Module 6
Temporary Pond and Silt Fence

by

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Contents

List of Figures

List of Tables

1.0 Introduction

1.1 Summary

This document describes the design of a temporary pond and the installation of silt fences for the site.

1.2 Objectives

The objective of this document is to design the temporary pond in order to treat the sediment and runoff during the construction period as well as the determination of suitable location of the silt fence.

2.0 Introduction and hydrology

2.1 Hydrology

Campus Derive Relocation Project is planted at the University of Alabama Campus on Campus Drive between Hackberry and Jefferson Avenue. The nearby receiving water, Black Warrior River is located approximately 1500 ft north of the construction site. Runoff is planned to collect to the creek locating at the north of the construction site and delivered to the Black Warrior River. Temporary pond will be designed at the north corner of the construction site where all the runoff is collected before runoff to the river. Figure 5 shows sub-drainages for the upslope, down-slope, and on-site areas for the construction site. Red line indicates the watershed area for the site and the pink line subdivides them into upstream (U1-U4), onsite (O1-O5), and downstream (D1) areas. Blue line shows the flow pass for the area and the proposed location of the pond is marked in the figure with a blue circle. The watershed area has approximately 63 acres.

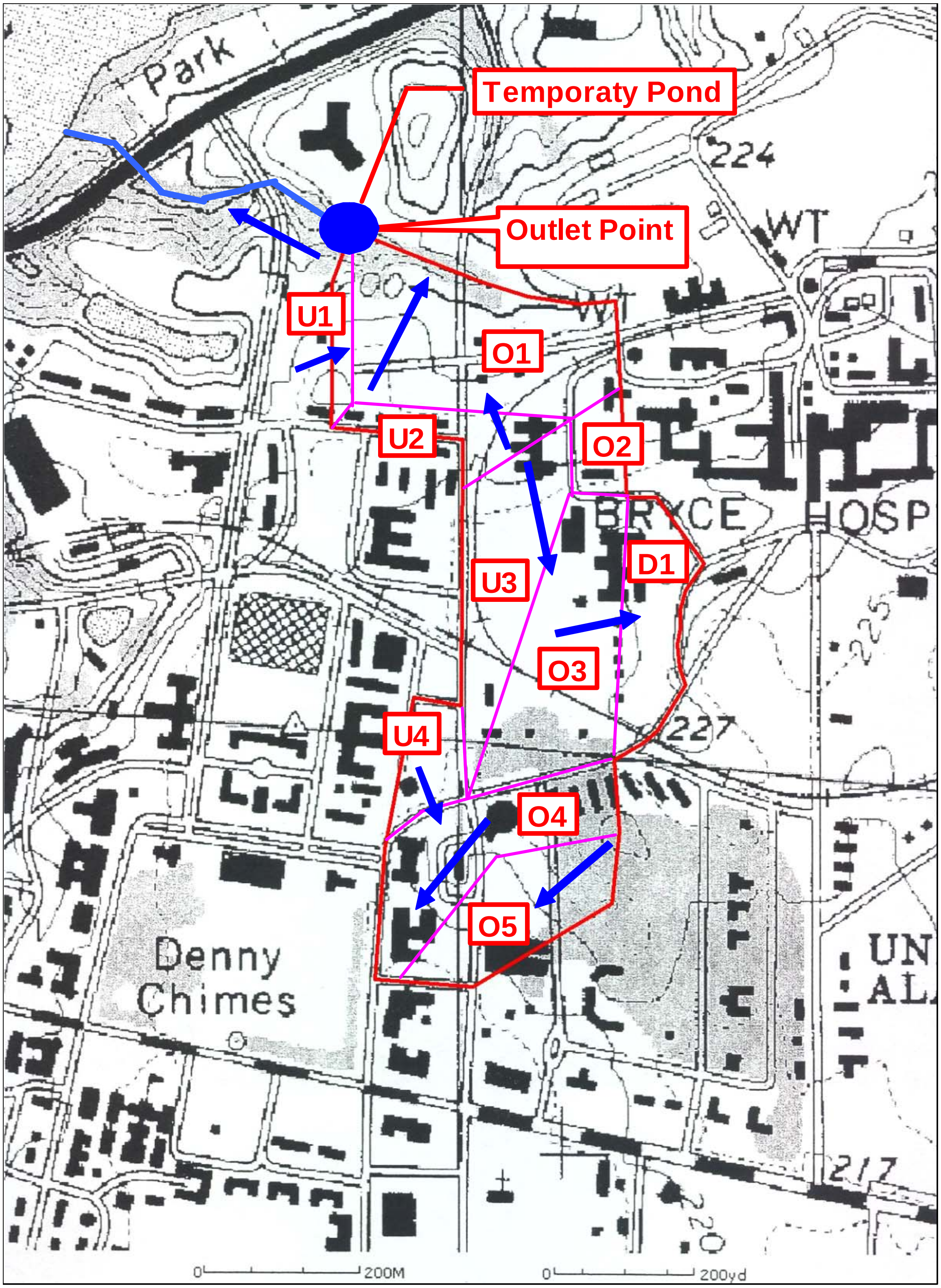

Figure 1: Watershed for the site (source: TerraServer)

3.0 Pond design calculation

The pond is designed to remove approximately 90% of suspended solids. The pond needs to safely pass the flows from the 25 yr storm. The soil type is described previously. The following are the areas associated with each land use in the drainage area.

- Paved area: 16.66 acres
- Undeveloped area: 17.32 acres
- Construction area: 29.24 acres
- Total site area: 63.22 acres

3.1 Basic pond area and "live" storage volume

Table 1 shows the calculation of the pond surface area and water quality volume for a runoff from the 1.25 inches of rainfall. The water quality live storage has a surface area of 1.04 acres and a volume of 34.68 acre-inches or 2.89 acre-ft.

