WALSH ENGINEERING
& SURVEYING, INC.

CEQA PRELIMINARY DRAINAGE STUDY
for
Vista De Lamar Tentative Map 5576
(PDS2013-TM-5576)

3053 & 3055 Bancroft Drive,
Spring Valley, CA 91977

Prepared for:
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(Walsh Engineering Job No. 9988-3 Vista De Lamar)

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SDC PDS RCVD 12-17-13
TM5576

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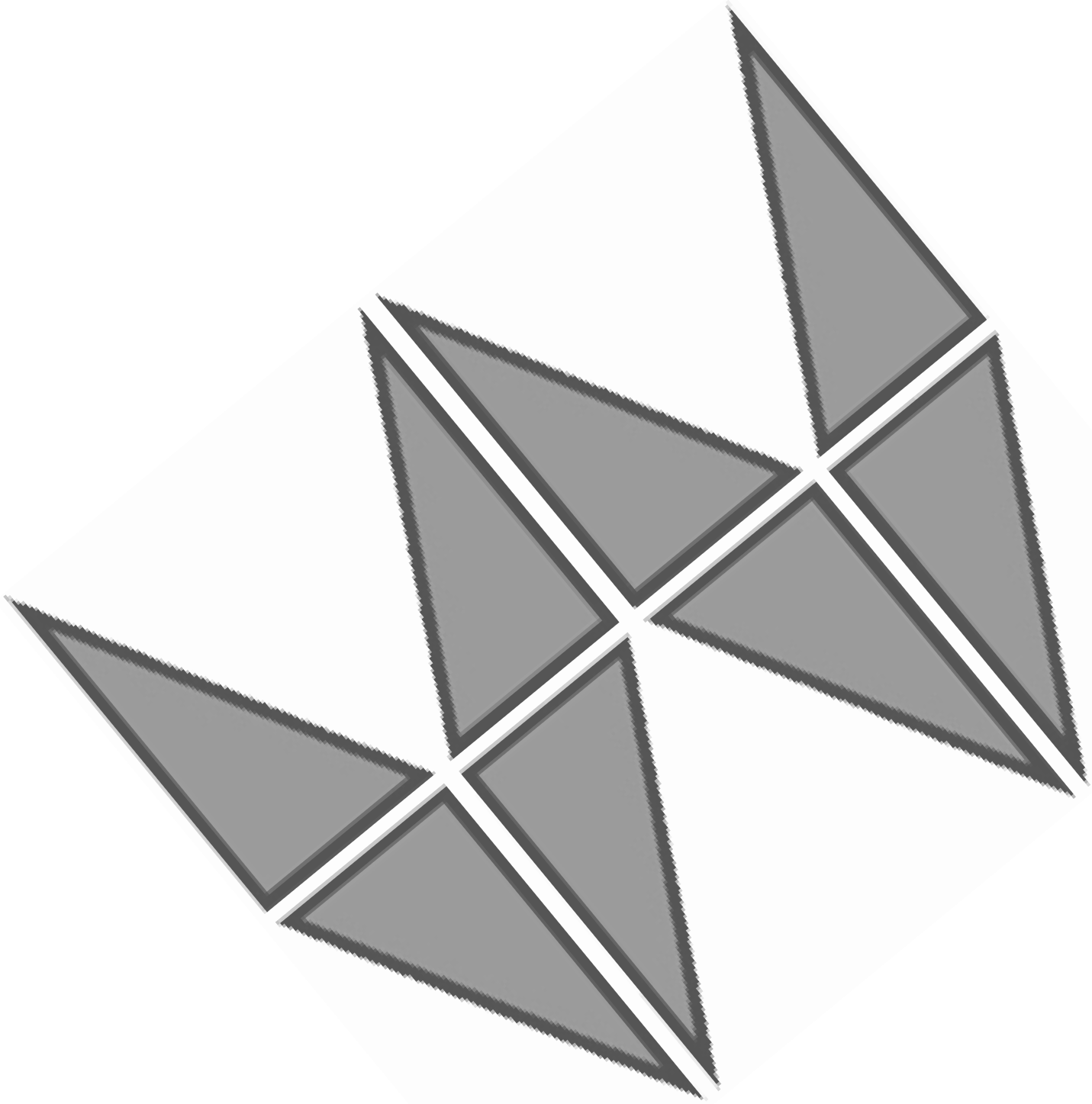


SECTION 1

Introduction / Summary

This CEQA Preliminary Drainage Study is prepared for the Vista De Lamar Tentative Map 5576 project. The gross area of the site is approximately 2.8 acres. The project is located at 3053 & 3055 Bancroft Drive in the community of Spring Valley, unincorporated area of the County of San Diego. See the Vicinity Map in the following pages. Vista de Lamar is a proposed 20-unit single-family residential project consisting of grading and retaining walls for building pads and improvements for a private driveway. Said private driveway, Vista de Lamar, will be the access to said residences and connect to Avenida de Lamar, a Public Road. See the attached Preliminary Grading Plan for details.

Existing Condition

There are two existing single family residences and paved areas for parking and access which will be removed as part of this project. There are five (5) small drainage basins associated with the project. Said Basins are comprised of portions of the existing houses, dirt surface, AC pavement and natural terrain. The drainage runoff from the basins sheet flow towards the concentration points where it leaves the site. See the attached Drainage Map 1 for more details.

Proposed Condition

In the proposed condition, the owner will construct twenty (20) new single-family residences, driveways, access walkways and a common shared driveway. All residences will access the property via said shared driveway, Vista de Lamar (see the attached Preliminary Grading Plan). The drainage patterns will not be altered significantly in the proposed condition. The runoff generated by the rooftops of the new residences will be routed to bioretention areas prior of exiting the site. Said bioretention areas will treat and detain the increase in runoff discharge rates and durations in order to mitigate potential hydromodification impacts due to the proposed development. In addition, the owner proposes to construct the shared private driveway with porous pavement to minimize the increase in impervious surfaces. The proposed drainage system is adequate to handle the Stormwater runoff from the proposed improvements and minimize any impacts in a 100-year storm. The flowrate produced by the 100-year storm are analyzed herein.

The runoff coefficients in the proposed conditions are based upon “C” values from Table 3-1 of the County of san Diego Hydrology manual (2003) and are conservative in order to insure adequate sizing for the proposed drainage structures (see appropriate section for further explanation).

HYDROLOGY & HYDRAULIC BASIN CALCULATION RESULTS:

Vista De Lamar, TM 5576
Existing vs Proposed Condition

Hydrology Results:

	Flow rate (cfs)	
Basin #	Existing Condition	Proposed Condition
1	2.5	3.8*
2	1.6	1.5
3	0.4	0.4
4	0.5	1.2*
5	0.5	1*

* Increase in flow rate will be detained / retained in the proposed Bioretention areas.

Hydraulic Results (Detention Calculations):

The flow rate for Basin 2 in the existing condition is 1.6 cfs and in the proposed condition is 1.5 cfs. Therefore, no detention is needed for said basin. However, the runoff from the rooftops within this basin will still be treated.

The flow rate in the existing and proposed condition for Basin 3 is 0.4 cfs and no proposed rooftops are within this basin. Therefore, no detention is needed for said basin.

For Detention Calculations, Hydrographs and Hydromodification Management Plan refer to Section 3.

Basin #	Increase in flow (cfs)	HMP Sizing Calculator Results (required) (cft)	Detention Calculations 100-Year Storm (required) (cft)	Proposed Bioretention Area Provided (cft)
1	1.3	661	1,190	1,200
2	-0.1	236	N/A	811
4	0.5	188	499	505
5	0.5	141	375	390

n and Rational Method Calculations

em	Area (acres)			C-Value			Street Slope (%)	Ti (min)	L ft	ΔE ft	Tt (min)	To (min
	Area Landscaping	Area Roof/Asphalt	**Total**	C-Value Landscaping	C-Value Roof/Asphalt	**C-Value Weighted**						
Yard	1.28	0.12	**1.40**	0.35	0.95	**0.40**	11	9.5	-	-	0.0	11.
Yard	0.61	0.06	**0.67**	0.35	0.95	**0.40**	10	6.5	165	22	0.9	7.4
Yard	0.20	0.01	**0.21**	0.35	0.95	**0.38**	5	8.0	74	10	0.5	8.9
Yard	0.27	0.01	**0.28**	0.35	0.95	**0.37**	5	8.0	-	-	0.0	8.6
Yard	0.26	0.01	**0.27**	0.35	0.95	**0.37**	5	8.0	-	-	0.0	9.0

Table II (attached herewith)
ttached herewith)
Figure 3-4 and 3-6 (attached herewith)

on Figure 3-1 (attached herewith)

A = Basin areas per Drainage Map(s) (attached herewith)
Elevations, Lengths and Drainage Systems per Drainage Map(s) (attached herewith)
$P6_{100}$ = 2.8 in
Element = MDR 7.3

	Browditch & Gutter flow				
em	**Street Slope** (%)	**Q (Avg) assumed** cfs	**V** ft/s	**L** ft	**Tt2** (min)
ard	11	1.25	5.1	460	1.5
ard	5	0.2	3.9	84	0.4
ard	5	0.25	5	175	0.6
ard	5	0.25	2.8	160	1.0

For CEQA purposes, the following information is provided in this study for project review and approval of the tentative map.

Q: Will the project substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?
A: No. The overall existing drainage patterns will be maintained, no alterations to streams or rivers will occur and no increase in off-site erosion or siltation will be caused by this project.

Q: Will the project substantially alter the existing drainage pattern of the site or area including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?
A: No. The overall existing drainage patterns will be maintained. No alterations to streams or rivers will occur and the rate or amount of runoff will not significantly increase.

Q: Will the project create or contribute runoff water which will exceed the capacity of existing or planned storm water drainage systems?
A: No. The project will not create or contribute runoff water which will exceed the capacity of existing or planned storm water drainage systems.

Q: Will the project place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map, including County Floodplain Maps?
A: No. The project does not propose to place housing within a 100-year flood hazard area.

Q: Will the project place within a 100-year flood hazard area structures which would impede or redirect flood flows?
A: No. The project will not place structures within a 100-year flood hazard area.

Q: Will the project expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam on-site or off-site?
A: No. The project will not expose people or structures to a significant risk of loss, injury or death involving flooding as a result of failure of Dam(s) or levee(s).

DECLARATION OF RESPONSIBLE CHARGE

I, HEREBY DECLARE THAT I AM THE ENGINEER OF WORK FOR THIS DRAINAGE STUDY, THAT I HAVE EXERCISED RESPONSIBLE CHARGE OVER THE PREPARATION OF SAID STUDY AS DEFINED IN SECTION 6703 OF THE BUSINESS AND PROFESSIONS CODE, AND THAT THE RECOMMENDATIONS ARE CONSISTENT WITH CURRENT STANDARDS.

I UNDERSTAND THAT THE CHECK OF THIS DRAINAGE STUDY BY THE COUNTY OF SAN DIEGO IS CONFINED TO A REVIEW ONLY AND DOES NOT RELIEVE ME, AS ENGINEER OF WORK, OF MY RESPONSIBILITIES.

