Appendix A
Stormwater Quality Best Management Practice Design Handbook

Extended Detention Basin Example

Datasheet

Example Site Conditions:

A_{trib} = 102.9 acres
V_{BMP} = 50820 ft^3 (from worksheet 1)
L:W Ratio = 2:1 (min 2:1, consider site constraints)
Basin depth = 4’ (min 3.5’, consider site constraints)

Design Assumptions:

In this example a rectangular basin shape was assumed for simplification. Actual volumes and dimensions will differ based on the configuration of the basin.

Two Stage Design (see Figure 1):
Based on the total depth (outlet to spillway) of 4’, set depth of each stage:
Upper Stage Depth = 2’ (2’ min)
Bottom Stage Depth = 2’ (1.5’ min)

Upper Stage:
The total basin volume must be greater than or equal to the design volume. The bottom stage will hold between 10 and 25 percent of the design volume. The top stage must therefore hold between 75 and 90 percent of the design volume. In this example, the top stage is designed to hold 90 percent of the design volume.

$L = 2 * W$
$0.9V_{BMP} = Depth * (2W^2)$
$45738 = 4*W^2$

W = 106.9’ → round to 110’
L = 220’
$Volume_{US} = 48400\ ft^2$

Bottom Stage:
The bottom stage must hold between 10 and 25 percent of the design volume.

At 10% → $0.1V_{BMP} = D_{Bottom} * W * L_{Bottom}$
$0.1(50820) = (2')*(110')* L_{Bottom}$
$L_{Bottom} = 23.1'$

At 25% → $0.25V_{BMP} = D_{Bottom} * W * L_{Bottom}$
$0.25(50820) = (2')*(110')* L_{Bottom}$

L_{Bottom} = 57.8'

Set L_{Bottom} = 30'
$Volume_{BS}$ = 6600 ft^3 (13% of V_{BMP})

Total Basin Volume check:
$Volume_{Basin} = V_{BS} + V_{US}$ = 55000 ft^3 (108% V_{BMP}) $\geq V_{BMP}$ ok

Forebay Design:

In this example a cylindrical forebay shape was assumed for simplification.

Set forebay volume between 5 and 10 percent of the design volume:
$V_F = 0.1V_{BMP}$ = 5082 ft^3
Forebay should drain into low-flow channel in approximately 45 minutes or less. Standing water is not allowable.
$Depth_F$ = 0.8 ft (assumed)
$Area_F$ = (5082)/ depth = 6352.5 ft^2
$Diameter_F$ = SQRT((4* $Area_F$)/ π) = 89.9 → use 90'
For a 45 minute drain time:
Forebay Q_{out} = (5082 ft^3) / (45 min * 60 sec/min) = 1.9 ft^3/s
Size outlet accordingly

Low-flow Channel:

This example assumes a low flow channel depth. The capacity is based on a v-ditch channel at a 2% slope, with side slopes of 2:1. The capacity should be at least twice the forebay outlet rate.

Depth = 0.9 ft (min. 0.75 ft)
Flow capacity = 4.5 ft/s > (2 * Forebay Q_{OUT}) → ok

Basin Outlet:

The stage versus storage graph shows the volume of the proposed basin at various depths:

stage (ft)	storage (ft^3)	storage (acre-ft)
0	0	0.0000
0.5	1650	0.0379
1	3300	0.0758
1.5	4950	0.1136
2	6600	0.1515
2.5	18700	0.4293
3	30800	0.7071
3.5	42900	0.9848
4	55000	1.2626

In this example CivilD was used to route the design volume through the basin for various orifice sizes. After several iterations an appropriate orifice size was chosen of a 2.1-inch diameter. The CivilD program determined the outflow rate at each depth. Please see the attached printout for the routing.

stage (ft)	storage (ft^3)	storage (acre-ft)	Q_{OUT} (cfs)
0	0	0.0000	0.00
0.5	1650	0.0379	0.11
1	3300	0.0758	0.15
1.5	4950	0.1136	0.18
2	6600	0.1515	0.21
2.5	18700	0.4293	0.23
3	30800	0.7071	0.25
3.5	42900	0.9848	0.27
4	55000	1.2626	0.29

For this size orifice:

50% of the V_{BMP} has drained from the basin in 27 hours $\geq$ 24 hours → ok

After	27 hours
Volume Remaining =	0.581 acre-ft
WS Elevation =	2.77 ft

100% of the V_{BMP} has drained from the basin in 60 hours $\geq$ 48 hours
$<$ 72 hours → ok

After	60 hours
Volume Remaining =	0.03 acre-ft

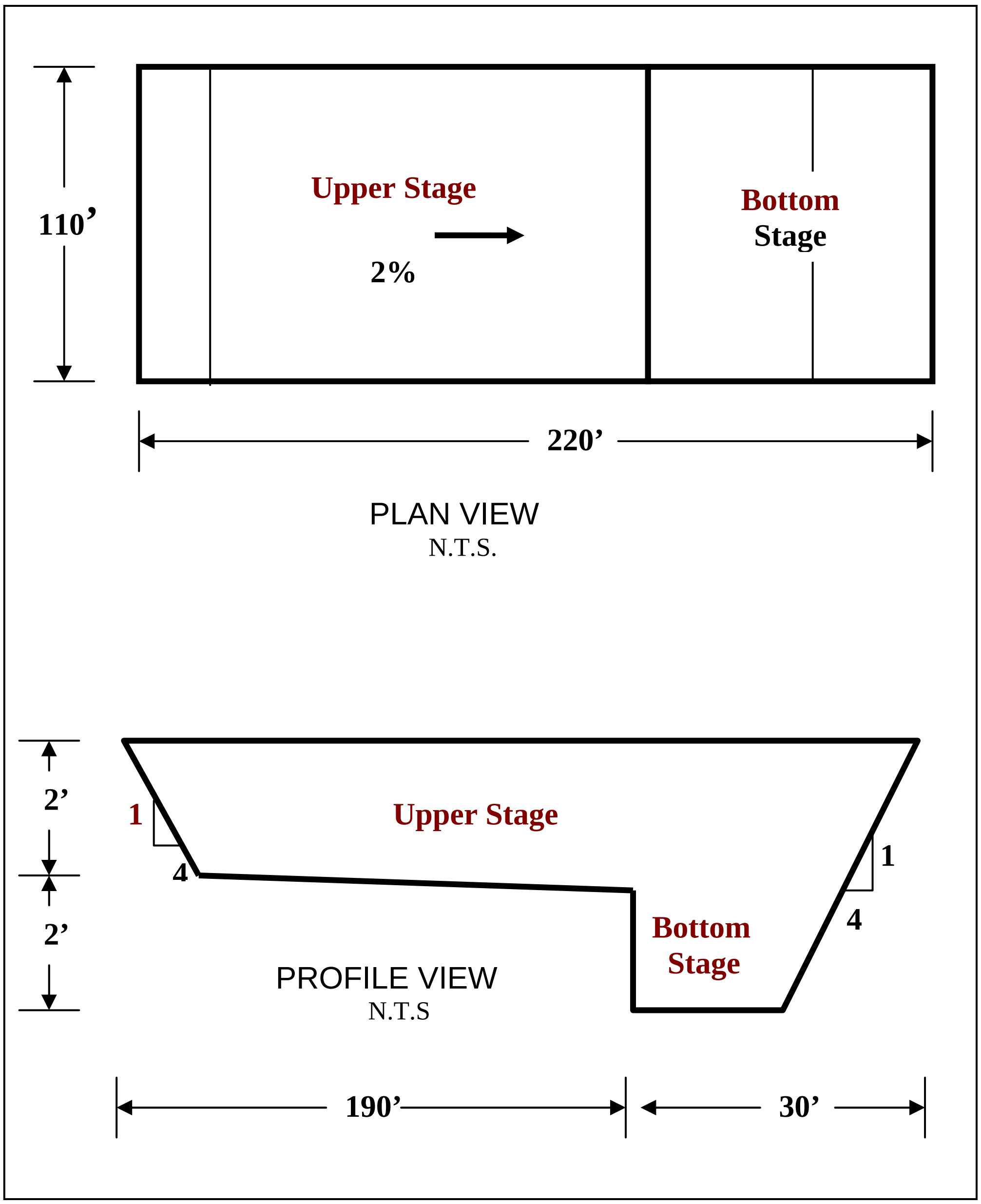
WS Elevation = 0.45 ft

Vegetation:
Native grass chosen as appropriate for the site.

Embankment:
Maximum interior slope of 4:1 and maximum exterior slope of 3:1 chosen.

Access:
Maximum 10% slope and minimum 16' access roads chosen.

Figure 1



Worksheet 1

Design Procedure Form for Extended Detention Basin

Designer:	NAME
Company:	ABC Engineering
Date:	June 15th, 2009
Project:	Extended Detention Basin Design Example
Location:	

1. Determine the Tributary Area to the BMP (A_{trib})	A_{trib} =	102.9	acres	***(1)***
2. Determine the impervious area ratio (*i*)				
a. Determine impervious area within (A_{trib})	A_{imp} =	51.5	acres	***(2)***
b. Calculate *i* = **(2)** / **(1)**	*i* =	0.50	acres/acre	***(3)***
3. Determine Runoff Coefficient (C) $C = 0.858 \cdot \boldsymbol{i}^3 - 0.78 \cdot \boldsymbol{i}^2 + 0.774 \cdot \boldsymbol{i} + 0.04$ $C = 0.858 \cdot \boldsymbol{(3)}^3 - 0.78 \cdot \boldsymbol{(3)}^2 + 0.774 \cdot \boldsymbol{(3)} + 0.04$	C =	0.34		***(4)***
4. Determine Unit Storage Volume (V_u) $V_u = 0.40 \cdot C$ $V_u = 0.40 \cdot \mathbf{(4)}$	V_u =	0.136	acre-in/acre	***(5)***
5. Determine Design Storage Volume				
a. V_{BMP} = ***(5)*** x ***(1)*** [acre-in]	V_{BMP} =	14	acre-in	***(6)***
b. V_{BMP} = ***(6)*** / 12 [acre-ft]	V_{BMP} =	1.17	acre-ft	***(7)***
c. V_{BMP} = ***(7)*** x 43560 [ft^3]	V_{BMP} =	50,820	ft^3	***(8)***

Notes:

Design Procedure for BMP Design Volume

Designer: NAME
Company: ABC Engineering
Date: June 15th, 2009
Project: Extended Detention Basin Design Example
Location:

1. Determine Design Volume (Use Worksheet 1) a. Total Tributary Area (minimum 5 ac.) b. Design Volume, V_{BMP}	A_{total} = 102.9 acres V_{BMP} = 50820 ft^3
2. Basin Length to Width Ratio (2:1 min.)	Ratio = 2:1 L:W
3. Two-Stage Design a. Overall Design 1) Depth (3.5' min.) 2) Width (30' min.) 3) Length (60' min.) 4) Volume (must be ≥ V_{BMP}) b. Upper Stage 1) Depth (2' min.) 2) Bottom Slope (2% to low flow channel recommended) c. Bottom Stage 1) Depth (1.5' to 3') 2) Length 3) Volume (10 to 25% of V_{BMP})	Depth = 4 ft Width = 110 ft Length = 220 ft Volume = 55000 ft^3 Depth = 2 ft Slope = 2 % Depth = 2 ft Length = 30 ft Volume = 6600 (13%) ft^3
4. Forebay Design a. Forebay Volume (5 to 10% of V_{BMP}) b. Outlet pipe drainage time (≅ 45 min)	Volume = 5082 (10%) ft^3 Drain time = 45 minutes
5. Low-flow Channel a. Depth (9" minimum) b. Flow Capacity (2 * Forebay Q_{OUT})	Depth = 0.9 ft $Q_{Low\ Flow}$ = 4.5 cfs

6. Trash Rack or Gravel Pack (check one)	Trash Rack __X___ Gravel Pack ______
7. Basin Outlet a. Outlet type (check one)	Single orifice __X__ Multi-orifice plate _____ Perforated Pipe _____ Other ____________________
b. Orifice Area c. Orifice Type d. Maximum Depth of water above bottom orifice e. Length of time for 50% V_{BMP} drainage (24 hour minimum) f. Length of time for 100% V_{BMP} drainage (between 48 and 72 hours) g. Attached Documents (all required) 1) Stage vs. Discharge 2) Stage vs. Volume 3) Inflow Hydrograph 4) Basin Routing	Area = 0.024 (2.1" Diameter) ft^2 Type _Pipe_______________ Depth = _3.8________ ft Time 50% = __27______ hrs Time 100% = __60______ hrs Attached Documents (check) 1) __X________ 2) __X________ 3) __X________ 4) __X________
8. Increased Runoff (optional) Is this basin also mitigating increased runoff? Attached Documents (all required) for 2, 5, & 10-year storms: 1) Stage vs. Discharge 2) Stage vs. Volume/Storage 3) Inflow Hydrograph 4) Basin Routing	Yes _______ No _X____ (if No, skip to #9) Attached Documents (check) 1) __________ 2) __________ 3) __________ 4) __________
9. Vegetation (check type)	_X__ Native Grasses ____ Irrigated Turf ____ Other ____________________________
10. Embankment a. Interior slope (4:1 max.) b. Exterior slope (3:1 max.)	Interior Slope = ___4:1___ Exterior Slope = ___3:1___
11. Maintenance Access a. Slope (10% max.)	Slope = ___10____ %

b. Width (16 feet min.)	Width = ___16____ ft

FLOOD HYDROGRAPH ROUTING PROGRAM

Study date: 06/15/09

********************* HYDROGRAPH INFORMATION **********************

From study/file name: BMPexampl.rte
********************** Hydrograph Information ***********************
From manual input hydrograph

