Percolation Data Sheet (Leach Line, ATU, Stormwater BMP)

Project: Woodcrest Christian		Project No. 4725-SF1	
Test Hole No. P-2		Date Excavated: 6/21/21	
Depth of Test Hole: 57" bgs		Soil Classification: SOT = D.G.	
Check for Sandy Soil Criteria Tested By: N/A		Date: N/A	Presoak: None
Field Percolation Test By: J. Lowe		Date: 7/7/21	

Sandy Soil Criteria Test

Trial No.	Time	Time Interval (Min.)	Initial Water Level (In.)	Final Water Level (In.)	Δ in Water Level (In.)
1					
2					

Use: ☒ Normal Soil Criteria ☐ Sandy Soil Criteria (>6" drop in <25 min. both trials)

Time	Time Interval (Min.)	Total Elapsed Time (Min.)	Initial Water Level (In.)	Final Water Level (In.)	Δ in Water Level (In.)	Percolation Rate (Min./In.)
0927						
0957	30	30	31 3/4	DRY	> 25 1/4	
0957						
1027	30	60	26.0	DRY	> 31	
1027						
1057	30	90	29 1/2	DRY	> 27 1/2	
1057						
1127	30	120	30.0	48.0	12.0	
1127						
1157	30	150	30.0	47.0	17.0	
1157						
1227	30	180	30 1/2	45 1/2	15.0	
1227						
1257	30	210	30.0	42 1/2	12 1/2	
1257						
1327	30	240	31.0	39 1/2	8 1/2	
1327						
1357	30	270	31.0	36.0	5.0	
1357						
1427	30	300	31.0	35 1/4	4 1/4	
1427						
1457	30	330	30.0	34.0	4.0	
1457						
1527	30	360	30.0	34.0	4.0	7.5

Aragón Geotechnical, Inc.

Percolation Data Sheet (Leach Line, ATU, Stormwater BMP)

Project: WOODCREST CHRISTIAN		Project No. 4725-SF1	
Test Hole No. P-3		Date Excavated: 6/21/21	
Depth of Test Hole: 43" bgs		Soil Classification: D.G. @ BOT	
Check for Sandy Soil Criteria Tested By: N/A		Date: N/A	Presoak: NONE
Field Percolation Test By: J. LONG		Date: 7/7/21	

Sandy Soil Criteria Test

Trial No.	Time	Time Interval (Min.)	Initial Water Level (In.)	Final Water Level (In.)	Δ in Water Level (In.)
1					
2					

Use: ☒ Normal Soil Criteria ☐ Sandy Soil Criteria (>6" drop in <25 min. both trials)

Time	Time Interval (Min.)	Total Elapsed Time (Min.)	Initial Water Level (In.)	Final Water Level (In.)	Δ in Water Level (In.)	Percolation Rate (Min./In.)
0928 / 0958	30	30	18 1/4	27.0	8 3/4	
0958 / 1028	30	60	17 1/2	24.0	6 1/2	
1028 / 1058	30	90	16 1/2	22.0	5 1/2	
1058 / 1128	30	120	19 1/2	23.0	4.0	
1128 / 1158	30	150	18.0	20.0	2.0	
1158 / 1228	30	180	18.0	20.0	2.0	
1228 / 1258	30	210	18.0	20.0	2.0	
1258 / 1328	30	240	18.0	20.0	2.0	
1328 / 1358	30	270	17 1/2	19 1/2	2.0	
1358 / 1428	30	300	17.0	19.0	2.0	
1428 / 1458	30	330	17.5	19 1/2	2.0	
1458 / 1528	30	360	18.0	20.0	2.0	15.0

EOD

Aragón Geotechnical, Inc.

Percolation Data Sheet (Leach Line, ATU, Stormwater BMP)

Project: WOODCREST CHRISTIAN		Project No. 4725-SF1	
Test Hole No. P-4		Date Excavated: 6/21/21	
Depth of Test Hole: 37" bgs		Soil Classification:	
Check for Sandy Soil Criteria Tested By: N/A		Date: N/A	Presoak: None
Field Percolation Test By: J. Lodge		Date: 7/7/21	

Sandy Soil Criteria Test

Trial No.	Time	Time Interval (Min.)	Initial Water Level (In.)	Final Water Level (In.)	Δ in Water Level (In.)
1					
2					

Use: ☒ Normal Soil Criteria ☐ Sandy Soil Criteria (>6" drop in <25 min. both trials)

Time	Time Interval (Min.)	Total Elapsed Time (Min.)	Initial Water Level (In.)	Final Water Level (In.)	Δ in Water Level (In.)	Percolation Rate (Min./In.)
0930			863			
1000	30	30	13 1/2	17 1/4	3 3/4	
1000						
1030	30	60	13 1/2	16.0	2 1/2	
1030						
1100	30	90	13.0	15 1/2	2 1/2	
1100						
1130	30	120	13.0	14 3/4	1 3/4	
1130						
1200	30	150	13 1/2	15.0	1 1/2	
1200						
1230	30	180	13 1/2	14 1/2	1.0	
1230						
1300	30	210	13 1/2	14 1/2	1.0	
1300						
1330	30	240	13 1/2	14 1/2	1.0	
1330						
1400	30	270	13 1/2	14 1/2	1.0	
1400						
1430	30	300	14.0	14 3/4	3/4	
1430						
1500	30	330	14.0	14 3/4	3/4	
1500						
1530	30	360	14.0	14 3/4	3/4	40.0

END

Aragón Geotechnical, Inc.

Appendix 4: Historical Site Conditions

Phase I Environmental Site Assessment or Other Information on Past Site Use

Appendix 5: LID Infeasibility

LID Technical Infeasibility Analysis

NOT APPLICABLE

Appendix 6: BMP Design Details

BMP Sizing, Design Details and other Supporting Documentation

- BMP DESIGN CALCULATIONS
- SUPPORTING DOCUMENTS

Santa Ana Watershed - BMP Design Volume, V_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	ADKAN ENGINEERS	Date	11/17/2023
Designed by	Jose Contreras	Case No	GP-2023-17709
Company Project Number/Name	Woodcrest Christian		

BMP Identification

BMP NAME / ID: BIO RETENTION BASIN FOR D-1, OVER-MITIGATION FOR D-2 AND D-3

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E

D_{85}= 0.51 inches

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Storm Depth (in)*	*Design Capture Volume, V_{BMP} (cubic feet)*	*Proposed Volume on Plans (cubic feet)*
D-1.1	*7,232*	*Roofs*	*1*	*0.89*	*6450.9*			
D-1.2	*6,309*	*Concrete or Asphalt*	*1*	*0.89*	*5627.6*			
D-1.3	*6,801*	*Ornamental Landscaping*	*0.1*	*0.11*	*751.2*			
D-2.1	*15,123*	*Roofs*	*1*	*0.89*	*13489.7*			
D-2.2	*5,999*	*Concrete or Asphalt*	*1*	*0.89*	*5351.1*			
D-2.3	*4,309*	*Ornamental Landscaping*	*0.1*	*0.11*	*476*			
D-3.1	*31,027*	*Roofs*	*1*	*0.89*	*27676.1*			
D-3.2	*66,043*	*Concrete or Asphalt*	*1*	*0.89*	*58910.4*			
D-3-3	*28378*	*Ornamental Landscaping*	*0.1*	*0.11*	*3134.6*			
	171221	***Total***			**121867.6**	**0.51**	***5179.4***	***5263***

Notes:

Bioretention Facility - Design Procedure	BMP ID: BIO	Legend:	Required Entries / Calculated Cells

Company Name:	Adkan Engineers	Date:	11-17-23'
Designed by:	Jose Contreras	County/City Case No.:	GP-2023 -17709

Design Volume

Enter the area tributary to this feature	A_T=	3.56	acres
Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP}=	5,179	ft^3

Type of Bioretention Facility Design

- ○ Side slopes required (parallel to parking spaces or adjacent to walkways)
- ◉ No side slopes required (perpendicular to parking space or Planter Boxes)

Bioretention Facility Surface Area

Depth of Soil Filter Media Layer	d_S =	3.0	ft
Top Width of Bioretention Facility, excluding curb	w_T =	5.0	ft
Total Effective Depth, d_E			
$d_E = [(0.3) \times d_S + (0.4) \times 1] + 0.5$	d_E =	1.80	ft
Minimum Surface Area, A_m			
$A_M\,(ft^2) = \frac{V_{BMP}\,(ft^3)}{d_E\,(ft)}$	A_M =	2,878	ft^2
Proposed Surface Area	A=	2,882	ft^2
Minimum Required Length of Bioretention Facility, L	L =	575.6	ft

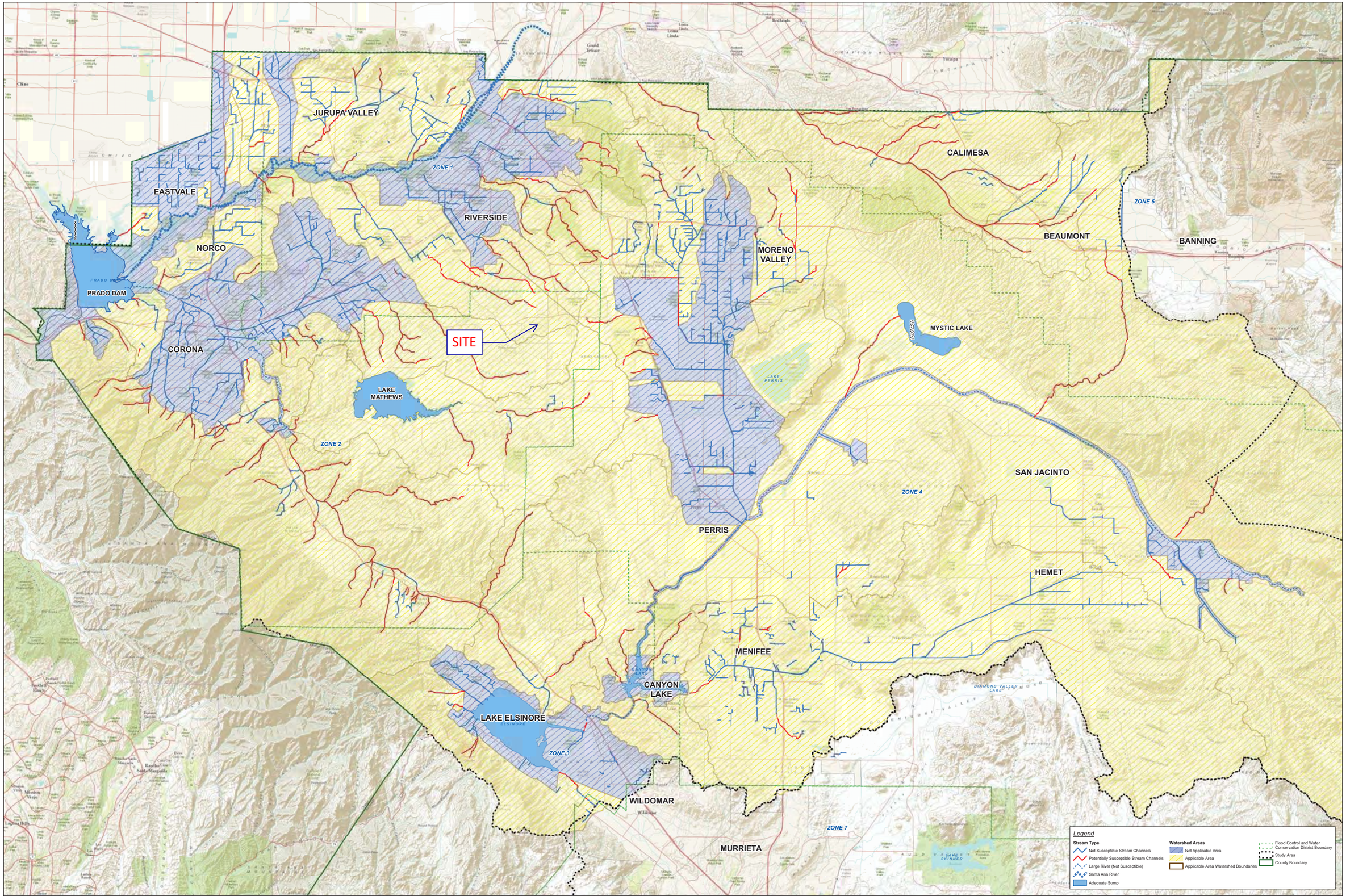
Bioretention Facility Properties

Side Slopes in Bioretention Facility	z =	4	:1
Diameter of Underdrain		6	inches
Longitudinal Slope of Site (3% maximum)		0	%
6" Check Dam Spacing		0	feet
Describe Vegetation:			

Notes:

Appendix 7: Hydromodification

Supporting Detail Relating to Hydrologic Conditions of Concern



HCOC Applicability Map

Hydromodification Susceptibility Documentation Report and Mapping
Riverside County Flood Control and Water Conservation District

Map 2

```
       U n i t   H y d r o g r a p h   A n a l y s i s

       Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2008, Version 8.1
              Study date  11/20/23 File: EX2YR242.out

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
------------------------------------------------------------------------------

Riverside County Synthetic Unit Hydrology Method
RCFC & WCD Manual date - April 1978


Program License Serial Number 5006

------------------------------------------------------------------------
 English (in-lb) Input Units Used
 English Rainfall Data (Inches) Input Values Used

 English Units used in output format



------------------------------------------------------------------------
------------------------------------------------------------------------
Drainage Area =       3.93(Ac.)  =      0.006 Sq. Mi.
Drainage Area for Depth-Area Areal Adjustment =       3.93(Ac.)  =      0.006 Sq. Mi.
Length along longest watercourse =     423.00(Ft.)
Length along longest watercourse measured to centroid =     212.00(Ft.)
Length along longest watercourse =      0.080 Mi.
Length along longest watercourse measured to centroid =      0.040 Mi.
Difference in elevation =      20.00(Ft.)
Slope along watercourse =    249.6454 Ft./Mi.
Average Manning's 'N' = 0.015
Lag time =    0.014 Hr.
Lag time =     0.85 Min.
25% of lag time =     0.21 Min.
40% of lag time =     0.34 Min.
Unit time =     5.00 Min.
Duration of storm = 24 Hour(s)
User Entered Base Flow =     0.00(CFS)

2 YEAR Area rainfall data:


Area(Ac.)[1]       Rainfall(In)[2]      Weighting[1*2]
        3.93            1.60                  6.29

100 YEAR Area rainfall data:


Area(Ac.)[1]       Rainfall(In)[2]      Weighting[1*2]
        3.93            4.50                 17.69

STORM EVENT (YEAR) =    2.00
Area Averaged 2-Year Rainfall =    1.600(In)
Area Averaged 100-Year Rainfall =    4.500(In)

Point rain (area averaged) =    1.600(In)
Areal adjustment factor =  100.00 %
Adjusted average point rain =    1.600(In)

Sub-Area Data:
Area(Ac.)         Runoff Index   Impervious %
     3.930           62.50          0.300
 Total Area Entered =      3.93(Ac.)


RI    RI   Infil. Rate Impervious   Adj. Infil. Rate  Area%     F
AMC2 AMC-1     (In/Hr)    (Dec.%)     (In/Hr)      (Dec.)    (In/Hr)
62.5  42.5      0.645     0.300        0.471       1.000      0.471
                                                 Sum (F) =   0.471
Area averaged mean soil loss (F) (In/Hr) =  0.471
Minimum soil loss rate ((In/Hr)) =  0.236
(for 24 hour storm duration)
Soil low loss rate (decimal) =   0.660
------------------------------------------------------------------------

               U n i t  H y d r o g r a p h
                      VALLEY S-Curve
------------------------------------------------------------------
               Unit Hydrograph Data
------------------------------------------------------------------
Unit time period   Time % of lag   Distribution   Unit Hydrograph
    (hrs)                          Graph %           (CFS)
```

1	0.083	585.049	74.671		2.958
2	0.167	1170.099	25.329		1.003
			Sum = 100.000	Sum=	3.961

The following loss rate calculations reflect use of the minimum calculated loss rate subtracted from the Storm Rain to produce the maximum Effective Rain value

Unit	Time (Hr.)	Pattern Percent	Storm Rain (In/Hr)	Loss rate(In./Hr) Max	Low	Effective (In/Hr)
1	0.08	0.07	0.013	(0.835)	0.008	0.004
2	0.17	0.07	0.013	(0.832)	0.008	0.004
3	0.25	0.07	0.013	(0.829)	0.008	0.004
4	0.33	0.10	0.019	(0.826)	0.013	0.007
5	0.42	0.10	0.019	(0.822)	0.013	0.007
6	0.50	0.10	0.019	(0.819)	0.013	0.007
7	0.58	0.10	0.019	(0.816)	0.013	0.007
8	0.67	0.10	0.019	(0.813)	0.013	0.007
9	0.75	0.10	0.019	(0.810)	0.013	0.007
10	0.83	0.13	0.026	(0.806)	0.017	0.009
11	0.92	0.13	0.026	(0.803)	0.017	0.009
12	1.00	0.13	0.026	(0.800)	0.017	0.009
13	1.08	0.10	0.019	(0.797)	0.013	0.007
14	1.17	0.10	0.019	(0.794)	0.013	0.007
15	1.25	0.10	0.019	(0.791)	0.013	0.007
16	1.33	0.10	0.019	(0.788)	0.013	0.007
17	1.42	0.10	0.019	(0.784)	0.013	0.007
18	1.50	0.10	0.019	(0.781)	0.013	0.007
19	1.58	0.10	0.019	(0.778)	0.013	0.007
20	1.67	0.10	0.019	(0.775)	0.013	0.007
21	1.75	0.10	0.019	(0.772)	0.013	0.007
22	1.83	0.13	0.026	(0.769)	0.017	0.009
23	1.92	0.13	0.026	(0.766)	0.017	0.009
24	2.00	0.13	0.026	(0.763)	0.017	0.009
25	2.08	0.13	0.026	(0.760)	0.017	0.009
26	2.17	0.13	0.026	(0.756)	0.017	0.009
27	2.25	0.13	0.026	(0.753)	0.017	0.009
28	2.33	0.13	0.026	(0.750)	0.017	0.009
29	2.42	0.13	0.026	(0.747)	0.017	0.009
30	2.50	0.13	0.026	(0.744)	0.017	0.009
31	2.58	0.17	0.032	(0.741)	0.021	0.011
32	2.67	0.17	0.032	(0.738)	0.021	0.011
33	2.75	0.17	0.032	(0.735)	0.021	0.011
34	2.83	0.17	0.032	(0.732)	0.021	0.011
35	2.92	0.17	0.032	(0.729)	0.021	0.011
36	3.00	0.17	0.032	(0.726)	0.021	0.011
37	3.08	0.17	0.032	(0.723)	0.021	0.011
38	3.17	0.17	0.032	(0.720)	0.021	0.011
39	3.25	0.17	0.032	(0.717)	0.021	0.011
40	3.33	0.17	0.032	(0.714)	0.021	0.011
41	3.42	0.17	0.032	(0.711)	0.021	0.011
42	3.50	0.17	0.032	(0.708)	0.021	0.011
43	3.58	0.17	0.032	(0.705)	0.021	0.011
44	3.67	0.17	0.032	(0.702)	0.021	0.011
45	3.75	0.17	0.032	(0.699)	0.021	0.011
46	3.83	0.20	0.038	(0.696)	0.025	0.013
47	3.92	0.20	0.038	(0.693)	0.025	0.013
48	4.00	0.20	0.038	(0.690)	0.025	0.013
49	4.08	0.20	0.038	(0.687)	0.025	0.013
50	4.17	0.20	0.038	(0.685)	0.025	0.013
51	4.25	0.20	0.038	(0.682)	0.025	0.013
52	4.33	0.23	0.045	(0.679)	0.030	0.015
53	4.42	0.23	0.045	(0.676)	0.030	0.015
54	4.50	0.23	0.045	(0.673)	0.030	0.015
55	4.58	0.23	0.045	(0.670)	0.030	0.015
56	4.67	0.23	0.045	(0.667)	0.030	0.015
57	4.75	0.23	0.045	(0.664)	0.030	0.015
58	4.83	0.27	0.051	(0.661)	0.034	0.017
59	4.92	0.27	0.051	(0.659)	0.034	0.017
60	5.00	0.27	0.051	(0.656)	0.034	0.017
61	5.08	0.20	0.038	(0.653)	0.025	0.013
62	5.17	0.20	0.038	(0.650)	0.025	0.013
63	5.25	0.20	0.038	(0.647)	0.025	0.013
64	5.33	0.23	0.045	(0.644)	0.030	0.015
65	5.42	0.23	0.045	(0.642)	0.030	0.015
66	5.50	0.23	0.045	(0.639)	0.030	0.015
67	5.58	0.27	0.051	(0.636)	0.034	0.017
68	5.67	0.27	0.051	(0.633)	0.034	0.017
69	5.75	0.27	0.051	(0.630)	0.034	0.017
70	5.83	0.27	0.051	(0.628)	0.034	0.017
71	5.92	0.27	0.051	(0.625)	0.034	0.017
72	6.00	0.27	0.051	(0.622)	0.034	0.017
73	6.08	0.30	0.058	(0.619)	0.038	0.020
74	6.17	0.30	0.058	(0.616)	0.038	0.020

75	6.25	0.30	0.058	(0.614)	0.038	0.020
76	6.33	0.30	0.058	(0.611)	0.038	0.020
77	6.42	0.30	0.058	(0.608)	0.038	0.020
78	6.50	0.30	0.058	(0.606)	0.038	0.020
79	6.58	0.33	0.064	(0.603)	0.042	0.022
80	6.67	0.33	0.064	(0.600)	0.042	0.022
81	6.75	0.33	0.064	(0.597)	0.042	0.022
82	6.83	0.33	0.064	(0.595)	0.042	0.022
83	6.92	0.33	0.064	(0.592)	0.042	0.022
84	7.00	0.33	0.064	(0.589)	0.042	0.022
85	7.08	0.33	0.064	(0.587)	0.042	0.022
86	7.17	0.33	0.064	(0.584)	0.042	0.022
87	7.25	0.33	0.064	(0.581)	0.042	0.022
88	7.33	0.37	0.070	(0.579)	0.046	0.024
89	7.42	0.37	0.070	(0.576)	0.046	0.024
90	7.50	0.37	0.070	(0.573)	0.046	0.024
91	7.58	0.40	0.077	(0.571)	0.051	0.026
92	7.67	0.40	0.077	(0.568)	0.051	0.026
93	7.75	0.40	0.077	(0.565)	0.051	0.026
94	7.83	0.43	0.083	(0.563)	0.055	0.028
95	7.92	0.43	0.083	(0.560)	0.055	0.028
96	8.00	0.43	0.083	(0.558)	0.055	0.028
97	8.08	0.50	0.096	(0.555)	0.063	0.033
98	8.17	0.50	0.096	(0.552)	0.063	0.033
99	8.25	0.50	0.096	(0.550)	0.063	0.033
100	8.33	0.50	0.096	(0.547)	0.063	0.033
101	8.42	0.50	0.096	(0.545)	0.063	0.033
102	8.50	0.50	0.096	(0.542)	0.063	0.033
103	8.58	0.53	0.102	(0.540)	0.068	0.035
104	8.67	0.53	0.102	(0.537)	0.068	0.035
105	8.75	0.53	0.102	(0.535)	0.068	0.035
106	8.83	0.57	0.109	(0.532)	0.072	0.037
107	8.92	0.57	0.109	(0.530)	0.072	0.037
108	9.00	0.57	0.109	(0.527)	0.072	0.037
109	9.08	0.63	0.122	(0.525)	0.080	0.041
110	9.17	0.63	0.122	(0.522)	0.080	0.041
111	9.25	0.63	0.122	(0.520)	0.080	0.041
112	9.33	0.67	0.128	(0.517)	0.084	0.044
113	9.42	0.67	0.128	(0.515)	0.084	0.044
114	9.50	0.67	0.128	(0.512)	0.084	0.044
115	9.58	0.70	0.134	(0.510)	0.089	0.046
116	9.67	0.70	0.134	(0.507)	0.089	0.046
117	9.75	0.70	0.134	(0.505)	0.089	0.046
118	9.83	0.73	0.141	(0.502)	0.093	0.048
119	9.92	0.73	0.141	(0.500)	0.093	0.048
120	10.00	0.73	0.141	(0.498)	0.093	0.048
121	10.08	0.50	0.096	(0.495)	0.063	0.033
122	10.17	0.50	0.096	(0.493)	0.063	0.033
123	10.25	0.50	0.096	(0.490)	0.063	0.033
124	10.33	0.50	0.096	(0.488)	0.063	0.033
125	10.42	0.50	0.096	(0.486)	0.063	0.033
126	10.50	0.50	0.096	(0.483)	0.063	0.033
127	10.58	0.67	0.128	(0.481)	0.084	0.044
128	10.67	0.67	0.128	(0.479)	0.084	0.044
129	10.75	0.67	0.128	(0.476)	0.084	0.044
130	10.83	0.67	0.128	(0.474)	0.084	0.044
131	10.92	0.67	0.128	(0.472)	0.084	0.044
132	11.00	0.67	0.128	(0.469)	0.084	0.044
133	11.08	0.63	0.122	(0.467)	0.080	0.041
134	11.17	0.63	0.122	(0.465)	0.080	0.041
135	11.25	0.63	0.122	(0.462)	0.080	0.041
136	11.33	0.63	0.122	(0.460)	0.080	0.041
137	11.42	0.63	0.122	(0.458)	0.080	0.041
138	11.50	0.63	0.122	(0.456)	0.080	0.041
139	11.58	0.57	0.109	(0.453)	0.072	0.037
140	11.67	0.57	0.109	(0.451)	0.072	0.037
141	11.75	0.57	0.109	(0.449)	0.072	0.037
142	11.83	0.60	0.115	(0.447)	0.076	0.039
143	11.92	0.60	0.115	(0.444)	0.076	0.039
144	12.00	0.60	0.115	(0.442)	0.076	0.039
145	12.08	0.83	0.160	(0.440)	0.106	0.054
146	12.17	0.83	0.160	(0.438)	0.106	0.054
147	12.25	0.83	0.160	(0.435)	0.106	0.054
148	12.33	0.87	0.166	(0.433)	0.110	0.057
149	12.42	0.87	0.166	(0.431)	0.110	0.057
150	12.50	0.87	0.166	(0.429)	0.110	0.057
151	12.58	0.93	0.179	(0.427)	0.118	0.061
152	12.67	0.93	0.179	(0.425)	0.118	0.061
153	12.75	0.93	0.179	(0.422)	0.118	0.061
154	12.83	0.97	0.186	(0.420)	0.122	0.063
155	12.92	0.97	0.186	(0.418)	0.122	0.063
156	13.00	0.97	0.186	(0.416)	0.122	0.063
157	13.08	1.13	0.218	(0.414)	0.144	0.074
158	13.17	1.13	0.218	(0.412)	0.144	0.074
159	13.25	1.13	0.218	(0.410)	0.144	0.074
160	13.33	1.13	0.218	(0.408)	0.144	0.074