Lawrence W. Walsh 12-13-13

Lawrence W. Walsh, RCE 46316 Date

REGISTERED PROFESSIONAL ENGINEER
LAWRENCE W. WALSH
No. C 46316
Exp. 12-31-14
CIVIL
STATE OF CALIFORNIA

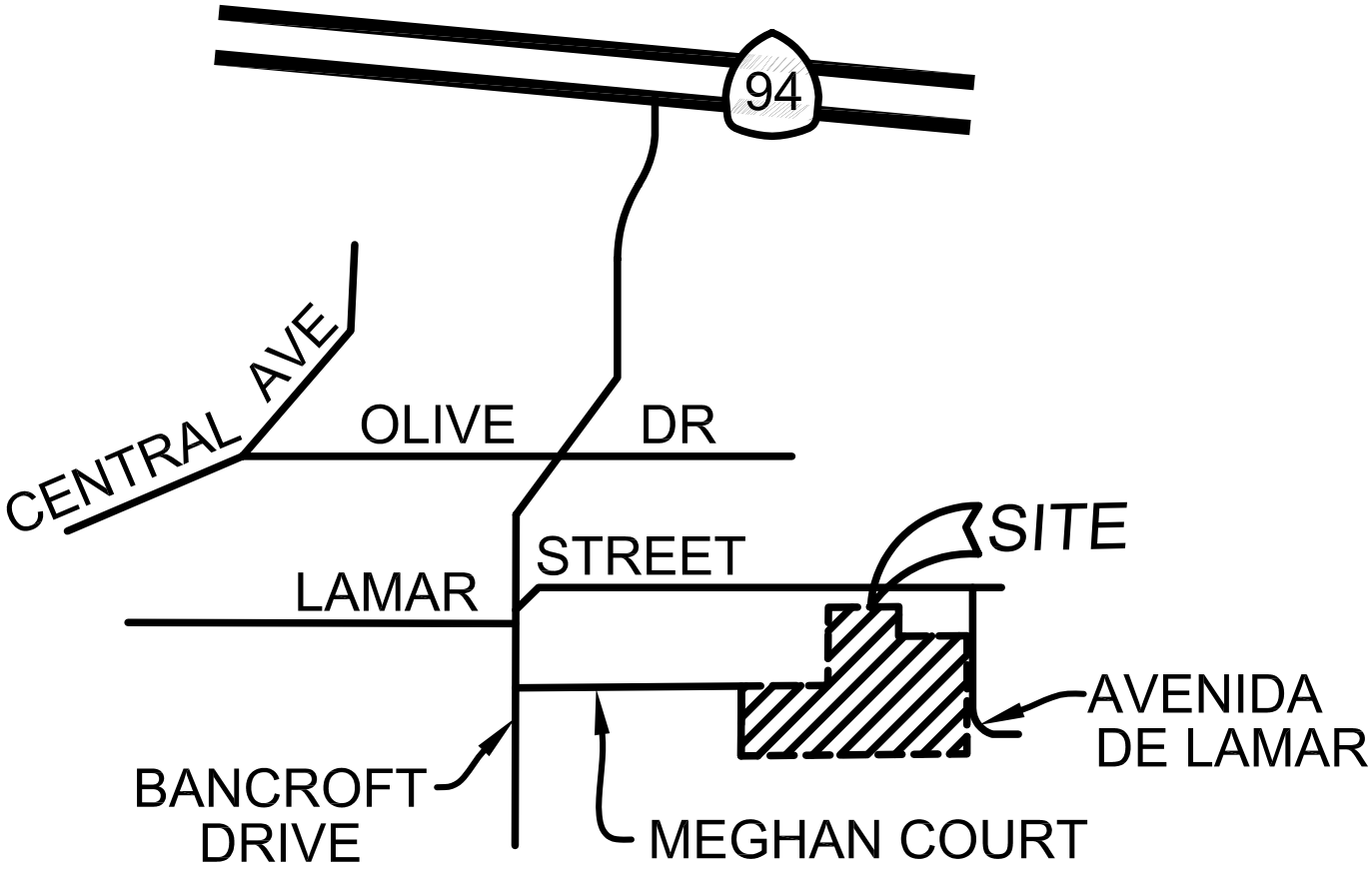
e Lamar, TM 5576
ed Condition

	Drainage System	Area (acre)	Runoff Coefficient	Initial Flow: Initial Slope (%)	Initial Flow: Ti (min)	Initial Slope (%)	Browditch, Pipe or Gutter Flow: Q (avg) assumed cfs	V(Avg) ft/s	L ft	Tt (min)	Tc (min)	Intensity (100-yr) (in/hr)
	Roofs, Front & Back Yards, Driveways, Private Driveway to Catch Basin and Pipe	1.36	0.57	1	8.4	5	3.8	8.3	460	0.9	9.3	4.9
	Roof, Private Yard to Catch Basin and Pipe	0.52	0.57	1	8.4	0	0.75	7.9	100	0.2	8.6	5.2
	Roof, Private Yard to Catch Basin and Pipe	0.13	0.57	1	8.4	0	0.2	3.9	84	0.4	8.8	5.1
	Roof, Private Yard to Catch Basin and Pipe	0.44	0.57	1	8.4	0	0.6	5.0	315	1.1	9.5	4.9
	Roofs, Front Yard, Driveways, Private road to gutter flow	0.37	0.57	1	8.4	0	0.5	2.8	170	1.0	9.4	4.9

C * I * A
values per Table 3-1 (attached herewith)
values per Table 3-2 (attached herewith)
values per formula on Figure 3-4 and 3-6 (attached herewith)

Ti + Tt
Intensity per Formula on Figure 3-1 (attached herewith)

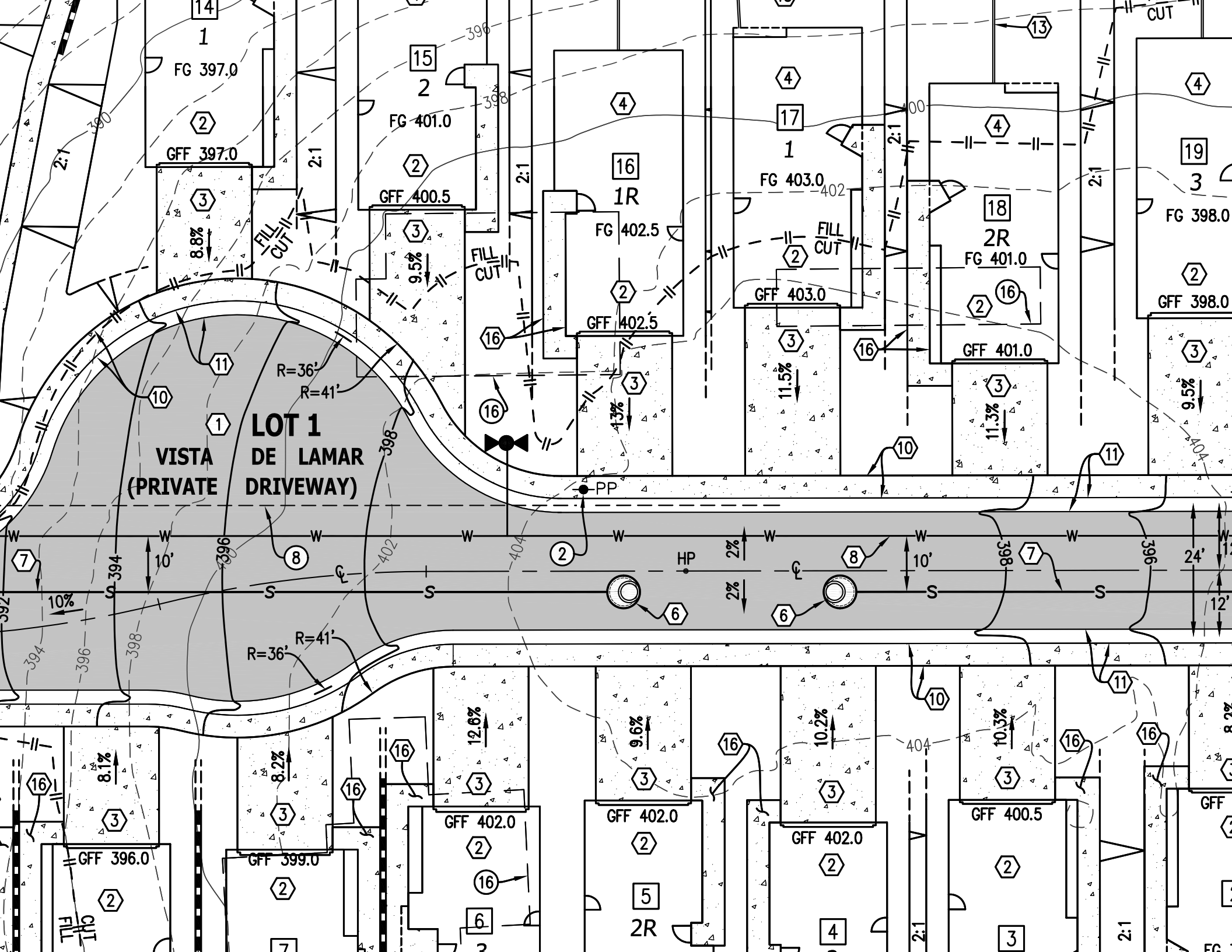
A = Basin areas per Drainage Map(s) (attached herewith)
Elevations, Lengths and Drainage Systems per Drainage Map(s) (attached herewith)
$P6_{100}$ = 2.8 in per isopluvial charts (attached herewith)
Element = MDR 7.3 Medium Density Residential