****************************HYDROGRAPH DATA****************************
Number of intervals = 2
Time interval = 5.0 (Min.)
Maximum/Peak flow rate = 84.700 (CFS)
Total volume = 1.167 (Ac.Ft)
Status of hydrographs being held in storage

	Stream 1	Stream 2	Stream 3	Stream 4	Stream 5
Peak (CFS)	0.000	0.000	0.000	0.000	0.000
Vol (Ac.Ft)	0.000	0.000	0.000	0.000	0.000

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Process from Point/Station 1.000 to Point/Station 2.000
**** RETARDING BASIN ROUTING ****

Program computation of outflow v. depth

CALCULATED OUTFLOW DATA AT DEPTH = 0.50(Ft.))
Pipe length = 1.00(Ft.) Elevation difference = 0.10(Ft.)
Manning's N = 0.013 No. of pipes = 1
Given pipe size = 2.10(In.)
NOTE: Assuming free outlet flow.
NOTE: Normal flow is pressure flow.
The total friction loss through the pipe is 0.600(Ft.)
Pipe friction loss = 0.105(Ft.)
Minor friction loss = 0.495(Ft.) K-factor = 1.50
Calculated flow rate through pipe(s) = 0.111(CFS)

Total outflow at this depth = 0.11(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 1.00(Ft.))
Pipe length = 1.00(Ft.) Elevation difference = 0.10(Ft.)
Manning's N = 0.013 No. of pipes = 1
Given pipe size = 2.10(In.)
NOTE: Assuming free outlet flow.
NOTE: Normal flow is pressure flow.
The total friction loss through the pipe is 1.100(Ft.)
Pipe friction loss = 0.193(Ft.)
Minor friction loss = 0.907(Ft.) K-factor = 1.50
Calculated flow rate through pipe(s) = 0.150(CFS)

Total outflow at this depth = 0.15(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 1.50(Ft.))
Pipe length = 1.00(Ft.) Elevation difference = 0.10(Ft.)
Manning's N = 0.013 No. of pipes = 1
Given pipe size = 2.10(In.)
NOTE: Assuming free outlet flow.
NOTE: Normal flow is pressure flow.
The total friction loss through the pipe is 1.600(Ft.)
Pipe friction loss = 0.281(Ft.)
Minor friction loss = 1.320(Ft.) K-factor = 1.50
Calculated flow rate through pipe(s) = 0.181(CFS)

Total outflow at this depth = 0.18(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 2.00(Ft.))
Pipe length = 1.00(Ft.) Elevation difference = 0.10(Ft.)
Manning's N = 0.013 No. of pipes = 1
Given pipe size = 2.10(In.)
NOTE: Assuming free outlet flow.
NOTE: Normal flow is pressure flow.
The total friction loss through the pipe is 2.100(Ft.)
Pipe friction loss = 0.369(Ft.)
Minor friction loss = 1.732(Ft.) K-factor = 1.50
Calculated flow rate through pipe(s) = 0.207(CFS)

Total outflow at this depth = 0.21(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 2.50(Ft.))
Pipe length = 1.00(Ft.) Elevation difference = 0.10(Ft.)
Manning's N = 0.013 No. of pipes = 1
Given pipe size = 2.10(In.)
NOTE: Assuming free outlet flow.
NOTE: Normal flow is pressure flow.
The total friction loss through the pipe is 2.600(Ft.)
Pipe friction loss = 0.457(Ft.)
Minor friction loss = 2.144(Ft.) K-factor = 1.50
Calculated flow rate through pipe(s) = 0.231(CFS)

Total outflow at this depth = 0.23(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 3.00(Ft.))
Pipe length = 1.00(Ft.) Elevation difference = 0.10(Ft.)
Manning's N = 0.013 No. of pipes = 1
Given pipe size = 2.10(In.)
NOTE: Assuming free outlet flow.
NOTE: Normal flow is pressure flow.
The total friction loss through the pipe is 3.100(Ft.)
Pipe friction loss = 0.545(Ft.)
Minor friction loss = 2.557(Ft.) K-factor = 1.50
Calculated flow rate through pipe(s) = 0.252(CFS)

Total outflow at this depth = 0.25(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 3.50(Ft.))
Pipe length = 1.00(Ft.) Elevation difference = 0.10(Ft.)
Manning's N = 0.013 No. of pipes = 1
Given pipe size = 2.10(In.)
NOTE: Assuming free outlet flow.
NOTE: Normal flow is pressure flow.
The total friction loss through the pipe is 3.600(Ft.)
Pipe friction loss = 0.633(Ft.)
Minor friction loss = 2.969(Ft.) K-factor = 1.50
Calculated flow rate through pipe(s) = 0.272(CFS)

Total outflow at this depth = 0.27(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 4.00(Ft.))
Pipe length = 1.00(Ft.) Elevation difference = 0.10(Ft.)
Manning's N = 0.013 No. of pipes = 1
Given pipe size = 2.10(In.)
NOTE: Assuming free outlet flow.
NOTE: Normal flow is pressure flow.
The total friction loss through the pipe is 4.100(Ft.)
Pipe friction loss = 0.721(Ft.)
Minor friction loss = 3.381(Ft.) K-factor = 1.50
Calculated flow rate through pipe(s) = 0.290(CFS)

Total outflow at this depth = 0.29(CFS)

Total number of inflow hydrograph intervals = 2
Hydrograph time unit = 5.000 (Min.)
Initial depth in storage basin = 0.00(Ft.)

Initial basin depth = 0.00 (Ft.)
Initial basin storage = 0.00 (Ac.Ft)
Initial basin outflow = 0.00 (CFS)

Depth vs. Storage and Depth vs. Discharge data:
Basin Depth Storage Outflow (S-O*dt/2) (S+O*dt/2)

(Ft.)	(Ac.Ft)	(CFS)	(Ac.Ft)	(Ac.Ft)
0.000	0.000	0.000	0.000	0.000
0.500	0.038	0.111	0.038	0.038
1.000	0.076	0.150	0.075	0.077
1.500	0.114	0.181	0.113	0.115
2.000	0.152	0.207	0.151	0.153
2.500	0.429	0.231	0.428	0.430
3.000	0.707	0.252	0.706	0.708
3.500	0.985	0.272	0.984	0.986
4.000	1.263	0.290	1.262	1.264

Hydrograph Detention Basin Routing

Graph values: 'I'= unit inflow; 'O'=outflow at time shown

Time (Hours)	Inflow (CFS)	Outflow (CFS)	Storage (Ac.Ft)	.0	21.2	42.35	63.53	84.70	Depth (Ft.)
0.083	84.70	0.22	0.291	O	|	|	|	I	2.25
0.167	84.70	0.26	0.873	O	|	|	|	I	3.30
0.250	0.00	0.28	1.162	O	|	|	|	|	3.82
0.333	0.00	0.28	1.160	O	|	|	|	|	3.82
0.417	0.00	0.28	1.158	O	|	|	|	|	3.81
0.500	0.00	0.28	1.157	O	|	|	|	|	3.81
0.583	0.00	0.28	1.155	O	|	|	|	|	3.80
0.667	0.00	0.28	1.153	O	|	|	|	|	3.80
0.750	0.00	0.28	1.151	O	|	|	|	|	3.80
0.833	0.00	0.28	1.149	O	|	|	|	|	3.79
0.917	0.00	0.28	1.147	O	|	|	|	|	3.79
1.000	0.00	0.28	1.145	O	|	|	|	|	3.79
1.083	0.00	0.28	1.143	O	|	|	|	|	3.78
1.167	0.00	0.28	1.141	O	|	|	|	|	3.78
1.250	0.00	0.28	1.139	O	|	|	|	|	3.78
1.333	0.00	0.28	1.137	O	|	|	|	|	3.77
1.417	0.00	0.28	1.135	O	|	|	|	|	3.77
1.500	0.00	0.28	1.133	O	|	|	|	|	3.77
1.583	0.00	0.28	1.131	O	|	|	|	|	3.76
1.667	0.00	0.28	1.129	O	|	|	|	|	3.76
1.750	0.00	0.28	1.127	O	|	|	|	|	3.76
1.833	0.00	0.28	1.125	O	|	|	|	|	3.75
1.917	0.00	0.28	1.124	O	|	|	|	|	3.75
2.000	0.00	0.28	1.122	O	|	|	|	|	3.75
2.083	0.00	0.28	1.120	O	|	|	|	|	3.74
2.167	0.00	0.28	1.118	O	|	|	|	|	3.74
2.250	0.00	0.28	1.116	O	|	|	|	|	3.74
2.333	0.00	0.28	1.114	O	|	|	|	|	3.73
2.417	0.00	0.28	1.112	O	|	|	|	|	3.73
2.500	0.00	0.28	1.110	O	|	|	|	|	3.72
2.583	0.00	0.28	1.108	O	|	|	|	|	3.72
2.667	0.00	0.28	1.106	O	|	|	|	|	3.72
2.750	0.00	0.28	1.104	O	|	|	|	|	3.71
2.833	0.00	0.28	1.102	O	|	|	|	|	3.71
2.917	0.00	0.28	1.100	O	|	|	|	|	3.71
3.000	0.00	0.28	1.098	O	|	|	|	|	3.70
3.083	0.00	0.28	1.097	O	|	|	|	|	3.70

3.167	0.00	0.28	1.095	O	|	|	|	|	3.70
3.250	0.00	0.28	1.093	O	|	|	|	|	3.69
3.333	0.00	0.28	1.091	O	|	|	|	|	3.69
3.417	0.00	0.28	1.089	O	|	|	|	|	3.69
3.500	0.00	0.28	1.087	O	|	|	|	|	3.68
3.583	0.00	0.28	1.085	O	|	|	|	|	3.68
3.667	0.00	0.28	1.083	O	|	|	|	|	3.68
3.750	0.00	0.28	1.081	O	|	|	|	|	3.67
3.833	0.00	0.28	1.079	O	|	|	|	|	3.67
3.917	0.00	0.28	1.077	O	|	|	|	|	3.67
4.000	0.00	0.28	1.075	O	|	|	|	|	3.66
4.083	0.00	0.28	1.074	O	|	|	|	|	3.66
4.167	0.00	0.28	1.072	O	|	|	|	|	3.66
4.250	0.00	0.28	1.070	O	|	|	|	|	3.65
4.333	0.00	0.28	1.068	O	|	|	|	|	3.65
4.417	0.00	0.28	1.066	O	|	|	|	|	3.65
4.500	0.00	0.28	1.064	O	|	|	|	|	3.64
4.583	0.00	0.28	1.062	O	|	|	|	|	3.64
4.667	0.00	0.28	1.060	O	|	|	|	|	3.64
4.750	0.00	0.28	1.058	O	|	|	|	|	3.63
4.833	0.00	0.28	1.056	O	|	|	|	|	3.63
4.917	0.00	0.28	1.055	O	|	|	|	|	3.63
5.000	0.00	0.28	1.053	O	|	|	|	|	3.62
5.083	0.00	0.28	1.051	O	|	|	|	|	3.62
5.167	0.00	0.28	1.049	O	|	|	|	|	3.61
5.250	0.00	0.28	1.047	O	|	|	|	|	3.61
5.333	0.00	0.28	1.045	O	|	|	|	|	3.61
5.417	0.00	0.28	1.043	O	|	|	|	|	3.60
5.500	0.00	0.28	1.041	O	|	|	|	|	3.60
5.583	0.00	0.28	1.039	O	|	|	|	|	3.60
5.667	0.00	0.28	1.037	O	|	|	|	|	3.59
5.750	0.00	0.27	1.036	O	|	|	|	|	3.59
5.833	0.00	0.27	1.034	O	|	|	|	|	3.59
5.917	0.00	0.27	1.032	O	|	|	|	|	3.58
6.000	0.00	0.27	1.030	O	|	|	|	|	3.58
6.083	0.00	0.27	1.028	O	|	|	|	|	3.58
6.167	0.00	0.27	1.026	O	|	|	|	|	3.57
6.250	0.00	0.27	1.024	O	|	|	|	|	3.57
6.333	0.00	0.27	1.022	O	|	|	|	|	3.57
6.417	0.00	0.27	1.020	O	|	|	|	|	3.56
6.500	0.00	0.27	1.019	O	|	|	|	|	3.56
6.583	0.00	0.27	1.017	O	|	|	|	|	3.56
6.667	0.00	0.27	1.015	O	|	|	|	|	3.55
6.750	0.00	0.27	1.013	O	|	|	|	|	3.55
6.833	0.00	0.27	1.011	O	|	|	|	|	3.55
6.917	0.00	0.27	1.009	O	|	|	|	|	3.54
7.000	0.00	0.27	1.007	O	|	|	|	|	3.54
7.083	0.00	0.27	1.005	O	|	|	|	|	3.54
7.167	0.00	0.27	1.003	O	|	|	|	|	3.53
7.250	0.00	0.27	1.002	O	|	|	|	|	3.53
7.333	0.00	0.27	1.000	O	|	|	|	|	3.53
7.417	0.00	0.27	0.998	O	|	|	|	|	3.52
7.500	0.00	0.27	0.996	O	|	|	|	|	3.52
7.583	0.00	0.27	0.994	O	|	|	|	|	3.52
7.667	0.00	0.27	0.992	O	|	|	|	|	3.51
7.750	0.00	0.27	0.990	O	|	|	|	|	3.51

