Appendix B
Stormwater Quality Best Management Practice
Design Handbook

Grass Swale Example

TENTATIVE TRACT MAP

BEING A BOUNDARY MAP OF THE SOUTHWEST QUARTER OF SECTION 11, TOWNSHIP 6 SOUTH, RANGE 3 WEST, SAN BERNARDINO MERIDIAN, IN THE COUNTY OF RIVERSIDE.

OWNER/DEVELOPER:

ENGINEER:

ASSESSORS PARCEL NO.:

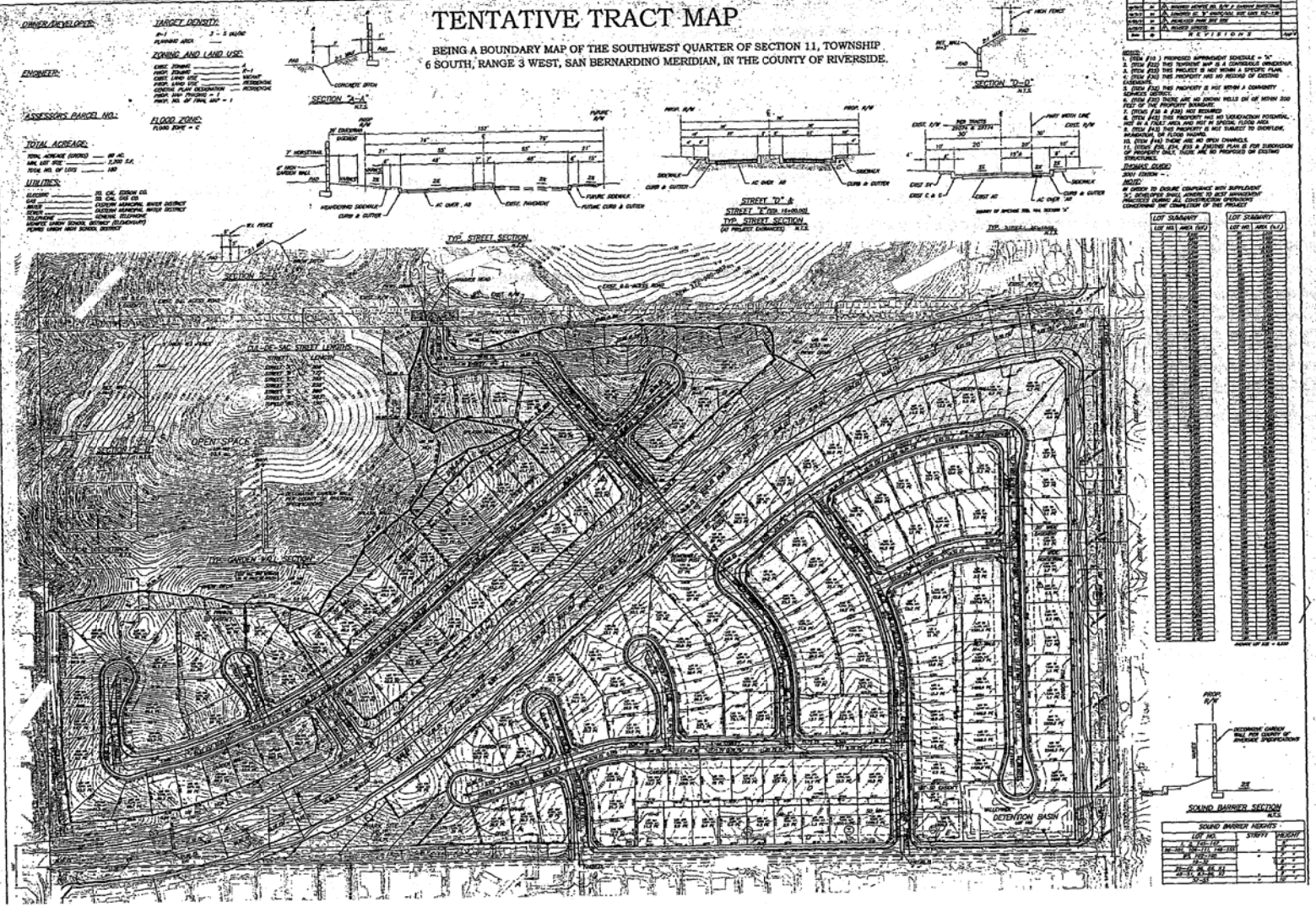
TOTAL ACREAGE:

UTILITIES:

TARGET DENSITY:

ZONING AND LAND USE:

FLOOD ZONE:
FLOOD ZONE = C



Datasheet

Site Conditions:

A_{total} = 80 acres (from worksheet 2)
Q_{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:

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

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 minutes) x (v) x (60 sec/min)
= 168 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

Worksheet 2

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:

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

Worksheet 9

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} = **9.31** cfs
2. Swale Geometry a. Swale bottom width (b) b. Side slope (z) c. Flow direction slope (s)	 b = **55** ft z = **3:1** s = **1** %
3. Design flow velocity (Manning n = 0.2)	v = **0.4** ft/s
4. Depth of flow (D)	D = **0.41 (5")** ft
5. Design Length (L) L = (7 min) x (flow velocity, ft/sec) x 60	L = **168** ft
6. Vegetation (describe)	Turf Grass
1. Outflow Collection (check type used or describe "other")	**X** Grated Inlet' ___ Infiltration Trench ___ Underdrain ___ Other

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