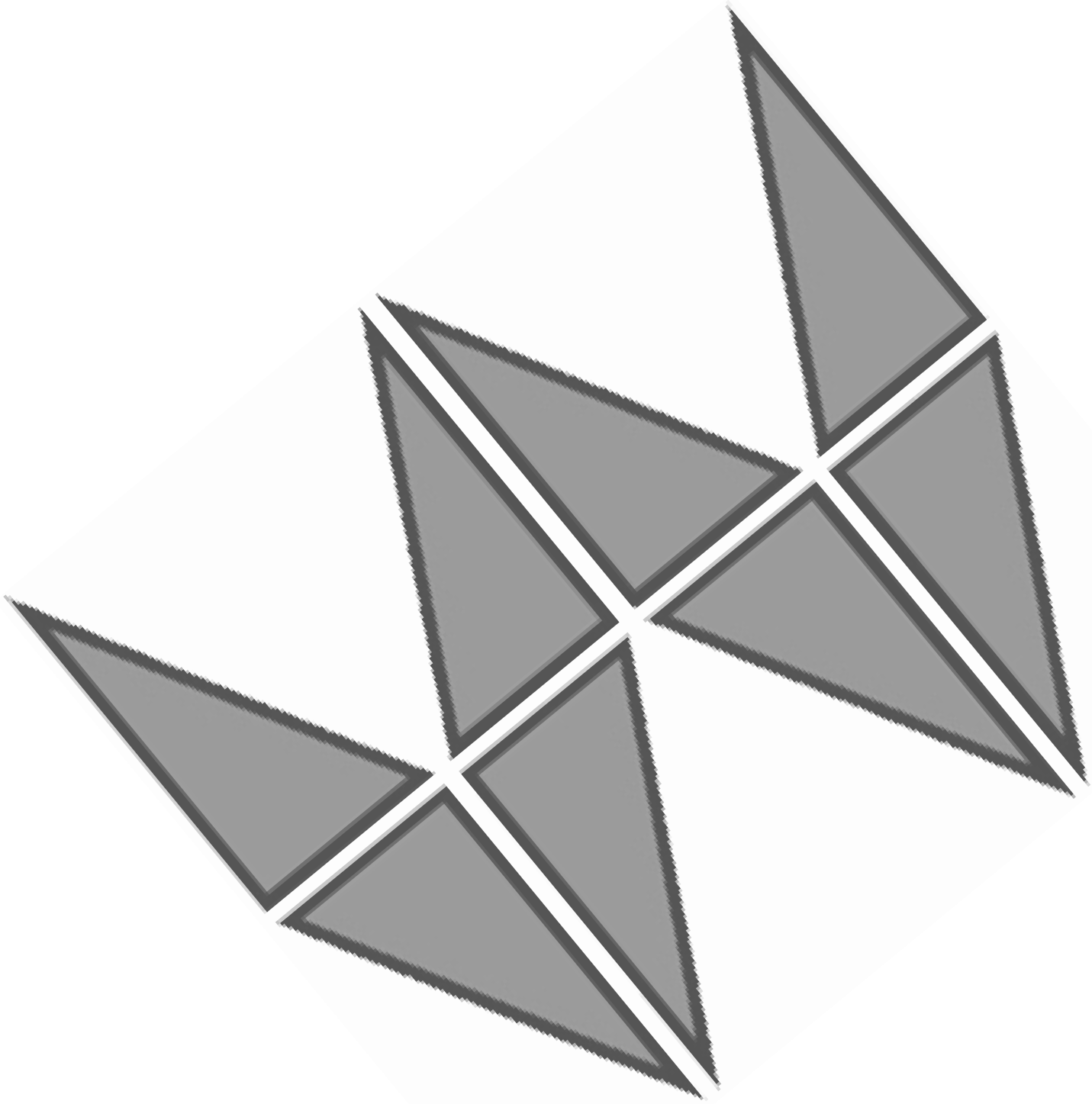


VICINITY MAP

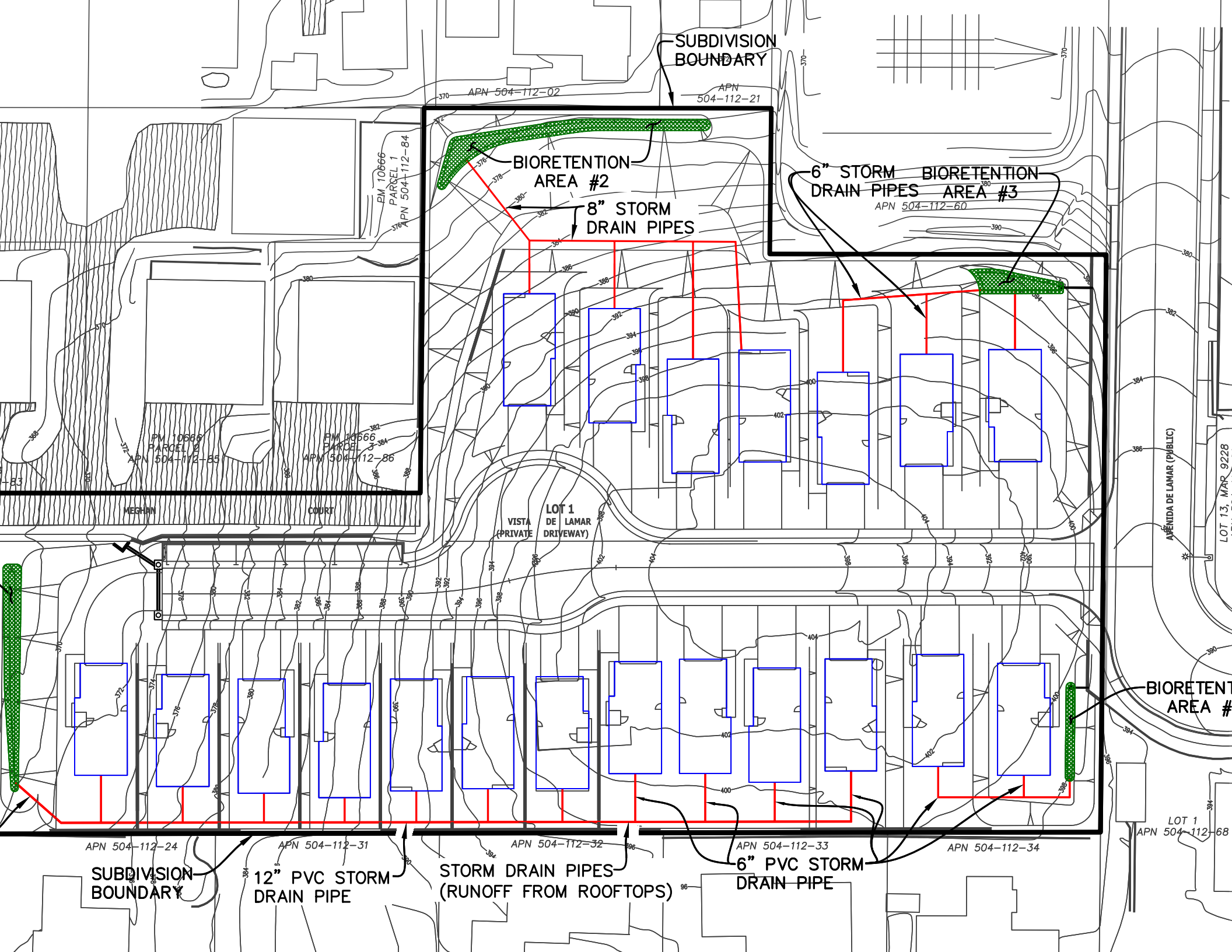
NO SCALE

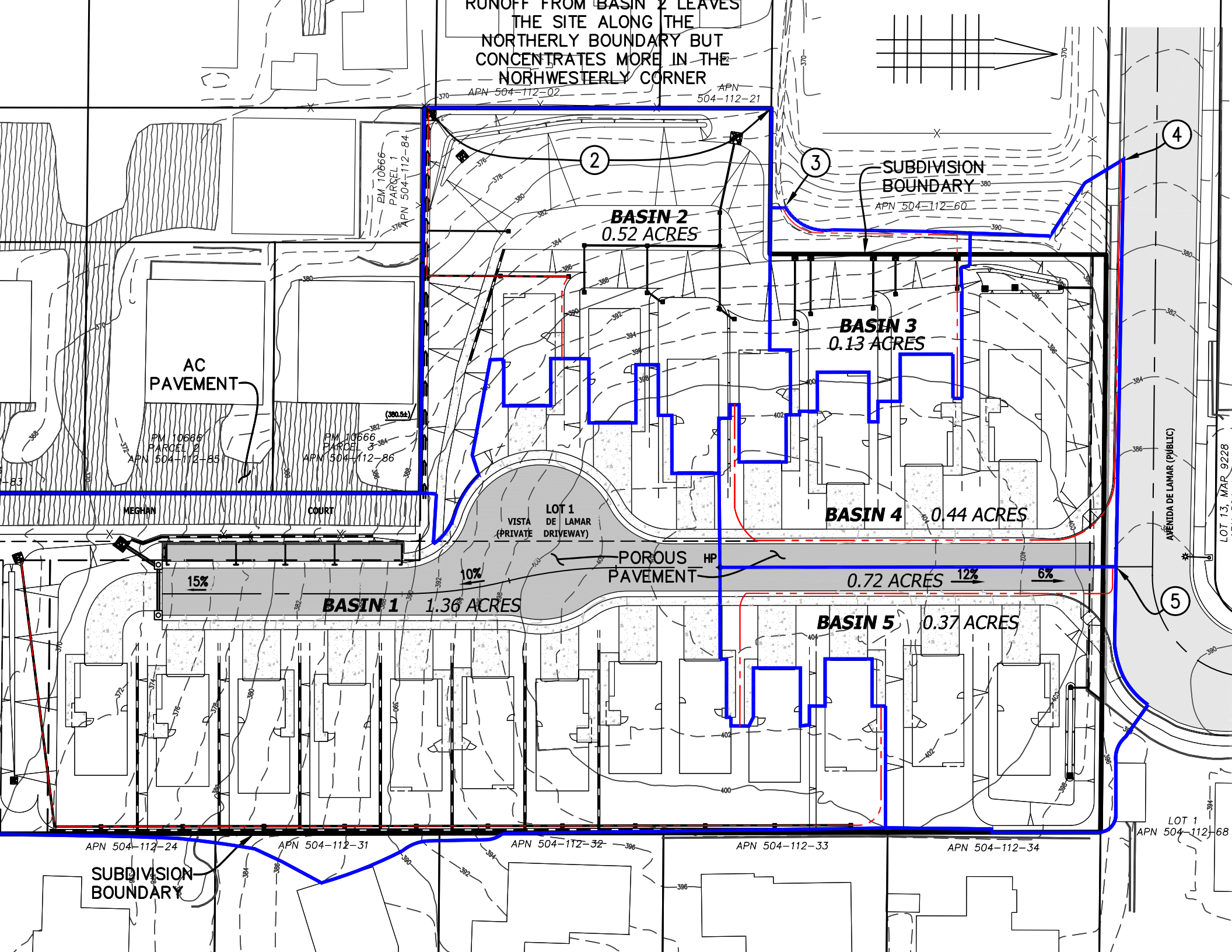
THOMAS BRO. MAP PG. 1271, B6

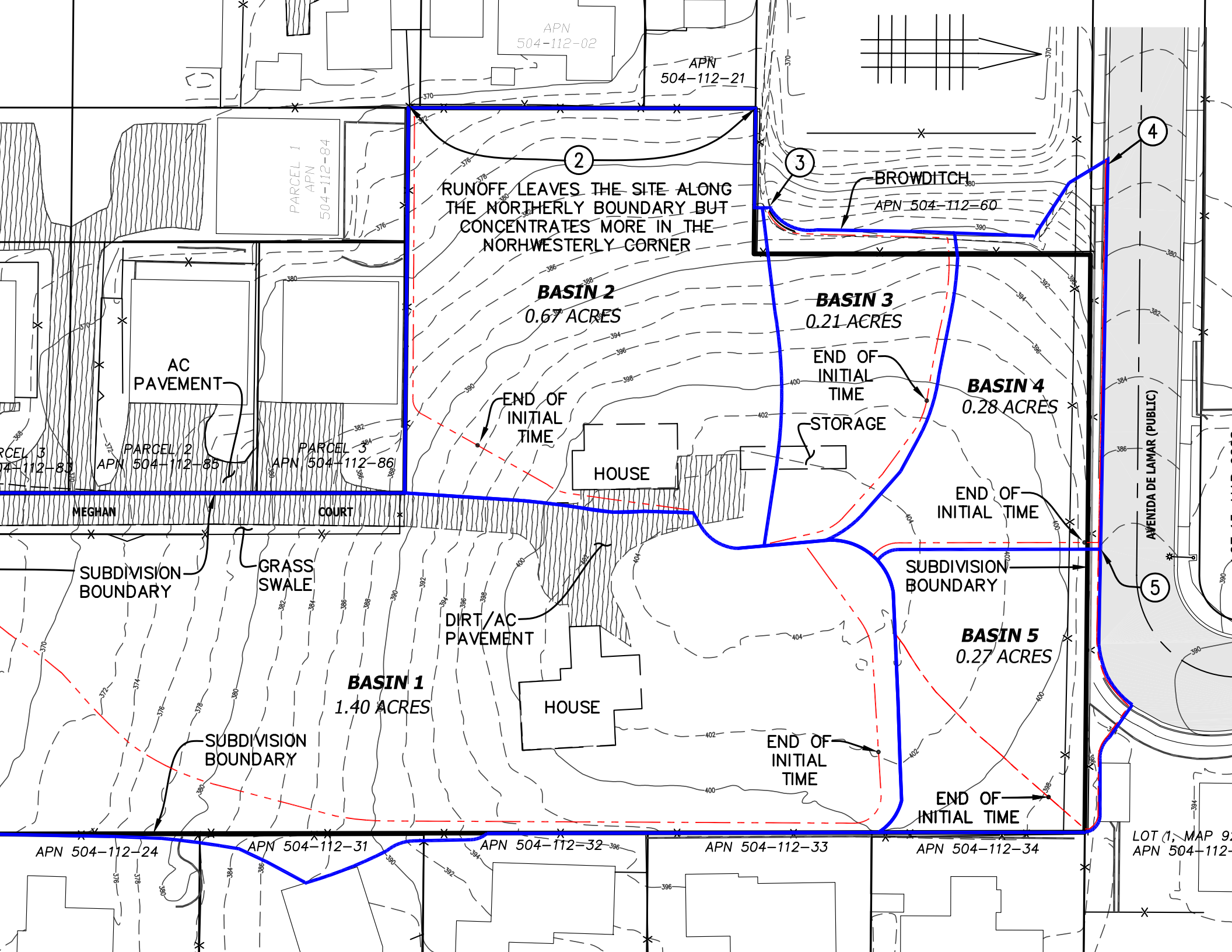

LOT 1
VISTA DE LAMAR
(PRIVATE DRIVEWAY)
R=36'
R=41'
10'
24'
12'
10%
2%
2%
HP
PP
FILL
CUT
2:1
14
1
FG 397.0
GFF 397.0
15
2
FG 401.0
GFF 400.5
16
1R
FG 402.5
GFF 402.5
17
1
FG 403.0
GFF 403.0
18
2R
FG 401.0
GFF 401.0
19
3
FG 398.0
GFF 398.0
8.8%
9.5%
13.3%
11.5%
11.3%
9.5%
8.1%
8.2%
12.6%
9.6%
10.2%
10.3%
GFF 396.0
GFF 399.0
GFF 402.0
GFF 402.0
GFF 402.0
GFF 400.5
5
2R
6
3
4
3



SECTION 2


SUBDIVISION BOUNDARY
APN 504-112-02
APN 504-112-21
BIORETENTION AREA #2
8" STORM DRAIN PIPES
6" STORM DRAIN PIPES
BIORETENTION AREA #3
APN 504-112-60
PM 10666 PARCEL 1 APN 504-112-84
PM 10666 PARCEL 2 APN 504-112-85
PM 10666 PARCEL 3 APN 504-112-86
MEGHAN COURT
VISTA DE LAMAR (PRIVATE DRIVEWAY)
LOT 1
AVENIDA DE LAMAR (PUBLIC)
LOT 13, MAP 9228
BIORETENTION AREA #
APN 504-112-24
APN 504-112-31
APN 504-112-32
APN 504-112-33
APN 504-112-34
LOT 1 APN 504-112-68
SUBDIVISION BOUNDARY
12" PVC STORM DRAIN PIPE
STORM DRAIN PIPES (RUNOFF FROM ROOFTOPS)
6" PVC STORM DRAIN PIPE


RUNOFF FROM BASIN 2 LEAVES THE SITE ALONG THE NORTHERLY BOUNDARY BUT CONCENTRATES MORE IN THE NORHWESTERLY CORNER
APN 504-112-02
APN 504-112-21
PM 10666 PARCEL 1 APN 504-112-84
2
3
4
5
SUBDIVISION BOUNDARY
APN 504-112-60
BASIN 2
0.52 ACRES
BASIN 3
0.13 ACRES
AC PAVEMENT
PM 10666 PARCEL 2 APN 504-112-85
PM 10666 PARCEL 3 APN 504-112-86
(380.5±)
MEGHAN
COURT
LOT 1
VISTA DE LAMAR
(PRIVATE DRIVEWAY)
POROUS PAVEMENT
HP
BASIN 4
0.44 ACRES
15%
10%
12%
6%
BASIN 1
1.36 ACRES
0.72 ACRES
BASIN 5
0.37 ACRES
AVENIDA DE LAMAR (PUBLIC)
LOT 13, MAP 9228
LOT 1
APN 504-112-68
APN 504-112-24
APN 504-112-31
APN 504-112-32
APN 504-112-33
APN 504-112-34
SUBDIVISION BOUNDARY


APN 504-112-02
APN 504-112-21
PARCEL 1 APN 504-112-84
2
RUNOFF LEAVES THE SITE ALONG THE NORTHERLY BOUNDARY BUT CONCENTRATES MORE IN THE NORHWESTERLY CORNER
3
BROWDITCH
APN 504-112-60
4
BASIN 2
0.67 ACRES
BASIN 3
0.21 ACRES
END OF INITIAL TIME
BASIN 4
0.28 ACRES
AC PAVEMENT
END OF INITIAL TIME
STORAGE
HOUSE
PARCEL 3 APN 504-112-83
PARCEL 2 APN 504-112-85
PARCEL 3 APN 504-112-86
MEGHAN
COURT
END OF INITIAL TIME
AVENIDA DE LAMAR (PUBLIC)
SUBDIVISION BOUNDARY
GRASS SWALE
SUBDIVISION BOUNDARY
5
DIRT/AC PAVEMENT
BASIN 5
0.27 ACRES
BASIN 1
1.40 ACRES
HOUSE
SUBDIVISION BOUNDARY
END OF INITIAL TIME
END OF INITIAL TIME
APN 504-112-24
APN 504-112-31
APN 504-112-32
APN 504-112-33
APN 504-112-34
LOT 1, MAP 9
APN 504-112-

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 1 (Existing Condition)

Basin 1 is comprised of landscaped areas, a driveway and structures. See the attached Drainage Map 1 for drainage patterns. The drainage runoff sheet flows across the basin and concentrates on Meghan Court. Shown below are hydrology calculations for the existing

FLOW RATE: Q_{100} = $C_{weighted} * I * A_{total}$ (Rational Method)

AREA:

Rooftops and Concrete Areas	=	0.12	Acres	
Landscaping Area	=	1.28	Acres	
A_{total}	**=**	**1.40**	**Acres**	(see Drainage Map 1, attached)

WEIGHTED C-VALUE:

Concrete & Rooftops	=	0.95	(see Table II, Section 4)
Landscaping	=	0.35	(see Table II, Section 4)

then:

$C_{weighted}$ = [(0.95 * 0.12) / 1.40] + [(0.35 * 1.28) / 1.40]

$C_{weighted}$ = 0.40 per Equation

TIME OF CONCENTRATION:

T_C = $T_i + T_t$

Where:

Initial Time, T_i

Land Use	=	Natural		
Slope	=	3	%	(See Drainage Map 2, attached)
Ti	=	9.5	min	(see Table 3-2, Section 4)

And:

Travel Time, T_t

T_t: T_t is the time it takes the runoff to travel along the landscaped and developed areas after the initial travel period. Said flow will be assumed to be developed sheet flow. The time it takes the runoff to travel from the end of the initial travel time to the concentration point is calculated using the velocity and the distance traveled. The velocity is assumed for each specific condition and the travel distance is obtained from the Drainage Map 1. See below for calculations:

Assumed Q_{100} = 2.5 cfs

At:

$Q_{100(Avg)}$ = 2.5 / 2 = 1.25 cfs

Assumed Velocity ($V_{100(Avg)}$) = 5.1 fps (see Hydraulic Calculations, Section 4)

HYDROLOGY BASIN CALCULATIONS
(100-year storm)

BASIN 1 (Existing Condition) Cont….