161	13.42	1.13	0.218	(0.406)	0.144	0.074
162	13.50	1.13	0.218	(0.404)	0.144	0.074
163	13.58	0.77	0.147	(0.402)	0.097	0.050
164	13.67	0.77	0.147	(0.400)	0.097	0.050
165	13.75	0.77	0.147	(0.397)	0.097	0.050
166	13.83	0.77	0.147	(0.395)	0.097	0.050
167	13.92	0.77	0.147	(0.393)	0.097	0.050
168	14.00	0.77	0.147	(0.391)	0.097	0.050
169	14.08	0.90	0.173	(0.389)	0.114	0.059
170	14.17	0.90	0.173	(0.387)	0.114	0.059
171	14.25	0.90	0.173	(0.385)	0.114	0.059
172	14.33	0.87	0.166	(0.383)	0.110	0.057
173	14.42	0.87	0.166	(0.382)	0.110	0.057
174	14.50	0.87	0.166	(0.380)	0.110	0.057
175	14.58	0.87	0.166	(0.378)	0.110	0.057
176	14.67	0.87	0.166	(0.376)	0.110	0.057
177	14.75	0.87	0.166	(0.374)	0.110	0.057
178	14.83	0.83	0.160	(0.372)	0.106	0.054
179	14.92	0.83	0.160	(0.370)	0.106	0.054
180	15.00	0.83	0.160	(0.368)	0.106	0.054
181	15.08	0.80	0.154	(0.366)	0.101	0.052
182	15.17	0.80	0.154	(0.364)	0.101	0.052
183	15.25	0.80	0.154	(0.362)	0.101	0.052
184	15.33	0.77	0.147	(0.361)	0.097	0.050
185	15.42	0.77	0.147	(0.359)	0.097	0.050
186	15.50	0.77	0.147	(0.357)	0.097	0.050
187	15.58	0.63	0.122	(0.355)	0.080	0.041
188	15.67	0.63	0.122	(0.353)	0.080	0.041
189	15.75	0.63	0.122	(0.351)	0.080	0.041
190	15.83	0.63	0.122	(0.350)	0.080	0.041
191	15.92	0.63	0.122	(0.348)	0.080	0.041
192	16.00	0.63	0.122	(0.346)	0.080	0.041
193	16.08	0.13	0.026	(0.344)	0.017	0.009
194	16.17	0.13	0.026	(0.343)	0.017	0.009
195	16.25	0.13	0.026	(0.341)	0.017	0.009
196	16.33	0.13	0.026	(0.339)	0.017	0.009
197	16.42	0.13	0.026	(0.337)	0.017	0.009
198	16.50	0.13	0.026	(0.336)	0.017	0.009
199	16.58	0.10	0.019	(0.334)	0.013	0.007
200	16.67	0.10	0.019	(0.332)	0.013	0.007
201	16.75	0.10	0.019	(0.330)	0.013	0.007
202	16.83	0.10	0.019	(0.329)	0.013	0.007
203	16.92	0.10	0.019	(0.327)	0.013	0.007
204	17.00	0.10	0.019	(0.325)	0.013	0.007
205	17.08	0.17	0.032	(0.324)	0.021	0.011
206	17.17	0.17	0.032	(0.322)	0.021	0.011
207	17.25	0.17	0.032	(0.321)	0.021	0.011
208	17.33	0.17	0.032	(0.319)	0.021	0.011
209	17.42	0.17	0.032	(0.317)	0.021	0.011
210	17.50	0.17	0.032	(0.316)	0.021	0.011
211	17.58	0.17	0.032	(0.314)	0.021	0.011
212	17.67	0.17	0.032	(0.313)	0.021	0.011
213	17.75	0.17	0.032	(0.311)	0.021	0.011
214	17.83	0.13	0.026	(0.310)	0.017	0.009
215	17.92	0.13	0.026	(0.308)	0.017	0.009
216	18.00	0.13	0.026	(0.306)	0.017	0.009
217	18.08	0.13	0.026	(0.305)	0.017	0.009
218	18.17	0.13	0.026	(0.303)	0.017	0.009
219	18.25	0.13	0.026	(0.302)	0.017	0.009
220	18.33	0.13	0.026	(0.301)	0.017	0.009
221	18.42	0.13	0.026	(0.299)	0.017	0.009
222	18.50	0.13	0.026	(0.298)	0.017	0.009
223	18.58	0.10	0.019	(0.296)	0.013	0.007
224	18.67	0.10	0.019	(0.295)	0.013	0.007
225	18.75	0.10	0.019	(0.293)	0.013	0.007
226	18.83	0.07	0.013	(0.292)	0.008	0.004
227	18.92	0.07	0.013	(0.291)	0.008	0.004
228	19.00	0.07	0.013	(0.289)	0.008	0.004
229	19.08	0.10	0.019	(0.288)	0.013	0.007
230	19.17	0.10	0.019	(0.286)	0.013	0.007
231	19.25	0.10	0.019	(0.285)	0.013	0.007
232	19.33	0.13	0.026	(0.284)	0.017	0.009
233	19.42	0.13	0.026	(0.282)	0.017	0.009
234	19.50	0.13	0.026	(0.281)	0.017	0.009
235	19.58	0.10	0.019	(0.280)	0.013	0.007
236	19.67	0.10	0.019	(0.279)	0.013	0.007
237	19.75	0.10	0.019	(0.277)	0.013	0.007
238	19.83	0.07	0.013	(0.276)	0.008	0.004
239	19.92	0.07	0.013	(0.275)	0.008	0.004
240	20.00	0.07	0.013	(0.274)	0.008	0.004
241	20.08	0.10	0.019	(0.272)	0.013	0.007
242	20.17	0.10	0.019	(0.271)	0.013	0.007
243	20.25	0.10	0.019	(0.270)	0.013	0.007
244	20.33	0.10	0.019	(0.269)	0.013	0.007
245	20.42	0.10	0.019	(0.268)	0.013	0.007
246	20.50	0.10	0.019	(0.267)	0.013	0.007

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247  20.58     0.10      0.019       (  0.265)       0.013        0.007
248  20.67     0.10      0.019       (  0.264)       0.013        0.007
249  20.75     0.10      0.019       (  0.263)       0.013        0.007
250  20.83     0.07      0.013       (  0.262)       0.008        0.004
251  20.92     0.07      0.013       (  0.261)       0.008        0.004
252  21.00     0.07      0.013       (  0.260)       0.008        0.004
253  21.08     0.10      0.019       (  0.259)       0.013        0.007
254  21.17     0.10      0.019       (  0.258)       0.013        0.007
255  21.25     0.10      0.019       (  0.257)       0.013        0.007
256  21.33     0.07      0.013       (  0.256)       0.008        0.004
257  21.42     0.07      0.013       (  0.255)       0.008        0.004
258  21.50     0.07      0.013       (  0.254)       0.008        0.004
259  21.58     0.10      0.019       (  0.253)       0.013        0.007
260  21.67     0.10      0.019       (  0.252)       0.013        0.007
261  21.75     0.10      0.019       (  0.251)       0.013        0.007
262  21.83     0.07      0.013       (  0.251)       0.008        0.004
263  21.92     0.07      0.013       (  0.250)       0.008        0.004
264  22.00     0.07      0.013       (  0.249)       0.008        0.004
265  22.08     0.10      0.019       (  0.248)       0.013        0.007
266  22.17     0.10      0.019       (  0.247)       0.013        0.007
267  22.25     0.10      0.019       (  0.246)       0.013        0.007
268  22.33     0.07      0.013       (  0.246)       0.008        0.004
269  22.42     0.07      0.013       (  0.245)       0.008        0.004
270  22.50     0.07      0.013       (  0.244)       0.008        0.004
271  22.58     0.07      0.013       (  0.243)       0.008        0.004
272  22.67     0.07      0.013       (  0.243)       0.008        0.004
273  22.75     0.07      0.013       (  0.242)       0.008        0.004
274  22.83     0.07      0.013       (  0.241)       0.008        0.004
275  22.92     0.07      0.013       (  0.241)       0.008        0.004
276  23.00     0.07      0.013       (  0.240)       0.008        0.004
277  23.08     0.07      0.013       (  0.240)       0.008        0.004
278  23.17     0.07      0.013       (  0.239)       0.008        0.004
279  23.25     0.07      0.013       (  0.239)       0.008        0.004
280  23.33     0.07      0.013       (  0.238)       0.008        0.004
281  23.42     0.07      0.013       (  0.238)       0.008        0.004
282  23.50     0.07      0.013       (  0.237)       0.008        0.004
283  23.58     0.07      0.013       (  0.237)       0.008        0.004
284  23.67     0.07      0.013       (  0.237)       0.008        0.004
285  23.75     0.07      0.013       (  0.236)       0.008        0.004
286  23.83     0.07      0.013       (  0.236)       0.008        0.004
287  23.92     0.07      0.013       (  0.236)       0.008        0.004
288  24.00     0.07      0.013       (  0.236)       0.008        0.004
               (Loss Rate Not Used)
    Sum =     100.0                                  Sum =      6.5
      Flood volume = Effective rainfall      0.54(In)
       times area       3.9(Ac.)/[(In)/(Ft.)] =       0.2(Ac.Ft)
      Total soil loss =      1.06(In)
      Total soil loss =     0.346(Ac.Ft)
      Total rainfall =      1.60(In)
      Flood volume =        7760.6 Cubic Feet
      Total soil loss =       15064.7 Cubic Feet
      ---------------------------------------------------------------------
       Peak flow rate of this hydrograph =      0.293(CFS)
      ---------------------------------------------------------------------
      +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                          24 - H O U R    S T O R M
                     R u n o f f      H y d r o g r a p h
      ---------------------------------------------------------------------
                  Hydrograph in   5   Minute intervals ((CFS))

      ---------------------------------------------------------------------
Time(h+m) Volume Ac.Ft   Q(CFS)  0        2.5       5.0       7.5      10.0
-------------------------------------------------------------------------
  0+ 5       0.0001      0.01  Q          |         |         |         |
  0+10       0.0002      0.02  Q          |         |         |         |
  0+15       0.0003      0.02  Q          |         |         |         |
  0+20       0.0005      0.02  Q          |         |         |         |
  0+25       0.0007      0.03  Q          |         |         |         |
  0+30       0.0008      0.03  Q          |         |         |         |
  0+35       0.0010      0.03  Q          |         |         |         |
  0+40       0.0012      0.03  Q          |         |         |         |
  0+45       0.0014      0.03  Q          |         |         |         |
  0+50       0.0016      0.03  Q          |         |         |         |
  0+55       0.0018      0.03  Q          |         |         |         |
  1+ 0       0.0021      0.03  Q          |         |         |         |
  1+ 5       0.0023      0.03  Q          |         |         |         |
  1+10       0.0024      0.03  Q          |         |         |         |
  1+15       0.0026      0.03  Q          |         |         |         |
  1+20       0.0028      0.03  Q          |         |         |         |
  1+25       0.0030      0.03  Q          |         |         |         |
  1+30       0.0032      0.03  Q          |         |         |         |
  1+35       0.0033      0.03  Q          |         |         |         |
  1+40       0.0035      0.03  Q          |         |         |         |
  1+45       0.0037      0.03  Q          |         |         |         |
  1+50       0.0039      0.03  Q          |         |         |         |
  1+55       0.0042      0.03  Q          |         |         |         |
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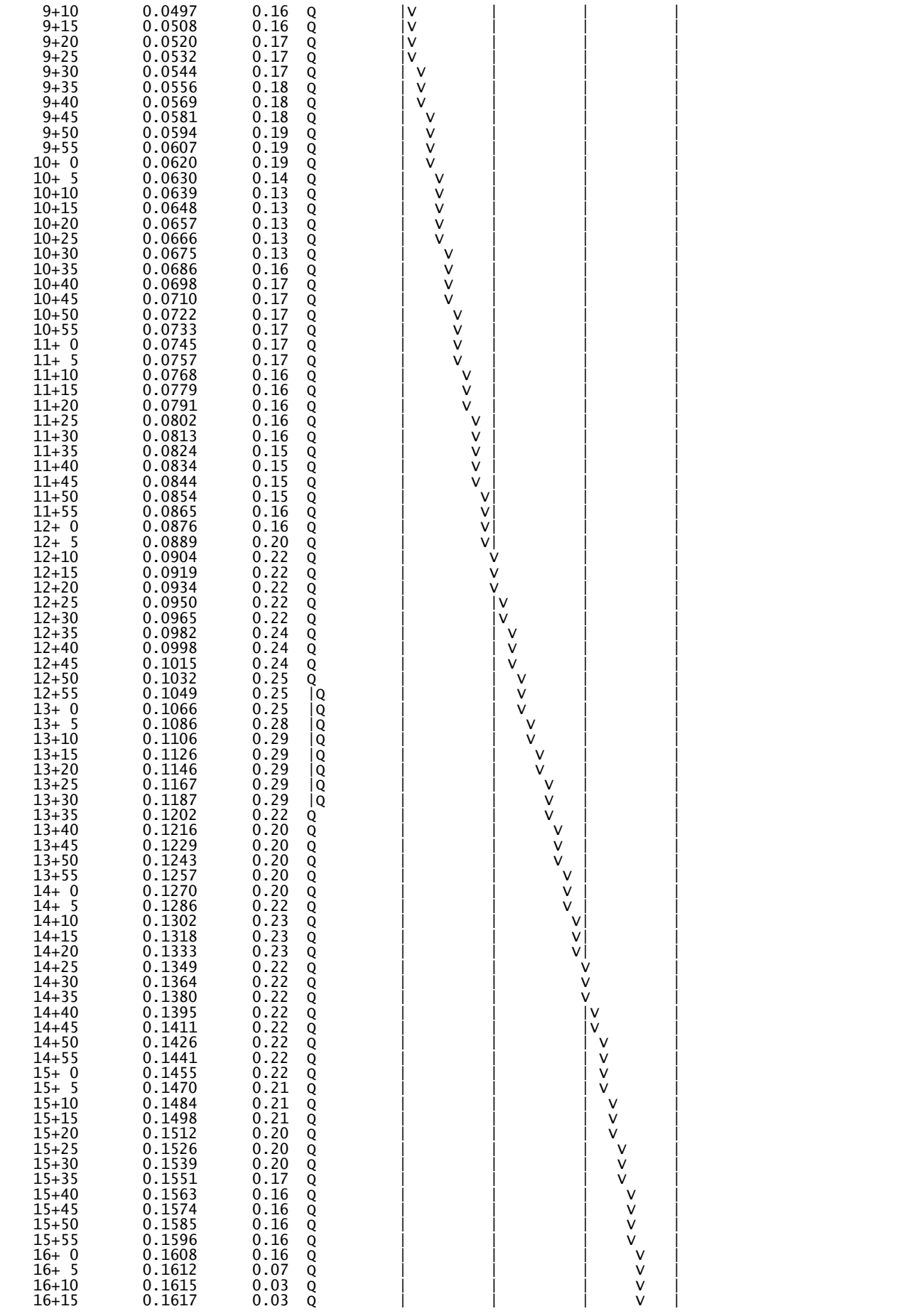
2+ 0       0.0044      0.03  Q          |          |          |          |
2+ 5       0.0046      0.03  QV         |          |          |          |
2+10       0.0049      0.03  QV         |          |          |          |
2+15       0.0051      0.03  QV         |          |          |          |
2+20       0.0053      0.03  QV         |          |          |          |
2+25       0.0056      0.03  QV         |          |          |          |
2+30       0.0058      0.03  QV         |          |          |          |
2+35       0.0061      0.04  QV         |          |          |          |
2+40       0.0064      0.04  QV         |          |          |          |
2+45       0.0067      0.04  QV         |          |          |          |
2+50       0.0070      0.04  QV         |          |          |          |
2+55       0.0073      0.04  QV         |          |          |          |
3+ 0       0.0076      0.04  QV         |          |          |          |
3+ 5       0.0079      0.04  QV         |          |          |          |
3+10       0.0082      0.04  QV         |          |          |          |
3+15       0.0085      0.04  QV         |          |          |          |
3+20       0.0088      0.04  QV         |          |          |          |
3+25       0.0091      0.04  Q V        |          |          |          |
3+30       0.0094      0.04  Q V        |          |          |          |
3+35       0.0097      0.04  Q V        |          |          |          |
3+40       0.0100      0.04  Q V        |          |          |          |
3+45       0.0103      0.04  Q V        |          |          |          |
3+50       0.0106      0.05  Q V        |          |          |          |
3+55       0.0110      0.05  Q V        |          |          |          |
4+ 0       0.0113      0.05  Q V        |          |          |          |
4+ 5       0.0117      0.05  Q V        |          |          |          |
4+10       0.0120      0.05  Q V        |          |          |          |
4+15       0.0124      0.05  Q V        |          |          |          |
4+20       0.0128      0.06  Q V        |          |          |          |
4+25       0.0132      0.06  Q V        |          |          |          |
4+30       0.0136      0.06  Q  V       |          |          |          |
4+35       0.0140      0.06  Q  V       |          |          |          |
4+40       0.0144      0.06  Q  V       |          |          |          |
4+45       0.0149      0.06  Q  V       |          |          |          |
4+50       0.0153      0.07  Q  V       |          |          |          |
4+55       0.0158      0.07  Q  V       |          |          |          |
5+ 0       0.0163      0.07  Q  V       |          |          |          |
5+ 5       0.0167      0.06  Q  V       |          |          |          |
5+10       0.0170      0.05  Q  V       |          |          |          |
5+15       0.0174      0.05  Q  V       |          |          |          |
5+20       0.0178      0.06  Q  V       |          |          |          |
5+25       0.0182      0.06  Q   V      |          |          |          |
5+30       0.0186      0.06  Q   V      |          |          |          |
5+35       0.0191      0.07  Q   V      |          |          |          |
5+40       0.0195      0.07  Q   V      |          |          |          |
5+45       0.0200      0.07  Q   V      |          |          |          |
5+50       0.0205      0.07  Q   V      |          |          |          |
5+55       0.0210      0.07  Q   V      |          |          |          |
6+ 0       0.0214      0.07  Q   V      |          |          |          |
6+ 5       0.0220      0.08  Q   V      |          |          |          |
6+10       0.0225      0.08  Q    V     |          |          |          |
6+15       0.0230      0.08  Q    V     |          |          |          |
6+20       0.0236      0.08  Q    V     |          |          |          |
6+25       0.0241      0.08  Q    V     |          |          |          |
6+30       0.0246      0.08  Q    V     |          |          |          |
6+35       0.0252      0.08  Q    V     |          |          |          |
6+40       0.0258      0.09  Q    V     |          |          |          |
6+45       0.0264      0.09  Q    V     |          |          |          |
6+50       0.0270      0.09  Q     V    |          |          |          |
6+55       0.0276      0.09  Q     V    |          |          |          |
7+ 0       0.0282      0.09  Q     V    |          |          |          |
7+ 5       0.0288      0.09  Q     V    |          |          |          |
7+10       0.0294      0.09  Q     V    |          |          |          |
7+15       0.0300      0.09  Q     V    |          |          |          |
7+20       0.0306      0.09  Q     V    |          |          |          |
7+25       0.0312      0.09  Q      V   |          |          |          |
7+30       0.0319      0.09  Q      V   |          |          |          |
7+35       0.0326      0.10  Q      V   |          |          |          |
7+40       0.0333      0.10  Q      V   |          |          |          |
7+45       0.0340      0.10  Q      V   |          |          |          |
7+50       0.0348      0.11  Q      V   |          |          |          |
7+55       0.0356      0.11  Q      V   |          |          |          |
8+ 0       0.0363      0.11  Q       V  |          |          |          |
8+ 5       0.0372      0.12  Q       V  |          |          |          |
8+10       0.0381      0.13  Q       V  |          |          |          |
8+15       0.0390      0.13  Q       V  |          |          |          |
8+20       0.0399      0.13  Q       V  |          |          |          |
8+25       0.0408      0.13  Q        V |          |          |          |
8+30       0.0416      0.13  Q        V |          |          |          |
8+35       0.0426      0.14  Q        V |          |          |          |
8+40       0.0435      0.14  Q        V |          |          |          |
8+45       0.0445      0.14  Q        V |          |          |          |
8+50       0.0455      0.14  Q         V          |          |          |
8+55       0.0465      0.15  Q         V          |          |          |
9+ 0       0.0475      0.15  Q         V          |          |          |
9+ 5       0.0486      0.16  Q         V          |          |          |
```

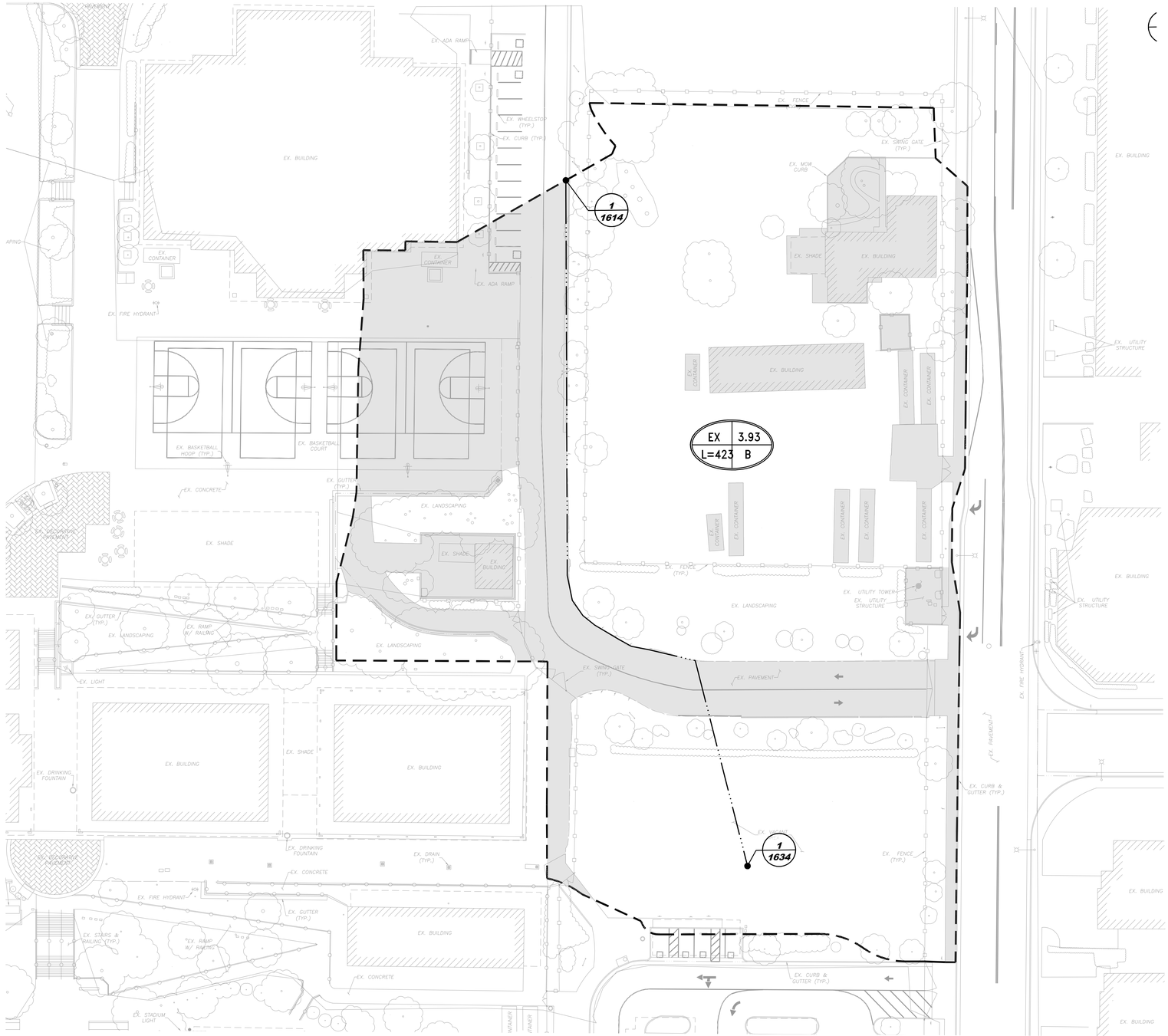


9+10	0.0497	0.16	Q	
9+15	0.0508	0.16	Q	
9+20	0.0520	0.17	Q	
9+25	0.0532	0.17	Q	
9+30	0.0544	0.17	Q	
9+35	0.0556	0.18	Q	
9+40	0.0569	0.18	Q	
9+45	0.0581	0.18	Q	
9+50	0.0594	0.19	Q	
9+55	0.0607	0.19	Q	
10+ 0	0.0620	0.19	Q	
10+ 5	0.0630	0.14	Q	
10+10	0.0639	0.13	Q	
10+15	0.0648	0.13	Q	
10+20	0.0657	0.13	Q	
10+25	0.0666	0.13	Q	
10+30	0.0675	0.13	Q	
10+35	0.0686	0.16	Q	
10+40	0.0698	0.17	Q	
10+45	0.0710	0.17	Q	
10+50	0.0722	0.17	Q	
10+55	0.0733	0.17	Q	
11+ 0	0.0745	0.17	Q	
11+ 5	0.0757	0.17	Q	
11+10	0.0768	0.16	Q	
11+15	0.0779	0.16	Q	
11+20	0.0791	0.16	Q	
11+25	0.0802	0.16	Q	
11+30	0.0813	0.16	Q	
11+35	0.0824	0.15	Q	
11+40	0.0834	0.15	Q	
11+45	0.0844	0.15	Q	
11+50	0.0854	0.15	Q	
11+55	0.0865	0.16	Q	
12+ 0	0.0876	0.16	Q	
12+ 5	0.0889	0.20	Q	
12+10	0.0904	0.22	Q	
12+15	0.0919	0.22	Q	
12+20	0.0934	0.22	Q	
12+25	0.0950	0.22	Q	
12+30	0.0965	0.22	Q	
12+35	0.0982	0.24	Q	
12+40	0.0998	0.24	Q	
12+45	0.1015	0.24	Q	
12+50	0.1032	0.25	Q	
12+55	0.1049	0.25	Q	
13+ 0	0.1066	0.25	Q	
13+ 5	0.1086	0.28	Q	
13+10	0.1106	0.29	Q	
13+15	0.1126	0.29	Q	
13+20	0.1146	0.29	Q	
13+25	0.1167	0.29	Q	
13+30	0.1187	0.29	Q	
13+35	0.1202	0.22	Q	
13+40	0.1216	0.20	Q	
13+45	0.1229	0.20	Q	
13+50	0.1243	0.20	Q	
13+55	0.1257	0.20	Q	
14+ 0	0.1270	0.20	Q	
14+ 5	0.1286	0.22	Q	
14+10	0.1302	0.23	Q	
14+15	0.1318	0.23	Q	
14+20	0.1333	0.23	Q	
14+25	0.1349	0.22	Q	
14+30	0.1364	0.22	Q	
14+35	0.1380	0.22	Q	
14+40	0.1395	0.22	Q	
14+45	0.1411	0.22	Q	
14+50	0.1426	0.22	Q	
14+55	0.1441	0.22	Q	
15+ 0	0.1455	0.22	Q	
15+ 5	0.1470	0.21	Q	
15+10	0.1484	0.21	Q	
15+15	0.1498	0.21	Q	
15+20	0.1512	0.20	Q	
15+25	0.1526	0.20	Q	
15+30	0.1539	0.20	Q	
15+35	0.1551	0.17	Q	
15+40	0.1563	0.16	Q	
15+45	0.1574	0.16	Q	
15+50	0.1585	0.16	Q	
15+55	0.1596	0.16	Q	
16+ 0	0.1608	0.16	Q	
16+ 5	0.1612	0.07	Q	
16+10	0.1615	0.03	Q	
16+15	0.1617	0.03	Q	

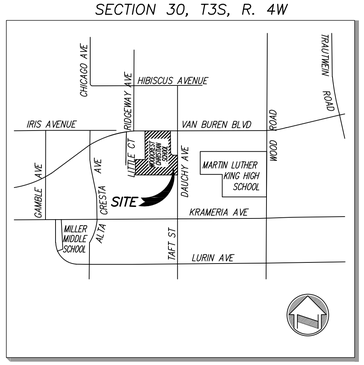
16+20	0.1619	0.03	Q	|	|	|	V |
16+25	0.1622	0.03	Q	|	|	|	V |
16+30	0.1624	0.03	Q	|	|	|	V |
16+35	0.1626	0.03	Q	|	|	|	V |
16+40	0.1628	0.03	Q	|	|	|	V |
16+45	0.1630	0.03	Q	|	|	|	V |
16+50	0.1631	0.03	Q	|	|	|	V |
16+55	0.1633	0.03	Q	|	|	|	V |
17+ 0	0.1635	0.03	Q	|	|	|	V |
17+ 5	0.1638	0.04	Q	|	|	|	V |
17+10	0.1641	0.04	Q	|	|	|	V |
17+15	0.1644	0.04	Q	|	|	|	V |
17+20	0.1647	0.04	Q	|	|	|	V |
17+25	0.1650	0.04	Q	|	|	|	V |
17+30	0.1653	0.04	Q	|	|	|	V |
17+35	0.1656	0.04	Q	|	|	|	V |
17+40	0.1658	0.04	Q	|	|	|	V |
17+45	0.1661	0.04	Q	|	|	|	V |
17+50	0.1664	0.04	Q	|	|	|	V |
17+55	0.1666	0.03	Q	|	|	|	V |
18+ 0	0.1669	0.03	Q	|	|	|	V |
18+ 5	0.1671	0.03	Q	|	|	|	V |
18+10	0.1673	0.03	Q	|	|	|	V |
18+15	0.1676	0.03	Q	|	|	|	V |
18+20	0.1678	0.03	Q	|	|	|	V |
18+25	0.1681	0.03	Q	|	|	|	V |
18+30	0.1683	0.03	Q	|	|	|	V |
18+35	0.1685	0.03	Q	|	|	|	V |
18+40	0.1687	0.03	Q	|	|	|	V |
18+45	0.1688	0.03	Q	|	|	|	V |
18+50	0.1690	0.02	Q	|	|	|	V |
18+55	0.1691	0.02	Q	|	|	|	V |
19+ 0	0.1692	0.02	Q	|	|	|	V |
19+ 5	0.1694	0.02	Q	|	|	|	V |
19+10	0.1696	0.03	Q	|	|	|	V |
19+15	0.1697	0.03	Q	|	|	|	V |
19+20	0.1700	0.03	Q	|	|	|	V |
19+25	0.1702	0.03	Q	|	|	|	V |
19+30	0.1704	0.03	Q	|	|	|	V |
19+35	0.1706	0.03	Q	|	|	|	V |
19+40	0.1708	0.03	Q	|	|	|	V |
19+45	0.1710	0.03	Q	|	|	|	V |
19+50	0.1711	0.02	Q	|	|	|	V |
19+55	0.1712	0.02	Q	|	|	|	V |
20+ 0	0.1714	0.02	Q	|	|	|	V |
20+ 5	0.1715	0.02	Q	|	|	|	V |
20+10	0.1717	0.03	Q	|	|	|	V |
20+15	0.1719	0.03	Q	|	|	|	V |
20+20	0.1721	0.03	Q	|	|	|	V |
20+25	0.1722	0.03	Q	|	|	|	V |
20+30	0.1724	0.03	Q	|	|	|	V |
20+35	0.1726	0.03	Q	|	|	|	V |
20+40	0.1728	0.03	Q	|	|	|	V |
20+45	0.1729	0.03	Q	|	|	|	V |
20+50	0.1731	0.02	Q	|	|	|	V |
20+55	0.1732	0.02	Q	|	|	|	V |
21+ 0	0.1733	0.02	Q	|	|	|	V |
21+ 5	0.1735	0.02	Q	|	|	|	V |
21+10	0.1737	0.03	Q	|	|	|	V |
21+15	0.1738	0.03	Q	|	|	|	V|
21+20	0.1740	0.02	Q	|	|	|	V|
21+25	0.1741	0.02	Q	|	|	|	V|
21+30	0.1742	0.02	Q	|	|	|	V|
21+35	0.1744	0.02	Q	|	|	|	V|
21+40	0.1746	0.03	Q	|	|	|	V|
21+45	0.1747	0.03	Q	|	|	|	V|
21+50	0.1749	0.02	Q	|	|	|	V|
21+55	0.1750	0.02	Q	|	|	|	V|
22+ 0	0.1751	0.02	Q	|	|	|	V|
22+ 5	0.1753	0.02	Q	|	|	|	V|
22+10	0.1754	0.03	Q	|	|	|	V|
22+15	0.1756	0.03	Q	|	|	|	V|
22+20	0.1758	0.02	Q	|	|	|	V|
22+25	0.1759	0.02	Q	|	|	|	V|
22+30	0.1760	0.02	Q	|	|	|	V|
22+35	0.1761	0.02	Q	|	|	|	V|
22+40	0.1762	0.02	Q	|	|	|	V|
22+45	0.1763	0.02	Q	|	|	|	V|
22+50	0.1765	0.02	Q	|	|	|	V|
22+55	0.1766	0.02	Q	|	|	|	V|
23+ 0	0.1767	0.02	Q	|	|	|	V|
23+ 5	0.1768	0.02	Q	|	|	|	V|
23+10	0.1769	0.02	Q	|	|	|	V|
23+15	0.1771	0.02	Q	|	|	|	V|
23+20	0.1772	0.02	Q	|	|	|	V|
23+25	0.1773	0.02	Q	|	|	|	V|