7.833	0.00	0.27	0.988	O	|	|	|	|	3.51
7.917	0.00	0.27	0.987	O	|	|	|	|	3.50
8.000	0.00	0.27	0.985	O	|	|	|	|	3.50
8.083	0.00	0.27	0.983	O	|	|	|	|	3.50
8.167	0.00	0.27	0.981	O	|	|	|	|	3.49
8.250	0.00	0.27	0.979	O	|	|	|	|	3.49
8.333	0.00	0.27	0.977	O	|	|	|	|	3.49
8.417	0.00	0.27	0.975	O	|	|	|	|	3.48
8.500	0.00	0.27	0.974	O	|	|	|	|	3.48
8.583	0.00	0.27	0.972	O	|	|	|	|	3.48
8.667	0.00	0.27	0.970	O	|	|	|	|	3.47
8.750	0.00	0.27	0.968	O	|	|	|	|	3.47
8.833	0.00	0.27	0.966	O	|	|	|	|	3.47
8.917	0.00	0.27	0.964	O	|	|	|	|	3.46
9.000	0.00	0.27	0.962	O	|	|	|	|	3.46
9.083	0.00	0.27	0.961	O	|	|	|	|	3.46
9.167	0.00	0.27	0.959	O	|	|	|	|	3.45
9.250	0.00	0.27	0.957	O	|	|	|	|	3.45
9.333	0.00	0.27	0.955	O	|	|	|	|	3.45
9.417	0.00	0.27	0.953	O	|	|	|	|	3.44
9.500	0.00	0.27	0.951	O	|	|	|	|	3.44
9.583	0.00	0.27	0.949	O	|	|	|	|	3.44
9.667	0.00	0.27	0.948	O	|	|	|	|	3.43
9.750	0.00	0.27	0.946	O	|	|	|	|	3.43
9.833	0.00	0.27	0.944	O	|	|	|	|	3.43
9.917	0.00	0.27	0.942	O	|	|	|	|	3.42
10.000	0.00	0.27	0.940	O	|	|	|	|	3.42
10.083	0.00	0.27	0.938	O	|	|	|	|	3.42
10.167	0.00	0.27	0.936	O	|	|	|	|	3.41
10.250	0.00	0.27	0.935	O	|	|	|	|	3.41
10.333	0.00	0.27	0.933	O	|	|	|	|	3.41
10.417	0.00	0.27	0.931	O	|	|	|	|	3.40
10.500	0.00	0.27	0.929	O	|	|	|	|	3.40
10.583	0.00	0.27	0.927	O	|	|	|	|	3.40
10.667	0.00	0.27	0.925	O	|	|	|	|	3.39
10.750	0.00	0.27	0.924	O	|	|	|	|	3.39
10.833	0.00	0.27	0.922	O	|	|	|	|	3.39
10.917	0.00	0.27	0.920	O	|	|	|	|	3.38
11.000	0.00	0.27	0.918	O	|	|	|	|	3.38
11.083	0.00	0.27	0.916	O	|	|	|	|	3.38
11.167	0.00	0.27	0.914	O	|	|	|	|	3.37
11.250	0.00	0.27	0.912	O	|	|	|	|	3.37
11.333	0.00	0.27	0.911	O	|	|	|	|	3.37
11.417	0.00	0.27	0.909	O	|	|	|	|	3.36
11.500	0.00	0.27	0.907	O	|	|	|	|	3.36
11.583	0.00	0.27	0.905	O	|	|	|	|	3.36
11.667	0.00	0.27	0.903	O	|	|	|	|	3.35
11.750	0.00	0.27	0.901	O	|	|	|	|	3.35
11.833	0.00	0.27	0.900	O	|	|	|	|	3.35
11.917	0.00	0.27	0.898	O	|	|	|	|	3.34
12.000	0.00	0.27	0.896	O	|	|	|	|	3.34
12.083	0.00	0.27	0.894	O	|	|	|	|	3.34
12.167	0.00	0.27	0.892	O	|	|	|	|	3.33
12.250	0.00	0.26	0.891	O	|	|	|	|	3.33
12.333	0.00	0.26	0.889	O	|	|	|	|	3.33
12.417	0.00	0.26	0.887	O	|	|	|	|	3.32

12.500	0.00	0.26	0.885	O	|	|	|	|	3.32
12.583	0.00	0.26	0.883	O	|	|	|	|	3.32
12.667	0.00	0.26	0.881	O	|	|	|	|	3.31
12.750	0.00	0.26	0.880	O	|	|	|	|	3.31
12.833	0.00	0.26	0.878	O	|	|	|	|	3.31
12.917	0.00	0.26	0.876	O	|	|	|	|	3.30
13.000	0.00	0.26	0.874	O	|	|	|	|	3.30
13.083	0.00	0.26	0.872	O	|	|	|	|	3.30
13.167	0.00	0.26	0.871	O	|	|	|	|	3.29
13.250	0.00	0.26	0.869	O	|	|	|	|	3.29
13.333	0.00	0.26	0.867	O	|	|	|	|	3.29
13.417	0.00	0.26	0.865	O	|	|	|	|	3.28
13.500	0.00	0.26	0.863	O	|	|	|	|	3.28
13.583	0.00	0.26	0.861	O	|	|	|	|	3.28
13.667	0.00	0.26	0.860	O	|	|	|	|	3.27
13.750	0.00	0.26	0.858	O	|	|	|	|	3.27
13.833	0.00	0.26	0.856	O	|	|	|	|	3.27
13.917	0.00	0.26	0.854	O	|	|	|	|	3.26
14.000	0.00	0.26	0.852	O	|	|	|	|	3.26
14.083	0.00	0.26	0.851	O	|	|	|	|	3.26
14.167	0.00	0.26	0.849	O	|	|	|	|	3.26
14.250	0.00	0.26	0.847	O	|	|	|	|	3.25
14.333	0.00	0.26	0.845	O	|	|	|	|	3.25
14.417	0.00	0.26	0.843	O	|	|	|	|	3.25
14.500	0.00	0.26	0.842	O	|	|	|	|	3.24
14.583	0.00	0.26	0.840	O	|	|	|	|	3.24
14.667	0.00	0.26	0.838	O	|	|	|	|	3.24
14.750	0.00	0.26	0.836	O	|	|	|	|	3.23
14.833	0.00	0.26	0.834	O	|	|	|	|	3.23
14.917	0.00	0.26	0.833	O	|	|	|	|	3.23
15.000	0.00	0.26	0.831	O	|	|	|	|	3.22
15.083	0.00	0.26	0.829	O	|	|	|	|	3.22
15.167	0.00	0.26	0.827	O	|	|	|	|	3.22
15.250	0.00	0.26	0.825	O	|	|	|	|	3.21
15.333	0.00	0.26	0.824	O	|	|	|	|	3.21
15.417	0.00	0.26	0.822	O	|	|	|	|	3.21
15.500	0.00	0.26	0.820	O	|	|	|	|	3.20
15.583	0.00	0.26	0.818	O	|	|	|	|	3.20
15.667	0.00	0.26	0.816	O	|	|	|	|	3.20
15.750	0.00	0.26	0.815	O	|	|	|	|	3.19
15.833	0.00	0.26	0.813	O	|	|	|	|	3.19
15.917	0.00	0.26	0.811	O	|	|	|	|	3.19
16.000	0.00	0.26	0.809	O	|	|	|	|	3.18
16.083	0.00	0.26	0.808	O	|	|	|	|	3.18
16.167	0.00	0.26	0.806	O	|	|	|	|	3.18
16.250	0.00	0.26	0.804	O	|	|	|	|	3.17
16.333	0.00	0.26	0.802	O	|	|	|	|	3.17
16.417	0.00	0.26	0.800	O	|	|	|	|	3.17
16.500	0.00	0.26	0.799	O	|	|	|	|	3.16
16.583	0.00	0.26	0.797	O	|	|	|	|	3.16
16.667	0.00	0.26	0.795	O	|	|	|	|	3.16
16.750	0.00	0.26	0.793	O	|	|	|	|	3.16
16.833	0.00	0.26	0.792	O	|	|	|	|	3.15
16.917	0.00	0.26	0.790	O	|	|	|	|	3.15
17.000	0.00	0.26	0.788	O	|	|	|	|	3.15
17.083	0.00	0.26	0.786	O	|	|	|	|	3.14

17.167	0.00	0.26	0.784	O	|	|	|	|	3.14
17.250	0.00	0.26	0.783	O	|	|	|	|	3.14
17.333	0.00	0.26	0.781	O	|	|	|	|	3.13
17.417	0.00	0.26	0.779	O	|	|	|	|	3.13
17.500	0.00	0.26	0.777	O	|	|	|	|	3.13
17.583	0.00	0.26	0.776	O	|	|	|	|	3.12
17.667	0.00	0.26	0.774	O	|	|	|	|	3.12
17.750	0.00	0.26	0.772	O	|	|	|	|	3.12
17.833	0.00	0.26	0.770	O	|	|	|	|	3.11
17.917	0.00	0.26	0.768	O	|	|	|	|	3.11
18.000	0.00	0.26	0.767	O	|	|	|	|	3.11
18.083	0.00	0.26	0.765	O	|	|	|	|	3.10
18.167	0.00	0.26	0.763	O	|	|	|	|	3.10
18.250	0.00	0.26	0.761	O	|	|	|	|	3.10
18.333	0.00	0.26	0.760	O	|	|	|	|	3.09
18.417	0.00	0.26	0.758	O	|	|	|	|	3.09
18.500	0.00	0.26	0.756	O	|	|	|	|	3.09
18.583	0.00	0.26	0.754	O	|	|	|	|	3.09
18.667	0.00	0.26	0.753	O	|	|	|	|	3.08
18.750	0.00	0.26	0.751	O	|	|	|	|	3.08
18.833	0.00	0.25	0.749	O	|	|	|	|	3.08
18.917	0.00	0.25	0.747	O	|	|	|	|	3.07
19.000	0.00	0.25	0.746	O	|	|	|	|	3.07
19.083	0.00	0.25	0.744	O	|	|	|	|	3.07
19.167	0.00	0.25	0.742	O	|	|	|	|	3.06
19.250	0.00	0.25	0.740	O	|	|	|	|	3.06
19.333	0.00	0.25	0.739	O	|	|	|	|	3.06
19.417	0.00	0.25	0.737	O	|	|	|	|	3.05
19.500	0.00	0.25	0.735	O	|	|	|	|	3.05
19.583	0.00	0.25	0.733	O	|	|	|	|	3.05
19.667	0.00	0.25	0.732	O	|	|	|	|	3.04
19.750	0.00	0.25	0.730	O	|	|	|	|	3.04
19.833	0.00	0.25	0.728	O	|	|	|	|	3.04
19.917	0.00	0.25	0.726	O	|	|	|	|	3.03
20.000	0.00	0.25	0.725	O	|	|	|	|	3.03
20.083	0.00	0.25	0.723	O	|	|	|	|	3.03
20.167	0.00	0.25	0.721	O	|	|	|	|	3.03
20.250	0.00	0.25	0.719	O	|	|	|	|	3.02
20.333	0.00	0.25	0.718	O	|	|	|	|	3.02
20.417	0.00	0.25	0.716	O	|	|	|	|	3.02
20.500	0.00	0.25	0.714	O	|	|	|	|	3.01
20.583	0.00	0.25	0.712	O	|	|	|	|	3.01
20.667	0.00	0.25	0.711	O	|	|	|	|	3.01
20.750	0.00	0.25	0.709	O	|	|	|	|	3.00
20.833	0.00	0.25	0.707	O	|	|	|	|	3.00
20.917	0.00	0.25	0.705	O	|	|	|	|	3.00
21.000	0.00	0.25	0.704	O	|	|	|	|	2.99
21.083	0.00	0.25	0.702	O	|	|	|	|	2.99
21.167	0.00	0.25	0.700	O	|	|	|	|	2.99
21.250	0.00	0.25	0.699	O	|	|	|	|	2.98
21.333	0.00	0.25	0.697	O	|	|	|	|	2.98
21.417	0.00	0.25	0.695	O	|	|	|	|	2.98
21.500	0.00	0.25	0.693	O	|	|	|	|	2.98
21.583	0.00	0.25	0.692	O	|	|	|	|	2.97
21.667	0.00	0.25	0.690	O	|	|	|	|	2.97
21.750	0.00	0.25	0.688	O	|	|	|	|	2.97