Then:

T_t = Travel Distance / Velocity = $D / V_{100(Avg)}$

Where:

Distance Traveled (D) = 460 ft (see Drainage Map 1, attached)

Then:

T_t = 460 / 5.1 = 90.2 sec = 1.5 minutes

Therefore:

$T_C = T_i + T_t$

$T_C = 9.5 + 1.5$

T_C = 11.0 minutes

INTENSITY CALCULATIONS:

$I = 7.44\ P_6\ T_C^{-0.645}$ (see Figure 3-1, Section 4)

Where

P_6 = 2.8 in (see 100-year Rainfall Isopluvial, Section 4)

Then:

$I = 7.44\ (2.8)\ (11.0)^{-0.645}$ (see Figure 3-1, Section 4)

Therefore:

I = 4.4 in/hr per Equation

FLOW RATE:

$Q_{100} = C_{weighted} * I * A_{total} = 0.40 * 4.4 * 1.40$

$\boxed{\mathbf{Q_{100} = 2.5\ CFS}}$

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 1 (Proposed Condition)

In the proposed condition, the drainage runoff from the backyards will be directed towards catch basins/storm drain pipes which will direct the flow towards the concentration point. The drainage runoff from the frontyards will be directed towards the gutters on the Private Driveway, Vista De Lamar, and direct the runoff to the concentration point. The concentration point is the same point as in the existing condition for both runoffs (see the attached Drainage Map 2).

FLOW RATE: Q_{100} = C * I * A (Rational Method)

AREA:

A = 1.36 Acres (see Drainage Map 2, attached)

C-VALUE:

C = 0.57 (see Table 3-1, Section 4)

TIME OF CONCENTRATION:

$T_C = T_i + T_t$

Where:

Initial Time, T_i

Land Use	=	MDR		
Slope	=	1	%	(See Drainage Map 2, attached)
Ti	=	8.4	min	(see Table 3-2, Section 4)

And:

Travel Time, T_t

T_t: T_t is the time it takes the runoff to travel along the landscaped and developed areas after the initial travel period. Said flow will be assumed to be developed sheet flow. The time it takes the runoff to travel from the end of the initial travel time to the concentration point is calculated using the velocity and the distance traveled. The velocity is assumed for each specific condition and the travel distance is obtained from the Drainage Map 2. See below for calculations:

Assumed Q_{100} = 3.8 cfs

At:

$Q_{100(Avg)}$ = 3.8 / 2 = 1.9 cfs

Assumed Velocity ($V_{100(Avg)}$) = 8.3 fps (see Hydraulic Calculations, Section 4)

Then:

T_t = Travel Distance / Velocity = D / V_{100}

Where:

Distance Traveled (D) = 460 ft (see Drainage Map 2, attached)

Then:

T_t = 460 / 8.3 = 55.42 sec = 0.9 minutes

Therefore:

T_C = 8.4 + 0.9 = 9.3 minutes

HYDROLOGY BASIN CALCULATIONS
(100-year storm)

BASIN 1 (Proposed Condition) Cont….

INTENSITY CALCULATIONS:

$I = 7.44\ P_6\ T_C^{-0.645}$ (see Figure 3-1, Section 4)

Where

$P_6 = 2.8$ in (see 100-year Rainfall Isopluvial, Section 4)

Then:

$I = 7.44\ (2.8)\ (9.3)^{-0.645}$ (see Figure 3-1, Section 4)

Therefore:

I = 4.9 in/hr per Equation

FLOW RATE:

$Q_{100} = C * I * A = 0.57 * 4.9 * 1.36$

$\boxed{\mathbf{Q_{100} = 3.8\ CFS}}$

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 2 (Existing Condition)

Basin 2 is comprised of landscaped areas, a portion of a house and driveway. See the attached Drainage Map 1 for drainage patterns. The drainage runoff sheet flows across the basin and concentrates at the northerly subdivision subdivision boundary. Shown below are the hydrology calculation:

FLOW RATE $Q_{100} = C_{weighted} * I * A_{total}$ (Rational Method)

AREA:

Rooftops and Concrete Areas	=	0.06	Acres	
Landscaping Area	=	0.61	Acres	
A_{total}	**=**	**0.67**	**Acres**	(See Drainage Map 1, attached)

WEIGHTED C-VALUE:

Concrete & Rooftops	=	0.95	(See Table II, Section 4)
Landscaping	=	0.35	(See Table II, Section 4)

then:

$C_{weighted}$ = [(0.95 * 0.06) / 0.67] + [(0.35 * 0.61) / 0.67]

$C_{weighted}$ = 0.40 per Equation

TIME OF CONCENTRATION:

$T_C = T_i + T_t$

Where:

Initial Time, T_i

Land Use	=	Natural		
Slope	=	10	%	(See Drainage Map 1, attached)
Ti	=	6.5	min	(see Table 3-2, Section 4)

And:

Travel Time, T_t

Elevation Difference =	22	feet	
Length =	165	feet	(See Drainage Map 1, attached)
Tt =	0.9	min	(See Equation on Figure 3-4, Section 4)

Tc = 6.4+ 0.9 = 7.4 min

INTENSITY: $I = 7.44\ (P6)\ (Tc)^{-0.645}$ (See Figure 3-1, Section 4)

Where: P6 **=** 2.8 in (see 100-year Rainfall Isopluvial, Section 4)

$I = 7.44\ (2.8)\ (7.4)^{-0.645}$ (see Figure 3-1, Section 3)

I = 5.7 in/hr per Equation

FLOW RATE:

$Q_{100} = C_{weighted} * I * A_{total}$ = 0.40 * 5.7 * 0.67

Q_{100} = 1.6 cfs

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 2 (Proposed Condition)

Basin 2 is comprised of landscaped areas, a porous-pavement walkway and Unit 14. See the attached Drainage Map 2 for drainage patterns. The drainage runoff flows towards a proposed catch basin, storm drain pipe, proposed browditch and ultimately is directed to the concentration point at the northwesterly corner of the subdivision. Shown below are the hydrology calculation:

FLOW RATE

Q_{100} = C * I * A (Rational Method)

AREA:

A = 0.52 Acres (See Drainage Map 2, attached)

C-VALUE:

C = 0.57 (see Table 3-1, Section 4)

TIME OF CONCENTRATION:

$T_C = T_i + T_t$

Where:

Initial Time, T_i

Land Use	=	MDR		
Slope	=	1	%	(See Drainage Map 2, attached)
Ti	=	8.4	min	(see Table 3-2, Section 4)

And:

Travel Time, T_t

$T_{t:}$ T_t is the time it takes the runoff to travel along the landscaped and developed areas after the initial travel period. Said flow will be assumed to be developed sheet flow. The time it takes the runoff to travel from the end of the initial travel time to the concentration point is calculated using the velocity and the distance traveled. The velocity is assumed for each specific condition and the travel distance is obtained from the Drainage Map 2. See below for calculations:

Assumed Q_{100} = 1.5 cfs

At:

$Q_{100(Avg)}$ = 1.5 / 2 = 0.75 cfs

Assumed Velocity ($V_{100(Avg)}$) = 7.9 fps (see Hydraulic Calculations, Section 4)

Then:

T_t = Travel Distance / Velocity = D / V_{100}

Where:

Distance Traveled (D) = 100 ft (see Drainage Map 2, attached)

Then:

T_t = 100 / 7.9 = 12.66 sec = 0.2 minutes

Therefore:

T_C = 8.4 + 02 = 8.6 minutes

HYDROLOGY BASIN CALCULATIONS
(100-year storm)

BASIN 2 (Proposed Condition) Cont….

INTENSITY:

$I = 7.44\ (P6)\ (Tc)^{-0.645}$ (See Figure 3-1, Section 4)

Where:

P6 = 2.8 in (see 100-year Rainfall Isopluvial, Section 4)

Then:

$I = 7.44\ (2.8)\ (8.6)^{-0.645}$ (see Figure 3-1, Section 4)

Therefore:

I = 5.2 in/hr per Equation

FLOW RATE:

$Q_{100} = C * I * A = 0.57 * 5.2 * 0.52$

$\boxed{\mathbf{Q_{100} = 1.5\ CFS}}$

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 3 (Existing Condition)

Basin 3 is comprised of landscaped areas and a portion of a garage. See the attached Drainage Map 1 for drainage patterns. The drainage runoff sheet flows across the basin and concentrates at the northerly subdivision boundary. Shown below are the hydrology calculation:

FLOW RATE Q_{100} = $C_{weighted} * I * A_{total}$ (Rational Method)

AREA:

Rooftops and Concrete Areas	=	0.01	Acres	
Landscaping Area	=	0.20	Acres	
$\mathbf{A_{total}}$	**=**	**0.21**	**Acres**	(See Drainage Map 1, attached)

WEIGHTED C-VALUE:

Concrete & Rooftops	=	0.95	(See Table II, Section 4)
Landscaping	=	0.35	(See Table II, Section 4)

then:

$C_{weighted}$ = [(0.95 * 0.01) / 0.21] + [(0.35 * 0.20) / 0.21]

$\mathbf{C_{weighted}}$ **=** **0.38** per Equation

TIME OF CONCENTRATION:

T_C = $T_i + T_{t1} + T_{t2}$

Where:

Initial Time, T_i

Land Use	=	Natural		
Slope	=	5	%	(See Drainage Map 1, attached)
T_i	=	8.0	min	(see Table 3-2, Section 4)

And:

Travel Time, T_{t1}

Elevation Difference	=	10	feet	
Length	=	74	feet	(See Drainage Map 1, attached)
T_{t1}	=	0.5	min	(See Equation on Figure 3-4, Section 4)

And:

Travel Time, T_{t2}

T_{t2}: T_{t2} is the time it takes the runoff to travel along the browditch after the first travel period. Said flow will be assumed to be developed sheet flow. The time it takes the runoff to travel from the end of the first travel time to the concentration point is calculated using the velocity and the distance traveled. The velocity is assumed for each specific condition and the travel distance is obtained from the Drainage Map 1. See below for calculations:

Assumed Q_{100} = 0.4 cfs

At:

$Q_{100(Avg)}$ = 0.4 / 2 = 0.2 cfs

Assumed Velocity ($V_{100(Avg)}$) = 3.9 fps (see Hydraulic Calculations, Section 4)

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 3 (Existing Condition) Cont….

Then:

T_{t2} = Travel Distance / Velocity = D / V_{100}

Where:

Distance Traveled (D) = 84 ft (see Drainage Map 2, attached)

Then:

T_{t2} = 84 / 3.9 = 21.54 sec = 0.4 minutes

Therefore:

$T_C = T_i + T_{t1} + T_{t2}$

$T_C = 8.0 + 0.5 + 0.4$

T_C = 8.9 minutes

INTENSITY:

$I = 7.44\ (P6)\ (Tc)^{-0.645}$ (See Figure 3-1, Section 4)

Where: P6 = 2.8 in (see 100-year Rainfall Isopluvial, Section 4)

$I = 7.44\ (2.8)\ (8.9)^{-0.645}$ (see Figure 3-1, Section 3)

I = 5.1 in/hr per Equation

FLOW RATE:

$Q_{100} = C_{weighted} * I * A_{total}$ (Rational Method)

$Q_{100} = 0.38 * 5.1 * 0.21$

$\boxed{\mathbf{Q_{100} = 0.4\ cfs}}$

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 3 (Proposed Condition)

Basin 3 is comprised of landscaped areas and Units 17-19. See the attached Drainage Map 2 for drainage patterns. The drainage runoff flows towards a proposed catch basin, storm drain pipe, undeveloped terrain, existing brow ditch and ultimately to the concentration point. Shown below are the hydrology calculation:

FLOW RATE Q_{100} = C * I * A (Rational Method)

AREA:

A = 0.13 Acres (See Drainage Map 2, attached)

C-VALUE:

C = 0.57 (see Table 3-1, Section 4)

TIME OF CONCENTRATION:

$T_C = T_i + T_t$

Where:

Initial Time, T_i Land Use = MDR

Slope = 1 % (See Drainage Map 2, attached)

Ti = 8.4 min (see Table 3-2, Section 4)

Travel Time, T_t

T_t: T_t is the time it takes the runoff to travel along the browditch after the first travel period. Said flow will be assumed to be developed sheet flow. The time it takes the runoff to travel from the end of the initial travel time to the concentration point is calculated using the velocity and the distance traveled. The velocity is assumed for each specific condition and the travel distance is obtained from the Drainage Map 2. See below for calculations:

Assumed Q_{100} = 0.4 cfs

At:

$Q_{100(Avg)}$ = 0.4 / 2 = 0.2 cfs

Assumed Velocity ($V_{100(Avg)}$) = 3.9 fps (see Hydraulic Calculations, Section 4)

Then:

T_t = Travel Distance / Velocity = D / V_{100}

Where:

Distance Traveled (D) = 84 ft (See Drainage Map 2, attached)

Then:

T_t = 84 / 3.9 = 21.54 sec = 0.4 minutes

Therefore:

$T_C = T_i + T_t$

T_C = 8.4 + 0.4

T_C = 8.8 minutes

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 3 (Proposed Condition) Cont….

INTENSITY:

$I = 7.44\ (P6)\ (Tc)^{-0.645}$ (See Figure 3-1, Section 4)

Where:

P6 = 2.8 in (see 100-year Rainfall Isopluvial, Section 4)

Then:

$I = 7.44\ (2.8)\ (8.8)^{-0.645}$ (see Figure 3-1, Section 3)

I = 5.1 in/hr per Equation

FLOW RATE:

$Q_{100} = C * I * A$ (Rational Method)

$Q_{100} = 0.57 * 5.1 * 0.13$

$\boxed{\mathbf{Q_{100} = 0.4\ cfs}}$

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 4 (Existing Condition)

Basin 4 is comprised of landscaped areas from the site, sidewalk and curb & gutter from Avenida De Lamar. See the attached Drainage Map 1 for drainage patterns. The drainage runoff sheet flows across the basin and runs along the westerly side of Avenida De Lamar till reaches the concentration point. Shown below are the hydrology calculation:

FLOW RATE Q_{100} = $C_{weighted} * I * A_{total}$ (Rational Method)

AREA:

Concrete Areas	=	0.01	Acres	
Landscaping Area	=	0.27	Acres	
A_{total}	**=**	**0.28**	**Acres**	(See Drainage Map 1, attached)

WEIGHTED C-VALUE:

Concrete & Rooftops	=	0.95	(See Table II, Section 4)
Landscaping	=	0.35	(See Table II, Section 4)

then:

$C_{weighted}$ = [(0.95 * 0.01) / 0.28] + [(0.35 * 0.27) / 0.28

$C_{weighted}$ = 0.37 per Equation

TIME OF CONCENTRATION:

T_C = $T_i + T_t$

Where:

Initial Time, T_i	Land Use	=	Natural		
	Slope	=	5	%	(See Drainage Map 1, attached)
	Ti	=	8.0	min	(see Table 3-2, Section 4)

And:

Travel Time, T_t

T_t: T_t is the time it takes the runoff to travel along the gutter after the initial travel time.