```
   23+30       0.1774      0.02  Q          |          |          |        v|
   23+35       0.1775      0.02  Q          |          |          |        v|
   23+40       0.1777      0.02  Q          |          |          |        v|
   23+45       0.1778      0.02  Q          |          |          |        v|
   23+50       0.1779      0.02  Q          |          |          |        v|
   23+55       0.1780      0.02  Q          |          |          |        v|
   24+ 0       0.1781      0.02  Q          |          |          |        v|
   24+ 5       0.1782      0.00  Q          |          |          |        v|
-------------------------------------------------------------------------
```

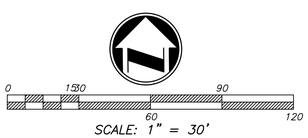
EXISTING UNIT HYDROGRAPH MAP
WOODCREST CHRISTIAN



SECTION 30, T3S, R. 4W



VICINITY MAP
(N.T.S.)



SCALE: 1" = 30'

PROPOSED
UNIT HYDROGRAPH MAP
PREPARATION DATE: NOVEMBER 2023
PLAN PREPARED BY:

adkan ENGINEERS
Civil Engineering • Surveying • Planning
6879 Airport Drive, Riverside, CA 92504
Tel:(951) 688-0241 Fax:(951) 688-0599

SHEET 1 OF 1

Plot Date: 11/30/2023

U:\Projects\Woodcrest Christian\100585\Engineering\Hydrology\100585 EX UNIT.dwg 12:10 PM

U n i t H y d r o g r a p h A n a l y s i s

Study date 11/20/23 File: pro2yr242.out

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Riverside County Synthetic Unit Hydrology Method
RCFC & WCD Manual date - April 1978

Program License Serial Number 5006

English (in-lb) Input Units Used
English Rainfall Data (Inches) Input Values Used

English Units used in output format

Drainage Area = 3.93(Ac.) = 0.006 Sq. Mi.
Drainage Area for Depth-Area Areal Adjustment = 3.93(Ac.) = 0.006 Sq. Mi.
Length along longest watercourse = 494.00(Ft.)
Length along longest watercourse measured to centroid = 247.00(Ft.)
Length along longest watercourse = 0.094 Mi.
Length along longest watercourse measured to centroid = 0.047 Mi.
Difference in elevation = 18.37(Ft.)
Slope along watercourse = 196.3433 Ft./Mi.
Average Manning's 'N' = 0.015
Lag time = 0.017 Hr.
Lag time = 1.01 Min.
25% of lag time = 0.25 Min.
40% of lag time = 0.40 Min.
Unit time = 5.00 Min.
Duration of storm = 24 Hour(s)
User Entered Base Flow = 0.00(CFS)

2 YEAR Area rainfall data:

Area(Ac.)[1]	Rainfall(In)[2]	Weighting[1*2]
3.93	1.60	6.29

100 YEAR Area rainfall data:

Area(Ac.)[1]	Rainfall(In)[2]	Weighting[1*2]
3.93	4.50	17.69

STORM EVENT (YEAR) = 2.00
Area Averaged 2-Year Rainfall = 1.600(In)
Area Averaged 100-Year Rainfall = 4.500(In)

Point rain (area averaged) = 1.600(In)
Areal adjustment factor = 100.00 %
Adjusted average point rain = 1.600(In)

Sub-Area Data:

Area(Ac.)	Runoff Index	Impervious %
3.930	62.50	0.800

Total Area Entered = 3.93(Ac.)

RI AMC2	RI AMC-1	Infil. Rate (In/Hr)	Impervious (Dec.%)	Adj. Infil. Rate (In/Hr)	Area% (Dec.)	F (In/Hr)
62.5	42.5	0.645	0.800	0.181	1.000	0.181
					Sum (F) =	0.181

Area averaged mean soil loss (F) (In/Hr) = 0.181
Minimum soil loss rate ((In/Hr)) = 0.090
(for 24 hour storm duration)
Soil low loss rate (decimal) = 0.260

U n i t H y d r o g r a p h
VALLEY S-Curve

Unit Hydrograph Data

Unit time period (hrs)	Time % of lag	Distribution Graph %	Unit Hydrograph (CFS)

1	0.083	497.222	70.784		2.804
2	0.167	994.443	29.216		1.157
			Sum = 100.000	Sum=	3.961

The following loss rate calculations reflect use of the minimum calculated loss rate subtracted from the Storm Rain to produce the maximum Effective Rain value

Unit	Time (Hr.)	Pattern Percent	Storm Rain (In/Hr)	Loss rate(In./Hr) Max	Low	Effective (In/Hr)
1	0.08	0.07	0.013	(0.320)	0.003	0.009
2	0.17	0.07	0.013	(0.319)	0.003	0.009
3	0.25	0.07	0.013	(0.318)	0.003	0.009
4	0.33	0.10	0.019	(0.317)	0.005	0.014
5	0.42	0.10	0.019	(0.315)	0.005	0.014
6	0.50	0.10	0.019	(0.314)	0.005	0.014
7	0.58	0.10	0.019	(0.313)	0.005	0.014
8	0.67	0.10	0.019	(0.312)	0.005	0.014
9	0.75	0.10	0.019	(0.311)	0.005	0.014
10	0.83	0.13	0.026	(0.309)	0.007	0.019
11	0.92	0.13	0.026	(0.308)	0.007	0.019
12	1.00	0.13	0.026	(0.307)	0.007	0.019
13	1.08	0.10	0.019	(0.306)	0.005	0.014
14	1.17	0.10	0.019	(0.304)	0.005	0.014
15	1.25	0.10	0.019	(0.303)	0.005	0.014
16	1.33	0.10	0.019	(0.302)	0.005	0.014
17	1.42	0.10	0.019	(0.301)	0.005	0.014
18	1.50	0.10	0.019	(0.300)	0.005	0.014
19	1.58	0.10	0.019	(0.298)	0.005	0.014
20	1.67	0.10	0.019	(0.297)	0.005	0.014
21	1.75	0.10	0.019	(0.296)	0.005	0.014
22	1.83	0.13	0.026	(0.295)	0.007	0.019
23	1.92	0.13	0.026	(0.294)	0.007	0.019
24	2.00	0.13	0.026	(0.293)	0.007	0.019
25	2.08	0.13	0.026	(0.291)	0.007	0.019
26	2.17	0.13	0.026	(0.290)	0.007	0.019
27	2.25	0.13	0.026	(0.289)	0.007	0.019
28	2.33	0.13	0.026	(0.288)	0.007	0.019
29	2.42	0.13	0.026	(0.287)	0.007	0.019
30	2.50	0.13	0.026	(0.285)	0.007	0.019
31	2.58	0.17	0.032	(0.284)	0.008	0.024
32	2.67	0.17	0.032	(0.283)	0.008	0.024
33	2.75	0.17	0.032	(0.282)	0.008	0.024
34	2.83	0.17	0.032	(0.281)	0.008	0.024
35	2.92	0.17	0.032	(0.280)	0.008	0.024
36	3.00	0.17	0.032	(0.278)	0.008	0.024
37	3.08	0.17	0.032	(0.277)	0.008	0.024
38	3.17	0.17	0.032	(0.276)	0.008	0.024
39	3.25	0.17	0.032	(0.275)	0.008	0.024
40	3.33	0.17	0.032	(0.274)	0.008	0.024
41	3.42	0.17	0.032	(0.273)	0.008	0.024
42	3.50	0.17	0.032	(0.272)	0.008	0.024
43	3.58	0.17	0.032	(0.270)	0.008	0.024
44	3.67	0.17	0.032	(0.269)	0.008	0.024
45	3.75	0.17	0.032	(0.268)	0.008	0.024
46	3.83	0.20	0.038	(0.267)	0.010	0.028
47	3.92	0.20	0.038	(0.266)	0.010	0.028
48	4.00	0.20	0.038	(0.265)	0.010	0.028
49	4.08	0.20	0.038	(0.264)	0.010	0.028
50	4.17	0.20	0.038	(0.263)	0.010	0.028
51	4.25	0.20	0.038	(0.261)	0.010	0.028
52	4.33	0.23	0.045	(0.260)	0.012	0.033
53	4.42	0.23	0.045	(0.259)	0.012	0.033
54	4.50	0.23	0.045	(0.258)	0.012	0.033
55	4.58	0.23	0.045	(0.257)	0.012	0.033
56	4.67	0.23	0.045	(0.256)	0.012	0.033
57	4.75	0.23	0.045	(0.255)	0.012	0.033
58	4.83	0.27	0.051	(0.254)	0.013	0.038
59	4.92	0.27	0.051	(0.253)	0.013	0.038
60	5.00	0.27	0.051	(0.251)	0.013	0.038
61	5.08	0.20	0.038	(0.250)	0.010	0.028
62	5.17	0.20	0.038	(0.249)	0.010	0.028
63	5.25	0.20	0.038	(0.248)	0.010	0.028
64	5.33	0.23	0.045	(0.247)	0.012	0.033
65	5.42	0.23	0.045	(0.246)	0.012	0.033
66	5.50	0.23	0.045	(0.245)	0.012	0.033
67	5.58	0.27	0.051	(0.244)	0.013	0.038
68	5.67	0.27	0.051	(0.243)	0.013	0.038
69	5.75	0.27	0.051	(0.242)	0.013	0.038
70	5.83	0.27	0.051	(0.241)	0.013	0.038
71	5.92	0.27	0.051	(0.240)	0.013	0.038
72	6.00	0.27	0.051	(0.239)	0.013	0.038
73	6.08	0.30	0.058	(0.238)	0.015	0.043
74	6.17	0.30	0.058	(0.236)	0.015	0.043

75	6.25	0.30	0.058	(0.235)	0.015	0.043
76	6.33	0.30	0.058	(0.234)	0.015	0.043
77	6.42	0.30	0.058	(0.233)	0.015	0.043
78	6.50	0.30	0.058	(0.232)	0.015	0.043
79	6.58	0.33	0.064	(0.231)	0.017	0.047
80	6.67	0.33	0.064	(0.230)	0.017	0.047
81	6.75	0.33	0.064	(0.229)	0.017	0.047
82	6.83	0.33	0.064	(0.228)	0.017	0.047
83	6.92	0.33	0.064	(0.227)	0.017	0.047
84	7.00	0.33	0.064	(0.226)	0.017	0.047
85	7.08	0.33	0.064	(0.225)	0.017	0.047
86	7.17	0.33	0.064	(0.224)	0.017	0.047
87	7.25	0.33	0.064	(0.223)	0.017	0.047
88	7.33	0.37	0.070	(0.222)	0.018	0.052
89	7.42	0.37	0.070	(0.221)	0.018	0.052
90	7.50	0.37	0.070	(0.220)	0.018	0.052
91	7.58	0.40	0.077	(0.219)	0.020	0.057
92	7.67	0.40	0.077	(0.218)	0.020	0.057
93	7.75	0.40	0.077	(0.217)	0.020	0.057
94	7.83	0.43	0.083	(0.216)	0.022	0.062
95	7.92	0.43	0.083	(0.215)	0.022	0.062
96	8.00	0.43	0.083	(0.214)	0.022	0.062
97	8.08	0.50	0.096	(0.213)	0.025	0.071
98	8.17	0.50	0.096	(0.212)	0.025	0.071
99	8.25	0.50	0.096	(0.211)	0.025	0.071
100	8.33	0.50	0.096	(0.210)	0.025	0.071
101	8.42	0.50	0.096	(0.209)	0.025	0.071
102	8.50	0.50	0.096	(0.208)	0.025	0.071
103	8.58	0.53	0.102	(0.207)	0.027	0.076
104	8.67	0.53	0.102	(0.206)	0.027	0.076
105	8.75	0.53	0.102	(0.205)	0.027	0.076
106	8.83	0.57	0.109	(0.204)	0.028	0.081
107	8.92	0.57	0.109	(0.203)	0.028	0.081
108	9.00	0.57	0.109	(0.202)	0.028	0.081
109	9.08	0.63	0.122	(0.201)	0.032	0.090
110	9.17	0.63	0.122	(0.200)	0.032	0.090
111	9.25	0.63	0.122	(0.199)	0.032	0.090
112	9.33	0.67	0.128	(0.198)	0.033	0.095
113	9.42	0.67	0.128	(0.197)	0.033	0.095
114	9.50	0.67	0.128	(0.196)	0.033	0.095
115	9.58	0.70	0.134	(0.196)	0.035	0.099
116	9.67	0.70	0.134	(0.195)	0.035	0.099
117	9.75	0.70	0.134	(0.194)	0.035	0.099
118	9.83	0.73	0.141	(0.193)	0.037	0.104
119	9.92	0.73	0.141	(0.192)	0.037	0.104
120	10.00	0.73	0.141	(0.191)	0.037	0.104
121	10.08	0.50	0.096	(0.190)	0.025	0.071
122	10.17	0.50	0.096	(0.189)	0.025	0.071
123	10.25	0.50	0.096	(0.188)	0.025	0.071
124	10.33	0.50	0.096	(0.187)	0.025	0.071
125	10.42	0.50	0.096	(0.186)	0.025	0.071
126	10.50	0.50	0.096	(0.185)	0.025	0.071
127	10.58	0.67	0.128	(0.184)	0.033	0.095
128	10.67	0.67	0.128	(0.184)	0.033	0.095
129	10.75	0.67	0.128	(0.183)	0.033	0.095
130	10.83	0.67	0.128	(0.182)	0.033	0.095
131	10.92	0.67	0.128	(0.181)	0.033	0.095
132	11.00	0.67	0.128	(0.180)	0.033	0.095
133	11.08	0.63	0.122	(0.179)	0.032	0.090
134	11.17	0.63	0.122	(0.178)	0.032	0.090
135	11.25	0.63	0.122	(0.177)	0.032	0.090
136	11.33	0.63	0.122	(0.176)	0.032	0.090
137	11.42	0.63	0.122	(0.176)	0.032	0.090
138	11.50	0.63	0.122	(0.175)	0.032	0.090
139	11.58	0.57	0.109	(0.174)	0.028	0.081
140	11.67	0.57	0.109	(0.173)	0.028	0.081
141	11.75	0.57	0.109	(0.172)	0.028	0.081
142	11.83	0.60	0.115	(0.171)	0.030	0.085
143	11.92	0.60	0.115	(0.170)	0.030	0.085
144	12.00	0.60	0.115	(0.170)	0.030	0.085
145	12.08	0.83	0.160	(0.169)	0.042	0.118
146	12.17	0.83	0.160	(0.168)	0.042	0.118
147	12.25	0.83	0.160	(0.167)	0.042	0.118
148	12.33	0.87	0.166	(0.166)	0.043	0.123
149	12.42	0.87	0.166	(0.165)	0.043	0.123
150	12.50	0.87	0.166	(0.165)	0.043	0.123
151	12.58	0.93	0.179	(0.164)	0.047	0.133
152	12.67	0.93	0.179	(0.163)	0.047	0.133
153	12.75	0.93	0.179	(0.162)	0.047	0.133
154	12.83	0.97	0.186	(0.161)	0.048	0.137
155	12.92	0.97	0.186	(0.160)	0.048	0.137
156	13.00	0.97	0.186	(0.160)	0.048	0.137
157	13.08	1.13	0.218	(0.159)	0.057	0.161
158	13.17	1.13	0.218	(0.158)	0.057	0.161
159	13.25	1.13	0.218	(0.157)	0.057	0.161
160	13.33	1.13	0.218	(0.156)	0.057	0.161

161	13.42	1.13	0.218	(0.156)	0.057	0.161
162	13.50	1.13	0.218	(0.155)	0.057	0.161
163	13.58	0.77	0.147	(0.154)	0.038	0.109
164	13.67	0.77	0.147	(0.153)	0.038	0.109
165	13.75	0.77	0.147	(0.152)	0.038	0.109
166	13.83	0.77	0.147	(0.152)	0.038	0.109
167	13.92	0.77	0.147	(0.151)	0.038	0.109
168	14.00	0.77	0.147	(0.150)	0.038	0.109
169	14.08	0.90	0.173	(0.149)	0.045	0.128
170	14.17	0.90	0.173	(0.149)	0.045	0.128
171	14.25	0.90	0.173	(0.148)	0.045	0.128
172	14.33	0.87	0.166	(0.147)	0.043	0.123
173	14.42	0.87	0.166	(0.146)	0.043	0.123
174	14.50	0.87	0.166	(0.146)	0.043	0.123
175	14.58	0.87	0.166	(0.145)	0.043	0.123
176	14.67	0.87	0.166	(0.144)	0.043	0.123
177	14.75	0.87	0.166	(0.143)	0.043	0.123
178	14.83	0.83	0.160	(0.143)	0.042	0.118
179	14.92	0.83	0.160	(0.142)	0.042	0.118
180	15.00	0.83	0.160	(0.141)	0.042	0.118
181	15.08	0.80	0.154	(0.140)	0.040	0.114
182	15.17	0.80	0.154	(0.140)	0.040	0.114
183	15.25	0.80	0.154	(0.139)	0.040	0.114
184	15.33	0.77	0.147	(0.138)	0.038	0.109
185	15.42	0.77	0.147	(0.138)	0.038	0.109
186	15.50	0.77	0.147	(0.137)	0.038	0.109
187	15.58	0.63	0.122	(0.136)	0.032	0.090
188	15.67	0.63	0.122	(0.135)	0.032	0.090
189	15.75	0.63	0.122	(0.135)	0.032	0.090
190	15.83	0.63	0.122	(0.134)	0.032	0.090
191	15.92	0.63	0.122	(0.133)	0.032	0.090
192	16.00	0.63	0.122	(0.133)	0.032	0.090
193	16.08	0.13	0.026	(0.132)	0.007	0.019
194	16.17	0.13	0.026	(0.131)	0.007	0.019
195	16.25	0.13	0.026	(0.131)	0.007	0.019
196	16.33	0.13	0.026	(0.130)	0.007	0.019
197	16.42	0.13	0.026	(0.129)	0.007	0.019
198	16.50	0.13	0.026	(0.129)	0.007	0.019
199	16.58	0.10	0.019	(0.128)	0.005	0.014
200	16.67	0.10	0.019	(0.127)	0.005	0.014
201	16.75	0.10	0.019	(0.127)	0.005	0.014
202	16.83	0.10	0.019	(0.126)	0.005	0.014
203	16.92	0.10	0.019	(0.125)	0.005	0.014
204	17.00	0.10	0.019	(0.125)	0.005	0.014
205	17.08	0.17	0.032	(0.124)	0.008	0.024
206	17.17	0.17	0.032	(0.124)	0.008	0.024
207	17.25	0.17	0.032	(0.123)	0.008	0.024
208	17.33	0.17	0.032	(0.122)	0.008	0.024
209	17.42	0.17	0.032	(0.122)	0.008	0.024
210	17.50	0.17	0.032	(0.121)	0.008	0.024
211	17.58	0.17	0.032	(0.121)	0.008	0.024
212	17.67	0.17	0.032	(0.120)	0.008	0.024
213	17.75	0.17	0.032	(0.119)	0.008	0.024
214	17.83	0.13	0.026	(0.119)	0.007	0.019
215	17.92	0.13	0.026	(0.118)	0.007	0.019
216	18.00	0.13	0.026	(0.118)	0.007	0.019
217	18.08	0.13	0.026	(0.117)	0.007	0.019
218	18.17	0.13	0.026	(0.116)	0.007	0.019
219	18.25	0.13	0.026	(0.116)	0.007	0.019
220	18.33	0.13	0.026	(0.115)	0.007	0.019
221	18.42	0.13	0.026	(0.115)	0.007	0.019
222	18.50	0.13	0.026	(0.114)	0.007	0.019
223	18.58	0.10	0.019	(0.114)	0.005	0.014
224	18.67	0.10	0.019	(0.113)	0.005	0.014
225	18.75	0.10	0.019	(0.113)	0.005	0.014
226	18.83	0.07	0.013	(0.112)	0.003	0.009
227	18.92	0.07	0.013	(0.111)	0.003	0.009
228	19.00	0.07	0.013	(0.111)	0.003	0.009
229	19.08	0.10	0.019	(0.110)	0.005	0.014
230	19.17	0.10	0.019	(0.110)	0.005	0.014
231	19.25	0.10	0.019	(0.109)	0.005	0.014
232	19.33	0.13	0.026	(0.109)	0.007	0.019
233	19.42	0.13	0.026	(0.108)	0.007	0.019
234	19.50	0.13	0.026	(0.108)	0.007	0.019
235	19.58	0.10	0.019	(0.107)	0.005	0.014
236	19.67	0.10	0.019	(0.107)	0.005	0.014
237	19.75	0.10	0.019	(0.106)	0.005	0.014
238	19.83	0.07	0.013	(0.106)	0.003	0.009
239	19.92	0.07	0.013	(0.105)	0.003	0.009
240	20.00	0.07	0.013	(0.105)	0.003	0.009
241	20.08	0.10	0.019	(0.104)	0.005	0.014
242	20.17	0.10	0.019	(0.104)	0.005	0.014
243	20.25	0.10	0.019	(0.104)	0.005	0.014
244	20.33	0.10	0.019	(0.103)	0.005	0.014
245	20.42	0.10	0.019	(0.103)	0.005	0.014
246	20.50	0.10	0.019	(0.102)	0.005	0.014

247	20.58	0.10	0.019	(	0.102)	0.005	0.014
248	20.67	0.10	0.019	(	0.101)	0.005	0.014
249	20.75	0.10	0.019	(	0.101)	0.005	0.014
250	20.83	0.07	0.013	(	0.101)	0.003	0.009
251	20.92	0.07	0.013	(	0.100)	0.003	0.009
252	21.00	0.07	0.013	(	0.100)	0.003	0.009
253	21.08	0.10	0.019	(	0.099)	0.005	0.014
254	21.17	0.10	0.019	(	0.099)	0.005	0.014
255	21.25	0.10	0.019	(	0.099)	0.005	0.014
256	21.33	0.07	0.013	(	0.098)	0.003	0.009
257	21.42	0.07	0.013	(	0.098)	0.003	0.009
258	21.50	0.07	0.013	(	0.097)	0.003	0.009
259	21.58	0.10	0.019	(	0.097)	0.005	0.014
260	21.67	0.10	0.019	(	0.097)	0.005	0.014
261	21.75	0.10	0.019	(	0.096)	0.005	0.014
262	21.83	0.07	0.013	(	0.096)	0.003	0.009
263	21.92	0.07	0.013	(	0.096)	0.003	0.009
264	22.00	0.07	0.013	(	0.095)	0.003	0.009
265	22.08	0.10	0.019	(	0.095)	0.005	0.014
266	22.17	0.10	0.019	(	0.095)	0.005	0.014
267	22.25	0.10	0.019	(	0.095)	0.005	0.014
268	22.33	0.07	0.013	(	0.094)	0.003	0.009
269	22.42	0.07	0.013	(	0.094)	0.003	0.009
270	22.50	0.07	0.013	(	0.094)	0.003	0.009
271	22.58	0.07	0.013	(	0.093)	0.003	0.009
272	22.67	0.07	0.013	(	0.093)	0.003	0.009
273	22.75	0.07	0.013	(	0.093)	0.003	0.009
274	22.83	0.07	0.013	(	0.093)	0.003	0.009
275	22.92	0.07	0.013	(	0.092)	0.003	0.009
276	23.00	0.07	0.013	(	0.092)	0.003	0.009
277	23.08	0.07	0.013	(	0.092)	0.003	0.009
278	23.17	0.07	0.013	(	0.092)	0.003	0.009
279	23.25	0.07	0.013	(	0.092)	0.003	0.009
280	23.33	0.07	0.013	(	0.091)	0.003	0.009
281	23.42	0.07	0.013	(	0.091)	0.003	0.009
282	23.50	0.07	0.013	(	0.091)	0.003	0.009
283	23.58	0.07	0.013	(	0.091)	0.003	0.009
284	23.67	0.07	0.013	(	0.091)	0.003	0.009
285	23.75	0.07	0.013	(	0.091)	0.003	0.009
286	23.83	0.07	0.013	(	0.091)	0.003	0.009
287	23.92	0.07	0.013	(	0.090)	0.003	0.009
288	24.00	0.07	0.013	(	0.090)	0.003	0.009

(Loss Rate Not Used)

Sum = 100.0 Sum = 14.2

Flood volume = Effective rainfall 1.18(In)
times area 3.9(Ac.)/[(In)/(Ft.)] = 0.4(Ac.Ft)
Total soil loss = 0.42(In)
Total soil loss = 0.136(Ac.Ft)
Total rainfall = 1.60(In)
Flood volume = 16890.7 Cubic Feet
Total soil loss = 5934.6 Cubic Feet

Peak flow rate of this hydrograph = 0.638(CFS)

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24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	2.5	5.0	7.5	10.0
0+ 5	0.0002	0.03	Q	|	|	|	|
0+10	0.0004	0.04	Q	|	|	|	|
0+15	0.0007	0.04	Q	|	|	|	|
0+20	0.0010	0.05	Q	|	|	|	|
0+25	0.0014	0.06	Q	|	|	|	|
0+30	0.0018	0.06	Q	|	|	|	|
0+35	0.0022	0.06	Q	|	|	|	|
0+40	0.0026	0.06	Q	|	|	|	|
0+45	0.0030	0.06	Q	|	|	|	|
0+50	0.0035	0.07	Q	|	|	|	|
0+55	0.0040	0.08	Q	|	|	|	|
1+ 0	0.0045	0.08	Q	|	|	|	|
1+ 5	0.0049	0.06	Q	|	|	|	|
1+10	0.0053	0.06	Q	|	|	|	|
1+15	0.0057	0.06	Q	|	|	|	|
1+20	0.0061	0.06	Q	|	|	|	|
1+25	0.0065	0.06	Q	|	|	|	|
1+30	0.0069	0.06	Q	|	|	|	|
1+35	0.0073	0.06	Q	|	|	|	|
1+40	0.0076	0.06	Q	|	|	|	|
1+45	0.0080	0.06	Q	|	|	|	|
1+50	0.0085	0.07	Q	|	|	|	|
1+55	0.0090	0.08	Q	|	|	|	|

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2+ 0       0.0095      0.08  Q          |          |          |          |
2+ 5       0.0101      0.08  QV         |          |          |          |
2+10       0.0106      0.08  QV         |          |          |          |
2+15       0.0111      0.08  QV         |          |          |          |
2+20       0.0116      0.08  QV         |          |          |          |
2+25       0.0121      0.08  QV         |          |          |          |
2+30       0.0126      0.08  QV         |          |          |          |
2+35       0.0133      0.09  QV         |          |          |          |
2+40       0.0139      0.09  QV         |          |          |          |
2+45       0.0145      0.09  QV         |          |          |          |
2+50       0.0152      0.09  QV         |          |          |          |
2+55       0.0158      0.09  QV         |          |          |          |
3+ 0       0.0165      0.09  QV         |          |          |          |
3+ 5       0.0171      0.09  QV         |          |          |          |
3+10       0.0178      0.09  QV         |          |          |          |
3+15       0.0184      0.09  QV         |          |          |          |
3+20       0.0191      0.09  QV         |          |          |          |
3+25       0.0197      0.09  Q V        |          |          |          |
3+30       0.0204      0.09  Q V        |          |          |          |
3+35       0.0210      0.09  Q V        |          |          |          |
3+40       0.0217      0.09  Q V        |          |          |          |
3+45       0.0223      0.09  Q V        |          |          |          |
3+50       0.0230      0.11  Q V        |          |          |          |
3+55       0.0238      0.11  Q V        |          |          |          |
4+ 0       0.0246      0.11  Q V        |          |          |          |
4+ 5       0.0254      0.11  Q V        |          |          |          |
4+10       0.0261      0.11  Q V        |          |          |          |
4+15       0.0269      0.11  Q V        |          |          |          |
4+20       0.0278      0.13  Q V        |          |          |          |
4+25       0.0287      0.13  Q V        |          |          |          |
4+30       0.0296      0.13  Q  V       |          |          |          |
4+35       0.0305      0.13  Q  V       |          |          |          |
4+40       0.0314      0.13  Q  V       |          |          |          |
4+45       0.0323      0.13  Q  V       |          |          |          |
4+50       0.0333      0.14  Q  V       |          |          |          |
4+55       0.0343      0.15  Q  V       |          |          |          |
5+ 0       0.0354      0.15  Q  V       |          |          |          |
5+ 5       0.0362      0.12  Q  V       |          |          |          |
5+10       0.0370      0.11  Q  V       |          |          |          |
5+15       0.0378      0.11  Q  V       |          |          |          |
5+20       0.0386      0.13  Q  V       |          |          |          |
5+25       0.0395      0.13  Q   V      |          |          |          |
5+30       0.0405      0.13  Q   V      |          |          |          |
5+35       0.0414      0.14  Q   V      |          |          |          |
5+40       0.0425      0.15  Q   V      |          |          |          |
5+45       0.0435      0.15  Q   V      |          |          |          |
5+50       0.0445      0.15  Q   V      |          |          |          |
5+55       0.0456      0.15  Q   V      |          |          |          |
6+ 0       0.0466      0.15  Q   V      |          |          |          |
6+ 5       0.0477      0.16  Q   V      |          |          |          |
6+10       0.0489      0.17  Q    V     |          |          |          |
6+15       0.0501      0.17  Q    V     |          |          |          |
6+20       0.0512      0.17  Q    V     |          |          |          |
6+25       0.0524      0.17  Q    V     |          |          |          |
6+30       0.0536      0.17  Q    V     |          |          |          |
6+35       0.0548      0.18  Q    V     |          |          |          |
6+40       0.0561      0.19  Q    V     |          |          |          |
6+45       0.0574      0.19  Q    V     |          |          |          |
6+50       0.0587      0.19  Q     V    |          |          |          |
6+55       0.0600      0.19  Q     V    |          |          |          |
7+ 0       0.0613      0.19  Q     V    |          |          |          |
7+ 5       0.0626      0.19  Q     V    |          |          |          |
7+10       0.0639      0.19  Q     V    |          |          |          |
7+15       0.0652      0.19  Q     V    |          |          |          |
7+20       0.0665      0.20  Q     V    |          |          |          |
7+25       0.0680      0.21  Q      V   |          |          |          |
7+30       0.0694      0.21  Q      V   |          |          |          |
7+35       0.0709      0.22  Q      V   |          |          |          |
7+40       0.0724      0.23  Q      V   |          |          |          |
7+45       0.0740      0.23  Q      V   |          |          |          |
7+50       0.0756      0.24  Q      V   |          |          |          |
7+55       0.0773      0.24  Q      V   |          |          |          |
8+ 0       0.0790      0.24  Q       V  |          |          |          |
8+ 5       0.0809      0.27  |Q       V  |          |          |          |
8+10       0.0828      0.28  |Q       V  |          |          |          |
8+15       0.0847      0.28  |Q       V  |          |          |          |
8+20       0.0867      0.28  |Q       V  |          |          |          |
8+25       0.0886      0.28  |Q        V|          |          |          |
8+30       0.0906      0.28  |Q        V|          |          |          |
8+35       0.0926      0.29  |Q        V|          |          |          |
8+40       0.0947      0.30  |Q        V|          |          |          |
8+45       0.0967      0.30  |Q        V|          |          |          |
8+50       0.0989      0.31  |Q         V          |          |          |
8+55       0.1011      0.32  |Q         V          |          |          |
9+ 0       0.1033      0.32  |Q         V          |          |          |
9+ 5       0.1057      0.35  |Q         V          |          |          |
```
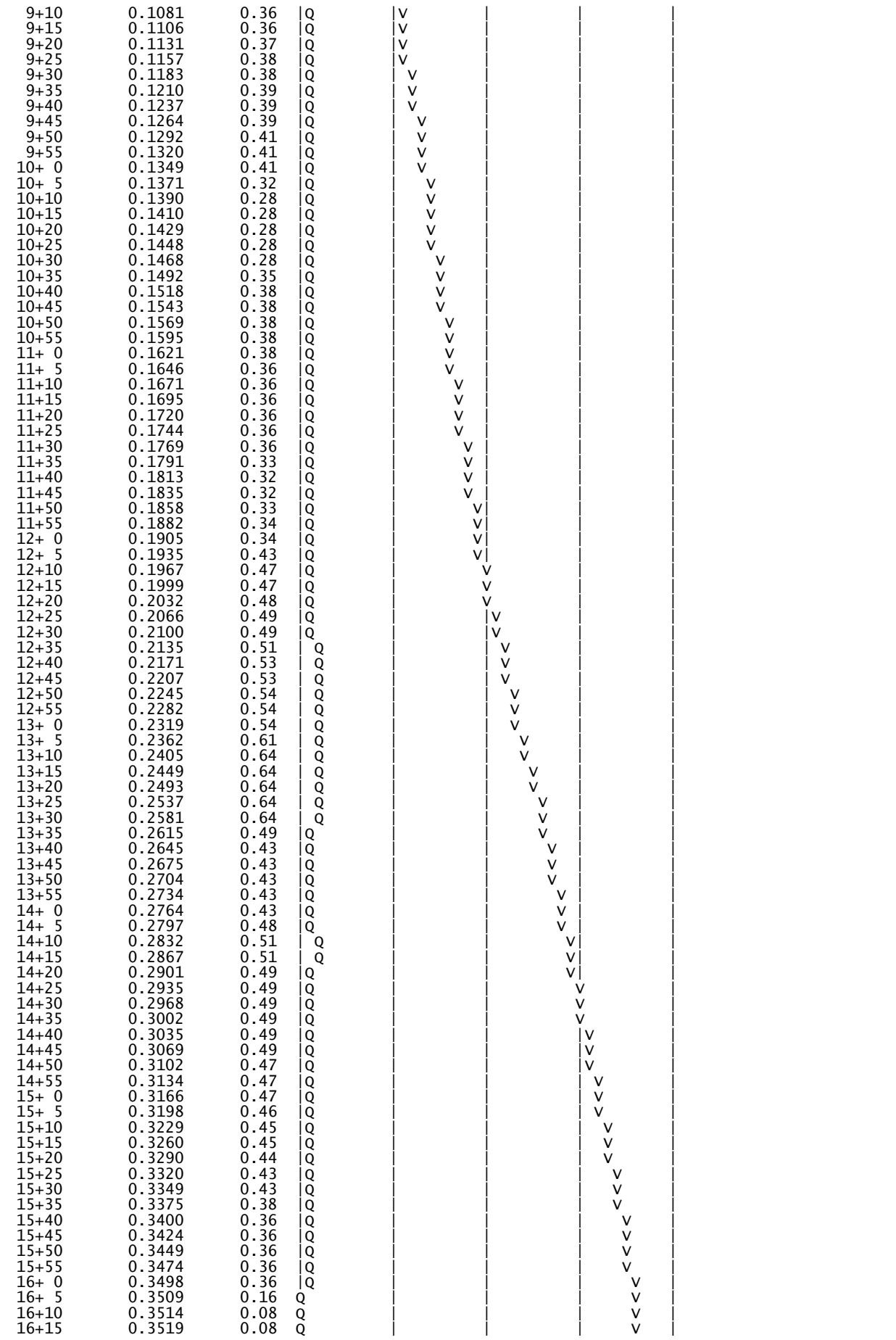
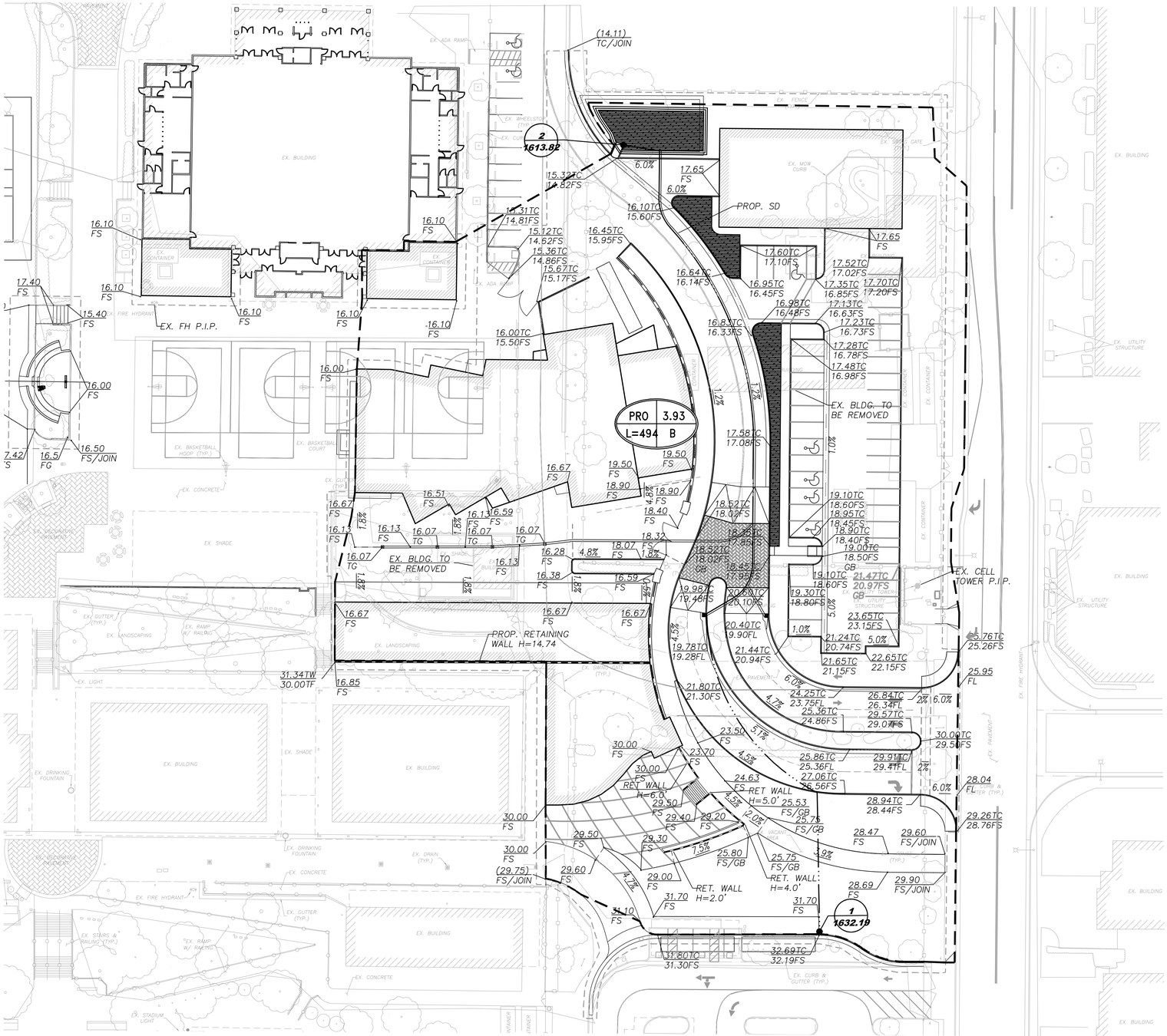