21.833	0.00	0.25	0.686	O	|	|	|	|	2.96
21.917	0.00	0.25	0.685	O	|	|	|	|	2.96
22.000	0.00	0.25	0.683	O	|	|	|	|	2.96
22.083	0.00	0.25	0.681	O	|	|	|	|	2.95
22.167	0.00	0.25	0.680	O	|	|	|	|	2.95
22.250	0.00	0.25	0.678	O	|	|	|	|	2.95
22.333	0.00	0.25	0.676	O	|	|	|	|	2.94
22.417	0.00	0.25	0.674	O	|	|	|	|	2.94
22.500	0.00	0.25	0.673	O	|	|	|	|	2.94
22.583	0.00	0.25	0.671	O	|	|	|	|	2.94
22.667	0.00	0.25	0.669	O	|	|	|	|	2.93
22.750	0.00	0.25	0.668	O	|	|	|	|	2.93
22.833	0.00	0.25	0.666	O	|	|	|	|	2.93
22.917	0.00	0.25	0.664	O	|	|	|	|	2.92
23.000	0.00	0.25	0.662	O	|	|	|	|	2.92
23.083	0.00	0.25	0.661	O	|	|	|	|	2.92
23.167	0.00	0.25	0.659	O	|	|	|	|	2.91
23.250	0.00	0.25	0.657	O	|	|	|	|	2.91
23.333	0.00	0.25	0.656	O	|	|	|	|	2.91
23.417	0.00	0.25	0.654	O	|	|	|	|	2.90
23.500	0.00	0.25	0.652	O	|	|	|	|	2.90
23.583	0.00	0.25	0.650	O	|	|	|	|	2.90
23.667	0.00	0.25	0.649	O	|	|	|	|	2.90
23.750	0.00	0.25	0.647	O	|	|	|	|	2.89
23.833	0.00	0.25	0.645	O	|	|	|	|	2.89
23.917	0.00	0.25	0.644	O	|	|	|	|	2.89
24.000	0.00	0.25	0.642	O	|	|	|	|	2.88
24.083	0.00	0.25	0.640	O	|	|	|	|	2.88
24.167	0.00	0.25	0.639	O	|	|	|	|	2.88
24.250	0.00	0.25	0.637	O	|	|	|	|	2.87
24.333	0.00	0.25	0.635	O	|	|	|	|	2.87
24.417	0.00	0.25	0.633	O	|	|	|	|	2.87
24.500	0.00	0.25	0.632	O	|	|	|	|	2.86
24.583	0.00	0.25	0.630	O	|	|	|	|	2.86
24.667	0.00	0.25	0.628	O	|	|	|	|	2.86
24.750	0.00	0.25	0.627	O	|	|	|	|	2.86
24.833	0.00	0.25	0.625	O	|	|	|	|	2.85
24.917	0.00	0.25	0.623	O	|	|	|	|	2.85
25.000	0.00	0.25	0.622	O	|	|	|	|	2.85
25.083	0.00	0.25	0.620	O	|	|	|	|	2.84
25.167	0.00	0.25	0.618	O	|	|	|	|	2.84
25.250	0.00	0.25	0.617	O	|	|	|	|	2.84
25.333	0.00	0.24	0.615	O	|	|	|	|	2.83
25.417	0.00	0.24	0.613	O	|	|	|	|	2.83
25.500	0.00	0.24	0.611	O	|	|	|	|	2.83
25.583	0.00	0.24	0.610	O	|	|	|	|	2.83
25.667	0.00	0.24	0.608	O	|	|	|	|	2.82
25.750	0.00	0.24	0.606	O	|	|	|	|	2.82
25.833	0.00	0.24	0.605	O	|	|	|	|	2.82
25.917	0.00	0.24	0.603	O	|	|	|	|	2.81
26.000	0.00	0.24	0.601	O	|	|	|	|	2.81
26.083	0.00	0.24	0.600	O	|	|	|	|	2.81
26.167	0.00	0.24	0.598	O	|	|	|	|	2.80
26.250	0.00	0.24	0.596	O	|	|	|	|	2.80
26.333	0.00	0.24	0.595	O	|	|	|	|	2.80
26.417	0.00	0.24	0.593	O	|	|	|	|	2.79

26.500	0.00	0.24	0.591	O	|	|	|	|	2.79
26.583	0.00	0.24	0.590	O	|	|	|	|	2.79
26.667	0.00	0.24	0.588	O	|	|	|	|	2.79
26.750	0.00	0.24	0.586	O	|	|	|	|	2.78
26.833	0.00	0.24	0.585	O	|	|	|	|	2.78
26.917	0.00	0.24	0.583	O	|	|	|	|	2.78
27.000	0.00	0.24	0.581	O	|	|	|	|	2.77
27.083	0.00	0.24	0.580	O	|	|	|	|	2.77
27.167	0.00	0.24	0.578	O	|	|	|	|	2.77
27.250	0.00	0.24	0.576	O	|	|	|	|	2.76
27.333	0.00	0.24	0.575	O	|	|	|	|	2.76
27.417	0.00	0.24	0.573	O	|	|	|	|	2.76
27.500	0.00	0.24	0.571	O	|	|	|	|	2.76
27.583	0.00	0.24	0.570	O	|	|	|	|	2.75
27.667	0.00	0.24	0.568	O	|	|	|	|	2.75
27.750	0.00	0.24	0.566	O	|	|	|	|	2.75
27.833	0.00	0.24	0.565	O	|	|	|	|	2.74
27.917	0.00	0.24	0.563	O	|	|	|	|	2.74
28.000	0.00	0.24	0.561	O	|	|	|	|	2.74
28.083	0.00	0.24	0.560	O	|	|	|	|	2.73
28.167	0.00	0.24	0.558	O	|	|	|	|	2.73
28.250	0.00	0.24	0.556	O	|	|	|	|	2.73
28.333	0.00	0.24	0.555	O	|	|	|	|	2.73
28.417	0.00	0.24	0.553	O	|	|	|	|	2.72
28.500	0.00	0.24	0.551	O	|	|	|	|	2.72
28.583	0.00	0.24	0.550	O	|	|	|	|	2.72
28.667	0.00	0.24	0.548	O	|	|	|	|	2.71
28.750	0.00	0.24	0.546	O	|	|	|	|	2.71
28.833	0.00	0.24	0.545	O	|	|	|	|	2.71
28.917	0.00	0.24	0.543	O	|	|	|	|	2.71
29.000	0.00	0.24	0.541	O	|	|	|	|	2.70
29.083	0.00	0.24	0.540	O	|	|	|	|	2.70
29.167	0.00	0.24	0.538	O	|	|	|	|	2.70
29.250	0.00	0.24	0.536	O	|	|	|	|	2.69
29.333	0.00	0.24	0.535	O	|	|	|	|	2.69
29.417	0.00	0.24	0.533	O	|	|	|	|	2.69
29.500	0.00	0.24	0.532	O	|	|	|	|	2.68
29.583	0.00	0.24	0.530	O	|	|	|	|	2.68
29.667	0.00	0.24	0.528	O	|	|	|	|	2.68
29.750	0.00	0.24	0.527	O	|	|	|	|	2.68
29.833	0.00	0.24	0.525	O	|	|	|	|	2.67
29.917	0.00	0.24	0.523	O	|	|	|	|	2.67
30.000	0.00	0.24	0.522	O	|	|	|	|	2.67
30.083	0.00	0.24	0.520	O	|	|	|	|	2.66
30.167	0.00	0.24	0.518	O	|	|	|	|	2.66
30.250	0.00	0.24	0.517	O	|	|	|	|	2.66
30.333	0.00	0.24	0.515	O	|	|	|	|	2.65
30.417	0.00	0.24	0.514	O	|	|	|	|	2.65
30.500	0.00	0.24	0.512	O	|	|	|	|	2.65
30.583	0.00	0.24	0.510	O	|	|	|	|	2.65
30.667	0.00	0.24	0.509	O	|	|	|	|	2.64
30.750	0.00	0.24	0.507	O	|	|	|	|	2.64
30.833	0.00	0.24	0.505	O	|	|	|	|	2.64
30.917	0.00	0.24	0.504	O	|	|	|	|	2.63
31.000	0.00	0.24	0.502	O	|	|	|	|	2.63
31.083	0.00	0.24	0.500	O	|	|	|	|	2.63

31.167	0.00	0.24	0.499	O	|	|	|	|	2.63
31.250	0.00	0.24	0.497	O	|	|	|	|	2.62
31.333	0.00	0.24	0.496	O	|	|	|	|	2.62
31.417	0.00	0.24	0.494	O	|	|	|	|	2.62
31.500	0.00	0.24	0.492	O	|	|	|	|	2.61
31.583	0.00	0.24	0.491	O	|	|	|	|	2.61
31.667	0.00	0.24	0.489	O	|	|	|	|	2.61
31.750	0.00	0.24	0.488	O	|	|	|	|	2.61
31.833	0.00	0.24	0.486	O	|	|	|	|	2.60
31.917	0.00	0.23	0.484	O	|	|	|	|	2.60
32.000	0.00	0.23	0.483	O	|	|	|	|	2.60
32.083	0.00	0.23	0.481	O	|	|	|	|	2.59
32.167	0.00	0.23	0.479	O	|	|	|	|	2.59
32.250	0.00	0.23	0.478	O	|	|	|	|	2.59
32.333	0.00	0.23	0.476	O	|	|	|	|	2.58
32.417	0.00	0.23	0.475	O	|	|	|	|	2.58
32.500	0.00	0.23	0.473	O	|	|	|	|	2.58
32.583	0.00	0.23	0.471	O	|	|	|	|	2.58
32.667	0.00	0.23	0.470	O	|	|	|	|	2.57
32.750	0.00	0.23	0.468	O	|	|	|	|	2.57
32.833	0.00	0.23	0.467	O	|	|	|	|	2.57
32.917	0.00	0.23	0.465	O	|	|	|	|	2.56
33.000	0.00	0.23	0.463	O	|	|	|	|	2.56
33.083	0.00	0.23	0.462	O	|	|	|	|	2.56
33.167	0.00	0.23	0.460	O	|	|	|	|	2.56
33.250	0.00	0.23	0.458	O	|	|	|	|	2.55
33.333	0.00	0.23	0.457	O	|	|	|	|	2.55
33.417	0.00	0.23	0.455	O	|	|	|	|	2.55
33.500	0.00	0.23	0.454	O	|	|	|	|	2.54
33.583	0.00	0.23	0.452	O	|	|	|	|	2.54
33.667	0.00	0.23	0.450	O	|	|	|	|	2.54
33.750	0.00	0.23	0.449	O	|	|	|	|	2.54
33.833	0.00	0.23	0.447	O	|	|	|	|	2.53
33.917	0.00	0.23	0.446	O	|	|	|	|	2.53
34.000	0.00	0.23	0.444	O	|	|	|	|	2.53
34.083	0.00	0.23	0.442	O	|	|	|	|	2.52
34.167	0.00	0.23	0.441	O	|	|	|	|	2.52
34.250	0.00	0.23	0.439	O	|	|	|	|	2.52
34.333	0.00	0.23	0.438	O	|	|	|	|	2.52
34.417	0.00	0.23	0.436	O	|	|	|	|	2.51
34.500	0.00	0.23	0.435	O	|	|	|	|	2.51
34.583	0.00	0.23	0.433	O	|	|	|	|	2.51
34.667	0.00	0.23	0.431	O	|	|	|	|	2.50
34.750	0.00	0.23	0.430	O	|	|	|	|	2.50
34.833	0.00	0.23	0.428	O	|	|	|	|	2.50
34.917	0.00	0.23	0.427	O	|	|	|	|	2.50
35.000	0.00	0.23	0.425	O	|	|	|	|	2.49
35.083	0.00	0.23	0.423	O	|	|	|	|	2.49
35.167	0.00	0.23	0.422	O	|	|	|	|	2.49
35.250	0.00	0.23	0.420	O	|	|	|	|	2.48
35.333	0.00	0.23	0.419	O	|	|	|	|	2.48
35.417	0.00	0.23	0.417	O	|	|	|	|	2.48
35.500	0.00	0.23	0.415	O	|	|	|	|	2.48
35.583	0.00	0.23	0.414	O	|	|	|	|	2.47
35.667	0.00	0.23	0.412	O	|	|	|	|	2.47
35.750	0.00	0.23	0.411	O	|	|	|	|	2.47