Table 1: Pond surface area and water quality volume

Site Subarea	Area (acres)	% of Area Needed-	Pond Surface Area (acres)	Water Quality Volume (inches of runoff)	Pond Volume (acre-inches)
Paved	16.66	3	0.500	1.1	18.326
Undeveloped	17.32	0.6	0.104	0.1	1.732
Construction	29.24	1.5	0.439	0.5	14.620
Total	**63.22**		**1.042**		**34.678**

3.2 Top surface area and side slope

Table 2 describes the calculation of the top surface area of the water quality live storage and determination of the site slope. Depth is calculated considering the alternative side slopes. The depth is determined 2.0 ft and the most appropriate slope would be 5 % having the top area of 1.85 acres.

Table 2: Top surface area and side slope

Surface Area (acres)	Volume (acre-ft)	Depth (ft)	Top Area (acres)	Top Area (ft^2)	Top Radius (ft)	Surface Area (ft^2)	Surface Radius (ft)	Slope (%)	Accept?
1.042	2.890	1.0	4.738	206387.280	256.311	45389.520	120.200	0.7	too shallow
1.042	2.890	1.5	2.811	122461.680	197.435	45389.520	120.200	1.9	too shallow
1.042	2.890	2.0	1.848	80498.880	160.074	45389.520	120.200	5.0	Yes
1.042	2.890	2.5	1.270	55321.200	132.700	45389.520	120.200	20.0	Too steep
1.042	2.890	3.0	0.885	38536.080	110.754	45389.520	120.200	-31.8	No
1.042	2.890	3.5	0.609	26546.709	91.924	45389.520	120.200	-12.4	No

3.3 Selection of primary outlet device

At the top of the live storage volume, this pond will have 2 ft of stage and 1.85 acres of maximum pond area.

According to Table 6.9 to 6.11 in Construction Site Erosion and Sediment Controls, the 60^{o} V-notch Weir requires at least 1.4 acres of pond surface at 2 feet of stage in order to provide about 90% control of sediment. The 45^o V-notch Weir will require 1.0 acres, while the 90^o V-notch Weir would require 2.5 acres. None of the rectangular weirs can be suitable, as the smallest 2 ft weir requires at least 2.6 acres at 2 feet of stage. The 60^o weir is closest to the area available and is therefore selected for this pond. Another possible outlet structure would be an 18" drop tube structure which requires at least 1.1 acres (Pitt, Clark, & Lake, 2007).