9+10	0.1081	0.36	Q
9+15	0.1106	0.36	Q
9+20	0.1131	0.37	Q
9+25	0.1157	0.38	Q
9+30	0.1183	0.38	Q
9+35	0.1210	0.39	Q
9+40	0.1237	0.39	Q
9+45	0.1264	0.39	Q
9+50	0.1292	0.41	Q
9+55	0.1320	0.41	Q
10+ 0	0.1349	0.41	Q
10+ 5	0.1371	0.32	Q
10+10	0.1390	0.28	Q
10+15	0.1410	0.28	Q
10+20	0.1429	0.28	Q
10+25	0.1448	0.28	Q
10+30	0.1468	0.28	Q
10+35	0.1492	0.35	Q
10+40	0.1518	0.38	Q
10+45	0.1543	0.38	Q
10+50	0.1569	0.38	Q
10+55	0.1595	0.38	Q
11+ 0	0.1621	0.38	Q
11+ 5	0.1646	0.36	Q
11+10	0.1671	0.36	Q
11+15	0.1695	0.36	Q
11+20	0.1720	0.36	Q
11+25	0.1744	0.36	Q
11+30	0.1769	0.36	Q
11+35	0.1791	0.33	Q
11+40	0.1813	0.32	Q
11+45	0.1835	0.32	Q
11+50	0.1858	0.33	Q
11+55	0.1882	0.34	Q
12+ 0	0.1905	0.34	Q
12+ 5	0.1935	0.43	Q
12+10	0.1967	0.47	Q
12+15	0.1999	0.47	Q
12+20	0.2032	0.48	Q
12+25	0.2066	0.49	Q
12+30	0.2100	0.49	Q
12+35	0.2135	0.51	Q
12+40	0.2171	0.53	Q
12+45	0.2207	0.53	Q
12+50	0.2245	0.54	Q
12+55	0.2282	0.54	Q
13+ 0	0.2319	0.54	Q
13+ 5	0.2362	0.61	Q
13+10	0.2405	0.64	Q
13+15	0.2449	0.64	Q
13+20	0.2493	0.64	Q
13+25	0.2537	0.64	Q
13+30	0.2581	0.64	Q
13+35	0.2615	0.49	Q
13+40	0.2645	0.43	Q
13+45	0.2675	0.43	Q
13+50	0.2704	0.43	Q
13+55	0.2734	0.43	Q
14+ 0	0.2764	0.43	Q
14+ 5	0.2797	0.48	Q
14+10	0.2832	0.51	Q
14+15	0.2867	0.51	Q
14+20	0.2901	0.49	Q
14+25	0.2935	0.49	Q
14+30	0.2968	0.49	Q
14+35	0.3002	0.49	Q
14+40	0.3035	0.49	Q
14+45	0.3069	0.49	Q
14+50	0.3102	0.47	Q
14+55	0.3134	0.47	Q
15+ 0	0.3166	0.47	Q
15+ 5	0.3198	0.46	Q
15+10	0.3229	0.45	Q
15+15	0.3260	0.45	Q
15+20	0.3290	0.44	Q
15+25	0.3320	0.43	Q
15+30	0.3349	0.43	Q
15+35	0.3375	0.38	Q
15+40	0.3400	0.36	Q
15+45	0.3424	0.36	Q
15+50	0.3449	0.36	Q
15+55	0.3474	0.36	Q
16+ 0	0.3498	0.36	Q
16+ 5	0.3509	0.16	Q
16+10	0.3514	0.08	Q
16+15	0.3519	0.08	Q

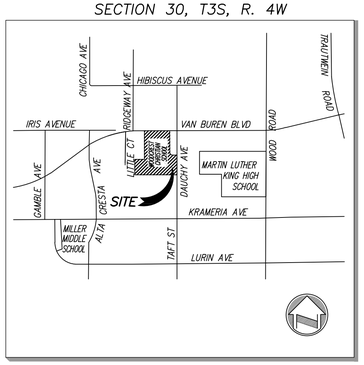
16+20	0.3524	0.08	Q	|	|	|	V |
16+25	0.3530	0.08	Q	|	|	|	V |
16+30	0.3535	0.08	Q	|	|	|	V |
16+35	0.3539	0.06	Q	|	|	|	V |
16+40	0.3543	0.06	Q	|	|	|	V |
16+45	0.3547	0.06	Q	|	|	|	V |
16+50	0.3551	0.06	Q	|	|	|	V |
16+55	0.3555	0.06	Q	|	|	|	V |
17+ 0	0.3558	0.06	Q	|	|	|	V |
17+ 5	0.3564	0.08	Q	|	|	|	V |
17+10	0.3571	0.09	Q	|	|	|	V |
17+15	0.3577	0.09	Q	|	|	|	V |
17+20	0.3584	0.09	Q	|	|	|	V |
17+25	0.3590	0.09	Q	|	|	|	V |
17+30	0.3596	0.09	Q	|	|	|	V |
17+35	0.3603	0.09	Q	|	|	|	V |
17+40	0.3609	0.09	Q	|	|	|	V |
17+45	0.3616	0.09	Q	|	|	|	V |
17+50	0.3621	0.08	Q	|	|	|	V |
17+55	0.3627	0.08	Q	|	|	|	V |
18+ 0	0.3632	0.08	Q	|	|	|	V |
18+ 5	0.3637	0.08	Q	|	|	|	V |
18+10	0.3642	0.08	Q	|	|	|	V |
18+15	0.3647	0.08	Q	|	|	|	V |
18+20	0.3652	0.08	Q	|	|	|	V |
18+25	0.3658	0.08	Q	|	|	|	V |
18+30	0.3663	0.08	Q	|	|	|	V |
18+35	0.3667	0.06	Q	|	|	|	V |
18+40	0.3671	0.06	Q	|	|	|	V |
18+45	0.3675	0.06	Q	|	|	|	V |
18+50	0.3678	0.04	Q	|	|	|	V |
18+55	0.3680	0.04	Q	|	|	|	V |
19+ 0	0.3683	0.04	Q	|	|	|	V |
19+ 5	0.3686	0.05	Q	|	|	|	V |
19+10	0.3690	0.06	Q	|	|	|	V |
19+15	0.3694	0.06	Q	|	|	|	V |
19+20	0.3699	0.07	Q	|	|	|	V |
19+25	0.3704	0.08	Q	|	|	|	V |
19+30	0.3709	0.08	Q	|	|	|	V |
19+35	0.3714	0.06	Q	|	|	|	V |
19+40	0.3717	0.06	Q	|	|	|	V |
19+45	0.3721	0.06	Q	|	|	|	V |
19+50	0.3724	0.04	Q	|	|	|	V |
19+55	0.3727	0.04	Q	|	|	|	V |
20+ 0	0.3729	0.04	Q	|	|	|	V |
20+ 5	0.3733	0.05	Q	|	|	|	V |
20+10	0.3737	0.06	Q	|	|	|	V |
20+15	0.3741	0.06	Q	|	|	|	V |
20+20	0.3745	0.06	Q	|	|	|	V |
20+25	0.3748	0.06	Q	|	|	|	V |
20+30	0.3752	0.06	Q	|	|	|	V |
20+35	0.3756	0.06	Q	|	|	|	V |
20+40	0.3760	0.06	Q	|	|	|	V |
20+45	0.3764	0.06	Q	|	|	|	V |
20+50	0.3767	0.04	Q	|	|	|	V |
20+55	0.3770	0.04	Q	|	|	|	V |
21+ 0	0.3772	0.04	Q	|	|	|	V |
21+ 5	0.3776	0.05	Q	|	|	|	V |
21+10	0.3779	0.06	Q	|	|	|	V |
21+15	0.3783	0.06	Q	|	|	|	V|
21+20	0.3786	0.04	Q	|	|	|	V|
21+25	0.3789	0.04	Q	|	|	|	V|
21+30	0.3792	0.04	Q	|	|	|	V|
21+35	0.3795	0.05	Q	|	|	|	V|
21+40	0.3799	0.06	Q	|	|	|	V|
21+45	0.3803	0.06	Q	|	|	|	V|
21+50	0.3806	0.04	Q	|	|	|	V|
21+55	0.3808	0.04	Q	|	|	|	V|
22+ 0	0.3811	0.04	Q	|	|	|	V|
22+ 5	0.3814	0.05	Q	|	|	|	V|
22+10	0.3818	0.06	Q	|	|	|	V|
22+15	0.3822	0.06	Q	|	|	|	V|
22+20	0.3825	0.04	Q	|	|	|	V|
22+25	0.3828	0.04	Q	|	|	|	V|
22+30	0.3830	0.04	Q	|	|	|	V|
22+35	0.3833	0.04	Q	|	|	|	V|
22+40	0.3835	0.04	Q	|	|	|	V|
22+45	0.3838	0.04	Q	|	|	|	V|
22+50	0.3841	0.04	Q	|	|	|	V|
22+55	0.3843	0.04	Q	|	|	|	V|
23+ 0	0.3846	0.04	Q	|	|	|	V|
23+ 5	0.3848	0.04	Q	|	|	|	V|
23+10	0.3851	0.04	Q	|	|	|	V|
23+15	0.3854	0.04	Q	|	|	|	V|
23+20	0.3856	0.04	Q	|	|	|	V|
23+25	0.3859	0.04	Q	|	|	|	V|

```
   23+30       0.3861      0.04  Q          |          |          |        v|
   23+35       0.3864      0.04  Q          |          |          |        v|
   23+40       0.3866      0.04  Q          |          |          |        v|
   23+45       0.3869      0.04  Q          |          |          |        v|
   23+50       0.3872      0.04  Q          |          |          |        v|
   23+55       0.3874      0.04  Q          |          |          |        v|
   24+ 0       0.3877      0.04  Q          |          |          |        v|
   24+ 5       0.3878      0.01  Q          |          |          |         v
-------------------------------------------------------------------------
```

PROPOSED UNIT HYDROGRAPH MAP
WOODCREST CHRISTIAN



SECTION 30, T3S, R. 4W



VICINITY MAP
(N.T.S.)

