

Appendix B
Stormwater Quality Best Management Practice
Design Handbook

Grass Swale Example

Datasheet

Site Conditions:

$A_{\text{total}} = 80$ acres (from worksheet 2)
 $Q_{\text{BMP}} = 9.31$ cfs (from worksheet 2)

Design Assumptions:

Swale Geometry:

Initially, some of the swale design parameters must be chosen within the ranges listed for the design criteria. Site constraints may influence some of these values. In this example the following assumptions were made:

Side slope $z = 3:1$ (maximum)
Channel slope $s = 1\%$ (2% maximum, 0.2% minimum)
Depth of flow $D = 5''$ (5" maximum)

These values can be used in the Manning Equation to solve for the required channel width:

$$Q_{\text{BMP}} = (1.49/n) AR^{2/3} s^{1/2}$$

where A = cross sectional area (ft^2)
 R = hydraulic radius (ft) = A/P
 P = wetted perimeter (ft)
 n = manning n value = 0.15 (standard)

Using Manning's Equation:

Swale bottom width $b = 55$ ft
Design flow velocity $v = 0.4$ fps

Design Length:

The design length is based on the following equation for a 7 minute minimum contact time:

$$L = (7 \text{ minutes}) \times (v) \times (60 \text{ sec/min}) \\ = 168 \text{ feet minimum}$$

Vegetation:

Turf grass chosen as appropriate for the site.

Outflow Collection:

Grated inlet chosen as appropriate for the site.

Table 4. Runoff Coefficients for an Intensity = 0.2 ⁱⁿ/_{hr} for Urban Soil Types*

Impervious %	A Soil RI =32	B Soil RI =56	C Soil RI =69	D Soil RI =75
0 (Natural)	0.06	0.14	0.23	0.28
5	0.10	0.18	0.26	0.31
10	0.14	0.22	0.29	0.34
15	0.19	0.26	0.33	0.37
20 (1-Acre)	0.23	0.30	0.36	0.40
25	0.27	0.33	0.39	0.43
30	0.31	0.37	0.43	0.47
35	0.35	0.41	0.46	0.50
40 (1/2-Acre)	0.40	0.45	0.50	0.53
45	0.44	0.48	0.53	0.56
50 (1/4-Acre)	0.48	0.52	0.56	0.59
55	0.52	0.56	0.60	0.62
60	0.56	0.60	0.63	0.65
65 (Condominiums)	0.61	0.64	0.66	0.68
70	0.65	0.67	0.70	0.71
75 (Mobilehomes)	0.69	0.71	0.73	0.74
80 (Apartments)	0.73	0.75	0.77	0.78
85	0.77	0.79	0.80	0.81
90 (Commercial)	0.82	0.82	0.83	0.84
95	0.86	0.86	0.87	0.87
100	0.90	0.90	0.90	0.90

*Complete District's standards can be found in the Riverside County Flood Control Hydrology Manual

Design Procedure Form for Design Flow

Uniform Intensity Design Flow

Designer: **Benjie Cho**

Company: **Riverside County Flood Control and Water Conservation District**

Date: **3/1/04**

Project: **BMP Example**

Location: _____

<p>1. Determine Impervious Percentage</p> <p>a. Determine total tributary area</p> <p>b. Determine Impervious %</p>	<p>$A_{total} = \underline{\quad 80 \quad} \text{ acres} \quad (1)$</p> <p>$i = \underline{\quad 50 \quad} \% \quad (2)$</p>
<p>2. Determine Runoff Coefficient Values Use Table 4 and impervious % found in step 1</p> <p>a. A Soil Runoff Coefficient</p> <p>b. B Soil Runoff Coefficient</p> <p>c. C Soil Runoff Coefficient</p> <p>d. D Soil Runoff Coefficient</p>	<p>$C_a = \underline{\quad .48 \quad} \quad (3)$</p> <p>$C_b = \underline{\quad .52 \quad} \quad (4)$</p> <p>$C_c = \underline{\quad .56 \quad} \quad (5)$</p> <p>$C_d = \underline{\quad .59 \quad} \quad (6)$</p>
<p>3. Determine the Area decimal fraction of each soil type in tributary area</p> <p>a. Area of A Soil / (1) =</p> <p>b. Area of B Soil / (1) =</p> <p>c. Area of C Soil / (1) =</p> <p>d. Area of D Soil / (1) =</p>	<p>$A_a = \underline{\quad - \quad} \quad (7)$</p> <p>$A_b = \underline{\quad - \quad} \quad (8)$</p> <p>$A_c = \underline{\quad .27 \quad} \quad (9)$</p> <p>$A_d = \underline{\quad .73 \quad} \quad (10)$</p>
<p>4. Determine Runoff Coefficient</p> <p>a. $C = (3) \times (7) + (4) \times (8) + (5) \times (9) + (6) \times (10) =$</p>	<p>$C = \underline{\quad .582 \quad} \quad (11)$</p>
<p>5. Determine BMP Design flow</p> <p>a. $Q_{BMP} = C \times I \times A = (11) \times 0.2 \times (1)$</p>	<p>$Q_{BMP} = \underline{\quad 9.31 \quad} \frac{\text{ft}^3}{\text{s}} \quad (12)$</p>

Design Procedure Form for Grassed Swale

Designer: **Benjie Cho**
 Company: **Riverside County Flood Control and Water Conservation District**
 Date: **3/1/04**
 Project: **BMP Example**
 Location:

1. Determine Design Flow (Use Worksheet 2)	$Q_{BMP} = \underline{\quad 9.31 \quad}$ cfs
2. Swale Geometry a. Swale bottom width (b) b. Side slope (z) c. Flow direction slope (s)	$b = \underline{\quad 55 \quad}$ ft $z = \underline{\quad 3:1 \quad}$ $s = \underline{\quad 1 \quad}$ %
3. Design flow velocity (Manning n = 0.2)	$v = \underline{\quad 0.4 \quad}$ ft/s
4. Depth of flow (D)	$D = \underline{\quad 0.41 \quad (5\prime\prime)}$ ft
5. Design Length (L) $L = (7 \text{ min}) \times (\text{flow velocity, ft/sec}) \times 60$	$L = \underline{\quad 168 \quad}$ ft
6. Vegetation (describe)	<u>Turf Grass</u> <hr/> <hr/>
1. Outflow Collection (check type used or describe "other")	<input checked="" type="checkbox"/> Grated Inlet' <input type="checkbox"/> Infiltration Trench <input type="checkbox"/> Underdrain <input type="checkbox"/> Other _____

Notes:

Assuming a depth of 1 foot, this swale will require 0.222 acres of area.