3.4 Sacrificial drainage volume

The pond water surface is 1.04 acres. With a 3 ft dead storage depth to minimize scour, the surface area at the top of the sediment storage zone (and the bottom of the scour protection zone), will be about 0.88 acres with a 30% underwater slope. Table 3 shows the calculation of the top sediment storage area.

Table 3: Top sediment storage area (bottom of the scour protection zone)

Surface Area (acres)	Volume (acre-ft)	Depth (ft)	Top Sediment Storage Area (acres)	Top Sediment Storage Area (ft^2)	Top Sediment Storage Radius (ft)	Surface Area (ft^2)	Surface Radius (ft)	Slope (%)
1.042	2.877	3.0	0.876	38151.319	110.200	45389.520	120.200	30.0

Calculate the sediment loss for the complete construction period for the site area draining to the pond. The sediment loss for different phases of the construction period is calculated at the previous analysis using the RUSLE equation. The calculated amount of dirt is 5014.43 tons for the 235 days of total project time which has a total area of 63.22 acres. The sediment volume is about 5114.72 yd^3, or 3.17 acre-ft. The sacrificial storage zone can be about 4 ft deep which will have the bottom pond area of about 0.71 acres with a side slope of 36%. Table 4 shows the calculation of the bottom area and a side slope.

Table 4: Bottom area and side slope

Top Sediment Storage Area (acres)	Volume (acre-ft)	Depth (ft)	Bottom Area (acres)	Bottom Area (ft^2)	Bottom Radius (ft)	Top Sediment Storage Area (ft^2)	Top Sediment Storage Radius (ft)	Slope (%)	Accept?
0.876	3.170	3.0	1.237	53905.481	130.991	38151.319	110.200	-14.4	No
0.876	3.170	3.5	0.936	40754.510	113.897	38151.319	110.200	-94.7	No
0.876	3.170	4.0	0.709	30891.281	99.161	38151.319	110.200	36.2	Yes
0.876	3.170	4.5	0.533	23219.881	85.972	38151.319	110.200	18.6	No
0.876	3.170	5.0	0.392	17082.761	73.740	38151.319	110.200	13.7	No
0.876	3.170	5.5	0.277	12061.481	61.962	38151.319	110.200	11.4	No

3.5 Selection of emergency spillway

The purpose for the pond is only a temporary storage of a runoff during the construction period. The design runoff for the emergency spillway is 50 year storm event. The design flow rate is calculated at the previous analysis using Win TR55 and the rate is 273.24 ft^3/s at 12.13 hrs later. The emergency spillway will be a rectangular weir. At the one foot of stage for this weir plus the spillway, the 60^o V-notch weir would have 3 ft of stage in total. The V-notch weir will discharge 28 ft^3/s at this stage. Therefore, the rectangular weir will need to handle 245.24 ft^3/s. The rectangular weir is calculated as follows.

$$L_w = \frac{q_o}{3.2 \times H_w^{1.5}}$$

where,
q_o = desired ourflow rate, ft^3/s
L_w = length of a rectangular weir, ft
H_w = stage, ft

The selected rectangular weir has a length of 76.64 ft and the stage of 1.0 ft. Table 5 describes the calculation of an emergency spillway.

Table 5: Emergency spillway

H_w (ft)	Total Discharge (ft^3/s)	60° Vnotch Discharge (ft^3/s)	q_0 (ft^3/s)	L_w (ft)	Accept?
1.0	273.240	28	245.240	76.638	Yes
2.0	273.240	46	227.240	25.107	No
3.0	273.240	81	192.240	11.561	No

Keeping the slope of 5% from the water quality storage, the top area of the emergency storage is 2.34 acres. The top area of the detention pond is 2.89 acres, considering 1.0 feet of freeboard above the maximum expected water level and a slope of 5%.

3.6 Final pond profile

Table 6 describes the pond profile and Figure 2 shows the corresponding drawing.