0 30 90
15 60 120
SCALE: 1" = 30'

PROPOSED
UNIT HYDROGRAPH MAP
PREPARATION DATE: NOVEMBER 2023
PLAN PREPARED BY:

adkan ENGINEERS
Civil Engineering · Surveying · Planning
6879 Airport Drive, Riverside, CA 92504
Tel:(951) 688-0241 Fax:(951) 688-0599

SHEET 1 OF 1

Plot Date: 11/20/2023

Basin Size and Flow Calculations

BIORETENTION BASIN

	BASIN PARAMETERS					OUTLET								
Basin Elevation	Depth	Area S.F.	Volume C.F.	Volume AC-FT	Effective Volume AC-FT	Q_1 Orrifice Plate (cfs)	Q_2 Orrifice Plate (cfs)	Q_3 Orrifice Plate (cfs)	Q_4 Orrifice Plate (cfs)	Q_5Orrifice Plate (cfs)	Q_6 Orrifice Plate (cfs)	Q_7Orrifice Plate (cfs)	Q Weir 1 (cfs)	Q Total (cfs)
10.20	0.00	788.40	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11.20	1.00	788.40	788.40	0.018	0.018	0.000	0.181	0.000	0.000	0.000	0.000	0.000	0.000	0.181
12.20	2.00	788.40	1,576.80	0.036	0.036	0.000	0.255	0.000	0.000	0.000	0.000	0.000	0.000	0.255
13.20	3.00	2,628.00	5,124.60	0.118	0.118	0.000	0.313	0.000	0.000	0.000	0.000	0.000	0.000	0.313
13.70	3.50	2,859.00	6,382.95	0.147	0.147	0.000	0.338	0.000	0.000	0.000	0.000	0.000	0.000	0.338
14.20	4.00	3,091.00	7,758.80	0.178	0.178	0.000	0.361	0.000	0.000	0.000	0.000	0.000	18.837	19.198
14.58	4.38	3,555.00	9,512.05	0.218	0.218	0.000	0.378	0.000	0.000	0.000	0.000	0.000	43.983	44.361

SUPPORTING DESIGN PARAMETERS

Orifice Coefficient	0.66		Dia of Orrifice		2.50						
Gravimetric Constant	32.2	ft/s^2	Eff Dia of Orrifice	0.0000	0.2083	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of Rows	1		Area of Orrifice	0.0000	0.0341	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Minimum Orrifice Plate Height			Number of Orrifeces	1	1	1	1	1	1	1	1
Minimum Orrifice Plate Width			Elev		10.2						

	.	Weir	Sharp Crest Weir Coefficient	3.33
			Length of Weir	16.00
			Elev. at Crest of Weir	13.7

Orifice Equation
$Q=Cd(1/4\pi D2)\sqrt{2gh}$
Weir Equation
(Q/(Weir Length* Weir Coefficent))^(2/3)

Q100 Elevation Weir Calc		
Inlet Weir Calc		
Crest Wier Elev.	13.70	
Q100	12	cfs
Weir Length	16	
Weir Coeff.	3.33	
H Weir	0.37018	
Q100 Elevation	**14.07**	

Q100 Elevation Weir Calc		
Emergency Spillway Weir Calc		
Crest Wier Elev.	14.08	
Q100	12	cfs
Weir Length	11	
Weir Coeff.	3.33	
H Weir	0.47522	
Q100 Elevation	**14.56**	

BIORETENTION

EXISTING			PROPOSED		ROUTING		
AREA	CFS	VOLUME AC.FT.	CFS	VOLUME AC.FT.	CFS	VOLUME AC.FT.	DEPTH FT.
EX	0.293	0.178	0.638	0.388	0.310	0.114	2.95

```
                FLOOD HYDROGRAPH ROUTING PROGRAM
          Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2004
                      Study date: 02/15/24

 ---------------------------------------------------------------------



 Program License Serial Number 5006

 ---------------------------------------------------------------------
 ********************* HYDROGRAPH INFORMATION **********************

               From study/file name: pro2yr242.rte
 ******************************HYDROGRAPH DATA*****************************
               Number of intervals =   289
               Time interval =    5.0 (Min.)
               Maximum/Peak flow rate =        0.638 (CFS)
               Total volume =       0.388 (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
 *************************************************************************



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

 User entry of depth-outflow-storage data
 ---------------------------------------------------------------------
 Total number of inflow hydrograph intervals = 289
 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
    1.000      0.018      0.181      0.017        0.019
    2.000      0.036      0.255      0.035        0.037
    3.000      0.118      0.313      0.117        0.119
    3.500      0.147      0.338      0.146        0.148
    4.000      0.178     19.198      0.112        0.244
    4.380      0.218     44.361      0.065        0.371
 ---------------------------------------------------------------------
                 Hydrograph Detention Basin Routing
 ---------------------------------------------------------------------

 Graph values: 'I'= unit inflow; 'O'=outflow at time shown
 ---------------------------------------------------------------------
  Time   Inflow  Outflow    Storage                                  Depth
 (Hours)  (CFS)   (CFS)     (Ac.Ft) .0       0.2    0.32    0.48    0.64 (Ft.)
  0.083    0.03    0.00      0.000  OI      |       |       |       |     0.00
  0.167    0.04    0.00      0.000  OI      |       |       |       |     0.02
  0.250    0.04    0.01      0.001  OI      |       |       |       |     0.03
  0.333    0.05    0.01      0.001  O I     |       |       |       |     0.04
  0.417    0.06    0.01      0.001  O I     |       |       |       |     0.06
  0.500    0.06    0.01      0.001  O I     |       |       |       |     0.08
  0.583    0.06    0.02      0.002  O I     |       |       |       |     0.09
  0.667    0.06    0.02      0.002  O I     |       |       |       |     0.11
  0.750    0.06    0.02      0.002  |OI     |       |       |       |     0.12
  0.833    0.07    0.02      0.002  |O I    |       |       |       |     0.14
  0.917    0.08    0.03      0.003  |O I    |       |       |       |     0.15
  1.000    0.08    0.03      0.003  |O I    |       |       |       |     0.17
  1.083    0.06    0.03      0.003  |O I    |       |       |       |     0.19
  1.167    0.06    0.04      0.004  |OI     |       |       |       |     0.19
  1.250    0.06    0.04      0.004  |OI     |       |       |       |     0.20
  1.333    0.06    0.04      0.004  |OI     |       |       |       |     0.21
  1.417    0.06    0.04      0.004  |OI     |       |       |       |     0.22
  1.500    0.06    0.04      0.004  | O     |       |       |       |     0.22
  1.583    0.06    0.04      0.004  | O     |       |       |       |     0.23
  1.667    0.06    0.04      0.004  | O     |       |       |       |     0.23
```

1.750	0.06	0.04	0.004	O				0.24
1.833	0.07	0.04	0.004	OI				0.25
1.917	0.08	0.05	0.005	OI				0.26
2.000	0.08	0.05	0.005	OI				0.27
2.083	0.08	0.05	0.005	OI				0.28
2.167	0.08	0.05	0.005	OI				0.29
2.250	0.08	0.05	0.005	OI				0.30
2.333	0.08	0.05	0.005	OI				0.30
2.417	0.08	0.06	0.006	OI				0.31
2.500	0.08	0.06	0.006	OI				0.32
2.583	0.09	0.06	0.006	O I				0.33
2.667	0.09	0.06	0.006	OI				0.34
2.750	0.09	0.06	0.006	OI				0.35
2.833	0.09	0.07	0.007	OI				0.36
2.917	0.09	0.07	0.007	OI				0.37
3.000	0.09	0.07	0.007	OI				0.38
3.083	0.09	0.07	0.007	OI				0.39
3.167	0.09	0.07	0.007	OI				0.40
3.250	0.09	0.07	0.007	OI				0.41
3.333	0.09	0.08	0.007	OI				0.41
3.417	0.09	0.08	0.008	OI				0.42
3.500	0.09	0.08	0.008	OI				0.43
3.583	0.09	0.08	0.008	OI				0.43
3.667	0.09	0.08	0.008	OI				0.44
3.750	0.09	0.08	0.008	O				0.45
3.833	0.11	0.08	0.008	OI				0.45
3.917	0.11	0.08	0.008	OI				0.46
4.000	0.11	0.09	0.009	OI				0.47
4.083	0.11	0.09	0.009	OI				0.48
4.167	0.11	0.09	0.009	OI				0.49
4.250	0.11	0.09	0.009	OI				0.50
4.333	0.13	0.09	0.009	O I				0.51
4.417	0.13	0.10	0.009	O I				0.53
4.500	0.13	0.10	0.010	O I				0.54
4.583	0.13	0.10	0.010	OI				0.55
4.667	0.13	0.10	0.010	OI				0.56
4.750	0.13	0.10	0.010	OI				0.57
4.833	0.14	0.11	0.011	O I				0.59
4.917	0.15	0.11	0.011	O I				0.60
5.000	0.15	0.11	0.011	O I				0.62
5.083	0.12	0.11	0.011	OI				0.63
5.167	0.11	0.11	0.011	O				0.63
5.250	0.11	0.11	0.011	O				0.63
5.333	0.13	0.11	0.011	OI				0.63
5.417	0.13	0.11	0.011	OI				0.64
5.500	0.13	0.12	0.012	OI				0.64
5.583	0.14	0.12	0.012	O I				0.65
5.667	0.15	0.12	0.012	O I				0.66
5.750	0.15	0.12	0.012	OI				0.67
5.833	0.15	0.12	0.012	OI				0.68
5.917	0.15	0.13	0.012	OI				0.69
6.000	0.15	0.13	0.013	OI				0.70
6.083	0.16	0.13	0.013	O I				0.71
6.167	0.17	0.13	0.013	O I				0.73
6.250	0.17	0.13	0.013	O I				0.74
6.333	0.17	0.14	0.014	O I				0.75
6.417	0.17	0.14	0.014	O I				0.76
6.500	0.17	0.14	0.014	OI				0.78
6.583	0.18	0.14	0.014	O|I				0.79
6.667	0.19	0.15	0.014	O|I				0.80
6.750	0.19	0.15	0.015	O|I				0.82
6.833	0.19	0.15	0.015	O|I				0.83
6.917	0.19	0.15	0.015	O|I				0.85
7.000	0.19	0.16	0.015	O|I				0.86
7.083	0.19	0.16	0.016	O|I				0.87
7.167	0.19	0.16	0.016	OI				0.88
7.250	0.19	0.16	0.016	OI				0.89
7.333	0.20	0.16	0.016	O I				0.91
7.417	0.21	0.17	0.017	O I				0.92
7.500	0.21	0.17	0.017	O I				0.94
7.583	0.22	0.17	0.017	O I				0.95
7.667	0.23	0.18	0.017	O I				0.97
7.750	0.23	0.18	0.018	O I				0.99
7.833	0.24	0.18	0.018	|O I				1.01
7.917	0.24	0.18	0.019	|O I				1.03
8.000	0.24	0.18	0.019	|O I				1.05
8.083	0.27	0.19	0.019	|O I				1.08
8.167	0.28	0.19	0.020	|O I				1.11
8.250	0.28	0.19	0.021	|O I				1.15
8.333	0.28	0.19	0.021	|O I				1.18
8.417	0.28	0.20	0.022	|O I				1.22
8.500	0.28	0.20	0.022	|O I				1.25
8.583	0.29	0.20	0.023	| O I				1.28
8.667	0.30	0.20	0.024	| O I|			1.32
8.750	0.30	0.21	0.024	| O I|			1.35
8.833	0.31	0.21	0.025	| O I|			1.39

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 8.917    0.32    0.21      0.026   |       | O     I       |       |     1.43
 9.000    0.32    0.22      0.026   |       | O     I       |       |     1.47
 9.083    0.35    0.22      0.027   |       | O     |I      |       |     1.52
 9.167    0.36    0.22      0.028   |       |  O    |I      |       |     1.56
 9.250    0.36    0.23      0.029   |       |  O    |I      |       |     1.62
 9.333    0.37    0.23      0.030   |       |  O    | I     |       |     1.67
 9.417    0.38    0.23      0.031   |       |  O    | I     |       |     1.72
 9.500    0.38    0.24      0.032   |       |  O    | I     |       |     1.77
 9.583    0.39    0.24      0.033   |       |   O   |  I    |       |     1.83
 9.667    0.39    0.25      0.034   |       |   O   |  I    |       |     1.88
 9.750    0.39    0.25      0.035   |       |   O   |  I    |       |     1.94
 9.833    0.41    0.25      0.036   |       |   O   |   I   |       |     2.00
 9.917    0.41    0.26      0.037   |       |   O   |   I   |       |     2.01
10.000    0.41    0.26      0.038   |       |   O   |   I   |       |     2.03
10.083    0.32    0.26      0.039   |       |   O   I       |       |     2.03
10.167    0.28    0.26      0.039   |       |   O I |       |       |     2.04
10.250    0.28    0.26      0.039   |       |   O I |       |       |     2.04
10.333    0.28    0.26      0.039   |       |   O I |       |       |     2.04
10.417    0.28    0.26      0.040   |       |   O I |       |       |     2.04
10.500    0.28    0.26      0.040   |       |   O I |       |       |     2.05
10.583    0.35    0.26      0.040   |       |   O   |I      |       |     2.05
10.667    0.38    0.26      0.041   |       |   O   | I     |       |     2.06
10.750    0.38    0.26      0.042   |       |   O   | I     |       |     2.07
10.833    0.38    0.26      0.043   |       |    O  | I     |       |     2.08
10.917    0.38    0.26      0.043   |       |    O  | I     |       |     2.09
11.000    0.38    0.26      0.044   |       |    O  | I     |       |     2.10
11.083    0.36    0.26      0.045   |       |    O  | I     |       |     2.11
11.167    0.36    0.26      0.046   |       |    O  |I      |       |     2.12
11.250    0.36    0.26      0.046   |       |    O  |I      |       |     2.12
11.333    0.36    0.26      0.047   |       |    O  |I      |       |     2.13
11.417    0.36    0.26      0.047   |       |    O  |I      |       |     2.14
11.500    0.36    0.26      0.048   |       |    O  |I      |       |     2.15
11.583    0.33    0.26      0.049   |       |    O  I       |       |     2.15
11.667    0.32    0.26      0.049   |       |    O  I       |       |     2.16
11.750    0.32    0.26      0.049   |       |    O  I       |       |     2.16
11.833    0.33    0.26      0.050   |       |    O  I       |       |     2.17
11.917    0.34    0.27      0.050   |       |    O  I       |       |     2.17
12.000    0.34    0.27      0.051   |       |    O  I       |       |     2.18
12.083    0.43    0.27      0.052   |       |    O  |    I  |       |     2.19
12.167    0.47    0.27      0.053   |       |    O  |      I|       |     2.21
12.250    0.47    0.27      0.054   |       |    O  |      I|       |     2.22
12.333    0.48    0.27      0.056   |       |    O  |       I       |     2.24
12.417    0.49    0.27      0.057   |       |    O  |       I       |     2.26
12.500    0.49    0.27      0.059   |       |    O  |       I       |     2.28
12.583    0.51    0.27      0.060   |       |    O  |       |I      |     2.30
12.667    0.53    0.27      0.062   |       |    O  |       | I     |     2.32
12.750    0.53    0.27      0.064   |       |    O  |       | I     |     2.34
12.833    0.54    0.28      0.066   |       |    O  |       |  I    |     2.36
12.917    0.54    0.28      0.067   |       |    O  |       |  I    |     2.38
13.000    0.54    0.28      0.069   |       |    O  |       |  I    |     2.40
13.083    0.61    0.28      0.071   |       |     O |       |     I |     2.43
13.167    0.64    0.28      0.074   |       |     O |       |       I     2.46
13.250    0.64    0.28      0.076   |       |     O |       |       I     2.49
13.333    0.64    0.29      0.078   |       |     O |       |       I     2.52
13.417    0.64    0.29      0.081   |       |     O |       |       I     2.55
13.500    0.64    0.29      0.083   |       |     O |       |       I     2.58
13.583    0.49    0.29      0.085   |       |     O |       I       |     2.60
13.667    0.43    0.29      0.086   |       |     O |    I  |       |     2.61
13.750    0.43    0.29      0.087   |       |     O |    I  |       |     2.63
13.833    0.43    0.29      0.088   |       |     O |    I  |       |     2.64
13.917    0.43    0.29      0.089   |       |     O |    I  |       |     2.65
14.000    0.43    0.29      0.090   |       |     O |    I  |       |     2.66
14.083    0.48    0.29      0.091   |       |     O |       I       |     2.68
14.167    0.51    0.30      0.093   |       |     O |       |I      |     2.69
14.250    0.51    0.30      0.094   |       |     O |       |I      |     2.71
14.333    0.49    0.30      0.096   |       |     O |       I       |     2.73
14.417    0.49    0.30      0.097   |       |     O |       I       |     2.74
14.500    0.49    0.30      0.098   |       |     O |       I       |     2.76
14.583    0.49    0.30      0.100   |       |      O|       I       |     2.77
14.667    0.49    0.30      0.101   |       |      O|       I       |     2.79
14.750    0.49    0.30      0.102   |       |      O|       I       |     2.81
14.833    0.47    0.30      0.103   |       |      O|      I|       |     2.82
14.917    0.47    0.30      0.105   |       |      O|      I|       |     2.84
15.000    0.47    0.30      0.106   |       |      O|      I|       |     2.85
15.083    0.46    0.31      0.107   |       |      O|     I |       |     2.86
15.167    0.45    0.31      0.108   |       |      O|     I |       |     2.88
15.250    0.45    0.31      0.109   |       |      O|     I |       |     2.89
15.333    0.44    0.31      0.110   |       |      O|    I  |       |     2.90
15.417    0.43    0.31      0.111   |       |      O|    I  |       |     2.91
15.500    0.43    0.31      0.111   |       |      O|    I  |       |     2.92
15.583    0.38    0.31      0.112   |       |      O| I     |       |     2.93
15.667    0.36    0.31      0.112   |       |      O|I      |       |     2.93
15.750    0.36    0.31      0.113   |       |      O|I      |       |     2.94
15.833    0.36    0.31      0.113   |       |      O|I      |       |     2.94
15.917    0.36    0.31      0.113   |       |      O|I      |       |     2.94
16.000    0.36    0.31      0.114   |       |      O|I      |       |     2.95
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16.083	0.16	0.31	0.113	| I| o| | |				2.94
16.167	0.08	0.31	0.112	| I | o| | |				2.93
16.250	0.08	0.31	0.110	| I | o| | |				2.91
16.333	0.08	0.31	0.109	| I | o| | |				2.89
16.417	0.08	0.31	0.107	| I | o| | |				2.87
16.500	0.08	0.30	0.106	| I | o| | |				2.85
16.583	0.06	0.30	0.104	| I | o| | |				2.83
16.667	0.06	0.30	0.102	| I | o| | |				2.81
16.750	0.06	0.30	0.101	| I | o| | |				2.79
16.833	0.06	0.30	0.099	| I | o| | |				2.77
16.917	0.06	0.30	0.097	| I | o | | |				2.75
17.000	0.06	0.30	0.096	| I | o | | |				2.73
17.083	0.08	0.30	0.094	| I | o | | |				2.71
17.167	0.09	0.30	0.093	| I | o | | |				2.69
17.250	0.09	0.29	0.091	| I | o | | |				2.67
17.333	0.09	0.29	0.090	| I | o | | |				2.66
17.417	0.09	0.29	0.089	| I | o | | |				2.64
17.500	0.09	0.29	0.087	| I | o | | |				2.62
17.583	0.09	0.29	0.086	| I | o | | |				2.61
17.667	0.09	0.29	0.085	| I | o | | |				2.59
17.750	0.09	0.29	0.083	| I | o | | |				2.58
17.833	0.08	0.29	0.082	| I | o | | |				2.56
17.917	0.08	0.29	0.080	| I | o | | |				2.54
18.000	0.08	0.29	0.079	| I | o | | |				2.52
18.083	0.08	0.28	0.077	| I | o | | |				2.51
18.167	0.08	0.28	0.076	| I | o | | |				2.49
18.250	0.08	0.28	0.075	| I | o | | |				2.47
18.333	0.08	0.28	0.073	| I | o | | |				2.45
18.417	0.08	0.28	0.072	| I | o | | |				2.44
18.500	0.08	0.28	0.070	| I | o | | |				2.42
18.583	0.06	0.28	0.069	| I | o | | |				2.40
18.667	0.06	0.28	0.067	| I | o | | |				2.38
18.750	0.06	0.28	0.066	| I | o | | |				2.36
18.833	0.04	0.28	0.064	| I | o | | |				2.35
18.917	0.04	0.27	0.063	|I | o | | |				2.33
19.000	0.04	0.27	0.061	|I | o | | |				2.31
19.083	0.05	0.27	0.060	| I | o | | |				2.29
19.167	0.06	0.27	0.058	| I | o | | |				2.27
19.250	0.06	0.27	0.057	| I | o | | |				2.25
19.333	0.07	0.27	0.055	| I | o | | |				2.23
19.417	0.08	0.27	0.054	| I | o | | |				2.22
19.500	0.08	0.27	0.052	| I | o | | |				2.20
19.583	0.06	0.27	0.051	| I | o | | |				2.18
19.667	0.06	0.26	0.050	| I | o | | |				2.17
19.750	0.06	0.26	0.048	| I | o | | |				2.15
19.833	0.04	0.26	0.047	| I | o | | |				2.13
19.917	0.04	0.26	0.045	|I | o | | |				2.11
20.000	0.04	0.26	0.044	|I | o | | |				2.09
20.083	0.05	0.26	0.042	| I | o | | |				2.08
20.167	0.06	0.26	0.041	| I | o | | |				2.06
20.250	0.06	0.26	0.039	| I | o | | |				2.04
20.333	0.06	0.26	0.038	| I | o | | |				2.02
20.417	0.06	0.26	0.037	| I | o | | |				2.01
20.500	0.06	0.25	0.035	| I | o | | |				1.96
20.583	0.06	0.25	0.034	| I | o | | |				1.89
20.667	0.06	0.24	0.033	| I | o | | |				1.82
20.750	0.06	0.24	0.031	| I | o | | |				1.75
20.833	0.04	0.23	0.030	| I | o | | |				1.68
20.917	0.04	0.23	0.029	|I | o | | |				1.60
21.000	0.04	0.22	0.028	|I | o | | |				1.53
21.083	0.05	0.22	0.026	| I | o | | |				1.47
21.167	0.06	0.21	0.025	| I | o | | |				1.40
21.250	0.06	0.21	0.024	| I | o | | |				1.35
21.333	0.04	0.20	0.023	| I | o | | |				1.29
21.417	0.04	0.20	0.022	|I |o | | |				1.23
21.500	0.04	0.19	0.021	|I |o | | |				1.17
21.583	0.05	0.19	0.020	| I |o | | |				1.11
21.667	0.06	0.19	0.019	| I |o | | |				1.06
21.750	0.06	0.18	0.018	| I |o | | |				1.01
21.833	0.04	0.17	0.017	| I | o | | |				0.96
21.917	0.04	0.16	0.016	|I | o | | |				0.91
22.000	0.04	0.16	0.016	|I | o| | |				0.86
22.083	0.05	0.15	0.015	| I | o| | |				0.82
22.167	0.06	0.14	0.014	| I | o| | |				0.79
22.250	0.06	0.14	0.014	| I | o | | |				0.76
22.333	0.04	0.13	0.013	| I | o | | |				0.72
22.417	0.04	0.12	0.012	|I | o | | |				0.69
22.500	0.04	0.12	0.012	|I | o | | |				0.66
22.583	0.04	0.11	0.011	|I | o | | |				0.63
22.667	0.04	0.11	0.011	|I | o | | |				0.60
22.750	0.04	0.10	0.010	|I | o | | |				0.57
22.833	0.04	0.10	0.010	|I | o | | |				0.55
22.917	0.04	0.10	0.009	|I | o | | |				0.53
23.000	0.04	0.09	0.009	|I | o | | |				0.50
23.083	0.04	0.09	0.009	|I | o | | |				0.48
23.167	0.04	0.08	0.008	|I | o | | |				0.47

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23.250    0.04    0.08      0.008  |I  O   |       |       |       |     0.45
23.333    0.04    0.08      0.008  |I O    |       |       |       |     0.43
23.417    0.04    0.08      0.008  |I O    |       |       |       |     0.42
23.500    0.04    0.07      0.007  |I O    |       |       |       |     0.40
23.583    0.04    0.07      0.007  |I O    |       |       |       |     0.39
23.667    0.04    0.07      0.007  |I O    |       |       |       |     0.38
23.750    0.04    0.07      0.007  |I O    |       |       |       |     0.37
23.833    0.04    0.06      0.006  |I O    |       |       |       |     0.36
23.917    0.04    0.06      0.006  |I O    |       |       |       |     0.35
24.000    0.04    0.06      0.006  |I O    |       |       |       |     0.34
24.083    0.01    0.06      0.006  I O     |       |       |       |     0.32
24.167    0.00    0.05      0.005  I O     |       |       |       |     0.30

       Remaining water in basin =    0.01 (Ac.Ft)


       ****************************HYDROGRAPH DATA****************************
                     Number of intervals =   290
                     Time interval =    5.0 (Min.)
                     Maximum/Peak flow rate =        0.310 (CFS)
                     Total volume =       0.382 (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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Appendix 8: Source Control

Pollutant Sources/Source Control Checklist

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

How to use this worksheet (also see instructions in Section G of the WQMP Template):

1. Review Column 1 and identify which of these potential sources of stormwater pollutants apply to your site. Check each box that applies.
2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your WQMP Exhibit.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in your WQMP. Use the format shown in Table G.1on page 23 of this WQMP Template. Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternative BMPs for those shown here.

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
☒ **A.** On-site storm drain inlets	☒ Locations of inlets.	☒ Mark all inlets with the words "Only Rain Down the Storm Drain" or similar. Catch Basin Markers may be available from the Riverside County Flood Control and Water Conservation District, call 951.955.1200 to verify.	☒ Maintain and periodically repaint or replace inlet markings. ☒ Provide stormwater pollution prevention information to new site owners, lessees, or operators. ☒ See applicable operational BMPs in Fact Sheet SC-44, "Drainage System Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com ☒ Include the following in lease agreements: "Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains."
☐ **B.** Interior floor drains and elevator shaft sump pumps		☐ State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.	☐ Inspect and maintain drains to prevent blockages and overflow.
☐ **C.** Interior parking garages		☐ State that parking garage floor drains will be plumbed to the sanitary sewer.	☐ Inspect and maintain drains to prevent blockages and overflow.

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on WQMP Drawings**	3 **Permanent Controls—List in WQMP Table and Narrative**	4 **Operational BMPs—Include in WQMP Table and Narrative**
☒ **D1.** Need for future indoor & structural pest control		☒ Note building design features that discourage entry of pests.	☒ Provide Integrated Pest Management information to owners, lessees, and operators.
☒ **D2.** Landscape/ Outdoor Pesticide Use	☒ Show locations of native trees or areas of shrubs and ground cover to be undisturbed and retained. ❑ Show self-retaining landscape areas, if any. ☒ Show stormwater treatment and hydrograph modification management BMPs. (See instructions in Chapter 3, Step 5 and guidance in Chapter 5.)	State that final landscape plans will accomplish all of the following. ☒ Preserve existing native trees, shrubs, and ground cover to the maximum extent possible. ☒ Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution. ❑ Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions. ☒ Consider using pest-resistant plants, especially adjacent to hardscape. To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.	☒ Maintain landscaping using minimum or no pesticides. ☒ See applicable operational BMPs in "What you should know for…..Landscape and Gardening" at http://rcflood.org/stormwater/**Error! Hyperlink reference not valid.** ☒ Provide IPM information to new owners, lessees and operators.