35.833	0.00	0.23	0.409	O	|	|	|	|	2.46
35.917	0.00	0.23	0.408	O	|	|	|	|	2.46
36.000	0.00	0.23	0.406	O	|	|	|	|	2.46
36.083	0.00	0.23	0.404	O	|	|	|	|	2.46
36.167	0.00	0.23	0.403	O	|	|	|	|	2.45
36.250	0.00	0.23	0.401	O	|	|	|	|	2.45
36.333	0.00	0.23	0.400	O	|	|	|	|	2.45
36.417	0.00	0.23	0.398	O	|	|	|	|	2.44
36.500	0.00	0.23	0.397	O	|	|	|	|	2.44
36.583	0.00	0.23	0.395	O	|	|	|	|	2.44
36.667	0.00	0.23	0.393	O	|	|	|	|	2.44
36.750	0.00	0.23	0.392	O	|	|	|	|	2.43
36.833	0.00	0.23	0.390	O	|	|	|	|	2.43
36.917	0.00	0.23	0.389	O	|	|	|	|	2.43
37.000	0.00	0.23	0.387	O	|	|	|	|	2.42
37.083	0.00	0.23	0.386	O	|	|	|	|	2.42
37.167	0.00	0.23	0.384	O	|	|	|	|	2.42
37.250	0.00	0.23	0.382	O	|	|	|	|	2.42
37.333	0.00	0.23	0.381	O	|	|	|	|	2.41
37.417	0.00	0.23	0.379	O	|	|	|	|	2.41
37.500	0.00	0.23	0.378	O	|	|	|	|	2.41
37.583	0.00	0.23	0.376	O	|	|	|	|	2.40
37.667	0.00	0.23	0.375	O	|	|	|	|	2.40
37.750	0.00	0.23	0.373	O	|	|	|	|	2.40
37.833	0.00	0.23	0.372	O	|	|	|	|	2.40
37.917	0.00	0.23	0.370	O	|	|	|	|	2.39
38.000	0.00	0.23	0.368	O	|	|	|	|	2.39
38.083	0.00	0.23	0.367	O	|	|	|	|	2.39
38.167	0.00	0.23	0.365	O	|	|	|	|	2.39
38.250	0.00	0.23	0.364	O	|	|	|	|	2.38
38.333	0.00	0.23	0.362	O	|	|	|	|	2.38
38.417	0.00	0.23	0.361	O	|	|	|	|	2.38
38.500	0.00	0.22	0.359	O	|	|	|	|	2.37
38.583	0.00	0.22	0.358	O	|	|	|	|	2.37
38.667	0.00	0.22	0.356	O	|	|	|	|	2.37
38.750	0.00	0.22	0.354	O	|	|	|	|	2.37
38.833	0.00	0.22	0.353	O	|	|	|	|	2.36
38.917	0.00	0.22	0.351	O	|	|	|	|	2.36
39.000	0.00	0.22	0.350	O	|	|	|	|	2.36
39.083	0.00	0.22	0.348	O	|	|	|	|	2.35
39.167	0.00	0.22	0.347	O	|	|	|	|	2.35
39.250	0.00	0.22	0.345	O	|	|	|	|	2.35
39.333	0.00	0.22	0.344	O	|	|	|	|	2.35
39.417	0.00	0.22	0.342	O	|	|	|	|	2.34
39.500	0.00	0.22	0.341	O	|	|	|	|	2.34
39.583	0.00	0.22	0.339	O	|	|	|	|	2.34
39.667	0.00	0.22	0.338	O	|	|	|	|	2.33
39.750	0.00	0.22	0.336	O	|	|	|	|	2.33
39.833	0.00	0.22	0.334	O	|	|	|	|	2.33
39.917	0.00	0.22	0.333	O	|	|	|	|	2.33
40.000	0.00	0.22	0.331	O	|	|	|	|	2.32
40.083	0.00	0.22	0.330	O	|	|	|	|	2.32
40.167	0.00	0.22	0.328	O	|	|	|	|	2.32
40.250	0.00	0.22	0.327	O	|	|	|	|	2.32
40.333	0.00	0.22	0.325	O	|	|	|	|	2.31
40.417	0.00	0.22	0.324	O	|	|	|	|	2.31

40.500	0.00	0.22	0.322	O	|	|	|	|	2.31
40.583	0.00	0.22	0.321	O	|	|	|	|	2.30
40.667	0.00	0.22	0.319	O	|	|	|	|	2.30
40.750	0.00	0.22	0.318	O	|	|	|	|	2.30
40.833	0.00	0.22	0.316	O	|	|	|	|	2.30
40.917	0.00	0.22	0.315	O	|	|	|	|	2.29
41.000	0.00	0.22	0.313	O	|	|	|	|	2.29
41.083	0.00	0.22	0.312	O	|	|	|	|	2.29
41.167	0.00	0.22	0.310	O	|	|	|	|	2.29
41.250	0.00	0.22	0.308	O	|	|	|	|	2.28
41.333	0.00	0.22	0.307	O	|	|	|	|	2.28
41.417	0.00	0.22	0.305	O	|	|	|	|	2.28
41.500	0.00	0.22	0.304	O	|	|	|	|	2.27
41.583	0.00	0.22	0.302	O	|	|	|	|	2.27
41.667	0.00	0.22	0.301	O	|	|	|	|	2.27
41.750	0.00	0.22	0.299	O	|	|	|	|	2.27
41.833	0.00	0.22	0.298	O	|	|	|	|	2.26
41.917	0.00	0.22	0.296	O	|	|	|	|	2.26
42.000	0.00	0.22	0.295	O	|	|	|	|	2.26
42.083	0.00	0.22	0.293	O	|	|	|	|	2.26
42.167	0.00	0.22	0.292	O	|	|	|	|	2.25
42.250	0.00	0.22	0.290	O	|	|	|	|	2.25
42.333	0.00	0.22	0.289	O	|	|	|	|	2.25
42.417	0.00	0.22	0.287	O	|	|	|	|	2.24
42.500	0.00	0.22	0.286	O	|	|	|	|	2.24
42.583	0.00	0.22	0.284	O	|	|	|	|	2.24
42.667	0.00	0.22	0.283	O	|	|	|	|	2.24
42.750	0.00	0.22	0.281	O	|	|	|	|	2.23
42.833	0.00	0.22	0.280	O	|	|	|	|	2.23
42.917	0.00	0.22	0.278	O	|	|	|	|	2.23
43.000	0.00	0.22	0.277	O	|	|	|	|	2.23
43.083	0.00	0.22	0.275	O	|	|	|	|	2.22
43.167	0.00	0.22	0.274	O	|	|	|	|	2.22
43.250	0.00	0.22	0.272	O	|	|	|	|	2.22
43.333	0.00	0.22	0.271	O	|	|	|	|	2.21
43.417	0.00	0.22	0.269	O	|	|	|	|	2.21
43.500	0.00	0.22	0.268	O	|	|	|	|	2.21
43.583	0.00	0.22	0.266	O	|	|	|	|	2.21
43.667	0.00	0.22	0.265	O	|	|	|	|	2.20
43.750	0.00	0.22	0.263	O	|	|	|	|	2.20
43.833	0.00	0.22	0.262	O	|	|	|	|	2.20
43.917	0.00	0.22	0.260	O	|	|	|	|	2.20
44.000	0.00	0.22	0.259	O	|	|	|	|	2.19
44.083	0.00	0.22	0.257	O	|	|	|	|	2.19
44.167	0.00	0.22	0.256	O	|	|	|	|	2.19
44.250	0.00	0.22	0.254	O	|	|	|	|	2.18
44.333	0.00	0.22	0.253	O	|	|	|	|	2.18
44.417	0.00	0.22	0.251	O	|	|	|	|	2.18
44.500	0.00	0.22	0.250	O	|	|	|	|	2.18
44.583	0.00	0.22	0.248	O	|	|	|	|	2.17
44.667	0.00	0.22	0.247	O	|	|	|	|	2.17
44.750	0.00	0.22	0.245	O	|	|	|	|	2.17
44.833	0.00	0.22	0.244	O	|	|	|	|	2.17
44.917	0.00	0.22	0.242	O	|	|	|	|	2.16
45.000	0.00	0.21	0.241	O	|	|	|	|	2.16
45.083	0.00	0.21	0.240	O	|	|	|	|	2.16

45.167	0.00	0.21	0.238	O	|	|	|	|	2.16
45.250	0.00	0.21	0.237	O	|	|	|	|	2.15
45.333	0.00	0.21	0.235	O	|	|	|	|	2.15
45.417	0.00	0.21	0.234	O	|	|	|	|	2.15
45.500	0.00	0.21	0.232	O	|	|	|	|	2.14
45.583	0.00	0.21	0.231	O	|	|	|	|	2.14
45.667	0.00	0.21	0.229	O	|	|	|	|	2.14
45.750	0.00	0.21	0.228	O	|	|	|	|	2.14
45.833	0.00	0.21	0.226	O	|	|	|	|	2.13
45.917	0.00	0.21	0.225	O	|	|	|	|	2.13
46.000	0.00	0.21	0.223	O	|	|	|	|	2.13
46.083	0.00	0.21	0.222	O	|	|	|	|	2.13
46.167	0.00	0.21	0.220	O	|	|	|	|	2.12
46.250	0.00	0.21	0.219	O	|	|	|	|	2.12
46.333	0.00	0.21	0.217	O	|	|	|	|	2.12
46.417	0.00	0.21	0.216	O	|	|	|	|	2.12
46.500	0.00	0.21	0.215	O	|	|	|	|	2.11
46.583	0.00	0.21	0.213	O	|	|	|	|	2.11
46.667	0.00	0.21	0.212	O	|	|	|	|	2.11
46.750	0.00	0.21	0.210	O	|	|	|	|	2.10
46.833	0.00	0.21	0.209	O	|	|	|	|	2.10
46.917	0.00	0.21	0.207	O	|	|	|	|	2.10
47.000	0.00	0.21	0.206	O	|	|	|	|	2.10
47.083	0.00	0.21	0.204	O	|	|	|	|	2.09
47.167	0.00	0.21	0.203	O	|	|	|	|	2.09
47.250	0.00	0.21	0.201	O	|	|	|	|	2.09
47.333	0.00	0.21	0.200	O	|	|	|	|	2.09
47.417	0.00	0.21	0.198	O	|	|	|	|	2.08
47.500	0.00	0.21	0.197	O	|	|	|	|	2.08
47.583	0.00	0.21	0.196	O	|	|	|	|	2.08
47.667	0.00	0.21	0.194	O	|	|	|	|	2.08
47.750	0.00	0.21	0.193	O	|	|	|	|	2.07
47.833	0.00	0.21	0.191	O	|	|	|	|	2.07
47.917	0.00	0.21	0.190	O	|	|	|	|	2.07
48.000	0.00	0.21	0.188	O	|	|	|	|	2.07
48.083	0.00	0.21	0.187	O	|	|	|	|	2.06
48.167	0.00	0.21	0.185	O	|	|	|	|	2.06
48.250	0.00	0.21	0.184	O	|	|	|	|	2.06
48.333	0.00	0.21	0.182	O	|	|	|	|	2.06
48.417	0.00	0.21	0.181	O	|	|	|	|	2.05
48.500	0.00	0.21	0.180	O	|	|	|	|	2.05
48.583	0.00	0.21	0.178	O	|	|	|	|	2.05
48.667	0.00	0.21	0.177	O	|	|	|	|	2.04
48.750	0.00	0.21	0.175	O	|	|	|	|	2.04
48.833	0.00	0.21	0.174	O	|	|	|	|	2.04
48.917	0.00	0.21	0.172	O	|	|	|	|	2.04
49.000	0.00	0.21	0.171	O	|	|	|	|	2.03
49.083	0.00	0.21	0.170	O	|	|	|	|	2.03
49.167	0.00	0.21	0.168	O	|	|	|	|	2.03
49.250	0.00	0.21	0.167	O	|	|	|	|	2.03
49.333	0.00	0.21	0.165	O	|	|	|	|	2.02
49.417	0.00	0.21	0.164	O	|	|	|	|	2.02
49.500	0.00	0.21	0.162	O	|	|	|	|	2.02
49.583	0.00	0.21	0.161	O	|	|	|	|	2.02
49.667	0.00	0.21	0.159	O	|	|	|	|	2.01
49.750	0.00	0.21	0.158	O	|	|	|	|	2.01

49.833	0.00	0.21	0.157	O	|	|	|	|	2.01
49.917	0.00	0.21	0.155	O	|	|	|	|	2.01
50.000	0.00	0.21	0.154	O	|	|	|	|	2.00
50.083	0.00	0.21	0.152	O	|	|	|	|	2.00
50.167	0.00	0.21	0.151	O	|	|	|	|	1.99
50.250	0.00	0.21	0.149	O	|	|	|	|	1.97
50.333	0.00	0.20	0.148	O	|	|	|	|	1.95
50.417	0.00	0.20	0.147	O	|	|	|	|	1.93
50.500	0.00	0.20	0.145	O	|	|	|	|	1.91
50.583	0.00	0.20	0.144	O	|	|	|	|	1.89
50.667	0.00	0.20	0.142	O	|	|	|	|	1.87
50.750	0.00	0.20	0.141	O	|	|	|	|	1.86
50.833	0.00	0.20	0.140	O	|	|	|	|	1.84
50.917	0.00	0.20	0.138	O	|	|	|	|	1.82
51.000	0.00	0.20	0.137	O	|	|	|	|	1.80
51.083	0.00	0.20	0.136	O	|	|	|	|	1.78
51.167	0.00	0.20	0.134	O	|	|	|	|	1.77
51.250	0.00	0.19	0.133	O	|	|	|	|	1.75
51.333	0.00	0.19	0.132	O	|	|	|	|	1.73
51.417	0.00	0.19	0.130	O	|	|	|	|	1.71
51.500	0.00	0.19	0.129	O	|	|	|	|	1.70
51.583	0.00	0.19	0.128	O	|	|	|	|	1.68
51.667	0.00	0.19	0.126	O	|	|	|	|	1.66
51.750	0.00	0.19	0.125	O	|	|	|	|	1.65
51.833	0.00	0.19	0.124	O	|	|	|	|	1.63
51.917	0.00	0.19	0.122	O	|	|	|	|	1.61
52.000	0.00	0.19	0.121	O	|	|	|	|	1.59
52.083	0.00	0.19	0.120	O	|	|	|	|	1.58
52.167	0.00	0.18	0.119	O	|	|	|	|	1.56
52.250	0.00	0.18	0.117	O	|	|	|	|	1.54
52.333	0.00	0.18	0.116	O	|	|	|	|	1.53
52.417	0.00	0.18	0.115	O	|	|	|	|	1.51
52.500	0.00	0.18	0.114	O	|	|	|	|	1.49
52.583	0.00	0.18	0.112	O	|	|	|	|	1.48
52.667	0.00	0.18	0.111	O	|	|	|	|	1.46
52.750	0.00	0.18	0.110	O	|	|	|	|	1.45
52.833	0.00	0.18	0.109	O	|	|	|	|	1.43
52.917	0.00	0.18	0.107	O	|	|	|	|	1.41
53.000	0.00	0.17	0.106	O	|	|	|	|	1.40
53.083	0.00	0.17	0.105	O	|	|	|	|	1.38
53.167	0.00	0.17	0.104	O	|	|	|	|	1.37
53.250	0.00	0.17	0.103	O	|	|	|	|	1.35
53.333	0.00	0.17	0.101	O	|	|	|	|	1.34
53.417	0.00	0.17	0.100	O	|	|	|	|	1.32
53.500	0.00	0.17	0.099	O	|	|	|	|	1.30
53.583	0.00	0.17	0.098	O	|	|	|	|	1.29
53.667	0.00	0.17	0.097	O	|	|	|	|	1.27
53.750	0.00	0.17	0.096	O	|	|	|	|	1.26
53.833	0.00	0.17	0.095	O	|	|	|	|	1.24
53.917	0.00	0.16	0.093	O	|	|	|	|	1.23
54.000	0.00	0.16	0.092	O	|	|	|	|	1.21
54.083	0.00	0.16	0.091	O	|	|	|	|	1.20
54.167	0.00	0.16	0.090	O	|	|	|	|	1.18
54.250	0.00	0.16	0.089	O	|	|	|	|	1.17
54.333	0.00	0.16	0.088	O	|	|	|	|	1.16
54.417	0.00	0.16	0.087	O	|	|	|	|	1.14