Said flow will be assumed to be developed sheet flow. The time it takes the runoff to travel from the end of the initial travel time to the concentration point is calculated using the velocity and the distance traveled. The velocity is assumed for each specific condition and the travel distance is obtained from the Drainage Map 1. See below for calculations:

Assumed Q_{100} = 0.5 cfs

At:

$Q_{100(Avg)}$ = 0.5 / 2 = 0.25 cfs

Assumed Velocity ($V_{100(Avg)}$) = 5.0 fps (see Figure 3-6, Section 4)

Then:

T_{t2} = Travel Distance / Velocity = D / V_{100}

Where:

Distance Traveled (D) = 175 ft (see Drainage Map 1, attached)

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 4 (Existing Condition) Cont….

T_t = 175 / 5.0 = 35 sec = 0.6 minutes

Therefore:

T_C = 8.0 + 0.6 8.6 minutes

INTENSITY:

$I = 7.44\ (P6)\ (Tc)^{-0.645}$ (See Figure 3-1, Section 4)

Where: P6 = 2.8 in (see 100-year Rainfall Isopluvial, Section 4)

$I = 7.44\ (2.8)\ (8.6)^{-0.645}$ (see Figure 3-1, Section 4)

I = 5.2 in/hr per Equation

FLOW RATE:

$Q_{100} = C_{weighted} * I * A_{total}$

$Q_{100} = 0.37 * 5.2 * 0.28$

$\boxed{\mathbf{Q_{100} = 0.5\ cfs}}$

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 4 (Proposed Condition)

Basin 4 is comprised of Units 18, 19 & 20, landscaped areas, sidewalk, curb & gutter from the Private Driveway (Vista de Lamar) and Avenida De Lamar. See the attached Drainage Map 2 for drainage patterns. The drainage runoff sheet flows across the basin and runs along the northerly side of the Private Driveway and is directed towards the westerly side of Avenida De Lamar till reaches the concentration point. Shown below are the hydrology calculation:

FLOW RATE Q_{100} = C * I * A (Rational Method)

AREA:

A = 0.44 Acres (See Drainage Map 2, attached)

C-VALUE:

C = 0.57 (see Table 3-1, Section 4)

TIME OF CONCENTRATION:

$T_C = T_i + T_t$

Where:

Initial Time, T_i Land Use = Natural

Slope = 1 % (See Drainage Map 2, attached)

Ti = 8.4 min (see Table 3-2, Section 4)

And:

Travel Time, T_{t1}

T_t: T_t is the time it takes the runoff to travel along the gutter after the initial travel time.

Said flow will be assumed to be developed sheet flow. The time it takes the runoff to travel from the end of the initial travel time to the concentration point is calculated using the velocity and the distance traveled. The velocity is assumed for each specific condition and the travel distance is obtained from the Drainage Map 2. See below for calculations:

Assumed Q_{100} = 1.2 cfs

At:

$Q_{100(Avg)}$ = 1.2 / 2 = 0.6 cfs

Assumed Velocity ($V_{100(Avg)}$) = 5.0 fps (see Figure 3-6, Section 4)

Then:

T_t = Travel Distance / Velocity = D / V_{100}

Where:

Distance Traveled (D) = 315 ft (see Drainage Map 2, attached)

Then:

T_t = 315 / 5.0 = 63 sec = 1.1 minutes

Therefore:

$T_C = T_i + T_t$

T_C = 8.4 + 1.1

T_C = 9.5 minutes

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 4 (Proposed Condition) Cont….

INTENSITY:

	I	=	7.44 (P6) $(Tc)^{-0.645}$		(See Figure 3-1, Section 4)
Where:	P6	=	2.8	in	(see 100-year Rainfall Isopluvial, Section 4)
	I	=	7.44 (2.8) $(9.5)^{-0.645}$		(see Figure 3-1, Section 4)
	I	=	**4.9**	**in/hr**	per Equation

FLOW RATE:

Q_{100}	=	C * I * A	
Q_{100}	=	0.57 * 4.9 * 0.44	
Q_{100}	=	**1.2**	**cfs**

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 5 (Existing Condition)

Basin 5 is comprised of landscaped areas from the site, sidewalk and curb & gutter from Avenida De Lamar. See the attached Drainage Map 1 for drainage patterns. The drainage runoff sheet flows across the basin and runs along the westerly side of Avenida De Lamar till reaches the concentration point. Shown below are the hydrology calculation:

FLOW RATE Q_{100} = $C_{weighted} * I * A_{total}$ (Rational Method)

AREA:

Concrete Areas	=	0.01	Acres	
Landscaping Area	=	0.26	Acres	
$\mathbf{A_{total}}$	**=**	**0.27**	**Acres**	(See Drainage Map 1, attached)

WEIGHTED C-VALUE:

Concrete & Rooftops	=	0.95	(See Table II, Section 4)
Landscaping	=	0.35	(See Table II, Section 4)

then:

$C_{weighted}$ = [(0.95 * 0.01) / 0.27] + [(0.35 * 0.26) / 0.27

$\mathbf{C_{weighted}}$ **=** **0.37** per Equation

TIME OF CONCENTRATION:

T_C = $\mathbf{T_i} + T_t$

Where:

Initial Time, T_i

Land Use	=	Natural		
Slope	=	5	%	(See Drainage Map 1, attached)
Ti	=	8.0	min	(see Table 3-2, Section 4)

And:

And:

Travel Time, T_t

T_t: T_t is the time it takes the runoff to travel along the gutter after the initial travel time.

Said flow will be assumed to be developed sheet flow. The time it takes the runoff to travel from the end of the initial travel time to the concentration point is calculated using the velocity and the distance traveled. The velocity is assumed for each specific condition and the travel distance is obtained from the Drainage Map 1. See below for calculations:

Assumed Q_{100} = 0.5 cfs

At:

$Q_{100(Avg)}$ = 0.5 / 2 = 0.25 cfs

Assumed Velocity ($V_{100(Avg)}$) = 2.8 fps (see Figure 3-6, Section 4)

Then:

T_{t2} = Travel Distance / Velocity = D / V_{100}

Where:

Distance Traveled (D) = 160 ft (see Drainage Map 1, attached)

Then:

T_{t2} = 160 / 2.8 = 57.14 sec = 1.0 minutes

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 5 (Existing Condition) Cont….

Therefore:

T_C = 8.0 + 1.0 9.0 minutes

INTENSITY:

$I = 7.44\ (P6)\ (Tc)^{-0.645}$ (See Figure 3-1, Section 4)

Where: P6 = 2.8 in (see 100-year Rainfall Isopluvial, Section 4)

$I = 7.44\ (2.8)\ (9.0)^{-0.645}$ (see Figure 3-1, Section 4)

I = 5.1 in/hr per Equation

FLOW RATE:

$Q_{100} = C_{weighted} * I * A_{total}$

$Q_{100} = 0.37 * 5.1 * 0.27$

$\boxed{\mathbf{Q_{100} = 0.5\ cfs}}$

HYDROLOGY BASIN CALCULATIONS
100-year storm

BASIN 5 (Proposed Condition)

Basin 5 is comprised of Units 1 & 2, landscaped areas, sidewalk, curb & gutter from the Private Driveway (Vista de Lamar) and Avenida De Lamar. See the attached Drainage Map 2 for drainage patterns. The drainage runoff sheet flows the westerly side ofacross the basin and runs along the southerly side of the Private Driveway and is directed towards Avenida De Lamar till reaches the concentration point. Shown below are the hydrology calculation:

FLOW RATE Q_{100} = C * I * A (Rational Method)

AREA:

A = 0.37 Acres (See Drainage Map 2, attached)

C-VALUE:

C = 0.57 (see Table 3-1, Section 4)

TIME OF CONCENTRATION:

$T_C = T_i + T_t$

Where:

Initial Time, T_i Land Use = Natural

Slope = 1 % (See Drainage Map 2, attached)

Ti = 8.4 min (see Table 3-2, Section 4)

And:

Travel Time, T_t

T_t: T_t is the time it takes the runoff to travel along the gutter after the initial travel time.

Said flow will be assumed to be developed sheet flow. The time it takes the runoff to travel from the end of the initial travel time to the concentration point is calculated using the velocity and the distance traveled. The velocity is assumed for each specific condition and the travel distance is obtained from the Drainage Map 2. See below for calculations:

Assumed Q_{100} = 1.0 cfs

At:

$Q_{100(Avg)}$ = 1.0 / 2 = 0.5 cfs

Assumed Velocity ($V_{100(Avg)}$) = 2.8 fps (see Figure 3-6, Section 4)

Then:

T_t = Travel Distance / Velocity = D / V_{100}

Where:

Distance Traveled (D) = 170 ft (see Drainage Map 2, attached)

Then:

T_t = 170 / 2.8 = 60.71 sec = 1.0 minutes

Therefore:

$T_C = T_i + T_t$

T_C = 8.4 + 1.0

T_C = 9.4 minutes

HYDROLOGY BASIN CALCULATIONS
100-year storm

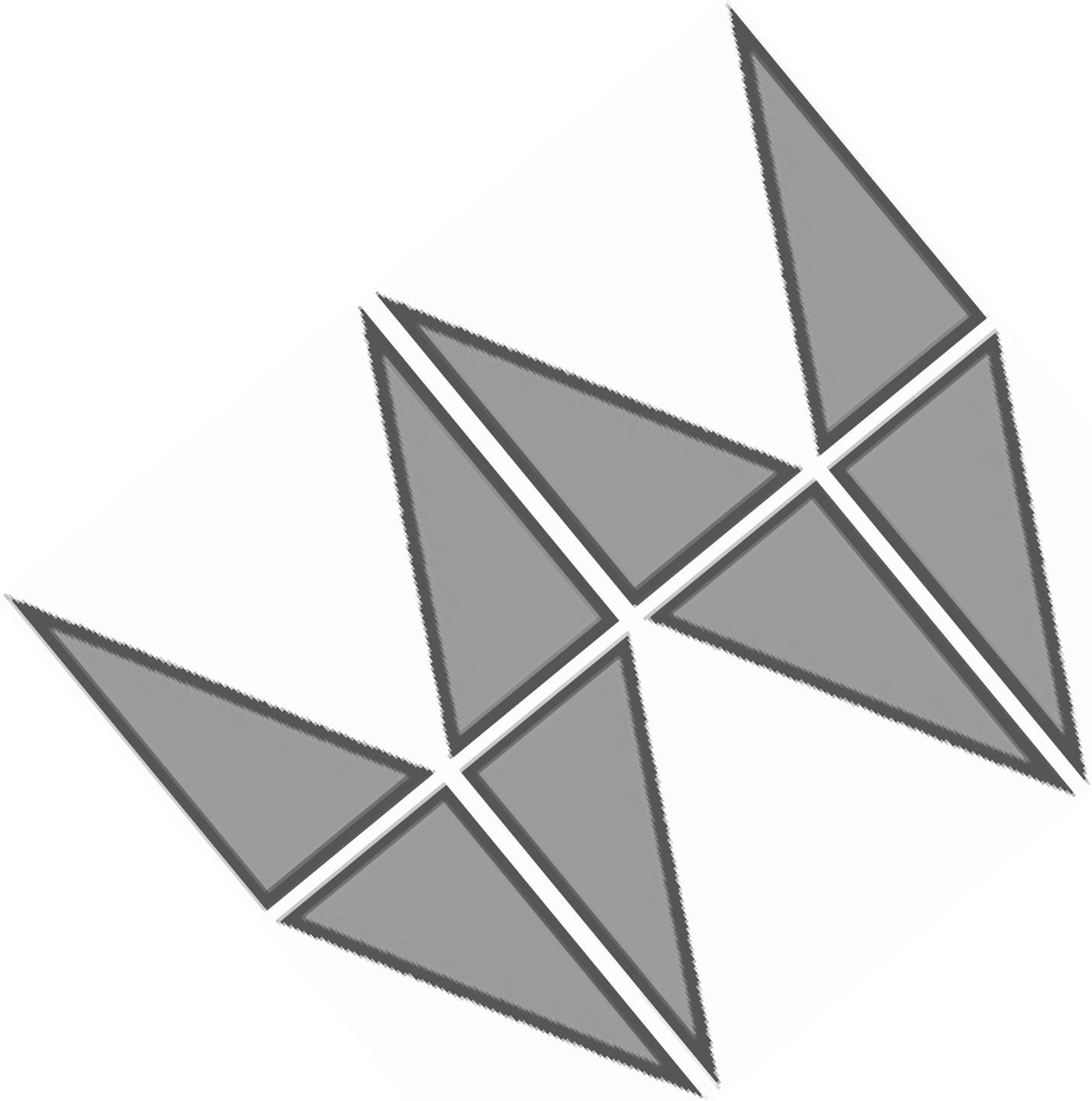
BASIN 5 (Proposed Condition) Cont….

INTENSITY:

	I	=	$7.44\ (P6)\ (Tc)^{-0.645}$		(See Figure 3-1, Section 4)
Where:	P6	=	2.8	in	(see 100-year Rainfall Isopluvial, Section 4)
	I	=	$7.44\ (2.8)\ (9.4)^{-0.645}$		(see Figure 3-1, Section 4)
	I	=	**4.9**	**in/hr**	per Equation

FLOW RATE:

Q_{100}	=	C * I * A	
Q_{100}	=	0.57 * 4.9 * 0.37	
Q_{100}	=	**1.0**	**cfs**



SETION

HYDRAULIC CALCULATIONS

Basin 1 (Existing Condition)

The following calculation determines the flow velocity of a grass swale which runs along the southerly edge of Meghan Court. See the attached Drainage Map 1. The parameters used below are the assumed values from the grass swale.