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on WQMP Drawings**	**3** **Permanent Controls—List in WQMP Table and Narrative**	**4** **Operational BMPs—Include in WQMP Table and Narrative**
❑ **E.** Pools, spas, ponds, decorative fountains, and other water features.	❑ Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet. (Exception: Public pools must be plumbed according to County Department of Environmental Health Guidelines.)	If the Co-Permittee requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to local requirements.	❑ See applicable operational BMPs in "Guidelines for Maintaining Your Swimming Pool, Jacuzzi and Garden Fountain" at http://rcflood.org/stormwater/
❑ **F.** Food service	❑ For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment. ❑ On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.	❑ Describe the location and features of the designated cleaning area. ❑ Describe the items to be cleaned in this facility and how it has been sized to insure that the largest items can be accommodated.	❑ See the brochure, "The Food Service Industry Best Management Practices for: Restaurants, Grocery Stores, Delicatessens and Bakeries" at http://rcflood.org/stormwater/ Provide this brochure to new site owners, lessees, and operators.
☒ **G.** Refuse areas	☒ Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas. ☒ If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area. ☒ Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.	☒ State how site refuse will be handled and provide supporting detail to what is shown on plans. ☒ State that signs will be posted on or near dumpsters with the words "Do not dump hazardous materials here" or similar.	☒ State how the following will be implemented: Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site. See Fact Sheet SC-34, "Waste Handling and Disposal" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on WQMP Drawings**	3 **Permanent Controls—List in WQMP Table and Narrative**	4 **Operational BMPs—Include in WQMP Table and Narrative**
☒ **J.** Vehicle and Equipment Cleaning	☒ **Show on drawings as appropriate:** **(1) Commercial/industrial facilities having vehicle/equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses.** **(2) Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited on-site and hoses are provided with an automatic shut-off to discourage such use).** **(3) Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer.** **(4) Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer, or a wastewater reclamation system shall be installed.**	❑ **If a car wash area is not provided, describe any measures taken to discourage on-site car washing and explain how these will be enforced.**	**Describe operational measures to implement the following (if applicable):** ☒ **Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system.** Refer to "Outdoor Cleaning Activities and Professional Mobile Service Providers" for many of the Potential Sources of Runoff Pollutants categories below. Brochure can be found at http://rcflood.org/stormwater/ ❑**Car dealerships and similar may rinse cars with water only.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
☒ **L.** Fuel Dispensing Areas	☒ Fueling areas[6] shall have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are: a) graded at the minimum slope necessary to prevent ponding; and b) separated from the rest of the site by a grade break that prevents run-on of stormwater to the maximum extent practicable. ☒ Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area[1].] The canopy [or cover] shall not drain onto the fueling area.		☒ The property owner shall dry sweep the fueling area routinely. ☒ See the Fact Sheet SD-30 , "Fueling Areas" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com

[6] The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
☒ **N.** Fire Sprinkler Test Water		☒ Provide a means to drain fire sprinkler test water to the sanitary sewer.	☒ See the note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com
O. Miscellaneous Drain or Wash Water or Other Sources ❑ Boiler drain lines ☒ Condensate drain lines ☒ Rooftop equipment ❑ Drainage sumps ☒ Roofing, gutters, and trim. ❑ Other sources		❑ Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system. ☒ Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system. ❑ Rooftop equipment with potential to produce pollutants shall be roofed and/or have secondary containment. ❑ Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water. ☒ Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff. Include controls for other sources as specified by local reviewer.	

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
☒ **P.** Plazas, sidewalks, and parking lots.			☒ Sweep plazas, sidewalks, and parking lots regularly to prevent accumulation of litter and debris. Collect debris from pressure washing to prevent entry into the storm drain system. Collect washwater containing any cleaning agent or degreaser and discharge to the sanitary sewer not to a storm drain.

Appendix 9: O&M

Operation and Maintenance Plan and Documentation of Finance, Maintenance and Recording Mechanisms, Covenant and Agreement

Operations & Maintenance Responsibility for Treatment Control BMP's

BMP Required Maintenance	Frequency	Maintenance Requirements	Responsibility
Trash	Weekly	Empty Dumpsters	Property Owner
Bioretention Facility / Planter box	Monthly	Remove litter and debris	Property Owner
	Semi-Annual	Remove and replace dead and diseased vegetation.	
	Annual	Add mulch, replace tree stakes and wires	
	As Needed	Remove sediment, remulch void areas, treat diseased trees and shrubs, mow turf areas, repair erosion at inflow points, repair outflow structures, unclog underdrain, and regulate soil pH regulation.	

BMP's should start and be inspected prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

Funding

Woodcrest Christian
18401 Van Buren Blvd
Riverside, CA 92508
951.780.2010

Basin Site Maintenance Summary Form

Date:	**Inspector Name:**	**Basin:**
Maintenance Performed:		
Date:	**Inspector Name:**	**Basin:**
Maintenance Performed:		
Date:	**Inspector Name:**	**Basin:**
Maintenance Performed:		
Date:	**Inspector Name:**	**Basin:**
Maintenance Performed:		
Date:	**Inspector Name:**	**Basin:**
Maintenance Performed:		
Date:	**Inspector Name:**	**Basin:**
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Maintenance Performed:		
Date:	**Inspector Name:**	**Basin:**
Maintenance Performed:		
Date:	**Inspector Name:**	**Basin:**
Maintenance Performed:		

Appendix 10: Educational Materials

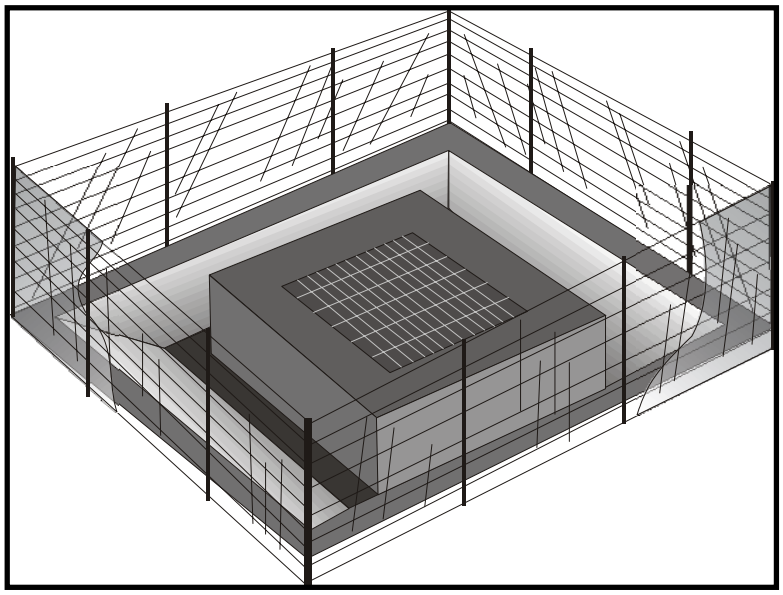
BMP Fact Sheets, Maintenance Guidelines and Other End-User BMP Information

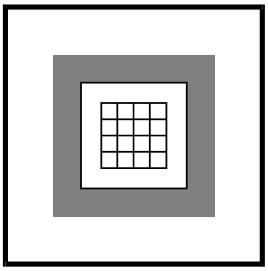
INDEX

{Select all applicable BMP's}

Storm Drain Inlet Protection

SC-10





Standard Symbol

BMP Objectives

- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Devices used at storm drain inlets that are subject to runoff from construction activities to detain and/or to filter sediment-laden runoff to allow sediment to settle and/or to filter sediment prior to discharge into storm drainage systems or watercourses.

Appropriate Applications

- Where ponding will not encroach into highway traffic.
- Where sediment laden surface runoff may enter an inlet.
- Where disturbed drainage areas have not yet been permanently stabilized.
- Where the drainage area is 0.4 ha (1 ac) or less.
- Appropriate during wet and snow-melt seasons.

Limitations

- Requires an adequate area for water to pond without encroaching upon traveled way and should not present itself to be an obstacle to oncoming traffic.
- May require other methods of temporary protection to prevent sediment-laden storm water and non-storm water discharges from entering the storm drain system.
- Sediment removal may be difficult in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are expected, use other on-site sediment trapping techniques (e.g. check dams) in conjunction with inlet protection.
- Frequent maintenance is required.
- For drainage areas larger than 0.4 ha (1 ac), runoff shall be routed to a sediment trapping device designed for larger flows. See BMPs SC-2, “Sediment/Desilting Basin,” and SC-3 “Sediment Trap.”

- Filter fabric fence inlet protection is appropriate in open areas that are subject to sheet flow and for flows not exceeding 0.014 m3/s (0.5 cfs).
- Gravel bag barriers for inlet protection are applicable when sheet flows or concentrated flows exceed 0.014 m3/s (0.5 cfs), and it is necessary to allow for overtopping to prevent flooding.
- Fiber rolls and foam barriers are not appropriate for locations where they cannot be properly anchored to the surface.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected and overflow capability is needed.

Standards and Specifications

Identify existing and/or planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed, and which method to use.

Methods and Installation

- ***DI Protection Type 1 - Filter Fabric Fence -*** The filter fabric fence (Type 1) protection is illustrated on Page 5. Similar to constructing a silt fence. See BMP SC-1, "Silt Fence." Do not place filter fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced.
- ***DI Protection Type 2 - Excavated Drop Inlet Sediment Trap -*** The excavated drop inlet sediment trap (Type 2) is illustrated in Page 6. Similar to constructing a temporary silt fence, See BMP SC-1, "Silt Fence." Size excavated trap to provide a minimum storage capacity calculated at the rate of 130 m3/ha (67 yd3/ac) of drainage area.
- ***DI Protection Type 3 – Gravel bag -*** The gravel bag barrier (Type 3) is illustrated in Page 7. Flow from a severe storm shall not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with BMP SC-6, "Gravel Bag Berm." Gravel bags shall be used due to their high permeability.
- ***DI Protection Type 4 – Foam Barriers and Fiber Rolls –*** Foam barrier or fiber roll (Type 4) is placed around the inlet and keyed and anchored to the surface. Foam barriers and fiber rolls are intended for use as inlet protection where the area around the inlet is unpaved and the foam barrier or fiber roll can be secured to the surface. RE or Construction Storm Water Coordinator approval is required.

Maintenance and Inspection

General

- Inspect all inlet protection devices before and after every rainfall event, and weekly during the rest of the rainy season. During extended rainfall events, inspect inlet protection devices at least once every 24 hours.

- Inspect the storm drain inlet after severe storms in the rainy season to check for bypassed material.
- Remove all inlet protection devices within thirty days after the site is stabilized, or when the inlet protection is no longer needed.
  - Bring the disturbed area to final grade and smooth and compact it. Appropriately stabilize all bare areas around the inlet.
  - Clean and re-grade area around the inlet and clean the inside of the storm drain inlet as it must be free of sediment and debris at the time of final inspection.

Requirements by Method

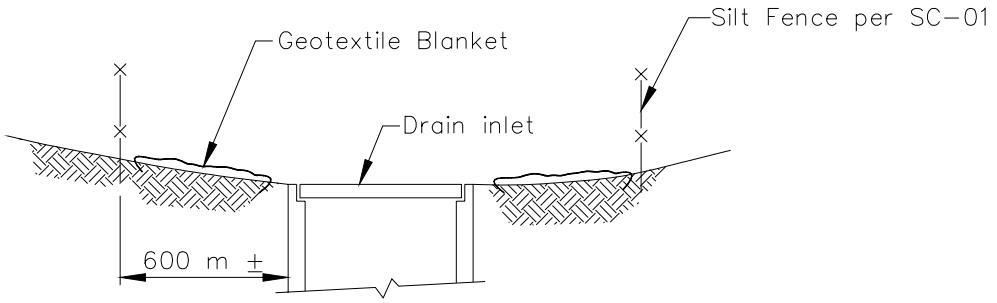
- ***Type 1 - Filter Fabric Fence***
  - This method shall be used for drain inlets requiring protection in areas where finished grade is established and erosion control seeding has been applied or is pending.
  - Make sure the stakes are securely driven in the ground and are structurally sound (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes.
  - Replace or clean the fabric when the fabric becomes clogged with sediment. Make sure the fabric does not have any holes or tears. Repair or replace fabric as needed or as directed by the RE.
  - At a minimum, remove the sediment behind the fabric fence when accumulation reaches one-third the height of the fence or barrier height. Removed sediment shall be incorporated in the project at locations designated by the RE or disposed of outside the highway right-of-way in conformance with the Standard Specifications Section 7-1.13.
- ***Type 2 – Excavated Drop Inlet Sediment Trap***
  - This method may be used for drain inlets requiring protection in areas that have been cleared and grubbed, and where exposed soil areas are subject to grading.
  - Remove sediment from basin when the volume of the basin has been reduced by one-half.
- ***Type 3 - Gravel Bag Barrier***
  - This method may be used for drain inlets surrounded by AC or paved surfaces.
  - Inspect bags for holes, gashes, and snags.

- Check gravel bags for proper arrangement and displacement. Remove the sediment behind the barrier when it reaches one-third the height of the barrier. Removed sediment shall be incorporated in the project at locations designated by the RE or disposed of outside the highway right-of-way in conformance with the Standard Specifications Section 7-1.13.

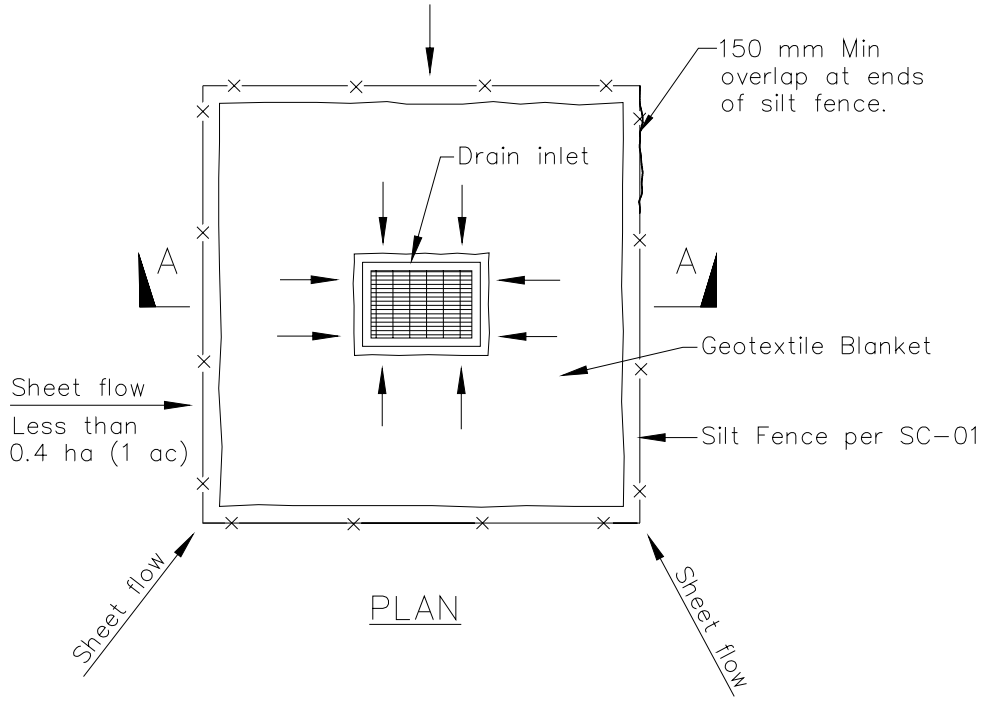
■ ***Type 4 Foam Barriers and Fiber Rolls***

- This method may be used for drain inlets requiring protection in areas that have been cleared and grubbed, and where exposed soil areas subject to grading. RE or Construction Storm Coordinator approval is required.

- Check foam barrier or fiber roll for proper arrangement and displacement. Remove the sediment behind the barrier when it reaches one-third the height of the barrier. Removed sediment shall be incorporated in the project at locations designated by the RE or disposed of outside the highway right-of-way in conformance with the Standard Specifications.



SECTION A–A

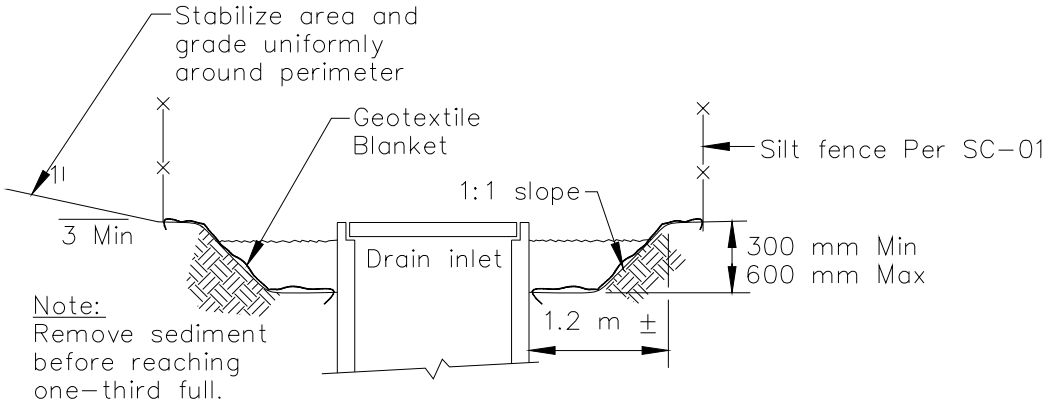


PLAN

DI PROTECTION TYPE 1
NOT TO SCALE

NOTES:

1. For use in areas where grading has been completed and final soil stabilization and seeding are pending.
2. Not applicable in paved areas.
3. Not applicable with concentrated flows.



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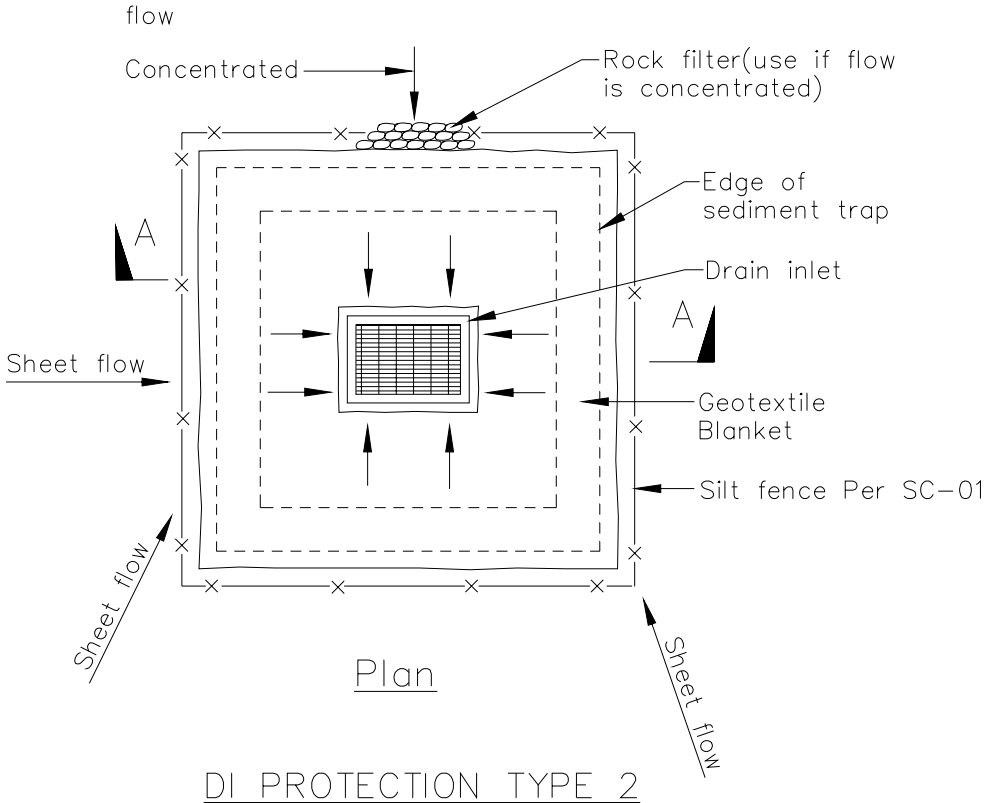
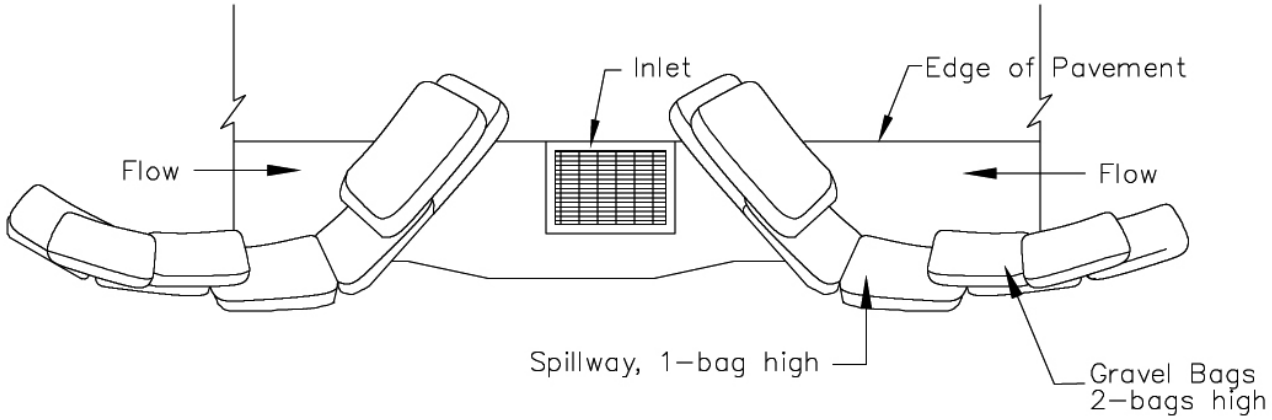


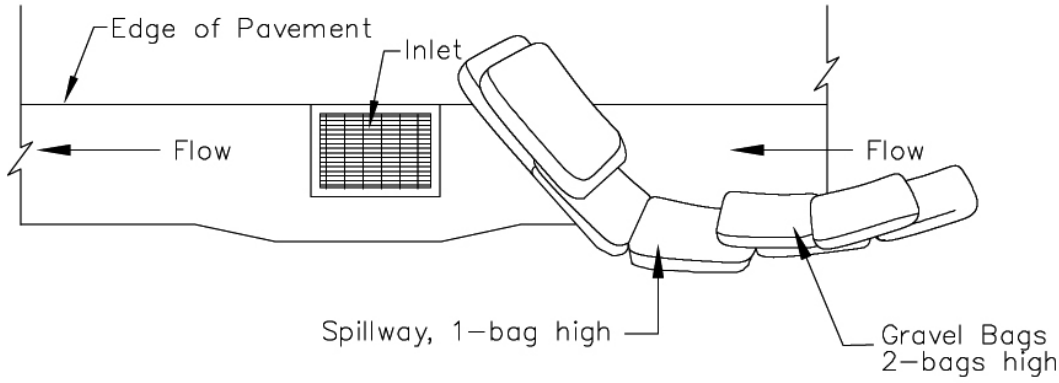
Plan

DI PROTECTION TYPE 2
NOT TO SCALE

Notes
1. For use in cleared and grubbed and in graded areas.
2. Shape basin so that longest inflow area faces longest length of trap.
3. For concentrated flows, shape basin in 2:1 ratio with length oriented towards direction of flow.



TYPICAL PROTECTION FOR INLET WITH OPOSING FLOW DIRECTIONS



TYPICAL PROTECTION FOR INLET WITH SINGLE FLOW DIRECTION

NOTES:

1. Intended for short–term use.
2. Use to inhibit non–storm water flow.
3. Allow for proper maintenance and cleanup.
4. Bags must be removed after adjacent operation is completed
5. Not applicable in areas with high silts and clays without filter fabric.

Spill Prevention, Control & Cleanup SC-11

Photo Credit: Geoff Brosseau

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Description

Many activities that occur at an industrial or commercial site have the potential to cause accidental or illegal spills. Preparation for accidental or illegal spills, with proper training and reporting systems implemented, can minimize the discharge of pollutants to the environment.

Spills and leaks are one of the largest contributors of stormwater pollutants. Spill prevention and control plans are applicable to any site at which hazardous materials are stored or used. An effective plan should have spill prevention and response procedures that identify potential spill areas, specify material handling procedures, describe spill response procedures, and provide spill clean-up equipment. The plan should take steps to identify and characterize potential spills, eliminate and reduce spill potential, respond to spills when they occur in an effort to prevent pollutants from entering the stormwater drainage system, and train personnel to prevent and control future spills.

Targeted Constituents

Sediment	
Nutrients	
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Approach

Pollution Prevention

- Develop procedures to prevent/mitigate spills to storm drain systems. Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.

- Develop a Spill Prevention Control and Countermeasure (SPCC) Plan. The plan should include:

CASQA California Stormwater Quality Association

- Description of the facility, owner and address, activities and chemicals present
- Facility map
- Notification and evacuation procedures
- Cleanup instructions
- Identification of responsible departments
- Identify key spill response personnel

- Recycle, reclaim, or reuse materials whenever possible. This will reduce the amount of process materials that are brought into the facility.

Suggested Protocols (including equipment needs)

Spill Prevention

- Develop procedures to prevent/mitigate spills to storm drain systems. Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.

- If consistent illegal dumping is observed at the facility:
  - Post "No Dumping" signs with a phone number for reporting illegal dumping and disposal. Signs should also indicate fines and penalties applicable for illegal dumping.
  - Landscaping and beautification efforts may also discourage illegal dumping.
  - Bright lighting and/or entrance barriers may also be needed to discourage illegal dumping.

- Store and contain liquid materials in such a manner that if the tank is ruptured, the contents will not discharge, flow, or be washed into the storm drainage system, surface waters, or groundwater.

- If the liquid is oil, gas, or other material that separates from and floats on water, install a spill control device (such as a tee section) in the catch basins that collects runoff from the storage tank area.

- Routine maintenance:
  - Place drip pans or absorbent materials beneath all mounted taps, and at all potential drip and spill locations during filling and unloading of tanks. Any collected liquids or soiled absorbent materials must be reused/recycled or properly disposed.
  - Store and maintain appropriate spill cleanup materials in a location known to all near the tank storage area; and ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.
  - Sweep and clean the storage area monthly if it is paved, *do not hose down the area to a storm drain*.

  - Check tanks (and any containment sumps) daily for leaks and spills. Replace tanks that are leaking, corroded, or otherwise deteriorating with tanks in good condition. Collect all spilled liquids and properly dispose of them.

- Label all containers according to their contents (e.g., solvent, gasoline).
- Label hazardous substances regarding the potential hazard (corrosive, radioactive, flammable, explosive, poisonous).
- Prominently display required labels on transported hazardous and toxic materials (per US DOT regulations).
- Identify key spill response personnel.

Spill Control and Cleanup Activities

- Follow the Spill Prevention Control and Countermeasure Plan.
- Clean up leaks and spills immediately.
- Place a stockpile of spill cleanup materials where it will be readily accessible (e.g., near storage and maintenance areas).
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste. Physical methods for the cleanup of dry chemicals include the use of brooms, shovels, sweepers, or plows.
- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.
- Chemical cleanups of material can be achieved with the use of adsorbents, gels, and foams. Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- For larger spills, a private spill cleanup company or Hazmat team may be necessary.

Reporting

- Report spills that pose an immediate threat to human health or the environment to the Regional Water Quality Control Board.
- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).
- Report spills to local agencies, such as the fire department; they can assist in cleanup.
- Establish a system for tracking incidents. The system should be designed to identify the following:

  - Types and quantities (in some cases) of wastes

  - Patterns in time of occurrence (time of day/night, month, or year)

- Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)

- Responsible parties

Training

- Educate employees about spill prevention and cleanup.
- Well-trained employees can reduce human errors that lead to accidental releases or spills:
  - The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur.
  - Employees should be familiar with the Spill Prevention Control and Countermeasure Plan.
- Employees should be educated about aboveground storage tank requirements. Employees responsible for aboveground storage tanks and liquid transfers should be thoroughly familiar with the Spill Prevention Control and Countermeasure Plan and the plan should be readily available.
- Train employees to recognize and report illegal dumping incidents.

Other Considerations (Limitations and Regulations)

- State regulations exist for facilities with a storage capacity of 10,000 gallons or more of petroleum to prepare a Spill Prevention Control and Countermeasure (SPCC) Plan (Health & Safety Code Chapter 6.67).
- State regulations also exist for storage of hazardous materials (Health & Safety Code Chapter 6.95), including the preparation of area and business plans for emergency response to the releases or threatened releases.
- Consider requiring smaller secondary containment areas (less than 200 sq. ft.) to be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.

Requirements

Costs (including capital and operation & maintenance)

- Will vary depending on the size of the facility and the necessary controls.
- Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.

Maintenance (including administrative and staffing)

- This BMP has no major administrative or staffing requirements. However, extra time is needed to properly handle and dispose of spills, which results in increased labor costs.