54.500	0.00	0.16	0.086	O	|	|	|	|	1.13
54.583	0.00	0.16	0.085	O	|	|	|	|	1.11
54.667	0.00	0.16	0.083	O	|	|	|	|	1.10
54.750	0.00	0.16	0.082	O	|	|	|	|	1.08
54.833	0.00	0.15	0.081	O	|	|	|	|	1.07
54.917	0.00	0.15	0.080	O	|	|	|	|	1.06
55.000	0.00	0.15	0.079	O	|	|	|	|	1.04
55.083	0.00	0.15	0.078	O	|	|	|	|	1.03
55.167	0.00	0.15	0.077	O	|	|	|	|	1.01
55.250	0.00	0.15	0.076	O	|	|	|	|	1.00
55.333	0.00	0.15	0.075	O	|	|	|	|	0.99
55.417	0.00	0.15	0.074	O	|	|	|	|	0.97
55.500	0.00	0.15	0.073	O	|	|	|	|	0.96
55.583	0.00	0.15	0.072	O	|	|	|	|	0.95
55.667	0.00	0.14	0.071	O	|	|	|	|	0.93
55.750	0.00	0.14	0.070	O	|	|	|	|	0.92
55.833	0.00	0.14	0.069	O	|	|	|	|	0.91
55.917	0.00	0.14	0.068	O	|	|	|	|	0.90
56.000	0.00	0.14	0.067	O	|	|	|	|	0.88
56.083	0.00	0.14	0.066	O	|	|	|	|	0.87
56.167	0.00	0.14	0.065	O	|	|	|	|	0.86
56.250	0.00	0.14	0.064	O	|	|	|	|	0.84
56.333	0.00	0.14	0.063	O	|	|	|	|	0.83
56.417	0.00	0.14	0.062	O	|	|	|	|	0.82
56.500	0.00	0.14	0.061	O	|	|	|	|	0.81
56.583	0.00	0.13	0.060	O	|	|	|	|	0.80
56.667	0.00	0.13	0.060	O	|	|	|	|	0.78
56.750	0.00	0.13	0.059	O	|	|	|	|	0.77
56.833	0.00	0.13	0.058	O	|	|	|	|	0.76
56.917	0.00	0.13	0.057	O	|	|	|	|	0.75
57.000	0.00	0.13	0.056	O	|	|	|	|	0.74
57.083	0.00	0.13	0.055	O	|	|	|	|	0.72
57.167	0.00	0.13	0.054	O	|	|	|	|	0.71
57.250	0.00	0.13	0.053	O	|	|	|	|	0.70
57.333	0.00	0.13	0.052	O	|	|	|	|	0.69
57.417	0.00	0.12	0.052	O	|	|	|	|	0.68
57.500	0.00	0.12	0.051	O	|	|	|	|	0.67
57.583	0.00	0.12	0.050	O	|	|	|	|	0.66
57.667	0.00	0.12	0.049	O	|	|	|	|	0.64
57.750	0.00	0.12	0.048	O	|	|	|	|	0.63
57.833	0.00	0.12	0.047	O	|	|	|	|	0.62
57.917	0.00	0.12	0.046	O	|	|	|	|	0.61
58.000	0.00	0.12	0.046	O	|	|	|	|	0.60
58.083	0.00	0.12	0.045	O	|	|	|	|	0.59
58.167	0.00	0.12	0.044	O	|	|	|	|	0.58
58.250	0.00	0.12	0.043	O	|	|	|	|	0.57
58.333	0.00	0.12	0.042	O	|	|	|	|	0.56
58.417	0.00	0.11	0.042	O	|	|	|	|	0.55
58.500	0.00	0.11	0.041	O	|	|	|	|	0.54
58.583	0.00	0.11	0.040	O	|	|	|	|	0.53
58.667	0.00	0.11	0.039	O	|	|	|	|	0.52
58.750	0.00	0.11	0.039	O	|	|	|	|	0.51
58.833	0.00	0.11	0.038	O	|	|	|	|	0.50
58.917	0.00	0.11	0.037	O	|	|	|	|	0.49
59.000	0.00	0.11	0.036	O	|	|	|	|	0.48
59.083	0.00	0.10	0.036	O	|	|	|	|	0.47

59.167	0.00	0.10	0.035	O	|	|	|	|	0.46
59.250	0.00	0.10	0.034	O	|	|	|	|	0.45

Remaining water in basin = 0.03 (Ac.Ft)

****************************HYDROGRAPH DATA****************************

Number of intervals = 711

Time interval = 5.0 (Min.)

Maximum/Peak flow rate = 0.283 (CFS)

Total volume = 1.133 (Ac.Ft)

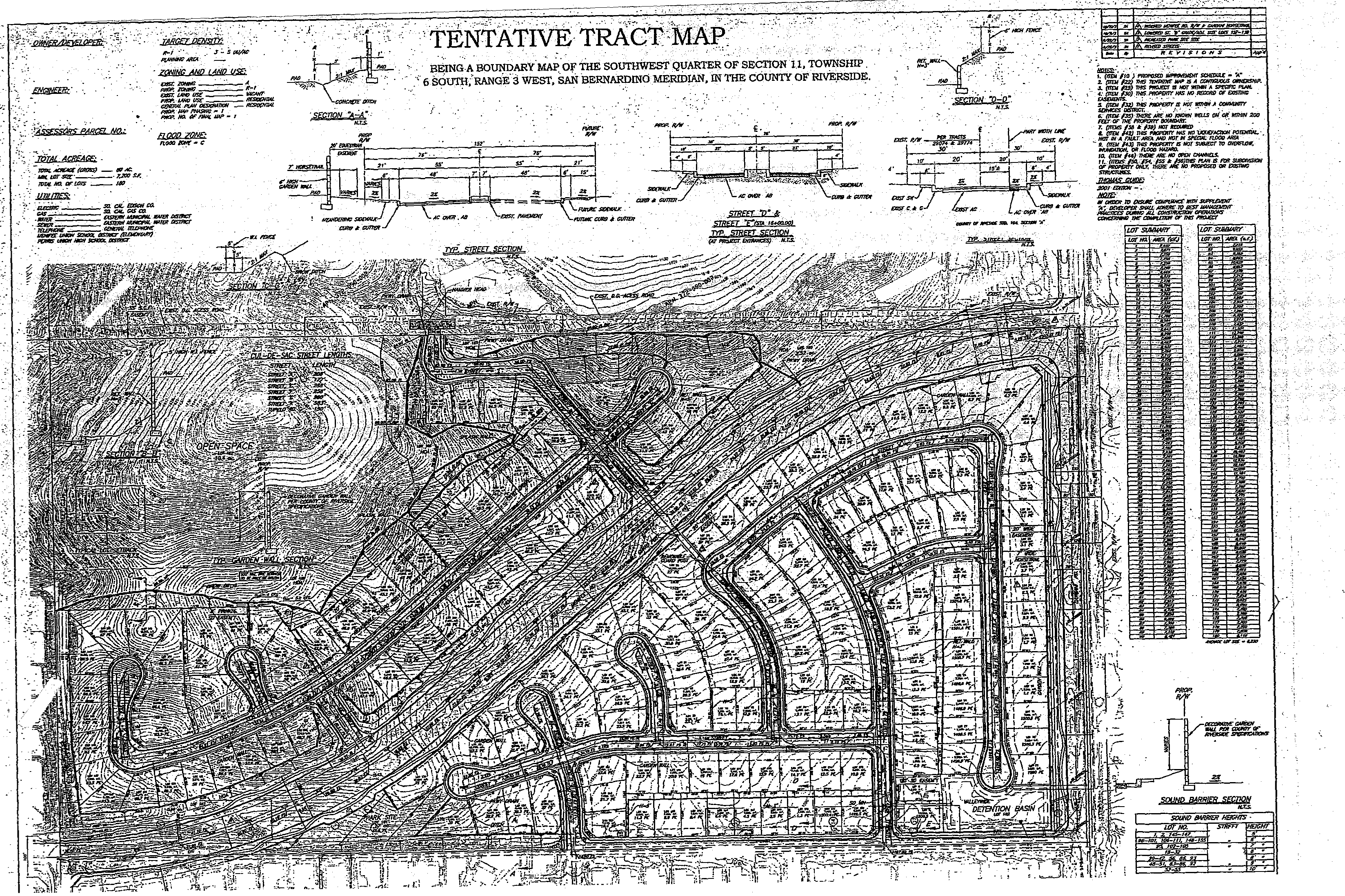
Status of hydrographs being held in storage

	Stream 1	Stream 2	Stream 3	Stream 4	Stream 5
Peak (CFS)	0.000	0.000	0.000	0.000	0.000
Vol (Ac.Ft)	0.000	0.000	0.000	0.000	0.000

****

Appendix A
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:
SECTION "A-A"
SECTION "D-D"
TYP. STREET SECTION
STREET "D" & STREET "E"
TYP. STREET SECTION
OPEN SPACE
CUL-DE-SAC STREET LENGTHS
SECTION "B-B"
TYP. GARDEN WALL SECTION
DETENTION BASIN
NOTES:
THOMAS GUIDE:
NOTE:
LOT SUMMARY
LOT SUMMARY
REVISIONS
SOUND BARRIER SECTION
SOUND BARRIER HEIGHTS

Datasheet

Site Conditions:

A_{total} = 80 acres
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:	**NAME**
Company:	**ABC Engineering**
Date:	**June 15, 2009**
Project:	**Grass Swale Design 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)***

Design Procedure Form for Grassed Swale

Designer: **NAME**
Company: **ABC Engineering**
Date: **June 15, 2009**
Project: **Grass Swale Design 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.

Appendix A
Stormwater Quality Best Management Practice
Design Handbook

Austin Sand Filter Example

Datasheet

Site Conditions:

A_{total} = 64.8 acres
V_{BMP} = 50820 ft^3 (from worksheet 1)
L:W Ratio = 2:1 (min 2:1, consider site constraints)
Site Elevation = 1509.1’ (at proposed BMP location)
Outlet Elevation = 1500’ (storm drain system to serve as outlet)

Design Assumptions:

Sedimentation Basin Design:
The sedimentation basin volume must be greater than or equal to the V_{BMP}. The maximum depth of water in the sedimentation basin, 2h, is determined based on the total elevation difference between the BMP inlet and outlet.

