GUIDE LINES FOR DRAINAGE DESIGNS OF UPLAND FARMS

P.B. Dharmasena, R.O.
Regional Research Station,
Maha Illuppallama.

The practice of the art of drainage is probably as old as the art of agriculture. "Drainage" in this context may refer to the physical network of streams and surface water ways in an area, by which water is being carried away. The safe disposal of rain water from an agricultural land maintains the level of fertility and the soil moisture status within a suitable range for crop production. Inadequate drainage leads to water logging problems and a poorly planned drainage system may reduce the productivity of the land by eroding top soil layer and forming gullies.

A proper drainage system of a land will remove water without causing any damage to the soil at desirable rate. Therefore, drainage should be designed by taking following factors into consideration which affect the rate of removal.

i. Soil condition.
ii. Land slope (length and percentage)
iii. Rainfall (amount and intensity)
iv. Vegetation.

The design of drains should indicate shape, dimension, roughness and gradient. The drainage network for upland comprises of four types of surface drains.

a. Storm water drain.
b. Field drain
c. Grass Water way.
d. Intercepting drain or Diverting drain.

The layout showing the various types of drains, roads, lots and the cross section of drains are shown in Fig.1. These different types of drains and their locations can be shown in the Blocking Out Plan of the proposed farm settlement. But detail designs should be prepared for each location on the basis of micro topographic information.

Design of Storm Water Drain.

Storm water drain diverts runoff water which would other wise flow down from higher ground on the arable land in which dry farming activities and the settlement take place. The step by step procedure for the storm water drain is described below.

1. Determine the extent of land from which the rain water flows to the concerned point of the storm water drain.

In this determination, extents should be reported seperately with respect to the existing vegetation.

2. Four types of vegetation are identified and different values for runoff coefficient of each type of vegetation are suggested as follows :

	Type of vegetation.	Runoff coefficient(C)	Area.
i.	Matured jungle(M)	0.2	Am
ii.	Intermediate jungle (I)	0.25	Ai
iii.	Shrub jungle (S)	0.27	As
iv.	Cultivated lands (C)	0.3	Ac

An average value for C can be calculated as follows :

$$C = \frac{0.2\ Am + 0.25\ Ai + 0.27\ As + 0.3\ Ac}{\text{Total extent.}}$$

3. Estimate the rate of runoff by using Rational Formula.

Q = C I A Where Q = Rate of runoff in cusec

C = Runoff coefficient

I = Rainfall intensity in inches/hour

A = Area in acres.

In case of Anuradhapura District, maximum rainfall intensity for 10 year return period has been used as 4 inches/hour.

4. Gradient of the channel should not exceed 1.0% as to prevent any scouring action. Higher gradients can be reduced below this level by placing drop structures.

Table - 1. Discharge values for storm water drains in cusec per foot width of channel.

Depth ft.	1.0	0.66	0.50	0.40	0.33	0.25	0.20	0.17
	Percent gradient of channel							
0.25	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3
0.50	2.2	1.8	1.6	1.4	1.3	1.1	1.0	0.9
0.75	4.3	3.5	3.0	2.7	2.5	2.2	2.0	1.8
1.00		5.6	4.8	4.3	3.9	3.4	3.0	2.8
1.25		8.0	7.0	6.3	5.7	5.0	4.4	4.0
1.50			9.5	8.5	7.7	6.7	6.0	5.5
1.75				11.0	10.0	8.6	7.7	7.0
2.00					13.0	11.0	10.0	9.0
2.25						13.0	12.0	11.0
2.50						16.0	14.0	13.0
2.75							16.0	15.0
3.00								18.0

5. Select depth and width of the drain in such a manner so that the depth would not exceed 20% of the width. By using Table - 1 the dimension can be determined for a channel with parabolic cross section.

Limitation of the depth also will call for change in the gradient by using drop structures.

Once the dimentions at each outlet are calculated, drop structures have to be fixed at least 3 meters away from the point of conjuction. Gradual change in dimension from one outlet to the other is more smart than sudden distortion.

Note: In these calculations, maximum permissiable velocity was assumed as 1.5 m/sec. or 4.5 ft/sec. and channel factor was taken accordingly.

X = V/S Where X - channel factor
V - velocity
1 in S - gradient of the channel.

Design of Grass Water Ways:

Grass water way is the common drain or a collector drain of runoff water flowing from field laterals. The water diverted from storm water drains is also carried by grass water ways. In this case soil is excavated to form a shallow dished drain and the excavated soil is either carted away or used to form low banks on either side.

In addition to the runoff water coming from storm water drain, parcels of cultivated land will contribute water at different points. Therefore, dimension of the grass water way may go on changing as it moves down- wards.