Supplemental Information

Further Detail of the BMP

Reporting

Record keeping and internal reporting represent good operating practices because they can increase the efficiency of the facility and the effectiveness of BMPs. A good record keeping system helps the facility minimize incident recurrence, correctly respond with appropriate cleanup activities, and comply with legal requirements. A record keeping and reporting system should be set up for documenting spills, leaks, and other discharges, including discharges of hazardous substances in reportable quantities. Incident records describe the quality and quantity of non-stormwater discharges to the storm sewer. These records should contain the following information:

- Date and time of the incident
- Weather conditions
- Duration of the spill/leak/discharge
- Cause of the spill/leak/discharge
- Response procedures implemented
- Persons notified
- Environmental problems associated with the spill/leak/discharge

Separate record keeping systems should be established to document housekeeping and preventive maintenance inspections, and training activities. All housekeeping and preventive maintenance inspections should be documented. Inspection documentation should contain the following information:

- The date and time the inspection was performed
- Name of the inspector
- Items inspected
- Problems noted
- Corrective action required
- Date corrective action was taken

Other means to document and record inspection results are field notes, timed and dated photographs, videotapes, and drawings and maps.

Aboveground Tank Leak and Spill Control

Accidental releases of materials from aboveground liquid storage tanks present the potential for contaminating stormwater with many different pollutants. Materials spilled, leaked, or lost from

tanks may accumulate in soils or on impervious surfaces and be carried away by stormwater runoff.

The most common causes of unintentional releases are:

- Installation problems
- Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves)
- External corrosion and structural failure
- Spills and overfills due to operator error
- Leaks during pumping of liquids or gases from truck or rail car to a storage tank or vice versa

Storage of reactive, ignitable, or flammable liquids should comply with the Uniform Fire Code and the National Electric Code. Practices listed below should be employed to enhance the code requirements:

- Tanks should be placed in a designated area.
- Tanks located in areas where firearms are discharged should be encapsulated in concrete or the equivalent.
- Designated areas should be impervious and paved with Portland cement concrete, free of cracks and gaps, in order to contain leaks and spills.
- Liquid materials should be stored in UL approved double walled tanks or surrounded by a curb or dike to provide the volume to contain 10 percent of the volume of all of the containers or 110 percent of the volume of the largest container, whichever is greater. The area inside the curb should slope to a drain.
- For used oil or dangerous waste, a dead-end sump should be installed in the drain.
- All other liquids should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
- Accumulated stormwater in petroleum storage areas should be passed through an oil/water separator.

Maintenance is critical to preventing leaks and spills. Conduct routine inspections and:

- Check for external corrosion and structural failure.
- Check for spills and overfills due to operator error.
- Check for failure of piping system (pipes, pumps, flanger, coupling, hoses, and valves).
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.

- Visually inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- Frequently relocate accumulated stormwater during the wet season.
- Periodically conduct integrity testing by a qualified professional.

Vehicle Leak and Spill Control

Major spills on roadways and other public areas are generally handled by highly trained Hazmat teams from local fire departments or environmental health departments. The measures listed below pertain to leaks and smaller spills at vehicle maintenance shops.

In addition to implementing the spill prevention, control, and clean up practices above, use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- Perform all vehicle fluid removal or changing inside or under cover to prevent the run-on of stormwater and the runoff of spills.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Immediately drain all fluids from wrecked vehicles.
- Store wrecked vehicles or damaged equipment under cover.
- Place drip pans or absorbent materials under heavy equipment when not in use.
- Use adsorbent materials on small spills rather than hosing down the spill.
- Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trashcans or dumpsters can leak oil and contaminate stormwater. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.

- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- Design the fueling area to prevent the run-on of stormwater and the runoff of spills:
  - Cover fueling area if possible.
  - Use a perimeter drain or slope pavement inward with drainage to a sump.
  - Pave fueling area with concrete rather than asphalt.
- If dead-end sump is not used to collect spills, install an oil/water separator.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Discourage "topping-off' of fuel tanks.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Use adsorbent materials on small spills and general cleaning rather than hosing down the area. Remove the adsorbent materials promptly.
- Carry out all Federal and State requirements regarding underground storage tanks, or install above ground tanks.
- Do not use mobile fueling of mobile industrial equipment around the facility; rather, transport the equipment to designated fueling areas.
- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Train employees in proper fueling and cleanup procedures.

Industrial Spill Prevention Response

For the purposes of developing a spill prevention and response program to meet the stormwater regulations, facility managers should use information provided in this fact sheet and the spill prevention/response portions of the fact sheets in this handbook, for specific activities. The program should:

- Integrate with existing emergency response/hazardous materials programs (e.g., Fire Department)
- Develop procedures to prevent/mitigate spills to storm drain systems
- Identify responsible departments
- Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures
- Address spills at municipal facilities, as well as public areas

- Provide training concerning spill prevention, response and cleanup to all appropriate personnel

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Stormwater Managers Resource Center http://www.stormwatercenter.net/

Vehicle and quipment Fueling SC-20

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

Sediment	
Nutrients	
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓
Oxygen Demanding	

Description

Spills and leaks that occur during vehicle and equipment fueling can contribute hydrocarbons, oil and grease, as well as heavy metals to stormwater runoff. Implementing the following management practices can help prevent fuel spills and leaks.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Use properly maintained offsite fueling stations whenever possible. These businesses are better equipped to handle fuel and spills properly.
- Educate employees about pollution prevention measures and goals
- Focus pollution prevention activities on containment of spills and leaks, most of which may occur during liquid transfers.

Suggested Protocols

General

- "Spot clean" leaks and drips routinely. Leaks are not cleaned up until the absorbent is picked up and disposed of properly.

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- Label drains within the facility boundary, by paint/stencil (or equivalent), to indicate whether they flow to an oil/water separator, directly to the sewer, or to a storm drain. Labels are not necessary for plumbing fixtures directly connected to the sanitary sewer but may be useful to help eliminate confusion about where the drain leads.
- Post signs to remind employees not to top off the fuel tank when filling and signs that ban employees from changing engine oil or other fluids at that location.
- Report leaking vehicles to fleet maintenance.
- Install inlet catch basin equipped with a small sedimentation basin or grit chamber to remove large particles from stormwater in highly impervious areas. Proper maintenance of these devices is necessary.
- Accumulated non-contaminated stormwater (e.g., in a secondary containment) should be released prior to next storm.
- Ensure the following safeguards are in place:
  - Overflow protection devices on tank systems to warn the operator to automatically shutdown transfer pumps when the tank reaches full capacity.
  - Protective guards around tanks and piping to prevent vehicle or forklift damage.
  - Clearly tagging or labeling all valves to reduce human error.
  - Automatic shut off for severed fuel hoses.

Fuel Dispensing Areas

- Maintain clean fuel-dispensing areas using dry cleanup methods such as sweeping for removal of litter and debris, or use of rags and absorbents for leaks and spills. Do not wash down areas with water.
- Fit underground storage tanks with spill containment and overfill prevention systems meeting the requirements of Section 2635(b) of Title 23 of the California Code of Regulations.
- Fit fuel dispensing nozzles with "hold-open latches" (automatic shutoffs) except where prohibited by local fire departments.
- Post signs at the fuel dispenser or fuel island warning vehicle owners/operators against "topping off" of vehicle fuel tanks.
- Design fueling area to prevent stormwater runoff and spills.
- Cover fueling area with an overhanging roof structure or canopy so that precipitation cannot come in contact with the fueling area and if possible use a perimeter drain or slope pavement inward with drainage to a blind sump (must be properly maintained and water properly disposed of); pave area with concrete rather than asphalt.

- Apply a suitable sealant that protects the asphalt from spilled fuels in areas where covering is infeasible and the fuel island is surrounded by pavement.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Cover storm drains in the vicinity during transfer.

Outdoor Waste Receptacle Area

- Spot clean leaks and drips routinely to prevent runoff of spillage.
- Minimize the possibility of stormwater pollution from outside waste receptacles by using an effective combination of the following:
  - use only watertight waste receptacle(s) and keep the lid(s) closed, or
  - grade and pave the waste receptacle area to prevent runon of stormwater, or
  - install a roof over the waste receptacle area, or
  - install a low containment berm around the waste receptacle area, or
  - use and maintain drip pans under waste receptacles. Containment areas and drip pans must be properly maintained and collected water disposed of properly (e.g., to sanitary sewer). Several drip pans should be stored in a covered location near outdoor waste receptacle area so that they are always available, yet protected from precipitation when not in use.
- Post "no littering" signs.

Air/Water Supply Area

- Minimize the possibility of stormwater pollution from air/water supply areas by implementing an effective combination of the following:
  - spot clean leaks and drips routinely to prevent runoff of spillage, or
  - grade and pave the air/water supply area to prevent runon of stormwater, or
  - install a roof over the air/water supply area, or
  - install a low containment berm around the air/water supply area. Maintain containment areas and dispose of contaminated water properly (e.g., to sanitary sewer).

Inspection

- Aboveground Tank Leak and Spill Control:
  - Check for external corrosion and structural failure.

- Check for spills and overfills due to operator error.
- Check for failure of piping system.
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.
- Visually inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- Periodically, integrity testing should be conducted by a qualified professional.

- Inspect and clean, if necessary, storm drain inlets and catch basins within the facility boundary before October 1 each year.

Training

- Train all employees upon hiring and annually thereafter on proper methods for handling and disposing of waste. Make sure that all employees understand stormwater discharge prohibitions, wastewater discharge requirements, and these best management practices.
- Train employees on proper fueling and cleanup procedures.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place stockpiles of spill cleanup materials where they are readily accessible.
- Use adsorbent materials on small spills and general cleaning rather than hosing down the area. Remove the adsorbent materials promptly and dispose properly.
- Store portable absorbent booms (long flexible shafts or barriers made of absorbent material) in unbermed fueling areas.
- Report spills promptly.
- Install an oil/water separator and connect to the sanitary sewer (if allowed), if a dead-end sump is not used to collect spills.

Other Considerations

- Carry out all federal and state requirements regarding underground storage tanks, or install above ground tanks.

Requirements

Costs

- The retrofitting of existing fueling areas to minimize stormwater exposure or spill runoff can be expensive. Good design must occur during the initial installation.
- Extruded curb along the "upstream" side of the fueling area to prevent stormwater runon is of modest cost.

Maintenance

- Clean oil/water separators at appropriate intervals.
- Keep ample supplies of spill cleanup materials onsite.
- Inspect fueling areas, storage tanks, catch basin inserts, containment areas, and drip pans on a regular schedule.

Supplemental Information

Design Considerations

Designing New Installations

The elements listed below should be included in the design and construction of new or substantially remodeled facilities.

Fuel Dispensing Areas

- Fuel dispensing areas must be paved with Portland cement concrete (or, equivalent smooth impervious surface), with a 2% to 4% slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents runon of stormwater to the extent practicable. The fuel dispensing area is defined as extending 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus 1 foot, whichever is less. The paving around the fuel dispensing area may exceed the minimum dimensions of the "fuel dispensing area" stated above.
- The fuel dispensing area must be covered, and the cover's minimum dimensions must be equal to or greater than the area within the grade break or the fuel dispensing area, as defined above. The cover must not drain onto the fuel dispensing area.
- If necessary install and maintain an oil control device in the appropriate catch basin(s) to treat runoff from the fueling area.

Outdoor Waste Receptacle Area

- Grade and pave the outdoor waste receptacle area to prevent runon of stormwater to the extent practicable.

Air/Water Supply Area

- Grade and pave the air/water supply area to prevent runon of stormwater to the extent practicable.

Designated Fueling Area

- If your facility has large numbers of mobile equipment working throughout the site and you currently fuel them with a mobile fuel truck, consider establishing a designated fueling area. With the exception of tracked equipment such as bulldozers and perhaps small forklifts, most vehicles should be able to travel to a designated area with little lost time. Place temporary "caps" over nearby catch basins or manhole covers so that if a spill occurs it is prevented from entering the storm drain.

Examples

The Spill Prevention Control and Countermeasure (SPCC) Plan, which is required by law for some facilities, is an effective program to reduce the number of accidental spills and minimize contamination of stormwater runoff.

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are also applicable to industrial facilities.

Referen es and Resour es

Best Management Practice Guide for Retail Gasoline Outlets, California Stormwater Quality Task Force. 1997.

King County Stormwater Pollution Control Manual – http//www.dnr.metrokc.gov/wlr/dss/spcm.htm

Orange County Stormwater Program http://www.ocwatersheds.com/StormWater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP)

Vehicle and Equipment Cleaning SC-21

Photo Credit: Geoff Brosseau

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Description

Wash water from vehicle and equipment cleaning activities performed outdoors or in areas where wash water flows onto the ground can contribute toxic hydrocarbons and other organic compounds, oils and greases, nutrients, phosphates, heavy metals, and suspended solids to stormwater runoff. Use of the procedures outlined below can prevent or reduce the discharge of pollutants to stormwater during vehicle and equipment cleaning.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives

Pollution Prevention

- If possible, use properly maintained off-site commercial washing and steam cleaning businesses whenever possible. These businesses are better equipped to handle and properly dispose of the wash waters.

- Good housekeeping practices can minimize the risk of contamination from wash water discharges.

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SC-21 Vehicle and Equipment Cleaning

Suggested Protocols

General

- Use biodegradable, phosphate-free detergents for washing vehicles as appropriate.
- Mark the area clearly as a wash area.
- Post signs stating that only washing is allowed in wash area.
- Provide trash container in wash area.
- Map on-site storm drain locations to avoid discharges to the storm drain system.
- Emphasize the connection between the storm drain system and runoff, help reinforce that car washing activities affect local water quality through storm drain stenciling programs.

Vehicle and Equipment Cleaning

- Have all vehicle washing done in areas designed to collect and hold the wash and rinse water or effluent generated. Recycle, collect or treat wash water effluent prior to discharge to the sanitary sewer system.
- If washing/cleaning must occur on-site, consider washing vehicle equipment inside the building or on an impervious surface to control the targeted constituents by directing them to the sanitary sewer.
- If washing must occur on-site and outdoor:
  - Use designated paved wash areas. Designated wash areas must be well marked with signs indicating where and how washing must be done. This area must be covered or bermed to collect the wash water and graded to direct the wash water to a treatment or disposal facility.
  - Do not conduct oil changes and other engine maintenance in the designated washing area. Perform these activities in a place designated for oil change and maintenance activities.
  - Cover the wash area when not in use to prevent contact with rain water.
- Install sumps or drain lines to collect wash water for treatment.
- Use hoses with nozzles that automatically turn off when left unattended.
- Do not permit steam cleaning wash water to enter the storm drain.
- Pressure and steam clean off-site to avoid generating runoff with high pollutant concentrations. If done on-site, no pressure cleaning and steam cleaning should be done in areas designated as wellhead protection areas for public water supply.

Disposal

- Consider filtering and recycling wash water.
- Discharge equipment wash water to the sanitary sewer, a holding tank, or a process treatment system, regardless of the washing method used.
- Collect all wash water from vehicle cleaning operations and (1) discharge to a sanitary sewer, holding tank, or process treatment system or (2) run through an enclosed recycling system.
- Collect and treat wash water at the facility and either recycle or discharge to the sanitary sewer system or collect and dispose of as an industrial waste.
- Discharge wash water to sanitary sewer after contacting local sewer authority to find out if pretreatment is required.

Training

- Train employees on proper cleaning and wash water disposal procedures and conduct "refresher" courses on a regular basis.
- Train staff on proper maintenance measures for the wash area.
- Train employees and contractors on proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur.

Spill Response and Prevention

- Keep the Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Have an emergency plan, equipment, and trained personnel ready at all times to deal immediately with major spills.
- Collect all spilled liquids and properly dispose of them.
- Store and maintain appropriate spill cleanup materials in a location known to all near the designated wash area.

Other Considerations (Limitations and Regulations)

- Some municipalities may require pretreatment and monitoring of wash water discharges to the sanitary sewer.
- Steam cleaning can generate significant pollutant concentrations requiring that careful consideration be given to the environmental impacts and compliance issues related to steam cleaning.
- Most car washing best management practices are inexpensive, and rely more on good housekeeping practices (where vehicles are washed, planning for the collection of wash water) than on expensive technology. However, the construction of a specialized area for vehicle washing can be expensive. Also, for facilities that cannot recycle their wash water, the cost of pre-treating wash water through either structural practices or planning for

collection and hauling of contaminated water to sewage treatment plants can be cost-prohibitive.

Requirements

Costs

- Capital costs vary as follows depending on measures implemented:
  - Low cost ($2000-5,000) for berm construction
  - Medium cost ($10,000-30,000) for plumbing modifications (including re-routing discharge to sanitary sewer and installing simple sump)
  - High cost ($60,000-200,000) for on-site treatment and recycling
- O&M costs increase with increasing capital investment.

Maintenance

- Perform berm repair and patching.
- Sweep washing areas frequently to remove solid debris.
- Inspect and maintain sumps, oil/water separators, and on-site treatment/recycling units.

Supplemental Information

Design Considerations

Designated Cleaning Areas

- Washing operations outside should be conducted in a designated wash area having the following characteristics:
  - Paved with Portland cement concrete
  - Covered and bermed to prevent contact with stormwater and contain wash water
  - Sloped for wash water collections
  - Discharges wash water to the sanitary or recycle treatment process waste sewer, or to a dead-end sump
  - Equipped with an oil/water separator if necessary

Examples

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are applicable to industrial vehicle service facilities.

The U.S. Postal Service in West Sacramento has a new vehicle wash system that collects, filters, and recycles wash water.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net

Waste Handling & Disposal SC-34

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Description

Improper storage and handling of solid wastes can allow toxic compounds, oils and greases, heavy metals, nutrients, suspended solids, and other pollutants to enter stormwater runoff. The discharge of pollutants to stormwater from waste handling and disposal can be prevented and reduced by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction, re-use, and recycling; and preventing runon and runoff.

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Approach

Pollution Prevention

- **Reduction in the amount of waste generated can be accomplished using the following source controls such as:**
  - **Production planning and sequencing**
  - **Process or equipment modification**
  - **Raw material substitution or elimination**
  - **Loss prevention and housekeeping**
  - **Waste segregation and separation**
  - **Close loop recycling**
- **Establish a material tracking system to increase awareness about material usage. This may reduce spills and minimize contamination, thus reducing the amount of waste produced.**
- **Recycle materials whenever possible.**

Suggested Protocols

General

- Cover storage containers with leak proof lids or some other means. If waste is not in containers, cover all waste piles (plastic tarps are acceptable coverage) and prevent stormwater runon and runoff with a berm. The waste containers or piles must be covered except when in use.
- Use drip pans or absorbent materials whenever grease containers are emptied by vacuum trucks or other means. Grease cannot be left on the ground. Collected grease must be properly disposed of as garbage.
- Check storage containers weekly for leaks and to ensure that lids are on tightly. Replace any that are leaking, corroded, or otherwise deteriorating.
- Sweep and clean the storage area regularly. If it is paved, do not hose down the area to a storm drain.
- Dispose of rinse and wash water from cleaning waste containers into a sanitary sewer if allowed by the local sewer authority. Do not discharge wash water to the street or storm drain.
- Transfer waste from damaged containers into safe containers.
- Take special care when loading or unloading wastes to minimize losses. Loading systems can be used to minimize spills and fugitive emission losses such as dust or mist. Vacuum transfer systems can minimize waste loss.

Controlling Litter

- Post "No Littering" signs and enforce anti-litter laws.
- Provide a sufficient number of litter receptacles for the facility.
- Clean out and cover litter receptacles frequently to prevent spillage.

Waste Collection

- Keep waste collection areas clean.
- Inspect solid waste containers for structural damage or leaks regularly. Repair or replace damaged containers as necessary.
- Secure solid waste containers; containers must be closed tightly when not in use.
- Place waste containers under cover if possible.
- Do not fill waste containers with washout water or any other liquid.
- Ensure that only appropriate solid wastes are added to the solid waste container. Certain wastes such as hazardous wastes, appliances, fluorescent lamps, pesticides, etc. may not be

disposed of in solid waste containers (see chemical/ hazardous waste collection section below).

- Do not mix wastes; this can cause chemical reactions, make recycling impossible, and complicate disposal.

Good Housekeeping

- Use all of the product before disposing of the container.
- Keep the waste management area clean at all times by sweeping and cleaning up spills immediately.
- Use dry methods when possible (e.g. sweeping, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.
- Stencil storm drains on the facility's property with prohibitive message regarding waste disposal.

Chemical/Hazardous Wastes

- Select designated hazardous waste collection areas on-site.
- Store hazardous materials and wastes in covered containers protected from vandalism, and in compliance with fire and hazardous waste codes.
- Place hazardous waste containers in secondary containment.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.

Runon/Runoff Prevention

- Prevent stormwater runon from entering the waste management area by enclosing the area or building a berm around the area.
- Prevent the waste materials from directly contacting rain.
- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropyleneor hypalon.
- Cover the area with a permanent roof if feasible.
- Cover dumpsters to prevent rain from washing waste out of holes or cracks in the bottom of the dumpster.
- Move the activity indoor after ensuring all safety concerns such as fire hazard and ventilation are addressed.

Inspection

- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.
- Check waste management areas for leaking containers or spills.
- Repair leaking equipment including valves, lines, seals, or pumps promptly.

Training

- Train staff pollution prevention measures and proper disposal methods.
- Train employees and contractors proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.
- Train employees and subcontractors in proper hazardous waste management.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.
- Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The spill prevention equipment includes:
  - Vehicles equipped with baffles for liquid waste
  - Trucks with sealed gates and spill guards for solid waste

Other Considerations

- Hazardous waste cannot be re-used or recycled; it must be disposed of by a licensed hazardous waste hauler.

Requirements

Costs

- Capital and operation and maintenance costs will vary substantially depending on the size of the facility and the types of waste handled. Costs should be low if there is an inventory program in place.

Maintenance

- None except for maintaining equipment for material tracking program.

Supplemental Information

Further Detail of the BMP

Land Treatment System

- **Minimize the runoff of polluted stormwater from land application of municipal waste on-site by:**
  - **Choosing a site where slopes are under 6%, the soil is permeable, there is a low water table, it is located away from wetlands or marshes, there is a closed drainage system.**
  - **Avoiding application of waste to the site when it is raining or when the ground is saturated with water.**
  - **Growing vegetation on land disposal areas to stabilize soils and reduce the volume of surface water runoff from the site.**
  - **Maintaining adequate barriers between the land application site and the receiving waters. Planted strips are particularly good.**
  - **Using erosion control techniques such as mulching and matting, filter fences, straw bales, diversion terracing, and sediment basins.**
  - **Performing routine maintenance to ensure the erosion control or site stabilization measures are working.**

References and Resources

King County Stormwater Pollution Control Manual - http://dnr.metrokc.gov/wlr/dss/spcm.htm

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Associations (BASMAA). On-line: http://www.basmaa.org

Building & Grounds Maintenance SC-41

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	
Organics	

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.

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- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

Suggested Protocols

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.
- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.
- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.

- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Training

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the nature of the staff.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Other Considerations

Alternative pest/weed controls may not be available, suitable, or effective in many cases.

Requirements

Costs

- Cost will vary depending on the type and size of facility.
- Overall costs should be low in comparison to other BMPs.

Maintenance

Sweep paved areas regularly to collect loose particles. Wipe up spills with rags and other absorbent material immediately, do not hose down the area to a storm drain.

Supplemental Information

Further Detail of the BMP

Fire Sprinkler Line Flushing

Building fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Mobile Cleaners Pilot Program: Final Report. 1997. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Parking/Storage Area Maintenance SC-43

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	✓
Nutrients	
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Description

Parking lots and storage areas can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants from parking/storage areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

Approach

The goal of this program is to ensure stormwater pollution prevention practices are considered when conducting activities on or around parking areas and storage areas to reduce potential for pollutant discharge to receiving waters. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Encourage alternative designs and maintenance strategies for impervious parking lots. (See New Development and Redevelopment BMP Handbook)

- Keep accurate maintenance logs to evaluate BMP implementation.

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SC-43 Parking/Storage Area Maintenance

Suggested Protocols

General

- Keep the parking and storage areas clean and orderly. Remove debris in a timely fashion.
- Allow sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low quantities.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.
- Discharge soapy water remaining in mop or wash buckets to the sanitary sewer through a sink, toilet, clean-out, or wash area with drain.

Controlling Litter

- Post "No Littering" signs and enforce anti-litter laws.
- Provide an adequate number of litter receptacles.
- Clean out and cover litter receptacles frequently to prevent spillage.
- Provide trash receptacles in parking lots to discourage litter.
- Routinely sweep, shovel, and dispose of litter in the trash.

Surface Cleaning

- Use dry cleaning methods (e.g., sweeping, vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system if possible.
- Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- Sweep all parking lots at least once before the onset of the wet season.
- Follow the procedures below if water is used to clean surfaces:
  - Block the storm drain or contain runoff.
  - Collect and pump wash water to the sanitary sewer or discharge to a pervious surface. Do not allow wash water to enter storm drains.
  - Dispose of parking lot sweeping debris and dirt at a landfill.
- Follow the procedures below when cleaning heavy oily deposits:
  - Clean oily spots with absorbent materials.
  - Use a screen or filter fabric over inlet, then wash surfaces.

- Do not allow discharges to the storm drain.
- Vacuum/pump discharges to a tank or discharge to sanitary sewer.
- Appropriately dispose of spilled materials and absorbents.

Surface Repair

- Preheat, transfer or load hot bituminous material away from storm drain inlets.
- Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff.
- Cover and seal nearby storm drain inlets where applicable (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.
- Use only as much water as necessary for dust control, to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Inspection

- Have designated personnel conduct inspections of parking facilities and stormwater conveyance systems associated with parking facilities on a regular basis.
- Inspect cleaning equipment/sweepers for leaks on a regular basis.

Training

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up fluid spills immediately with absorbent rags or material.
- Dispose of spilled material and absorbents properly.

Other Considerations

Limitations related to sweeping activities at large parking facilities may include high equipment costs, the need for sweeper operator training, and the inability of current sweeper technology to remove oil and grease.

SC-43 Parking/Storage Area Maintenance

Requirements

Costs

Cleaning/sweeping costs can be quite large. Construction and maintenance of stormwater structural controls can be quite expensive as well.

Maintenance

- Sweep parking lot regularly to minimize cleaning with water.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Clean parking facilities regularly to prevent accumulated wastes and pollutants from being discharged into conveyance systems during rainy conditions.

Supplemental Information

Further Detail of the BMP

Surface Repair

Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff. Where applicable, cover and seal nearby storm drain inlets (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal. Only use only as much water as is necessary for dust control to avoid runoff.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Site Design & Landscape Planning SD-10

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.

Designing New Installations

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Conserve Natural Areas during Landscape Planning

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

Protection of Slopes and Channels during Landscape Design

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define “redevelopment” in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of “ redevelopment” must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under “designing new installations” above should be followed.

SD-10 Site Design & Landscape Planning

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Roof Runoff Controls SD-11

Rain Garden

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Description

Various roof runoff controls are available to address stormwater that drains off rooftops. The objective is to reduce the total volume and rate of runoff from individual lots, and retain the pollutants on site that may be picked up from roofing materials and atmospheric deposition. Roof runoff controls consist of directing the roof runoff away from paved areas and mitigating flow to the storm drain system through one of several general approaches: cisterns or rain barrels; dry wells or infiltration trenches; pop-up emitters, and foundation planting. The first three approaches require the roof runoff to be contained in a gutter and downspout system. Foundation planting provides a vegetated strip under the drip line of the roof.