Channel Calculator

Given Input Data:

Shape ..... Trapezoidal

Solving for ..... Depth of Flow

Flowrate ($Q_{100(Avg)}$).....1.25 cfs (assumed flow rate, see Hydrology Calculations)

Slope ..... 0.11 ft/ft

Manning's n 0.028

Height ..... 1.0 ft

Bottom width ..... 1.0 ft

Left slope ..... 1.0 ft/ft (V/H)

Right slope ..... 1.0 ft/ft (V/H)

Computed Results:

Velocity ($V_{100(Avg)}$) ..... 5.1 fps

The assumed values for Q_{100} and V_{100} in Section A are correct.

HYDRAULIC CALCULATIONS

Basin 1 (Proposed Condition)

The following calculation determines the flow velocity of a proposed 12” PVC storm drain pipe which runs along the southerly and westerly subdivision boundaries. See the attached Drainage Map 2.

Manning Pipe Calculator

Given Input Data:

Shape ..... Circular

Solving for ..... Depth of Flow

Diameter ..... 12 in

Flowrate ..... 1.9 cfs (assumed flow rate, see Hydrology Calculations)

Slope ..... 0.05 ft/ft

Manning's n 0.013

Computed Results:

Velocity ..... 8.3 fps

The assumed values for Q_{100} and V_{100} in Section A are correct.

HYDRAULIC CALCULATIONS

Basin 2 (Proposed Condition)

The following calculation determines the flow velocity of the proposed brow ditch which runs along the westerly subdivision boundary, west of Unit 14. See the attached Drainage Map 2.

Manning Pipe Calculator

Given Input Data:

Shape ..... Circular

Solving for ..... Depth of Flow

Diameter ..... 24 in

Flowrate ..... 0.75 cfs (assumed flow rate, see Hydrology Calculations)

Slope ..... 0.12 ft/ft

Manning's n 0.013

Computed Results:

Velocity ..... 7.9 fps

The assumed values for Q_{100} and V_{100} in Section A are correct.

HYDRAULIC CALCULATIONS

Basin 3 (Existing Condition)

The following calculation determines the flow velocity of the existing brow ditch which runs along the southerly property boundary of APN 504-112-60, north of proposed Units 18-20. See the attached Drainage Maps 1 & 2.

Manning Pipe Calculator

Given Input Data:

Shape ..... Circular

Solving for ..... Depth of Flow

Diameter ..... 24 in

Flowrate ..... 0.2 cfs (assumed flow rate, see Hydrology Calculations)

Slope ..... 0.05 ft/ft

Manning's n 0.013

Computed Results:

Velocity ..... 3.9 fps

The assumed values for Q_{100} and V_{100} in Section A are correct.

HYDRAULIC CALCULATIONS

Basin 3 (Proposed Condition)

The following calculation determines the flow velocity of the existing brow ditch which runs along the southerly property boundary of APN 504-112-60, north of Units 18-20. See the attached Drainage Map 2.

Manning Pipe Calculator

Given Input Data:

Shape ..... Circular

Solving for ..... Depth of Flow

Diameter ..... 24 in

Flowrate ..... 0.2 cfs (assumed flow rate, see Hydrology Calculations)

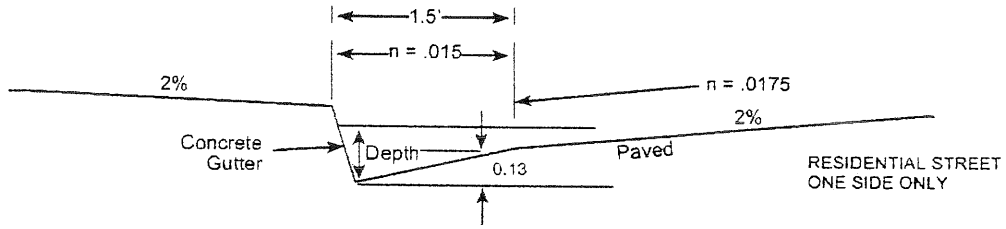
Slope ..... 0.05 ft/ft

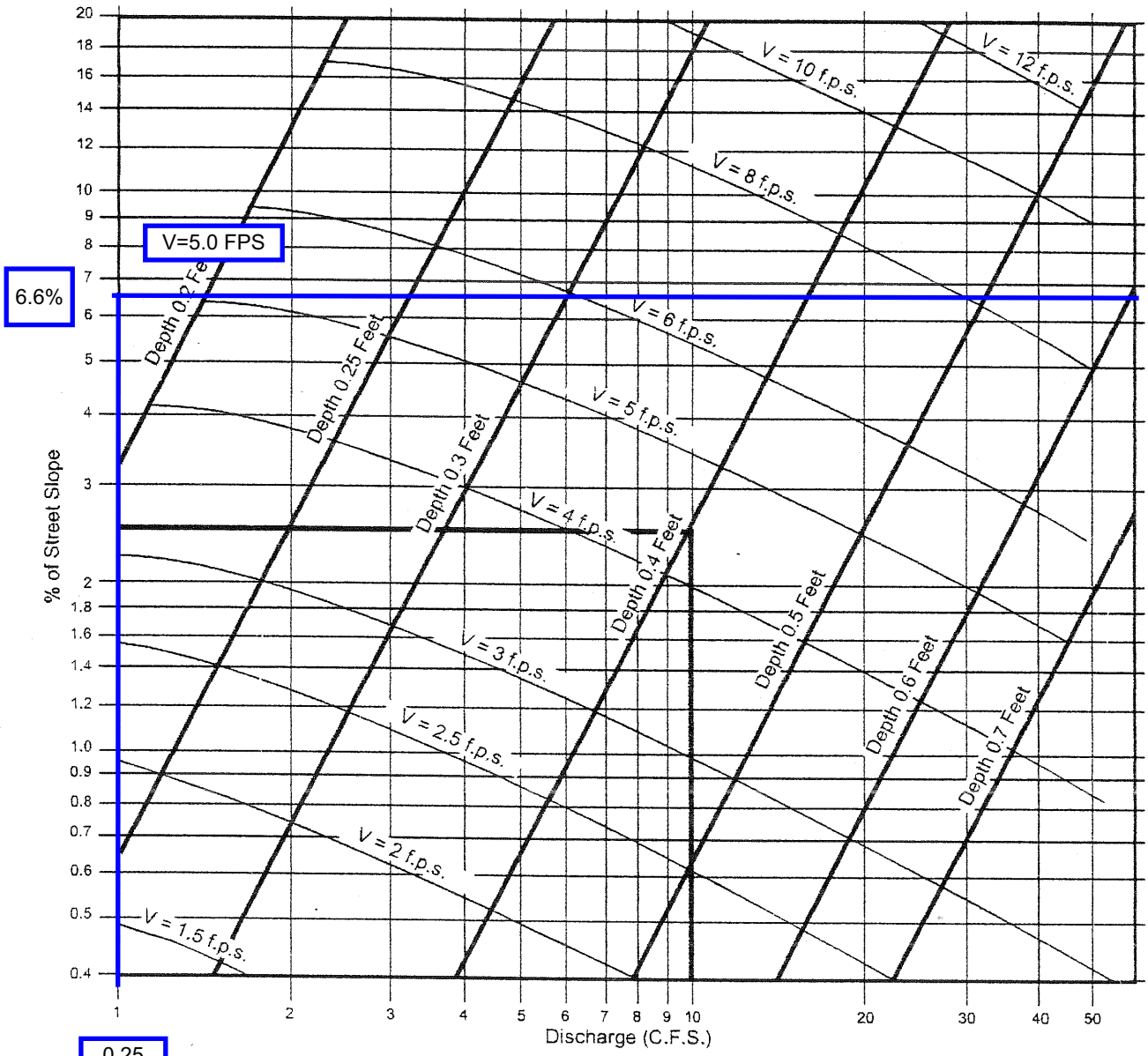
Manning's n 0.013

Computed Results:

Velocity ..... 3.9 fps

The assumed values for Q_{100} and V_{100} in Section A are correct.





EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

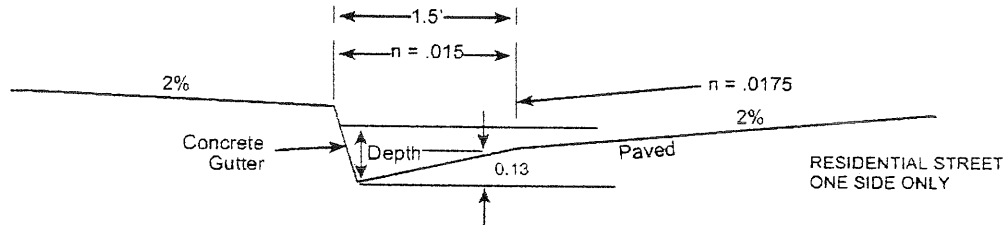
SOURCE: San Diego County Department of Special District Services Design Manual

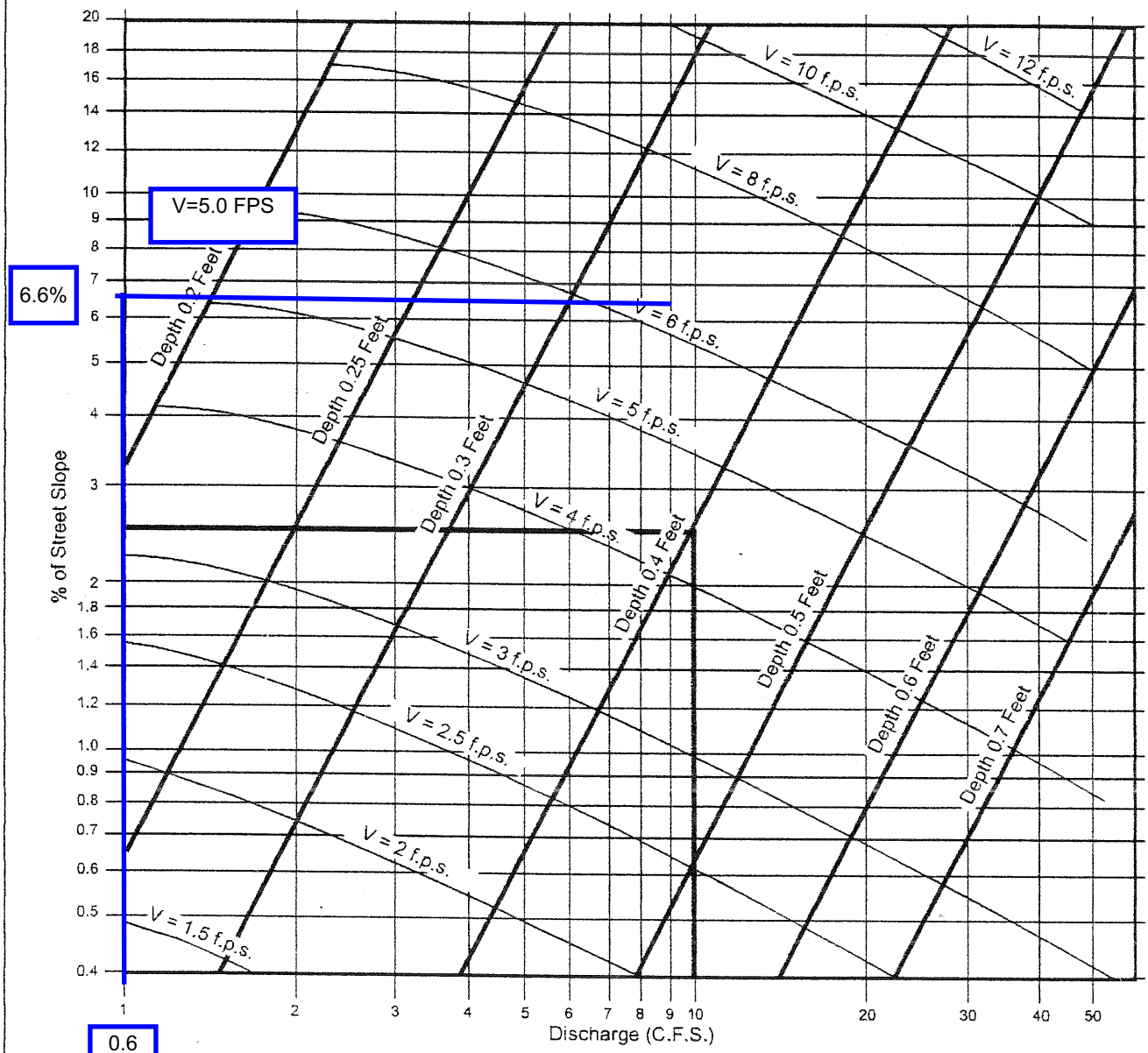
F I G U R E

3-6

Gutter and Roadway Discharge - Velocity Chart

BASIN 4 - EXISTING CONDITION





EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

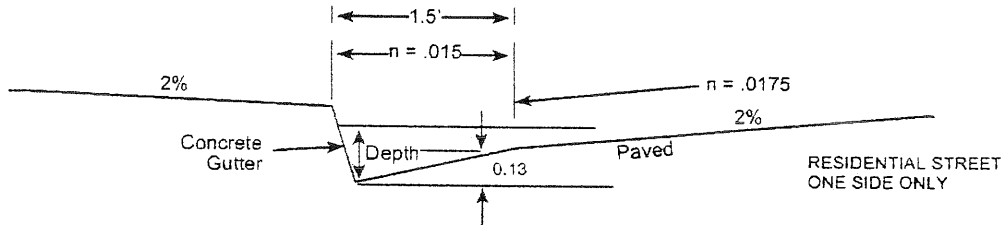
SOURCE: San Diego County Department of Special District Services Design Manual