Using Figure 9:
Elev. of point A = 1500.1 ft (assuming 10’ to connect to outlet at 1% slope)
Filter Depth = 3 ft (assuming the minimum depth of 3 ft)
Elev. of point B = 1503.1 ft
Elev. of point C = 1509.1 ft (site elevation)
2h = [(C-B)-1’ freeboard]
= 5 ft

Sedimentation Basin Area
$A_s = V_{BMP} / (2h) = 50820\ ft^3 / (5\ ft) = 10164\ ft^2$

L = 2 * W
$A_s = 2W^2$
$10164\ ft^2 = 4*W^2$

W = 71.3 ft → round to 72 ft
L = 144 ft
$A_S = 10368\ ft^2$

Filter Basin Design:
The minimum filter basin surface area is determined with the following equation:

$A_f = V_{BMP} / 18$
$= 50820\ ft^3 / 18 = 2823\ ft^2$

$V_{fb} = A_f$ * filter depth
$= 2823\ ft^2 * 3\ ft = 8469\ ft^3$

The required filter basin volume shall be at least 20 percent of the V_{BMP}:

$V_r = 0.2 * V_{BMP} = 10164\ ft^3 \geq V_{fb}$ → Not Ok, increase filter area

$A_f = V_r$ / filter depth
$= 10164\ ft^3 / 3\ ft = 3388\ ft^2$

width = 72 ft (same as sedimentation basin)
length = $3388\ ft^2 / 72\ ft = 47.1$ → round to 50 ft

$A_f = 3600\ ft^2$
$V_f = 3600\ ft^2 * 3\ ft = 10800\ ft^3$

$V_{fb} = A_f$ * filter depth
$= 2823\ ft^2 * 3\ ft = 8469\ ft^3 \geq Vr$ → Ok

Design Procedure for BMP Design Volume

Designer: NAME
Company: ABC Engineering
Date: June 15th, 2009
Project: Austin Sand Filter Design Example
Location:

1. Determine the Tributary Area to the BMP (A_{trib})	A_{trib} = 64.8 acres ***(1)***
2. Determine the impervious area ratio (*i*)	
a. Determine impervious area within (A_{trib})	A_{imp} = 48.6 acres ***(2)***
b. Calculate *i* = **(2)** / **(1)**	*i* = 0.75 acres/acre ***(3)***
3. Determine Runoff Coefficient (C) $C = 0.858 \cdot \boldsymbol{i}^3 - 0.78 \cdot \boldsymbol{i}^2 + 0.774 \cdot \boldsymbol{i} + 0.04$ $C = 0.858 \cdot \boldsymbol{(3)}^3 - 0.78 \cdot \boldsymbol{(3)}^2 + 0.774 \cdot \boldsymbol{(3)} + 0.04$	C = 0.54 ***(4)***
4. Determine Unit Storage Volume (V_u) $V_u = 0.40 \cdot C$ $V_u = 0.40 \cdot$ **(4)**	V_u = .216 acre-in/acre ***(5)***
5. Determine Design Storage Volume	
a. V_{BMP} = ***(5)*** x ***(1)*** [acre-in]	V_{BMP} = 14 acre-in ***(6)***
b. V_{BMP} = ***(6)*** / 12 [acre-ft]	V_{BMP} = 1.17 acre-ft ***(7)***
c. V_{BMP} = ***(7)*** x 43560 [ft^3]	V_{BMP} = 50,820 ft^3 ***(8)***

Notes:

Design Procedure Form for Austin Sand Filter

Designer: NAME
Company: ABC Engineering
Date: June 15, 2009
Project: BMP Example
Location: ______

1. Determine Design Storage Volume (Use Worksheet 1) a. Total Tributary Area (maximum 100) b. Design Storage Volume, V_{BMP}	A_{total} = 64.8 acres V_{BMP} = 50820 ft^3
2. Maximum Water Height in Sedimentation Basin* a. Invert elevation at connection to storm drain system. b. Sand Filter invert elevation (consider min. grade (1%) from storm drain). Point A, Figure 9. c. Estimate filter depth or use min. (3'). d. Top elevation of filter bed. Point B, Figure 9. e. Surface elevation at BMP inlet. Point C, Figure 9. f. Determine max. allowable height (2h) of water in the sedimentation basin using the elevation difference between points C and B. (min. 2', max. 10') 2h = [(C-B) – 1' Freeboard]	Elev. Storm Drain = 1500 ft Elev. Pt A = 1500.1 ft Filter Depth = 3 ft Elev. Pt B = 1503.1 ft Elev. Pt C = 1509.1 ft 2h = 5 ft
3. Size Sedimentation Basin a. Find Sedimentation Basin Area, A_s $A_s = V_{BMP} / (2h)$ b. Determine basin length and width, using a length to width ratio ≥ 2:1 $A_s = 2 \times W^2$ length = 2 x width	A_s = 10164 ft^2 width = 72 ft length = 144 ft
4. Size Filter Basin a. Determine Filter Basin Area, A_f minimum $A_f = V_{BMP} / 18$	A_f = 3600 ft^2

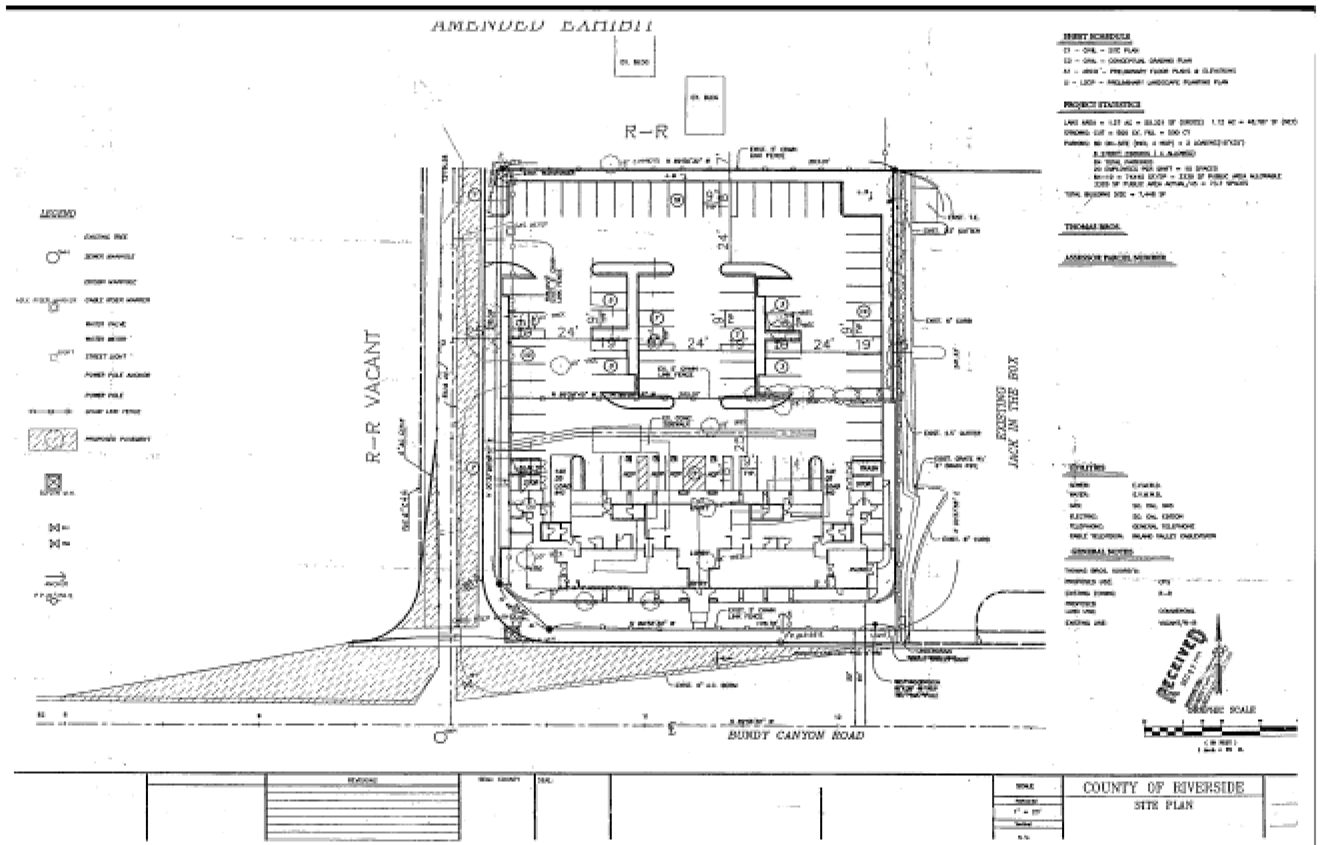
b. Determine Filter Basin Volume $V_f = A_f$ x filter depth (part 2c) c. Determine Required Volume, V_r $V_r = 0.2 \times V_{BMP}$ d. Check if $V_r \geq V_f$? If no, redesign with an increased filter depth or increase filter area.	V_f = __10800__ ft^3 V_r = __10164__ ft^3 Check $V_r \geq V_f$ ____ok___

Notes:
The total surface area occupied by this BMP is 0.32 Acres

* Based on these elevations, is there a sufficient elevation drop to allow gravity flow from the outlet of the control measure to the storm drain system? If no, investigate alternative on-site locations for treatment control, consider another treatment control measure more suitable for site conditions, or contact the District to discuss on-site pumping requirements.

Appendix A
Stormwater Quality Best Management Practice
Design Handbook

Infiltration Basin Example


AMENDED EXHIBIT
R-R
R-R VACANT
EXISTING JACK IN THE BOX
BUNDY CANYON ROAD
LEGEND
SHEET SCHEDULE
PROJECT STATISTICS
UTILITIES
GENERAL NOTES
RECEIVED
GRAPHIC SCALE
COUNTY OF RIVERSIDE
SITE PLAN

Worksheet 1

Design Procedure for BMP Design Volume

Designer: NAME

Company: ABC Engineering

Date: June 15, 2009

Project: Infiltration Basin Design Example

Location:

1. Determine the Tributary Area to the BMP (A_{trib})	A_{trib} = 3.84	acres	*(1)*
2. Determine the impervious area ratio (*i*)			
a. Determine impervious area within (A_{trib})	A_{imp} = 1.92	acres	*(2)*
b. Calculate *i* = **(2)** / **(1)**	*i* = 0.90	acres / acre	*(3)*
3. Determine Runoff Coefficient (C) $C = 0.858 \cdot \boldsymbol{i}^3 - 0.78 \cdot \boldsymbol{i}^2 + 0.774 \cdot \boldsymbol{i} + 0.04$ $C = 0.858 \cdot \boldsymbol{(3)}^3 - 0.78 \cdot \boldsymbol{(3)}^2 + 0.774 \cdot \boldsymbol{(3)} + 0.04$	C = .73		*(4)*
4. Determine Unit Storage Volume (V_u) $V_u = 0.40 \cdot C$ $V_u = 0.40 \cdot \mathbf{(4)}$	V_u = 0.292	acre-in / acre	*(5)*
5. Determine Design Storage Volume			
a. V_{BMP} = ***(5)*** x ***(1)*** [acre-in]	V_{BMP} = 1.12	acre-in	*(6)*
b. V_{BMP} = ***(6)*** / 12 [acre-ft]	V_{BMP} = 0.093	acre-ft	*(7)*
c. V_{BMP} = ***(7)*** x 43560 [ft^3]	V_{BMP} = 4051	ft^3	*(8)*

Notes:

Datasheet

Site Conditions

A_{total} = 3.84 acres
Land Use = Commercial
Impervious Cover = 90%

Design Assumptions

1. Design Storage Volume

V_{BMP} = 4051 ft^3 (from worksheet 1)

2. Trench Water Depth

Maximum depth should not exceed 8 feet
Calculate the maximum allowable depth of water in the trench, Dm, in feet using the following equation:

$$D_m = [(t) \times (I)] / 12s$$

Where I = site infiltration rate (in/hr)
s = safety factor
t = minimum draw down time (48 hours)

Step#1: For urban cover with B type soil the District uses a RI value of 56
Step#2: Using Plate E-6.2, Fp (infiltration rate) = 0.517 in/hr (for an AMC II)
Step#3: Assuming a safety factor of 3, **D_m = 0.689 feet**

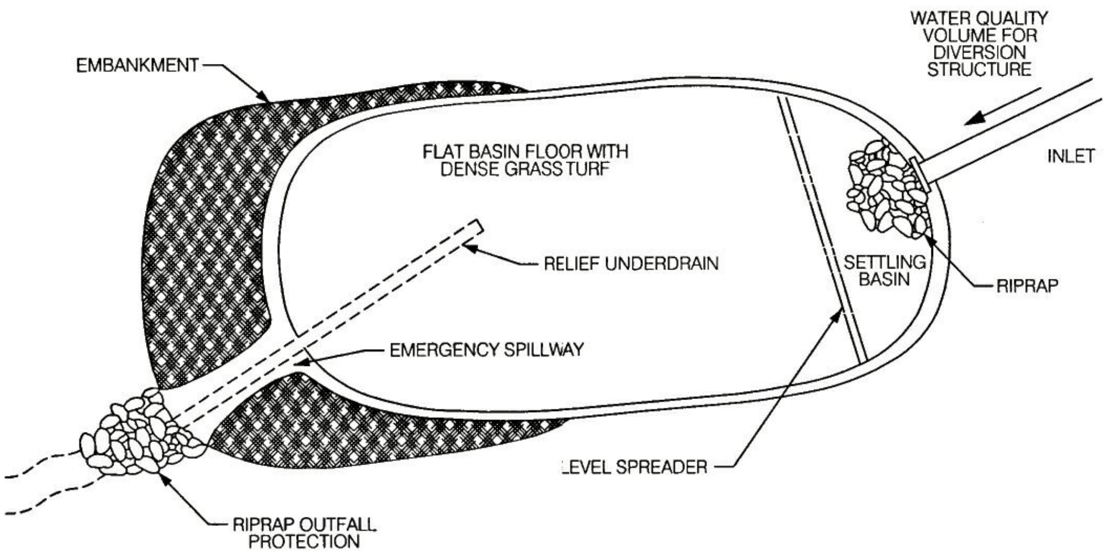
3. Trench Surface Area

Calculate the minimum surface area of the trench bottom will the following equation:

$$A_m = V_{BMP} / D_m$$

$A_m = 5880\ ft^2 = 0.135$ Acres

Where A_m = minimum area required (ft^2)
V_{BMP} = volume of the infiltration basin (ft^3)
D_m = maximum allowable depth (ft)