Following values have been fixed to design grass water ways for upland farms in Anuradhapura District.

Maximum intensity of rainfall with a ten year. return period = 4"/hour.

Catchment coefficient = 0.3

Maximum permissiable velocity of the flow = 6 ft./sec.

Roughness coefficient = 0.035

Using Rational Formula,

Q = C I A

C = 0.3 and I = 4"/hour

Q = 1.2 A cusec.

This means that an addition of one acre land may contribute additional 1.2 cusec to the drain. The width and the depth of channel may be determined by using Table 2. It is desirable to keep the depth below 20% of the top width.

Field Laterals:

Field drain or field lateral is aligned just above the conservation bund to collect water flowing downward from the field and moves at a gradient of 0.4 - 0.5 toward the grass water way. Parabolic shape of small drain is desirable to serve the purpose. A general range of dimension can be given for these laterals as mentioned below.

Top width = 1.5 - 2.0 ft.

Depth = 4 - 6 inches

The drain should be free of cultivation and thick growth of weed is undesirable.

Table - 2:

Discharge values for Grass Water Ways in cusec per foot width of channel.

Depth of flow ft.	1.0%	0.66%	0.5%	0.4%	0.33%	0.25%
	Percent slope					
0.25	0.2	0.2	0.2	0.1	0.1	0.1
0.50	0.7	0.6	0.5	0.4	0.4	0.3
0.75	1.4	1.1	1.0	0.9	0.8	0.7
1.00	2.2	1.8	1.6	1.4	1.3	1.1
1.25	3.1	2.5	2.2	2.0	1.8	1.6
1.50	4.3	3.5	3.0	2.7	2.5	2.2
1.75	5.5	4.5	3.9	3.5	3.2	2.8
2.00	6.8	5.6	4.8	4.3	3.9	3.4
2.50	10.0	8.0	7.0	6.3	5.7	5.0
3.00	12.0	11.0	9.5	8.5	7.7	6.7

Intercepting Drains (Diverting Drains

This drain is used to intercept runoff water flowing along grass water ways and divert out side the paddy field. Design procedure is similar to the storm water drain.

Spot heights may be required to produce a survey line along the teritory of upland and paddy area most probably parallel to the irrigation main supply channel. Longitudinal section of the intercepting drain has to be designed on the basis of this survey.