Approach

Design of individual lots for single-family homes as well as lots for higher density residential and commercial structures should consider site design provisions for containing and infiltrating roof runoff or directing roof runoff to vegetative swales or buffer areas. Retained water can be reused for watering gardens, lawns, and trees. Benefits to the environment include reduced demand for potable water used for irrigation, improved stormwater quality, increased groundwater recharge, decreased runoff volume and peak flows, and decreased flooding potential.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

One method of addressing roof runoff is to direct roof downspouts to cisterns or rain barrels. A cistern is an above ground storage vessel with either a manually operated valve or a permanently open outlet. Roof runoff is temporarily stored and then released for irrigation or infiltration between storms. The number of rain

barrels needed is a function of the rooftop area. Some low impact developers recommend that every house have at least 2 rain barrels, with a minimum storage capacity of 1000 liters. Roof barrels serve several purposes including mitigating the first flush from the roof which has a high volume, amount of contaminants, and thermal load. Several types of rain barrels are commercially available. Consideration must be given to selecting rain barrels that are vector proof and childproof. In addition, some barrels are designed with a bypass valve that filters out grit and other contaminants and routes overflow to a soak-away pit or rain garden.

If the cistern has an operable valve, the valve can be closed to store stormwater for irrigation or infiltration between storms. This system requires continual monitoring by the resident or grounds crews, but provides greater flexibility in water storage and metering. If a cistern is provided with an operable valve and water is stored inside for long periods, the cistern must be covered to prevent mosquitoes from breeding.

A cistern system with a permanently open outlet can also provide for metering stormwater runoff. If the cistern outlet is significantly smaller than the size of the downspout inlet (say ¼ to ½ inch diameter), runoff will build up inside the cistern during storms, and will empty out slowly after peak intensities subside. This is a feasible way to mitigate the peak flow increases caused by rooftop impervious land coverage, especially for the frequent, small storms.

Dry wells and Infiltration Trenches

Roof downspouts can be directed to dry wells or infiltration trenches. A dry well is constructed by excavating a hole in the ground and filling it with an open graded aggregate, and allowing the water to fill the dry well and infiltrate after the storm event. An underground connection from the downspout conveys water into the dry well, allowing it to be stored in the voids. To minimize sedimentation from lateral soil movement, the sides and top of the stone storage matrix can be wrapped in a permeable filter fabric, though the bottom may remain open. A perforated observation pipe can be inserted vertically into the dry well to allow for inspection and maintenance.

In practice, dry wells receiving runoff from single roof downspouts have been successful over long periods because they contain very little sediment. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top (maximum depth of 10 feet).

To protect the foundation, dry wells must be set away from the building at least 10 feet. They must be installed in solids that accommodate infiltration. In poorly drained soils, dry wells have very limited feasibility.

Infiltration trenches function in a similar manner and would be particularly effective for larger roof areas. An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives stormwater runoff. These are described under Treatment Controls.

Pop-up Drainage Emitter

Roof downspouts can be directed to an underground pipe that daylights some distance from the building foundation, releasing the roof runoff through a pop-up emitter. Similar to a pop-up irrigation head, the emitter only opens when there is flow from the roof. The emitter remains flush to the ground during dry periods, for ease of lawn or landscape maintenance.

Foundation Planting

Landscape planting can be provided around the base to allow increased opportunities for stormwater infiltration and protect the soil from erosion caused by concentrated sheet flow coming off the roof. Foundation plantings can reduce the physical impact of water on the soil and provide a subsurface matrix of roots that encourage infiltration. These plantings must be sturdy enough to tolerate the heavy runoff sheet flows, and periodic soil saturation.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Supplemental Information

Examples

- City of Ottawa's Water Links Surface –Water Quality Protection Program
- City of Toronto Downspout Disconnection Program
- City of Boston, MA, Rain Barrel Demonstration Program

Other Resources

Hager, Marty Catherine, Stormwater, "Low-Impact Development", January/February 2003. www.stormh2o.com

Low Impact Urban Design Tools, Low Impact Development Design Center, Beltsville, MD. www.lid-stormwater.net

Start at the Source, Bay Area Stormwater Management Agencies Association, 1999 Edition

Efficient Irrigation SD-12

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Irrigation water provided to landscaped areas may result in excess irrigation water being conveyed into stormwater drainage systems.

Approach

Project plan designs for development and redevelopment should include application methods of irrigation water that minimize runoff of excess irrigation water into the stormwater conveyance system.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Designing New Installations

The following methods to reduce excessive irrigation runoff should be considered, and incorporated and implemented where determined applicable and feasible by the Permittee:

- Employ rain-triggered shutoff devices to prevent irrigation after precipitation.
- Design irrigation systems to each landscape area's specific water requirements.
- Include design featuring flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.
- Implement landscape plans consistent with County or City water conservation resolutions, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

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- Design timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm water drainage system.
- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider design features such as:
  - Using mulches (such as wood chips or bar) in planter areas without ground cover to minimize sediment in runoff
  - Installing appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant materials where possible and/or as recommended by the landscape architect
  - Leaving a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible
  - Choosing plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth
- Employ other comparable, equally effective methods to reduce irrigation water runoff.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Storm Drain Signage SD-13

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ☑ Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

Designing New Installations

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include “NO DUMPING

– DRAINS TO OCEAN" and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of "redevelopment", then the requirements stated under " designing new installations" above should be included in all project design plans.

Additional Information

Maintenance Considerations

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

Placement

- Signage on top of curbs tends to weather and fade.

- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

Supplemental Information

Examples

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Fueling Areas SD-30

Photo Credit: Geoff Brosseau

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- ☑ Collect and Convey

Description

Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the stormwater conveyance system. Spills at vehicle and equipment fueling areas can be a significant source of pollution because fuels contain toxic materials and heavy metals that are not easily removed by stormwater treatment devices.

Approach

Project plans must be developed for cleaning near fuel dispensers, emergency spill cleanup, containment, and leak prevention.

Suitable Applications

Appropriate applications include commercial, industrial, and any other areas planned to have fuel dispensing equipment, including retail gasoline outlets, automotive repair shops, and major non-retail dispensing areas.

Design Considerations

Design requirements for fueling areas are governed by Building and Fire Codes and by current local agency ordinances and zoning requirements. Design requirements described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements.

Designing New Installations

Covering

Fuel dispensing areas should provide an overhanging roof structure or canopy. The cover's minimum dimensions must be equal to or greater than the area within the grade break. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. The fueling area should drain to the project's treatment control BMP(s) prior to discharging to the stormwater conveyance system. Note - If fueling large equipment or vehicles that would prohibit the use of covers or roofs, the fueling island should be designed to sufficiently accommodate the larger vehicles and equipment and to prevent stormwater run-on and runoff. Grade to direct stormwater to a dead-end sump.

Surfacing

Fuel dispensing areas should be paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete should be prohibited. Use asphalt sealant to protect asphalt paved areas surrounding the fueling area. This provision may be made to sites that have pre-existing asphalt surfaces.

The concrete fuel dispensing area should be extended a minimum of 6.5 ft from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 ft, whichever is less.

Grading/Contouring

Dispensing areas should have an appropriate slope to prevent ponding, and be separated from the rest of the site by a grade break that prevents run-on of urban runoff. (Slope is required to be 2 to 4% in some jurisdictions' stormwater management and mitigation plans.)

Fueling areas should be graded to drain toward a dead-end sump. Runoff from downspouts/roofs should be directed away from fueling areas. Do not locate storm drains in the immediate vicinity of the fueling area.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

- In the case of an emergency, provide storm drain seals, such as isolation valves, drain plugs, or drain covers, to prevent spills or contaminated stormwater from entering the stormwater conveyance system.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Trash Storage Areas SD-32

Description

Trash storage areas are areas where a trash receptacle (s) are located for use as a repository for solid wastes. Stormwater runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by water or wind into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles.

Approach

This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling. Preventative measures including enclosures, containment structures, and impervious pavements to mitigate spills, should be used to reduce the likelihood of contamination.

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulation.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria in this fact sheet are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection areas. Conflicts or issues should be discussed with the local agency.

Designing New Installations

Trash storage areas should be designed to consider the following structural or treatment control BMPs:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include berming or grading the waste handling area to prevent run-on of stormwater.
- Make sure trash container areas are screened or walled to prevent off-site transport of trash.

- Use lined bins or dumpsters to reduce leaking of liquid waste.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.
- Pave trash storage areas with an impervious surface to mitigate spills.
- Do not locate storm drains in immediate vicinity of the trash storage area.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Maintenance Considerations

The integrity of structural elements that are subject to damage (i.e., screens, covers, and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Vehicle Washing Areas SD-33

Photo Credit: Geoff Brosseau

Design Objectives

- ☑ Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- ☑ Collect and Convey

Description

Vehicle washing, equipment washing, and steam cleaning may contribute high concentrations of metals, oil and grease, solvents, phosphates, and suspended solids to wash waters that drain to stormwater conveyance systems.

Approach

Project plans should include appropriately designed area(s) for washing-steam cleaning of vehicles and equipment. Depending on the size and other parameters of the wastewater facility, wash water may be conveyed to a sewer, an infiltration system, recycling system or other alternative. Pretreatment may be required for conveyance to a sanitary sewer.

Suitable Applications

Appropriate applications include commercial developments, restaurants, retail gasoline outlets, automotive repair shops and others.

Design Considerations

Design requirements for vehicle maintenance are governed by Building and Fire Codes, and by current local agency ordinances, and zoning requirements. Design criteria described in this fact sheet are meant to enhance and be consistent with these code requirements.

Designing New Installations

Areas for washing/steam cleaning should incorporate one of the following features:

- Be self-contained and/or covered with a roof or overhang
- Be equipped with a clarifier or other pretreatment facility
- Have a proper connection to a sanitary sewer

- Include other features which are comparable and equally effective

CAR WASH AREAS - Some jurisdictions' stormwater management plans include vehicle-cleaning area source control design requirements for community car wash racks in complexes with a large number of dwelling units. In these cases, wash water from the areas may be directed to the sanitary sewer, to an engineered infiltration system, or to an equally effective alternative. Pre-treatment may also be required.

Depending on the jurisdiction, developers may be directed to divert surface water runoff away from the exposed area around the wash pad (parking lot, storage areas), and wash pad itself to alternatives other than the sanitary sewer. Roofing may be required for exposed wash pads.

It is generally advisable to cover areas used for regular washing of vehicles, trucks, or equipment, surround them with a perimeter berm, and clearly mark them as a designated washing area. Sumps or drain lines can be installed to collect wash water, which may be treated for reuse or recycling, or for discharge to the sanitary sewer. Jurisdictions may require some form of pretreatment, such as a trap, for these areas.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment.

Additional Information

Maintenance Considerations

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

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Bioretention TC-32

Design Considerations

- Soil for Infiltration
- Tributary Area
- Slope
- Aesthetics
- Environmental Side-effects

Description

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days.

Targeted Constituents

☑	Sediment	■
☑	Nutrients	▲
☑	Trash	■
☑	Metals	■
☑	Bacteria	■
☑	Oil and Grease	■
☑	Organics	■

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

California Experience

None documented. Bioretention has been used as a stormwater BMP since 1992. In addition to Prince George's County, MD and Alexandria, VA, bioretention has been used successfully at urban and suburban areas in Montgomery County, MD; Baltimore County, MD; Chesterfield County, VA; Prince William County, VA; Smith Mountain Lake State Park, VA; and Cary, NC.

Advantages

- Bioretention provides stormwater treatment that enhances the quality of downstream water bodies by temporarily storing runoff in the BMP and releasing it over a period of four days to the receiving water (EPA, 1999).
- The vegetation provides shade and wind breaks, absorbs noise, and improves an area's landscape.

Limitations

- The bioretention BMP is not recommended for areas with slopes greater than 20% or where mature tree removal would

be required since clogging may result, particularly if the BMP receives runoff with high sediment loads (EPA, 1999).

- Bioretention is not a suitable BMP at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable.
- By design, bioretention BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water.
- In cold climates the soil may freeze, preventing runoff from infiltrating into the planting soil.

Design and Sizing Guidelines

- The bioretention area should be sized to capture the design storm runoff.
- In areas where the native soil permeability is less than 0.5 in/hr an underdrain should be provided.
- Recommended minimum dimensions are 15 feet by 40 feet, although the preferred width is 25 feet. Excavated depth should be 4 feet.
- Area should drain completely within 72 hours.
- Approximately 1 tree or shrub per 50 ft^2 of bioretention area should be included.
- Cover area with about 3 inches of mulch.

Construction/Inspection Considerations

Bioretention area should not be established until contributing watershed is stabilized.

Performance

Bioretention removes stormwater pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization (EPA, 1999). Adsorption is the process whereby particulate pollutants attach to soil (e.g., clay) or vegetation surfaces. Adequate contact time between the surface and pollutant must be provided for in the design of the system for this removal process to occur. Thus, the infiltration rate of the soils must not exceed those specified in the design criteria or pollutant removal may decrease. Pollutants removed by adsorption include metals, phosphorus, and hydrocarbons. Filtration occurs as runoff passes through the bioretention area media, such as the sand bed, ground cover, and planting soil.

Common particulates removed from stormwater include particulate organic matter, phosphorus, and suspended solids. Biological processes that occur in wetlands result in pollutant uptake by plants and microorganisms in the soil. Plant growth is sustained by the uptake of nutrients from the soils, with woody plants locking up these nutrients through the seasons. Microbial activity within the soil also contributes to the removal of nitrogen and organic matter. Nitrogen is removed by nitrifying and denitrifying bacteria, while aerobic bacteria are responsible for the decomposition of the organic matter. Microbial processes require oxygen and can result in depleted oxygen levels if the bioretention area is not adequately

aerated. Sedimentation occurs in the swale or ponding area as the velocity slows and solids fall out of suspension.

The removal effectiveness of bioretention has been studied during field and laboratory studies conducted by the University of Maryland (Davis et al, 1998). During these experiments, synthetic stormwater runoff was pumped through several laboratory and field bioretention areas to simulate typical storm events in Prince George's County, MD. Removal rates for heavy metals and nutrients are shown in Table 1.

Table 1 Laboratory and Estimated Bioretention Davis et al. (1998); PGDER (1993)

Pollutant	Removal Rate
Total Phosphorus	70-83%
Metals (Cu, Zn, Pb)	93-98%
TKN	68-80%
Total Suspended Solids	90%
Organics	90%
Bacteria	90%

Results for both the laboratory and field experiments were similar for each of the pollutants analyzed. Doubling or halving the influent pollutant levels had little effect on the effluent pollutants concentrations (Davis et al, 1998).

The microbial activity and plant uptake occurring in the bioretention area will likely result in higher removal rates than those determined for infiltration BMPs.

Siting Criteria

Bioretention BMPs are generally used to treat stormwater from impervious surfaces at commercial, residential, and industrial areas (EPA, 1999). Implementation of bioretention for stormwater management is ideal for median strips, parking lot islands, and swales. Moreover, the runoff in these areas can be designed to either divert directly into the bioretention area or convey into the bioretention area by a curb and gutter collection system.

The best location for bioretention areas is upland from inlets that receive sheet flow from graded areas and at areas that will be excavated (EPA, 1999). In order to maximize treatment effectiveness, the site must be graded in such a way that minimizes erosive conditions as sheet flow is conveyed to the treatment area. Locations where a bioretention area can be readily incorporated into the site plan without further environmental damage are preferred. Furthermore, to effectively minimize sediment loading in the treatment area, bioretention only should be used in stabilized drainage areas.

Additional Design Guidelines

The layout of the bioretention area is determined after site constraints such as location of utilities, underlying soils, existing vegetation, and drainage are considered (EPA, 1999). Sites with loamy sand soils are especially appropriate for bioretention because the excavated soil can be backfilled and used as the planting soil, thus eliminating the cost of importing planting soil.

The use of bioretention may not be feasible given an unstable surrounding soil stratum, soils with clay content greater than 25 percent, a site with slopes greater than 20 percent, and/or a site with mature trees that would be removed during construction of the BMP.

Bioretention can be designed to be off-line or on-line of the existing drainage system (EPA, 1999). The drainage area for a bioretention area should be between 0.1 and 0.4 hectares (0.25 and 1.0 acres). Larger drainage areas may require multiple bioretention areas. Furthermore, the maximum drainage area for a bioretention area is determined by the expected rainfall intensity and runoff rate. Stabilized areas may erode when velocities are greater than 5 feet per second (1.5 meter per second). The designer should determine the potential for erosive conditions at the site.

The size of the bioretention area, which is a function of the drainage area and the runoff generated from the area is sized to capture the water quality volume.

The recommended minimum dimensions of the bioretention area are 15 feet (4.6 meters) wide by 40 feet (12.2 meters) long, where the minimum width allows enough space for a dense, randomly-distributed area of trees and shrubs to become established. Thus replicating a natural forest and creating a microclimate, thereby enabling the bioretention area to tolerate the effects of heat stress, acid rain, runoff pollutants, and insect and disease infestations which landscaped areas in urban settings typically are unable to tolerate. The preferred width is 25 feet (7.6 meters), with a length of twice the width. Essentially, any facilities wider than 20 feet (6.1 meters) should be twice as long as they are wide, which promotes the distribution of flow and decreases the chances of concentrated flow.

In order to provide adequate storage and prevent water from standing for excessive periods of time the ponding depth of the bioretention area should not exceed 6 inches (15 centimeters). Water should not be left to stand for more than 72 hours. A restriction on the type of plants that can be used may be necessary due to some plants' water intolerance. Furthermore, if water is left standing for longer than 72 hours mosquitoes and other insects may start to breed.

The appropriate planting soil should be backfilled into the excavated bioretention area. Planting soils should be sandy loam, loamy sand, or loam texture with a clay content ranging from 10 to 25 percent.

Generally the soil should have infiltration rates greater than 0.5 inches (1.25 centimeters) per hour, which is typical of sandy loams, loamy sands, or loams. The pH of the soil should range between 5.5 and 6.5, where pollutants such as organic nitrogen and phosphorus can be adsorbed by the soil and microbial activity can flourish. Additional requirements for the planting soil include a 1.5 to 3 percent organic content and a maximum 500 ppm concentration of soluble salts.

Soil tests should be performed for every 500 cubic yards (382 cubic meters) of planting soil, with the exception of pH and organic content tests, which are required only once per bioretention area (EPA, 1999). Planting soil should be 4 inches (10.1 centimeters) deeper than the bottom of the largest root ball and 4 feet (1.2 meters) altogether. This depth will provide adequate soil for the plants' root systems to become established, prevent plant damage due to severe wind, and provide adequate moisture capacity. Most sites will require excavation in order to obtain the recommended depth.

Planting soil depths of greater than 4 feet (1.2 meters) may require additional construction practices such as shoring measures (EPA, 1999). Planting soil should be placed in 18 inches or greater lifts and lightly compacted until the desired depth is reached. Since high canopy trees may be destroyed during maintenance the bioretention area should be vegetated to resemble a terrestrial forest community ecosystem that is dominated by understory trees. Three species each of both trees and shrubs are recommended to be planted at a rate of 2500 trees and shrubs per hectare (1000 per acre). For instance, a 15 foot (4.6 meter) by 40 foot (12.2 meter) bioretention area (600 square feet or 55.75 square meters) would require 14 trees and shrubs. The shrub-to-tree ratio should be 2:1 to 3:1.

Trees and shrubs should be planted when conditions are favorable. Vegetation should be watered at the end of each day for fourteen days following its planting. Plant species tolerant of pollutant loads and varying wet and dry conditions should be used in the bioretention area.

The designer should assess aesthetics, site layout, and maintenance requirements when selecting plant species. Adjacent non-native invasive species should be identified and the designer should take measures, such as providing a soil breach to eliminate the threat of these species invading the bioretention area. Regional landscaping manuals should be consulted to ensure that the planting of the bioretention area meets the landscaping requirements established by the local authorities. The designers should evaluate the best placement of vegetation within the bioretention area. Plants should be placed at irregular intervals to replicate a natural forest. Trees should be placed on the perimeter of the area to provide shade and shelter from the wind. Trees and shrubs can be sheltered from damaging flows if they are placed away from the path of the incoming runoff. In cold climates, species that are more tolerant to cold winds, such as evergreens, should be placed in windier areas of the site.

Following placement of the trees and shrubs, the ground cover and/or mulch should be established. Ground cover such as grasses or legumes can be planted at the beginning of the growing season. Mulch should be placed immediately after trees and shrubs are planted. Two to 3 inches (5 to 7.6 cm) of commercially-available fine shredded hardwood mulch or shredded hardwood chips should be applied to the bioretention area to protect from erosion.

Maintenance

The primary maintenance requirement for bioretention areas is that of inspection and repair or replacement of the treatment area's components. Generally, this involves nothing more than the routine periodic maintenance that is required of any landscaped area. Plants that are appropriate for the site, climatic, and watering conditions should be selected for use in the bioretention cell. Appropriately selected plants will aide in reducing fertilizer, pesticide, water, and overall maintenance requirements. Bioretention system components should blend over time through plant and root growth, organic decomposition, and the development of a natural

soil horizon. These biologic and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Routine maintenance should include a biannual health evaluation of the trees and shrubs and subsequent removal of any dead or diseased vegetation (EPA, 1999). Diseased vegetation should be treated as needed using preventative and low-toxic measures to the extent possible. BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water. Routine inspections for areas of standing water within the BMP and corrective measures to restore proper infiltration rates are necessary to prevent creating mosquito and other vector habitat. In addition, bioretention BMPs are susceptible to invasion by aggressive plant species such as cattails, which increase the chances of water standing and subsequent vector production if not routinely maintained.

In order to maintain the treatment area's appearance it may be necessary to prune and weed. Furthermore, mulch replacement is suggested when erosion is evident or when the site begins to look unattractive. Specifically, the entire area may require mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas. Mulch replacement should be done prior to the start of the wet season.

New Jersey's Department of Environmental Protection states in their bioretention systems standards that accumulated sediment and debris removal (especially at the inflow point) will normally be the primary maintenance function. Other potential tasks include replacement of dead vegetation, soil pH regulation, erosion repair at inflow points, mulch replenishment, unclogging the underdrain, and repairing overflow structures. There is also the possibility that the cation exchange capacity of the soils in the cell will be significantly reduced over time. Depending on pollutant loads, soils may need to be replaced within 5-10 years of construction (LID, 2000).

Cost

Construction Cost

Construction cost estimates for a bioretention area are slightly greater than those for the required landscaping for a new development (EPA, 1999). A general rule of thumb (Coffman, 1999) is that residential bioretention areas average about $3 to $4 per square foot, depending on soil conditions and the density and types of plants used. Commercial, industrial and institutional site costs can range between $10 to $40 per square foot, based on the need for control structures, curbing, storm drains and underdrains.

Retrofitting a site typically costs more, averaging $6,500 per bioretention area. The higher costs are attributed to the demolition of existing concrete, asphalt, and existing structures and the replacement of fill material with planting soil. The costs of retrofitting a commercial site in Maryland, Kettering Development, with 15 bioretention areas were estimated at $111,600.

In any bioretention area design, the cost of plants varies substantially and can account for a significant portion of the expenditures. While these cost estimates are slightly greater than those of typical landscaping treatment (due to the increased number of plantings, additional soil excavation, backfill material, use of underdrains etc.), those landscaping expenses that would be required regardless of the bioretention installation should be subtracted when determining the net cost.

Perhaps of most importance, however, the cost savings compared to the use of traditional structural stormwater conveyance systems makes bioretention areas quite attractive financially. For example, the use of bioretention can decrease the cost required for constructing stormwater conveyance systems at a site. A medical office building in Maryland was able to reduce the amount of storm drain pipe that was needed from 800 to 230 feet - a cost savings of $24,000 (PGDER, 1993). And a new residential development spent a total of approximately $100,000 using bioretention cells on each lot instead of nearly $400,000 for the traditional stormwater ponds that were originally planned (Rappahanock,). Also, in residential areas, stormwater management controls become a part of each property owner's landscape, reducing the public burden to maintain large centralized facilities.

Maintenance Cost

The operation and maintenance costs for a bioretention facility will be comparable to those of typical landscaping required for a site. Costs beyond the normal landscaping fees will include the cost for testing the soils and may include costs for a sand bed and planting soil.

References and Sources of Additional Information

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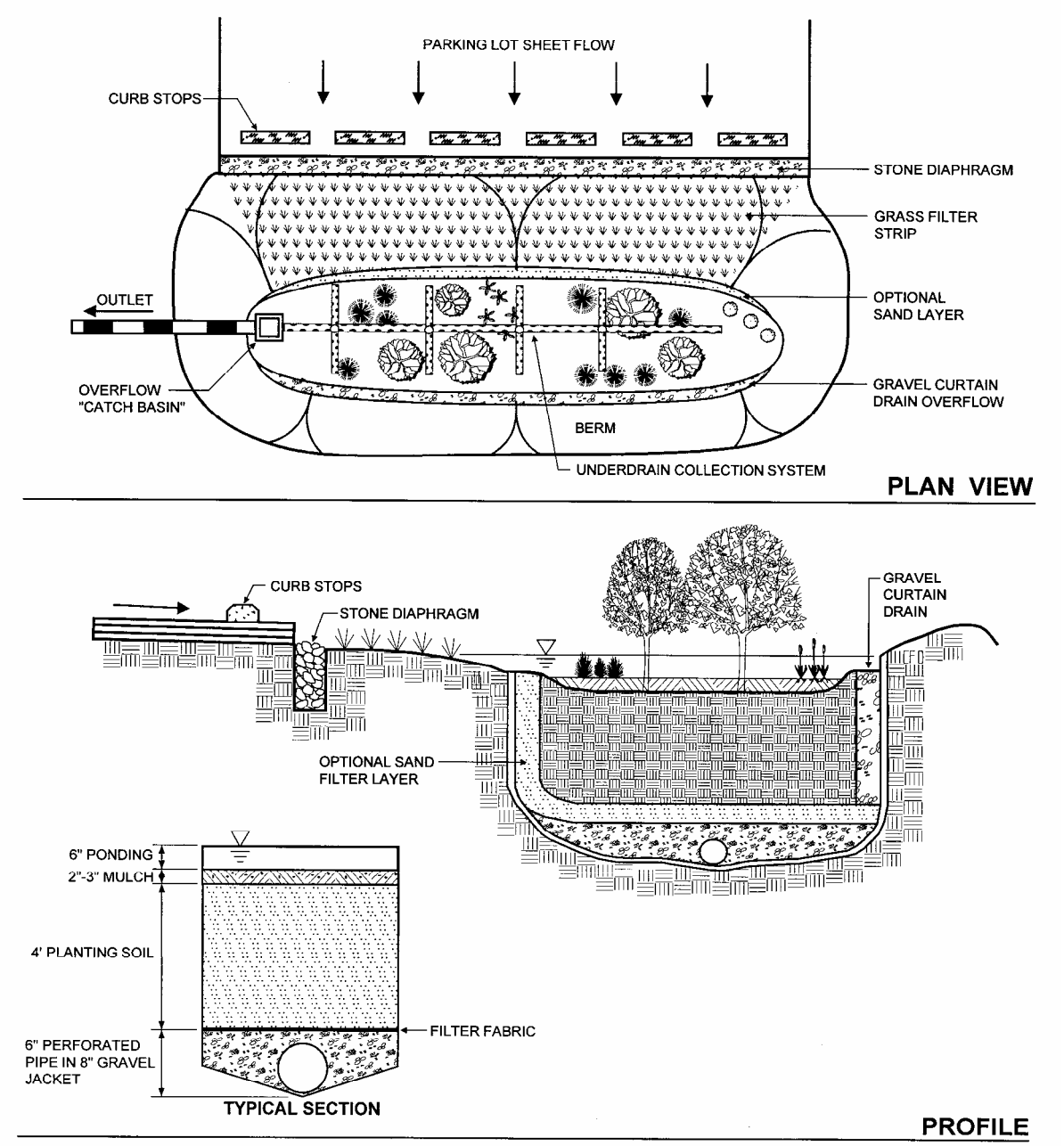

Schematic of a Bioretention Facility (MDE, 2000)