Table 6: Pond final profile

Zone	Depth (ft)	Pond Depth from the Bottom (ft)	Surface Area at Depth (acres)	Pond Storage Below Elevation (acre-ft)	Pond Slope Between Elevations (%)
Bottom	0	0	0.71	0	-
Sediment Storage	4	4	0.88	3.18	36
Scour Protection	3	7	1.04	2.88	30
Water Quality Live Storage	2	9	1.85	2.89	5
Emergency Spillway	1	10	2.34	2.10	5
Freeboard	1	11	2.89	2.62	5

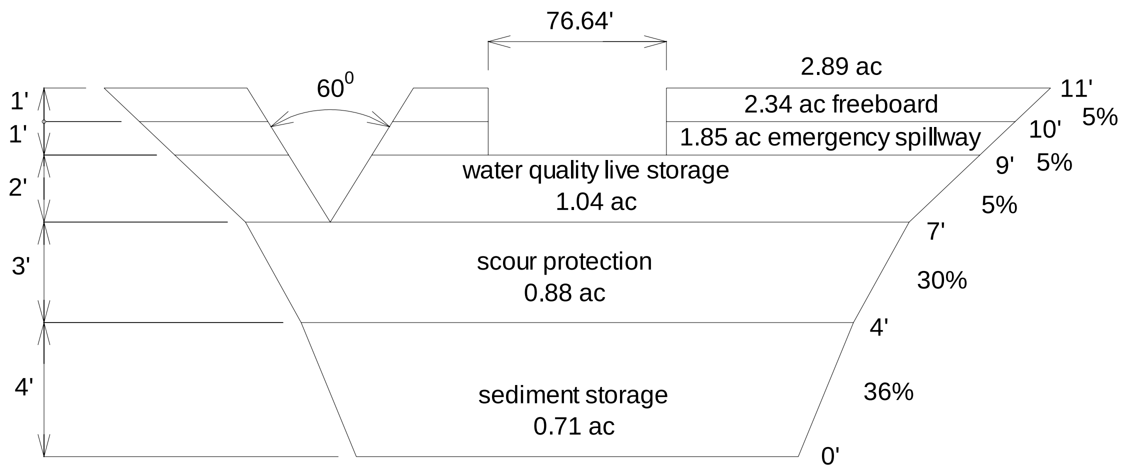

Figure 2: Pond final profile

4.0 Filter fence design

The filter fence is expected to remove maximum 50 % of suspended solids. The following section describes the design of filter fences for the site. The fence will be installed all side and down slopes areas.

4.1 Location and type of the fence

The site has a relatively high slope at the edge of the construction site where the fence is planed to install. Type "A" silt filter fences are used at all side slopes and down slope edges of the construction site. Figure 3 describes the location of the fence which is shown in the green line in the figure.

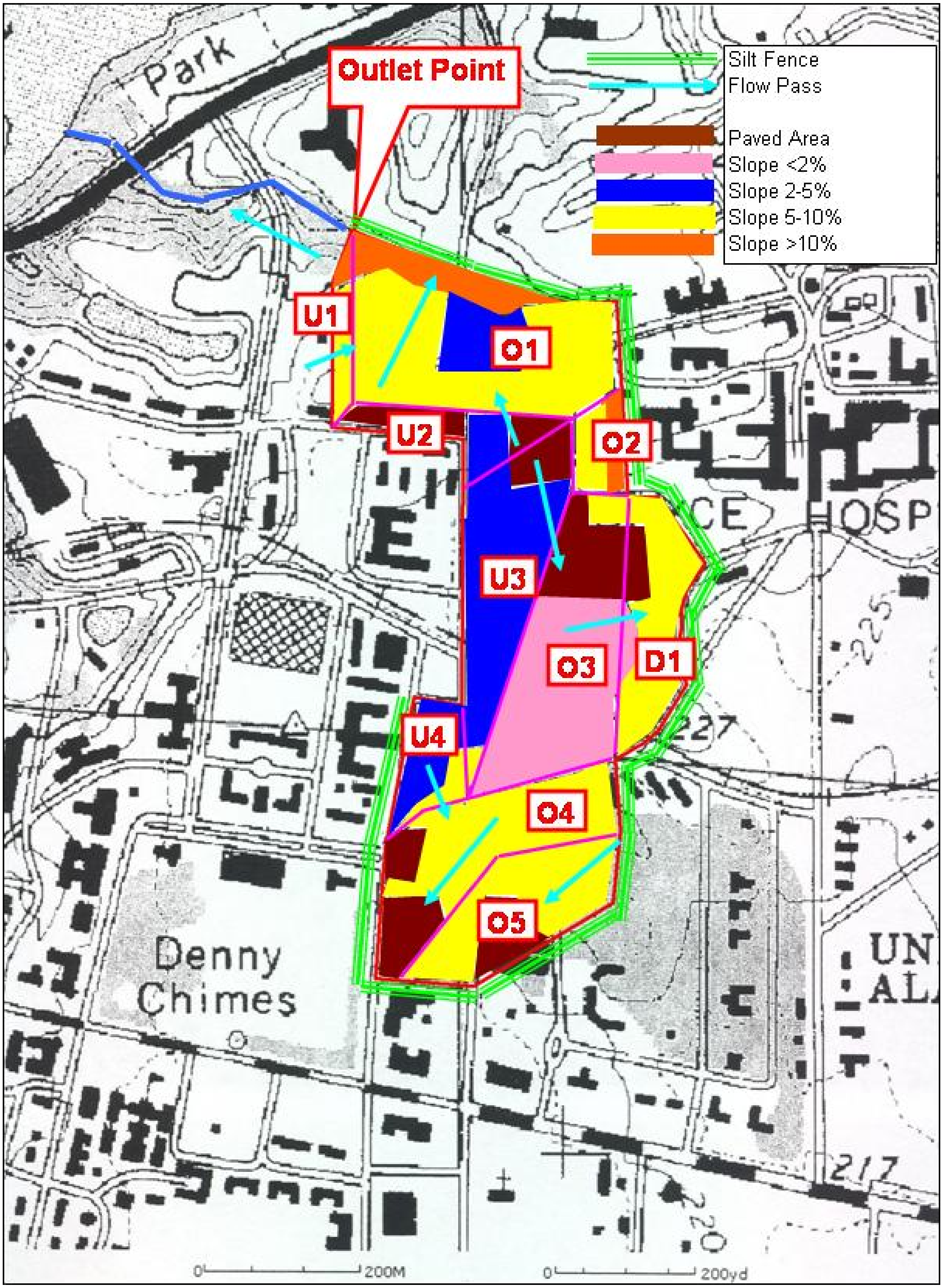

Figure 3: Filter fence location

4.2 Expected silt fence performance for Phase 1 Improvement

The first phase improvement has been started from December 15th 2006 to May 3rd 2007 which includes the 4 active construction areas and 7 undisturbed areas including the site for Phase 2 improvement. The total soil loss on the site for this period was estimated at the previous analysis and it is 3313 tons. After the installation of Type "A" silt filter fence, the estimated soil loss is 1657 tons. The Table 7 shows the soil runoff for the phase 1 improvement with and without the fence

Table 7: Phase 1 soil runoff with and without the fence

Phase 1 Improvement Soil Runoff (December 15, 2006-May 3, 2007)						
	Description	Area (ac.)	Unit Area Soil Loss (tons/acres/period)	Soil Loss Without Fence (tons/period)	Type of the Fence	Soil Loss With Fence (tons/period)
A	Undisturbed	2.01	0.112	0.22	-	0.22
B	Undisturbed	3.04	0.063	0.19	-	0.19
C	Undisturbed	9.13	0.094	0.85	-	0.85
D	Undisturbed	3.14	0.008	0.03	A	0.01
E1	Active	6.11	173.565	1060.48	A	530.24
E2	Active	9.17	166.692	1528.57	A	764.28
F	Active	2.37	138.852	329.08	A	164.54
G	Active	11.59	33.756	391.23	A	195.62
H	Phase 2	10.11	0.089	0.90	A	0.45
I1	Phase 2	1.31	0.282	0.37	A	0.19
I2	Phase 2	5.24	0.115	0.60	A	0.30
total		63.220		3312.52		1656.90