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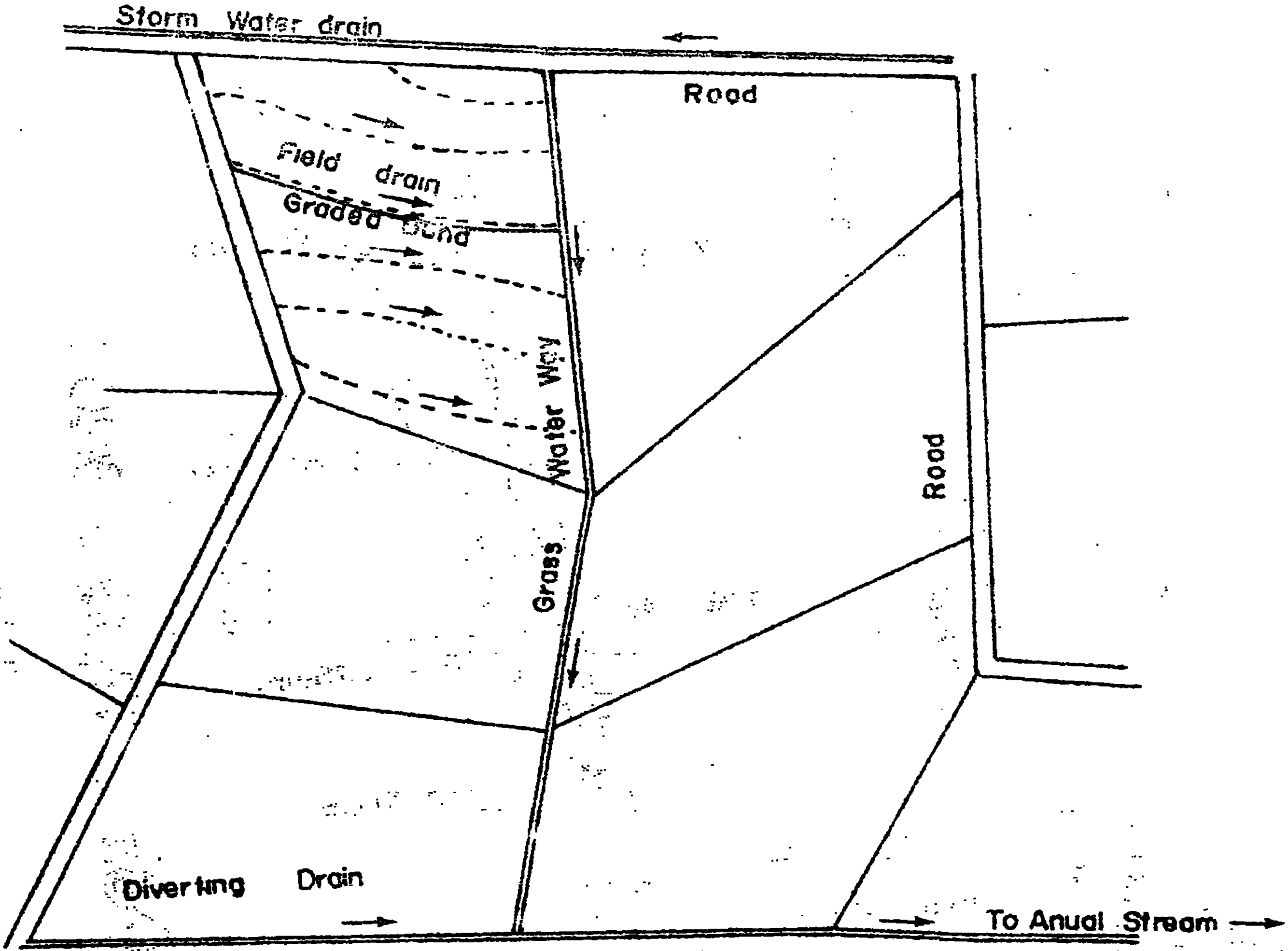
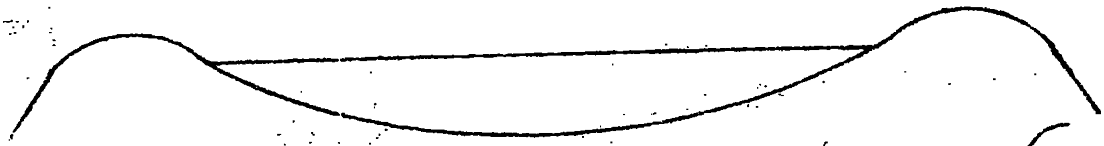
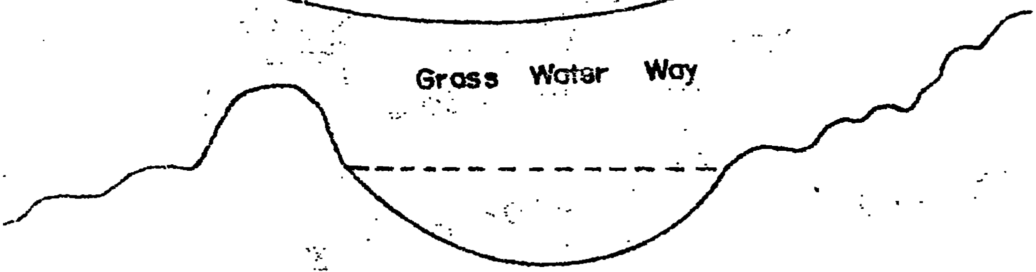
Fig. LAYOUT OF DRAINAGE SYSTEM AND CROSS SECTIONS OF DRAINS



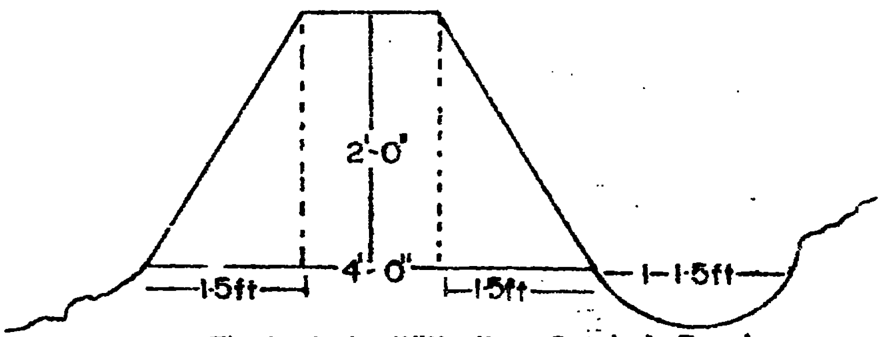
Section of Drains



Grass Water Way



Storm Water Drain or Diverting Drain



Field drain With the Graded Bund

DESIGN OF GRASS WATER WAY
UP LAND

GULUPETHTHAWEWA - T.001

Drain No: HL 001 / W1

LONGITUDINAL PROFILE