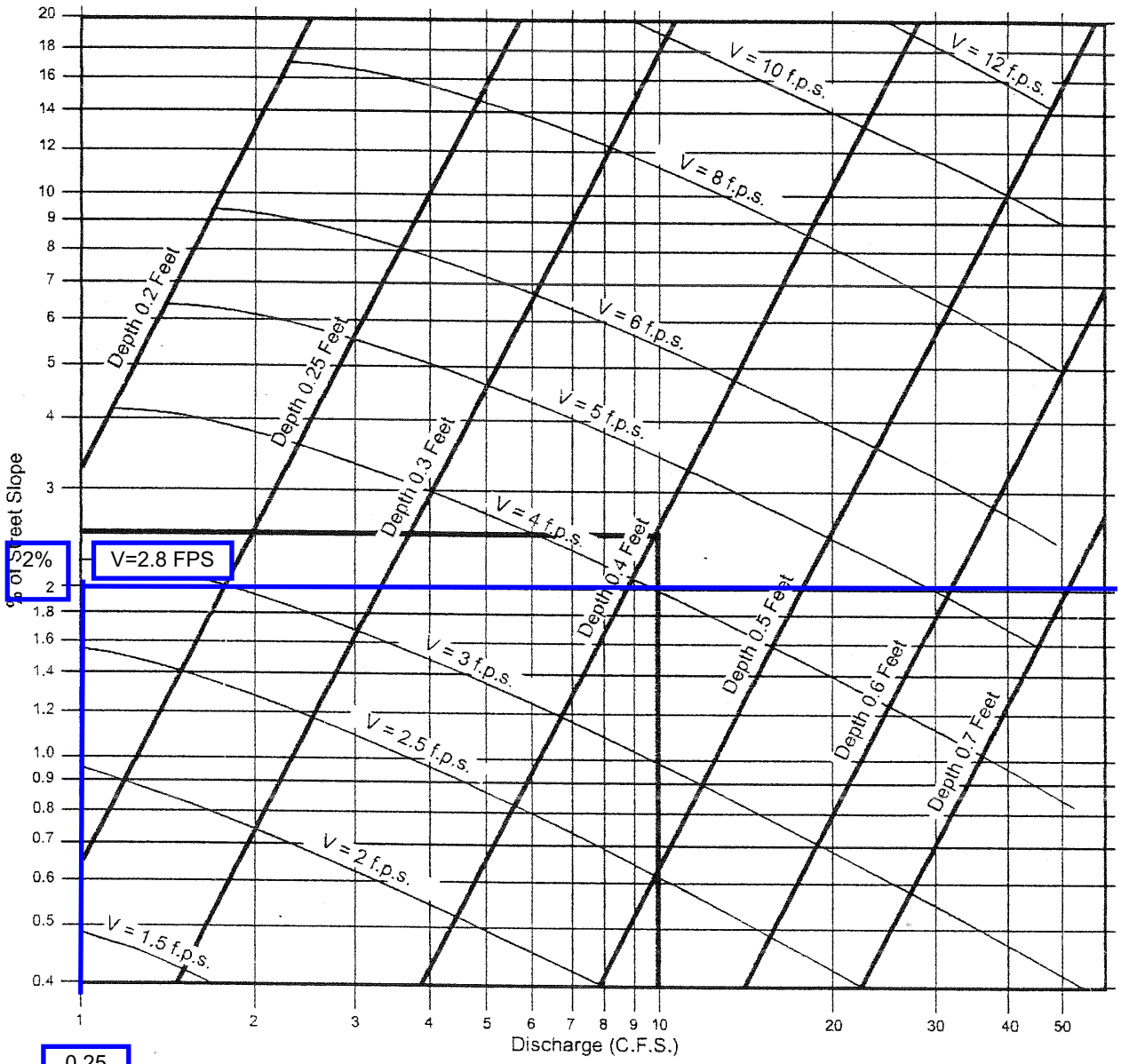
FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

BASIN 4 - PROPOSED CONDITION





0.25

EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

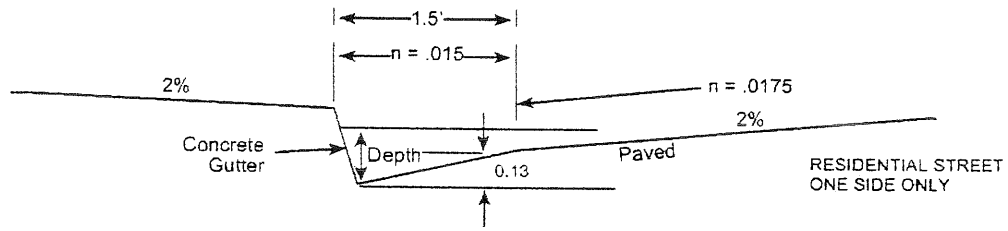
SOURCE: San Diego County Department of Special District Services Design Manual

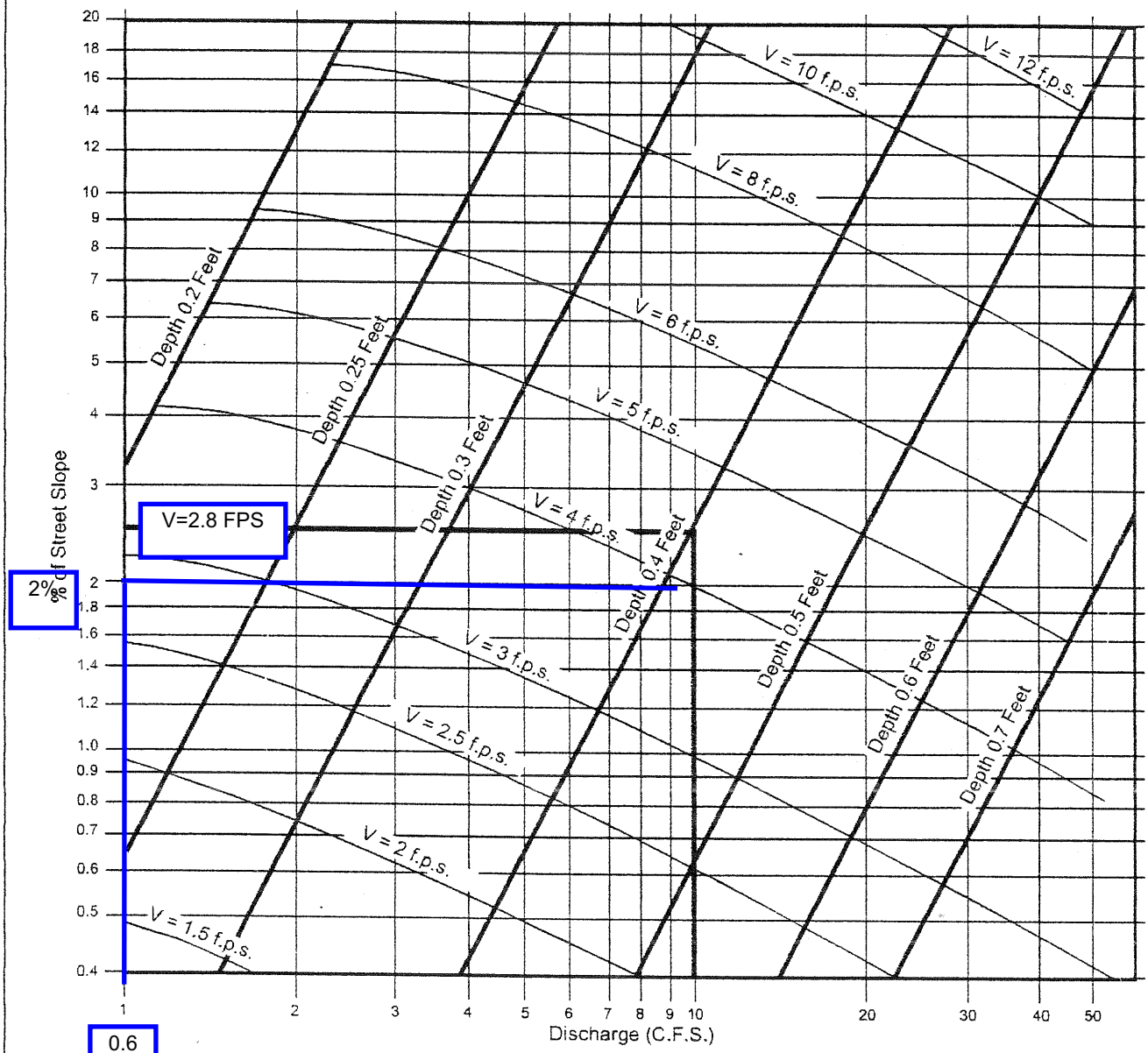
FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

BASIN 5 - EXISTING CONDITION





EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

SOURCE: San Diego County Department of Special District Services Design Manual

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

BASIN 5 - PROPOSED CONDITION

HYDRAULIC CALCULATIONS

Basin 1 (Proposed Condition)

METHODOLOGY: The volume to be detained is calculated using the "Detention Storage Computation Procedure, Single Hydrograph Form" as outlined in the 2003 County of San Diego Hydrology Manual. Since we have a target flowrate (Q_O=2.5 cfs), a Detention Volume (V_D) is calculated herein.

GIVEN:
P_6 = 2.8 IN
T_C = 11.0 MIN
C = 0.40
A = 1.4 AC
Q_P = 3.8 CFS
Q_O = 2.5 CFS

Time to Peak:
$T_P = 1.1072 * T_C$
$= 1.1072 * 11.0$ MIN
$= 12.2$ MIN

Depth of Precipitation (2 HRS):
$D_{120} = 0.6785(P_6)$
$= 0.6785(2.8)$
$= 1.9$ IN

Depth of Precipitation for Hydrograph:
$D_H = (P_6 * TC^{0.355}) / 5.83$
$= (2.8 * 11.0^{.355}) / 5.83$
$= 1.1$

Surrounding Intensity:
$I_S = [60 (D_{120} – D_H) / (120 - 2.5 * T_C)]$
$= [60 (1.9 – 1.1) / (120 - 2.5 * 11.0)]$
$= 0.52$ $^{IN}/_{HR}$

Surrounding Flowrate:
$Q_S = C * I_S * A$
$= 0.40 * 0.52 * 1.4$
$= 0.29$ CFS

Flowrate Out:

(See hydrograph for all values)

$V_D = 1.25 T_P (Q_P – Q_O) * 60$ min/sec

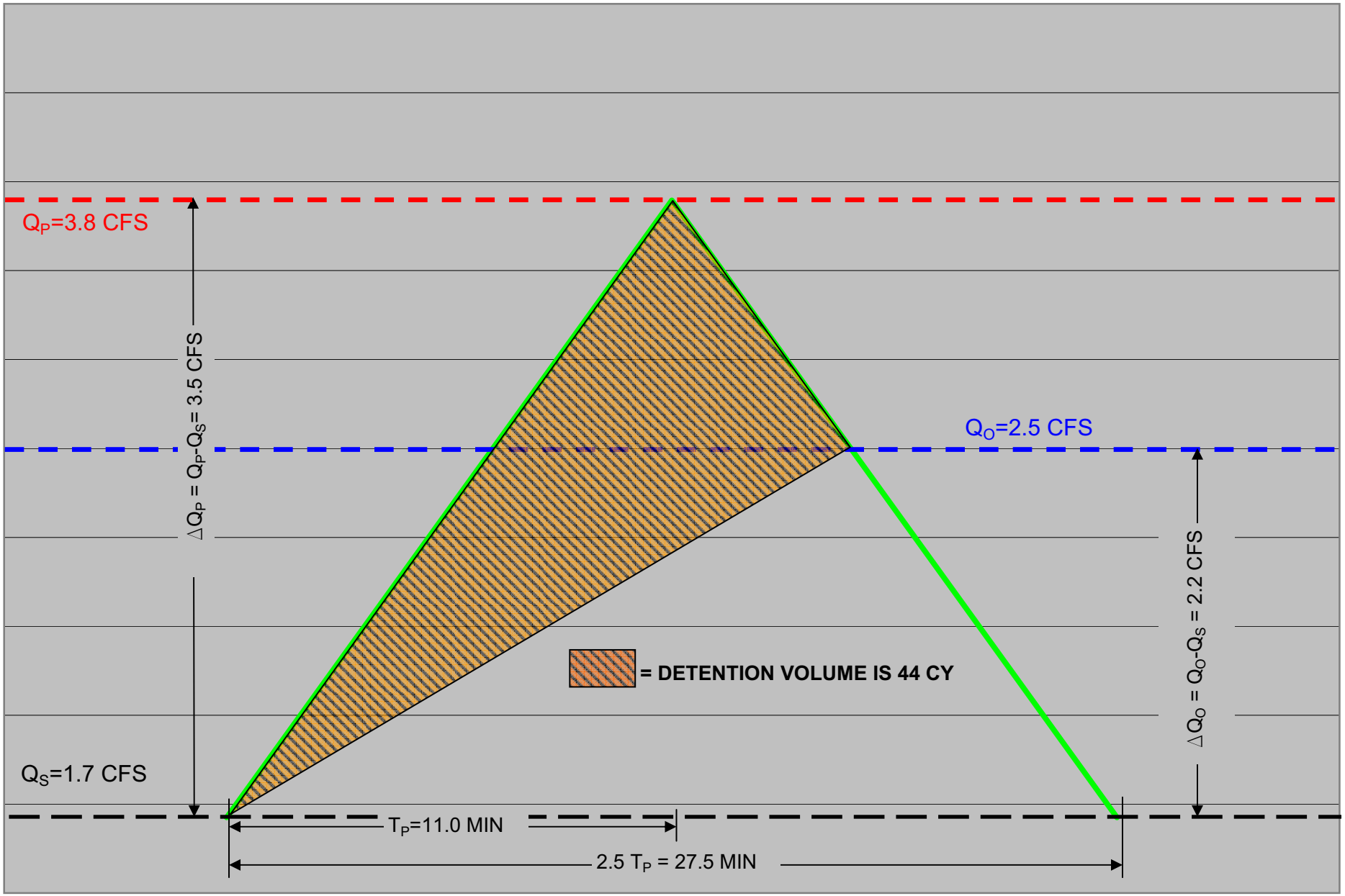
:

$V_D = 1.25*12.2 (3.8 – 2.5) * 60$ min/sec = 1190 CF

$V_D = 1190$ CF * 1 CY / 27 CF

V_D = 44 CY

Hydrograph
Basin 1



HYDRAULIC CALCULATIONS

Basin 2 (Proposed Condition)

The flow rate in the existing condition for Basin 2 is 1.6 cfs and in the proposed condition is 1.5 cfs. Therefore, no detention is needed in said basin. However, the runoff from the proposed rooftops will still be treated. Based on the Hydromofification Management Plan, a 236 cubic-foot detention facility is required. The proposed Bioretention Area for Basin 2 is 811 cubic feet.