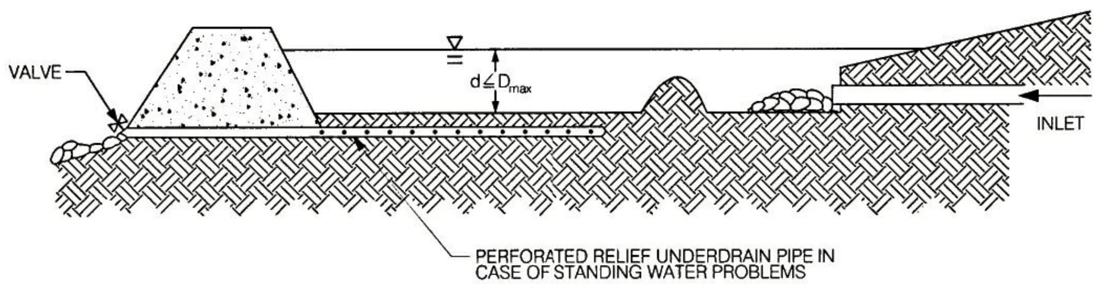


Figure 6: INFILTRATION BASIN

Source: City of Modesto Guidance Manual

Worksheet 4

Design Procedure Form for Infiltration Basin

Designer: NAME

Company: ABC Engineering

Date: June 15, 2009

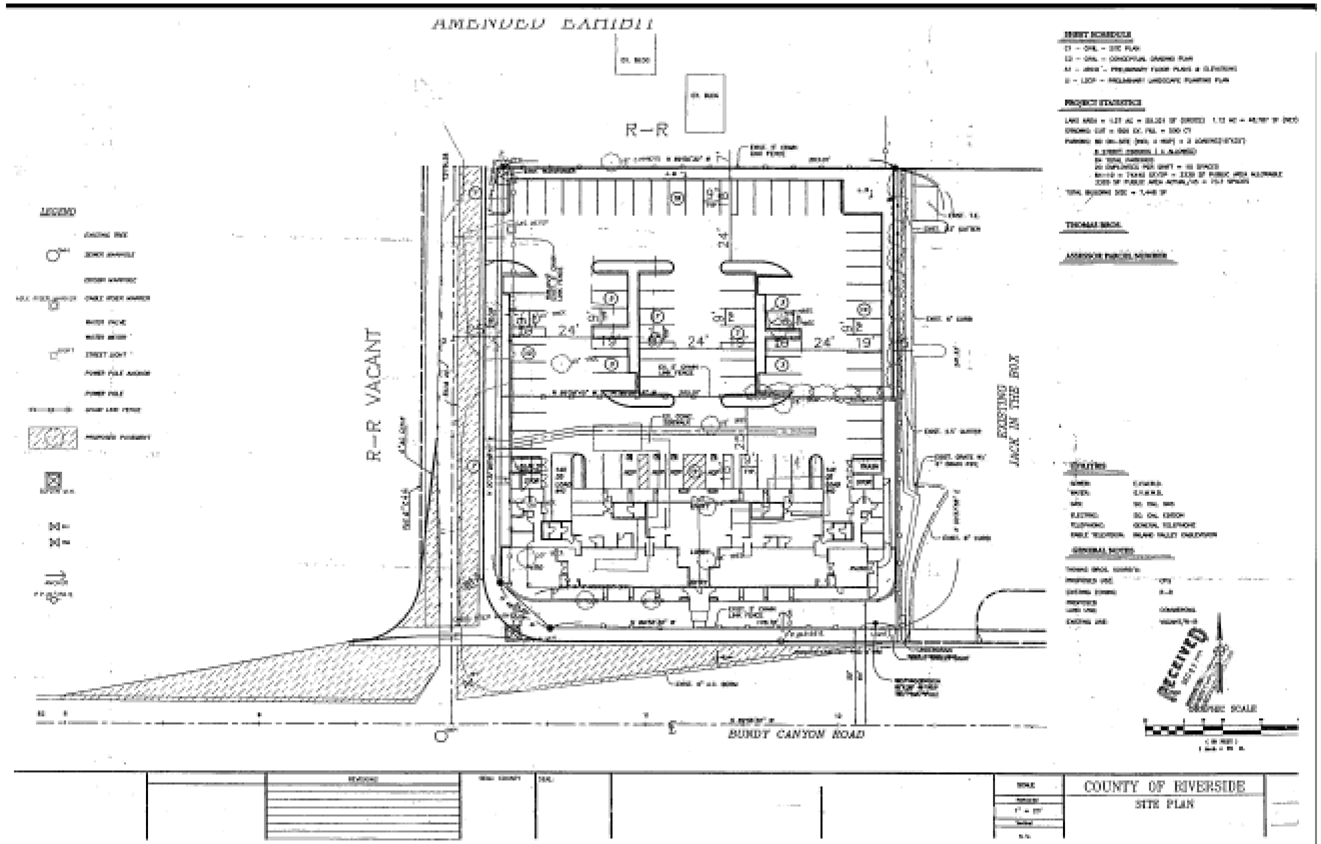
Project: ____________________

1. Determine Design Storage Volume (Use Worksheet 1) a. Total Tributary Area (maximum 50) b. Design Storage Volume, V_{BMP}	A_{total} = 3.84 acres V_{BMP} = 4051 ft^3
2. Maximum Allowable Depth (D_m) a. Site infiltration rate (I) b. Minimum drawdown time (48 hrs) c. Safety factor (s) d. $D_m = [(t) \times (I)]/[12s]$	I = 0.517 in/hr t = 48 hrs s = 3 D_m = 0.689 ft
3. Basin Surface Area $A_m = V_{BMP} / D_m$	A_m = 5880 ft^2
4. Vegetation (check type used or describe "other")	____ Native Grasses _X_ Irrigated Turf Grass ____ Other

Notes:

Appendix A
Stormwater Quality Best Management Practice Design Handbook

Filter Strip Example



AMENDED EXHIBIT
R–R
R–R VACANT
LEGEND
EXISTING JACK IN THE BOX
BUNDY CANYON ROAD
RECEIVED
GRAPHIC SCALE
COUNTY OF RIVERSIDE
SITE PLAN

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:	**NAME**
Company:	**ABC Engineering**
Date:	**June 15, 2009**
Project:	**Filter Strip Design Example**
Location:	

1. Determine Impervious Percentage

a. Determine total tributary area	A_{total} =	**1.27**	acres	***(1)***
b. Determine Impervious %	i =	**90**	%	***(2)***

2. Determine Runoff Coefficient Values
Use **Table 4** and impervious % found in step 1

a. A Soil Runoff Coefficient	C_a =	**.82**	***(3)***
b. B Soil Runoff Coefficient	C_b =	**.82**	***(4)***
c. C Soil Runoff Coefficient	C_c =		***(5)***
d. D Soil Runoff Coefficient	C_d =		***(6)***

3. Determine the Area decimal fraction of each soil type in tributary area

a. Area of A Soil / ***(1)*** =	A_a =	**0.5**	***(7)***
b. Area of B Soil / ***(1)*** =	A_b =	**0.5**	***(8)***
c. Area of C Soil / ***(1)*** =	A_c =		***(9)***
d. Area of D Soil / ***(1)*** =	A_d =		***(10)***

4. Determine Runoff Coefficient

a. C = ***(3)***x***(7)*** + ***(4)***x***(8)*** + ***(5)***x***(9)*** + ***(6)***x***(10)*** **=**	C =	**.82**	***(11)***

5. Determine BMP Design flow

a. Q_{BMP} = C x I x A = ***(11)*** x 0.2 x ***(1)***	Q_{BMP} =	**0.21**	$\frac{ft^3}{s}$	***(12)***

Datasheet

Site Conditions:

A_{total} = 1.27 acres
Q_{BMP} = 0.21 cfs (from worksheet 2)

Design Assumptions:

1. **Design Flow**
   Q_{BMP} = 0.211 cfs

2. **Minimum Width**
   Calculate minimum width of the grass strip filter (W_m) normal to flow direction:
   $W_m = (Q_{BMP})/0.005$ cfs/ft (minimum) = 42.2 ft

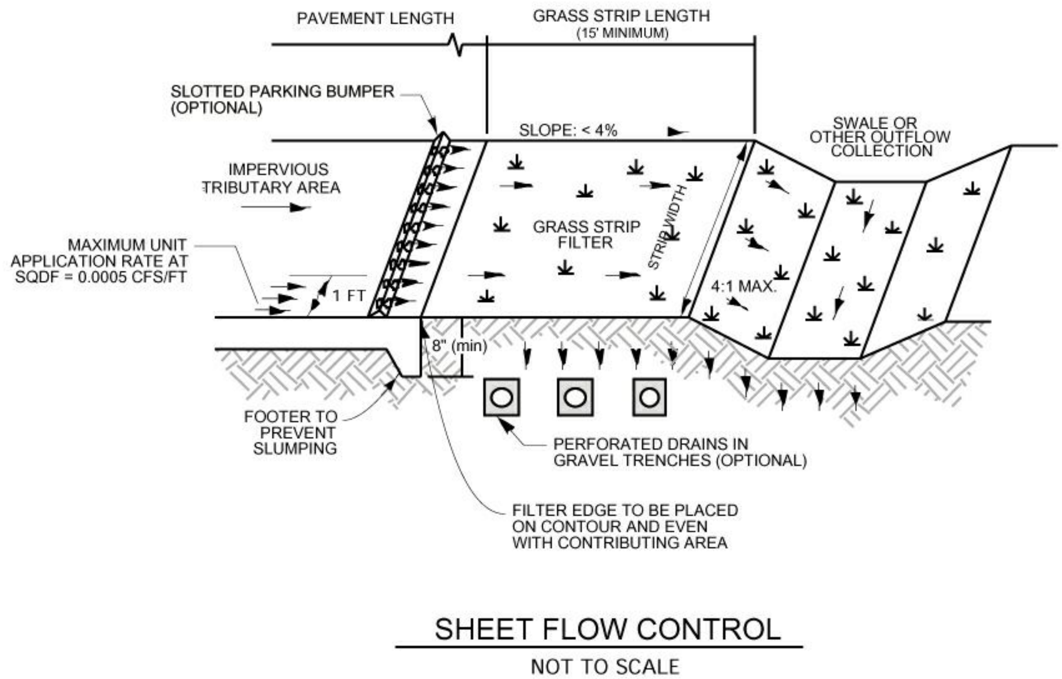
3. **Minimum Length**
   Length of the grass strip filter (Lm) in the direction of flow shall not be less than 15 feet.
   L_m = 15 feet (minimum)

4. **Slope Requirement**
   Slope = 4%

5. **Flow Distribution**
   Level spreader of similar concept.

6. **Vegetation**
   3" Grass

7. **Outflow Collection**
   Street gutter



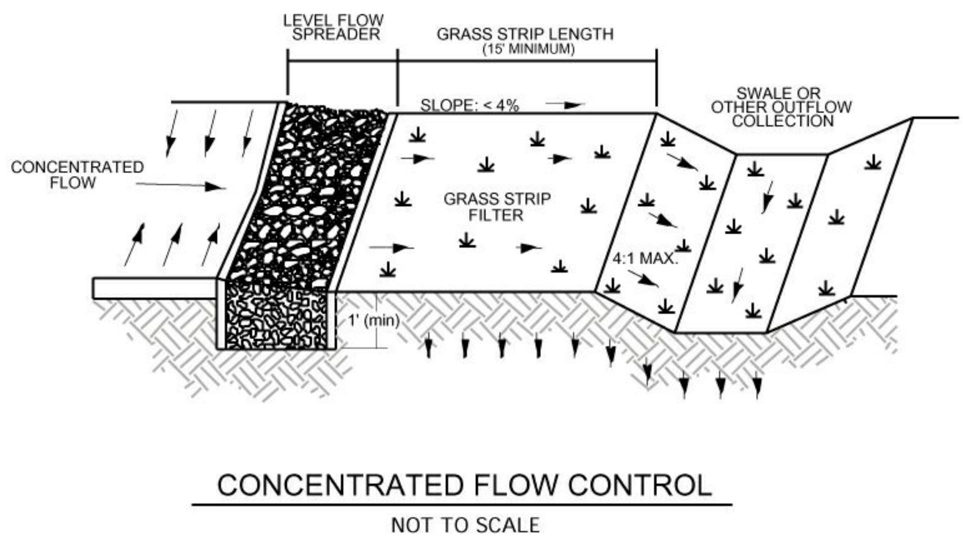


Figure 12: Grass Filter Strip

Source: Ventura County Guidance Manual

Design Procedure Form for Filter Strip

Designer: NAME

Company: ABC Engineering

Date: June 15, 2009

Project: BMP Example

Location: ______

1. Determine Design Flow (Use Worksheet 2)	Q_{BMP} = **.21** cfs
2. Design Width $W_m = (Q_{BMP})/0.005$ cfs/ft	W_m = **42** ft
3. Design Length (15 ft minimum)	L_m = 15 ft
4. Design Slope (4 % maximum)	S_D = 4 %
5. Flow Distribution (check type used or describe "other")	___ slotted curbing ___ Modular Block Porous Pavement _X_ Level Spreader ___ other______
6. Vegetation (describe)	3" grass
5. Outflow Collection (check type used or describe "other")	___ Grass Swale _X_ Street Gutter ___ Storm Drain ___ Underdrain ___ Other______

Notes: