UNIVERSITY OF SWAZILAND
FINAL EXAMINATION PAPER

PROGRAMME: BSC LWM 3 AND BSC AG ED 3

COURSE CODE: LUM 301 M (NEW)

TITLE OF PAPER: SOIL AND WATER CONSERVATION

TIME ALLOWED: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: NONE

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS.

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SECTION A. COMPULSORY QUESTION

Question One

a. Using the rationale method, determine the peak flow of a 10 year return storm of 110 mm/h, on a dairy farm, 20 ha of which is covered with cultivated grass for grazing and terrace banks are used to convey surface water flow while 26 ha of the farm is under maize cultivation for making silage. The rows are spaced 60 cm apart and grass strips are used for soil conservation purposes. The soil groups for the different portions of the farm are B and A respectively and soil conditions are good.

10 marks

b. Design a parabolic waterway to convey the peak runoff in (a) if the slope of the area is 4%, permissible velocity $1.6m^3/s$ and the roughness coefficient is 0.04. Allow a 20 % freeboard.

20 marks

c. Give a brief description of waterways and their operation and management for effective soil conservation.

10 marks

SECTION B. ANSWER ANY TWO QUESTIONS

Question two

a. Explain the importance of the following soil and water conservation measures highlighting the conditions where they are most applicable.
   i. Tied ridges
   ii. Bench terraces

15 marks

b. Briefly describe what agronomic soil conservation is.

5 marks

c. Using the Zimbabwe method, determine the recommended spacing between terraces constructed on highly erodible soils with an average slope of 3.6^0 and the soil erodibility factor 3.Express your answer in metres.

10 marks

Question three

a. Describe the difference between the Reynolds' and Froudes' numbers explaining the types of soil erosion each of these are used to predict.

10 marks

b. Calculate the total energy derived from the rainfall information presented in the table below:

Kinetic energy: $E = 12.1 + 8.9 \log i$

Time from start (minutes)	**Rainfall intensity (mm/h)**	**Rainfall (mm)**	**Kinetic energy ($J/m^{2}/mm$)**	**Total energy (J/m^2)**
0 - 30	62.52			
30 - 60	120.00			
60 - 90	98.20			
90 -120	22.42			

15 marks

c. Explain the relevance of crop management factor when estimating the amount of soil loss in an area.

5 marks

Question four

a. Describe the traditional grazing pattern used in Swaziland and outline its weaknesses.

15 marks

b. Describe how the following conditions influence the amount of run-off water

i. Row crop
ii. Forested areas
iii. Bare soil

15 marks

Cover and hydrologic condition	Coefficient C for rainfall rates of:		
	25 mm/h (1 iph)	100 mm/h (4 iph)	200 mm/h(8 iph)
Row crop, poor practice	0.63	0.65	0.66
Row crop, good practice	0.47	0.56	0.62
Small grain, poor practice	0.38	0.38	0.38
Small grain, good practice	0.18	0.21	0.22
Meadow, rotation, good	0.29	0.36	0.39
Pasture, permanent, good	0.02	0.17	0.23
Woodland, mature, good	0.02	0.10	0.15

Table 2.1 : Runoff Coefficient "C" for Agricultural Watersheds (Soil Group B)
Source : Horn and Schwab (1963) As Cited by Schwab et al (1981).

Cover and hydrologic condition	Factors for converting the runoff coefficient C from group B soils to:		
	Group A	Group C	Group D
Row crop, poor practice	0.89	1.09	1.12
Row crop, good practice	0.86	1.09	1.14
Small grain, poor practice	0.86	1.11	1.16
Small grain, good practice	0.84	1.11	1.16
Meadow, rotation, good	0.811	1.13	1.18
Pasture, permanent, good	0.64	1.21	1.31
Woodland, mature, good	0.45	1.27	1.40

Factors were computed from table 2.3 by dividing curve number for the desired soil group by the curve number for group B.

Table 2.2 : Hydrologic Soil Group Conversion Factors
Source : Horn and Schwab (1963) As Cited by Schwab et al (1981).

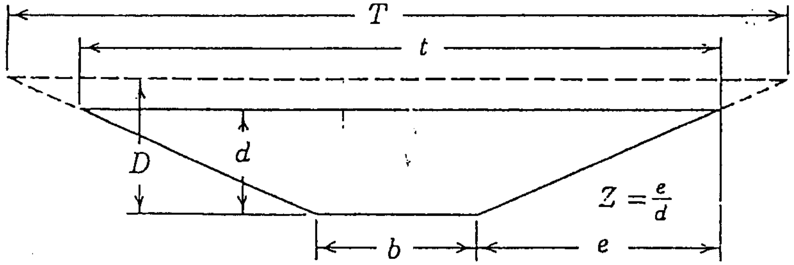
Table 2.3 (Continued)

Land Use or Cover	Treatment or Practice	Hydrologic Condition	* Hydrologic Soil Group			
			A	B	C	D
Meadow (Permanent		Good	30	58	71	78
Woods		Poor	45	66	77	83
(Farm wood-lots)		Fair	36	60	73	79
		Good	25	55	70	77
[illegible]		-	59	74	82	86
Right-of-way (hard surface		-	74	84	90	92

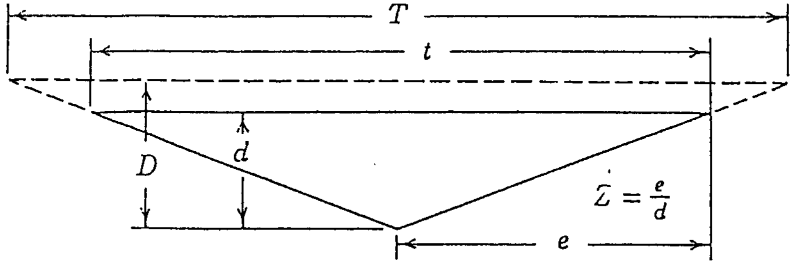
*Soil Group	Description	Final Infiltration rate (mm/h)
A	Lowest Runoff Potential. Includes deep sands with very little silt and clay. also deep, rapidly permeable loess.	8 - 12
B	Moderately Low Runoff Potential. Mostly sandy soils less deep than A, and loess less deep or less aggregated than A, but the group as a whole has above average infiltration after thorough wetting.	4 - 8
C	Moderately High Runoff Potential. Comprises shallow soils and soils containing considerable clay and colloids, though less that those of group D. The group has below average infiltration after pre-saturation.	1 - 4
D	Highest Runoff Potential. Includes mostly clays of high swelling percent, but the group also includes some shallow soils with nearly impermeable sub-horizons near the surface.	0 -1

Source: U.S. Soil Conservation Service, National Engineering Handbook, Hydrology, Section 4 (1972) and U.S. Dept. Agr. ARS 41 - 172 (1970). As Cited By Schwab et al (1981).

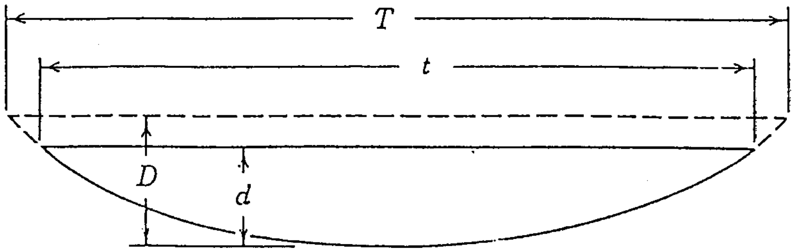
Note: Freeboard = $D-d$ for all sections



Trapezoidal cross section



Triangular cross section



Parabolic cross section

Section	Cross-Sectional Area a	Wetted Perimeter, p	Hydraulic Radius $R=\frac{a}{p}$	Top Width
Trapezoidal	$bd + Zd^2$	$b + 2d\sqrt{Z^2+1}$	$\frac{bd + Zd^2}{b + 2d\sqrt{Z^2+1}}$	$t = b + 2dZ$ $T = b + 2DZ$
Triangular	Zd^2	$2d\sqrt{Z^2+1}$	$\frac{Zd}{2\sqrt{Z^2+1}}$ or $\frac{d}{2}$ approx.	$t = 2dZ$ $T = \frac{D}{d}t$
Parabolic	$\frac{2}{3}td$	$t + \frac{8d^2}{3t}$	$\frac{t^2 d}{1.5t^2 + 4d^2}$ or $\frac{2d}{3}$ approx.	$t = \frac{a}{0.67d}$ $T = t\left(\frac{D}{d}\right)^{1/2}$

Fig. 1. Channel cross section, wetted perimeter, hydraulic radius, and top width formulas.