons/acre/period)**	**Calculated total area soil loss (tons/period)**
Active construction	15.64	77	0.24	2.31	1	2.729	42.689

Table 3.4b: 7/2/07 - 10/15/07 After Grading Through Paving and Landscaping							
Area Description	**Land Area (acres)**	**R for phase period**	**K soil factor**	**LS slope length factor**	**C cover factor**	**Calculated unit area soil loss (tons/acre/period)**	**Calculated total area soil loss (tons/period)**
Graded/undeveloped	15.64	143.5	0.24	0.37	0.17	0.139	2.166

Table 3.4c: 10/15/07 - 6/6/08 After Paving and Landscaping through End of Project							
Area Description	**Land Area (acres)**	**R for phase period**	**K soil factor**	**LS slope length factor**	**C cover factor**	**Calculated unit area soil loss (tons/acre/period)**	**Calculated total area soil loss (tons/period)**
Graded/undeveloped	15.64	178.5	0.24	0.41	0.11	0.124	1.932

Total (tons) = 47

Assuming the conventional conversion factor of tons x 1yd^3 for clay soil the sediment volume is about 47 yd^3, or 0.04 acre-ft.

The required sediment "sacrificial" storage area is calculated using 25% side slopes and the top area of 0.7 acres. The resulting required depth of the sediment storage is calculated to be 0.06 ft., we will round this up to one foot. The reason required depth being so small is most likely due to the large percentage of undisturbed land which will drain into the pond. Calculations for this depth are shown in table 3.5.

Top Area (acre)	Radius top (ft)	Slope (ft/ft)	Volume (acre-ft)	Depth (ft)	Bottom Radius (ft)	Bottom Area (acres)
0.7	98	0.25	0.04	0.06	97.77	0.69
0.7	98	0.25	0.67	1.00	94.00	0.64

Table 3.5 Sediment Storage Calculation

3.3 Emergency Spillway

WinTR-55 was used to calculate the peak flood flow rate that the emergency spillway must accommodate. The 50-yr rain event was used. The expected 50-yr peak flow rate which the emergency spillway must handle is 383.78 cfs. A width of 64 ft for the emergency spillway is chosen with a head of 1.5 ft., the calculations are shown in Table 3.6.

Q (cfs)	H_w, depth in spillway (ft)	q_{wier} (cfs)	$q_{spillway}$ (cfs)	L_w (ft)
383.78	1	6.5	377.28	118
383.78	1.5	6.5	377.28	64
383.78	2	6.5	377.28	42

Table 3.6 Emergency Spillway Calculations

3.4 Final Pond Cross Section

The final pond dimensions are given in Table 3-7 and Figure 3-1.

Table 3.7: Final Pond Cross Section

Zone	Pond level from the bottom (ft)	Surface area at depth (acres)	Pond Storage below elevation (acre-ft)	Pond slope between elevations (%)
Bottom	0	0.64	0	-
Sediment Storage	1	0.7	0.67	25
Scour Protection	4	0.88	3.04	25
Water Quality Storage	7	1.41	6.48	10.16
Emergency Spillway	8.5	1.73	8.84	10
Freeboard	9.5	1.96	10.8	10

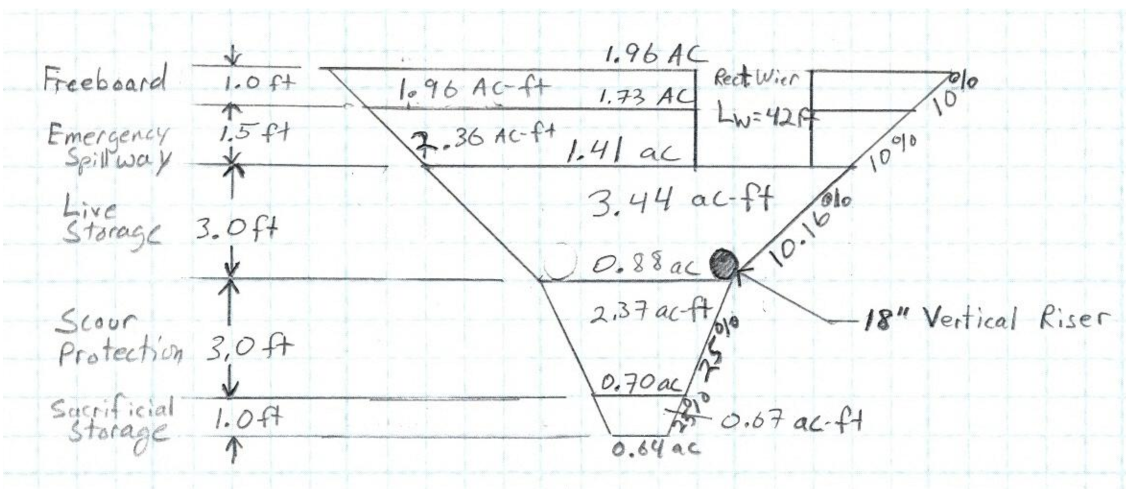

Figure 3-1: Cross Section of Sediment Pond

4.0 Design Perimeter Filter Fences & Diversion Ditches

For locations of filter fence, and diversion ditches see figure 4-1: Filter Fence and Diversion Ditch Locations. Filter fences are to be placed around the entire perimeter of the project site and at the toe of all slopes. Also along the graded areas filter fence should be placed approximately across the center of each lot site, each site has a slope length of approximately 190 ft. These fences should be placed along a contour. Diversion ditches should be constructed across the slopes at lot lines. Each diversion ditch has an approximate drainage area of 1.5 acres. WinTR-55 was used to calculate peak flow rates of 7.19 cfs for a 10-yr event, 12 inch, corrugated plastic pipe should be used for the diversion pipes down the slopes.

Figure 4-1: Filter Fence and Diversion Ditch Locations