4.3 Expected silt fence performance for Phase 2 Improvement and Campus and Hackberry X-section

Site is currently the second phase improvement and it has been started from May 14th 2007 to July 27th 2007 which includes the 4 active construction areas and 7 undisturbed areas including the site completed during the phase 1 improvement. The total soil loss on the site for this period was estimated in 1701 tons at the previous analysis. After the installation of Type "A" silt filter fence, the estimated soil loss is 851 tons. The Table 8 shows the soil runoff calculation result with and without the fence.

Table 8: Phase 2 Improvement and Campus & Hackberry X-Section soil runoff with and without the fence

Phase 2 Improvement and Campus & Hackberry X-Section Soil Runoff (May 14, 2007-July 27, 2007)						
	Description	Area (ac.)	Unit Area Soil Loss (tons/acres/period)	Total Area Soil Loss (tons/period)	Type of the Fence	Soil Loss With Fence (tons/period)
A	Undisturbed	2.01	0.100	0.20	-	0.20
B	Undisturbed	3.04	0.056	0.17	-	0.17
C	Undisturbed	9.13	0.084	0.77	-	0.77
D	Active	3.14	7.176	22.53	A	11.27
E1	Completed	6.11	0.056	0.34	A	0.17
E2	Completed	9.17	0.069	0.63	A	0.32
F	Completed	2.37	0.029	0.07	A	0.03
G	Completed	11.59	0.039	0.46	A	0.23
H	Active	10.11	79.560	804.35	A	402.18
I1	Active	1.31	253.247	331.75	A	165.88
I2	Active	5.24	102.960	539.51	A	269.76
total		63.220		1700.79		850.96

4.4 Expected silt fence performance for after active construction and all land covered

The soil runoff calculation is for the construction of July 30th 2007 to August 6th 2007. The entire site is covered after the completion of the construction. The total soil loss on the site for this period was estimated in 1.12 tons which is analyzed previously. After the installation of Type "A" silt filter fence, the estimated soil loss is 0.71 tons. Table 4 shows the soil runoff calculation result with and without the fence.

Table 9: After active construction and all land covered soil runoff with and without the fence

After Active Construction and All Land Covered Soil Runoff (July 30, 2007-August 6, 2007)						
	Description	Area (ac.)	Unit Area Soil Loss (tons/acres/period)	Total Area Soil Loss (tons/period)	Type of the Fence	Soil Loss With Fence (tons/period)
A	Undisturbed	2.01	0.027	0.05	-	0.05
B	Undisturbed	3.04	0.015	0.05	-	0.05
C	Undisturbed	9.13	0.023	0.21	-	0.21
D	Completed	3.14	0.003	0.01	A	0.00
E1	Completed	6.11	0.015	0.09	A	0.05
E2	Completed	9.17	0.019	0.17	A	0.09
F	Completed	2.37	0.008	0.02	A	0.01
G	Completed	11.59	0.011	0.12	A	0.06
H	Completed	10.11	0.016	0.16	A	0.08
I1	Completed	1.31	0.018	0.02	A	0.01
I2	Completed	5.24	0.041	0.22	A	0.11
total		63.220		1.12		0.71

5.0 Conclusion

This discussion has shown that the use of simple erosion control method can provide an effective water quality benefits. The temporary detention pond is designed at the site and this pond may have a future, used as a permanent pond after the construction. Fitter fences are suitable for much smaller and moderate slope areas, but their maximum expected performance is less. In order to increase the level of protection, it is necessary to combine several erosion control plans at the site.

References

Pitt, R., Clark, E., Shirley, & Lake, D. (2007). Construction Site Erosion and Sediment Controls.

Alabama Soil and Water Conservation Committee. Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas. June 2003. Website: http://www.swcc.state.al.us/