HYDRAULIC CALCULATIONS

Basin 3 (Proposed Condition)

Since there are no proposed rooftops and the flow rate in the existing and proposed condition for Basin 3 is the same, 0.4 cfs. Therefore, no detention / treatment is needed in said basin.

HYDRAULIC CALCULATIONS

Basin 4 (Proposed Condition)

METHODOLOGY: The volume to be detained is calculated using the "Detention Storage Computation Procedure, Single Hydrograph Form" as outlined in the 2003 County of San Diego Hydrology Manual. Since we have a target flowrate (Q_O=0.5 cfs), a Detention Volume (V_D) is calculated herein.

GIVEN:
P_6 = 2.8 IN
T_C = 8.6 MIN
C = 0.37
A = 0.28 AC
Q_P = 1.2 CFS
Q_O = 0.5 CFS

Time to Peak:
$T_P = 1.1072 * T_C$
= 1.1072 * 8.6 MIN
= 9.5 MIN

Depth of Precipitation (2 HRS):
$D_{120} = 0.6785(P_6)$
= 0.6785(2.8)
= 1.9 IN

Depth of Precipitation for Hydrograph:
$D_H = (P_6 * TC^{0.355}) / 5.83$
$= (2.8 * 8.6^{.355}) / 5.83$
= 1.0

Surrounding Intensity:
$I_S = [60 (D_{120} – D_H) / (120 - 2.5 * T_C)]$
$= [60 (1.9 – 1.0) / (120 - 2.5 * 8.6)]$
$= 0.55\ ^{IN}/_{HR}$

Surrounding Flowrate:
$Q_S = C * I_S * A$
= 0.37 * 0.55 * 0.28
= 0.06 CFS

Flowrate Out:

(See hydrograph for all values)

$V_D = 1.25\ T_P\ (Q_P – Q_O) * 60$ min/sec

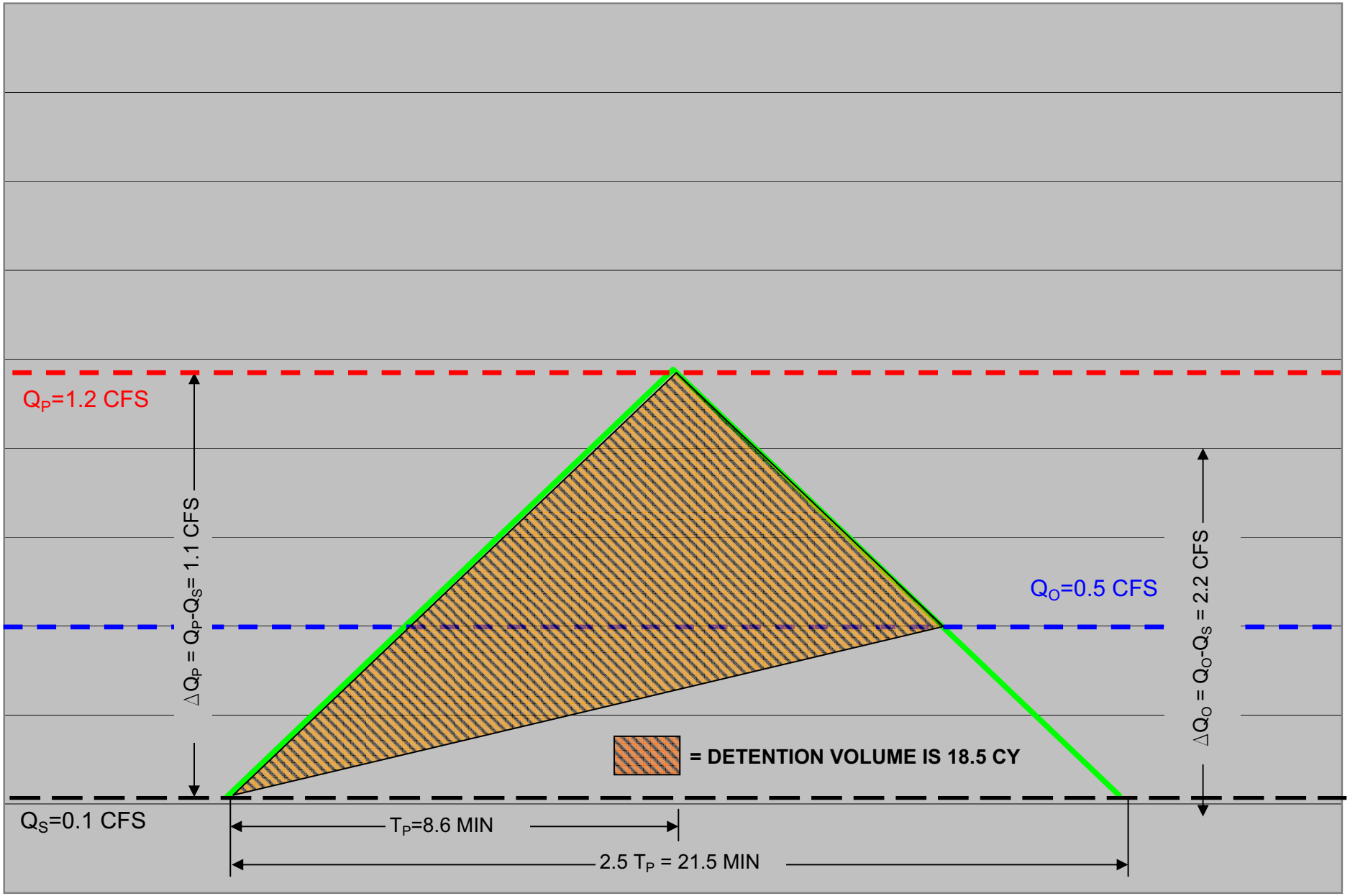
:

V_D = 1.25 * 9.5 (1.2 – 0.5) * 60 min/sec = 499 CF

V_D = 499 CF * 1 CY / 27 CF = 18.5 CY

The proposed Bioretention volume for Basin 4 is 505 CF (18.7 CY)

Hydrograph
Basin 4



HYDRAULIC CALCULATIONS

Basin 5 (Proposed Condition)

METHODOLOGY: The volume to be detained is calculated using the "Detention Storage Computation Procedure, Single Hydrograph Form" as outlined in the 2003 County of San Diego Hydrology Manual. Since we have a target flowrate (Q_O=0.5 cfs), a Detention Volume (V_D) is calculated herein.

GIVEN:
P_6 = 2.8 IN
T_C = 9.0 MIN
C = 0.37
A = 0.27 AC
Q_P = 1.0 CFS
Q_O = 0.5 CFS

Time to Peak:
$T_P = 1.1072 * T_C$
= 1.1072 * 9.0 MIN
= 10.0 MIN

Depth of Precipitation (2 HRS):
$D_{120} = 0.6785(P_6)$
= 0.6785(2.8)
= 1.9 IN

Depth of Precipitation for Hydrograph:
$D_H = (P_6 * TC^{0.355}) / 5.83$
$= (2.8 * 9.0^{.355}) / 5.83$
= 1.0

Surrounding Intensity:
$I_S = [60 (D_{120} – D_H) / (120 - 2.5 * T_C)]$
$= [60 (1.9 – 1.0) / (120 - 2.5 * 9.0)]$
$= 0.55\ ^{IN}/_{HR}$

Surrounding Flowrate:
$Q_S = C * I_S * A$
= 0.37 * 0.55 * 0.27
= 0.06 CFS

Flowrate Out:

(See hydrograph for all values)

$V_D = 1.25\ T_P\ (Q_P – Q_O) * 60$ min/sec

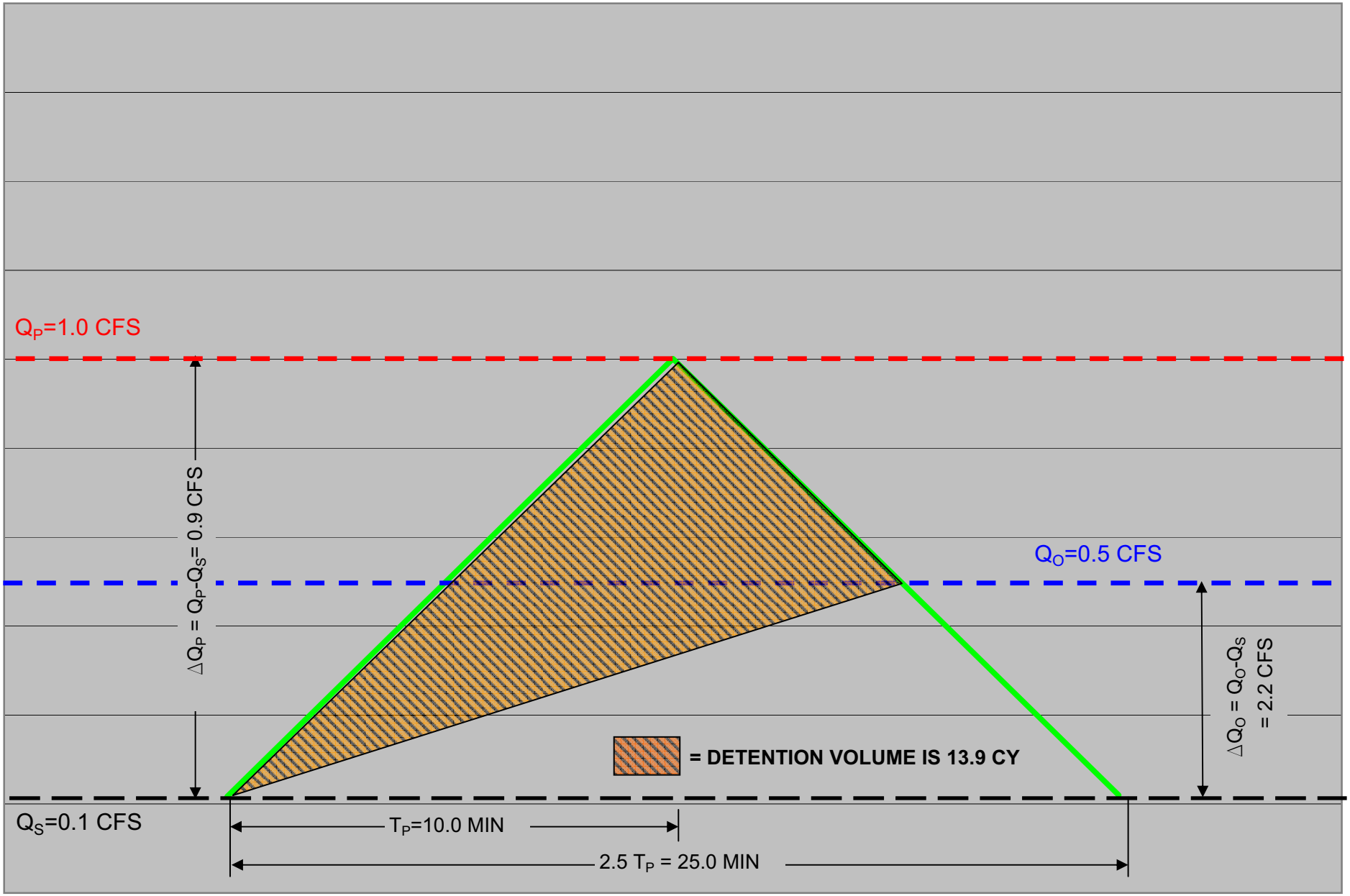
:

V_D = 1.25 * 10.0 (1.2 – 0.5) * 60 min/sec = 375 CF

V_D = 375 CF * 1 CY / 27 CF = 13.9 CY

The proposed Bioretention volume for Basin 5 is 390 CF (14.5 CY)

Hydrograph
Basin 5



HYDRAULIC CALCULATIONS

6” PVC Storm Drain Pipe:

The runoff from the rooftops will be directed on a proposed 6” PVC storm drain pipes towards a proposed 12” PVC storm drain pipe (see Drainage Map #3, attached). The following calculation is to determine the adequacy of a 6” PVC pipe.

Manning Pipe Calculator

Given Input Data:

Shape ..... Circular

Solving for ..... Flowrate

Diameter ..... 6 in

Depth ..... 6 in

Slope ..... 0.02 ft/ft

Manning's n 0.013

Computed Results:

Flowrate ..... 0.79 cfs

Area 0.20 ft2

Percent Full ..... 100 %

Full flow Flowrate ..... 0.79 cfs

Full flow velocity ..... 4.04 fps

Hydrology Calculation for 1 rooftop:

$$Q = CIA = 0.95 \times (7.44 \times 2.8 \times 5^{-0.645}) \times 0.03 = 0.2 \text{ cfs}$$

Since the capacity of a 6” PVC pipe flowing at 2% is 0.79 cfs, the proposed 6” PVC pipe is adequate to handle a 100-year storm.

HYDRAULIC CALCULATIONS

Proposed 12" PVC Storm Drain Pipe:

The drainage runoff from the 6" PVC storm drain pipes will outlet into a proposed 12" PVC storm drain pipes (see Drainage Map 2). The 12" PVC pipe will direct the runoff to the proposed bioretention areas. The following calculation is to determine the adequacy of a 12" PVC pipe.

Manning Pipe Calculator

Given Input Data:

Shape ..... Circular

Solving for ..... Flowrate

Diameter ..... 12 in

Depth ..... 12 in

Slope ..... 0.02 ft/ft

Manning's n 0.013

Computed Results:

Flowrate ..... 5.0 cfs

Area 0.79 ft2

Percent Full ..... 100 %

Full flow Flowrate ..... 5.0 cfs

Full flow velocity ..... 6.4 fps

Hydrology Calculation for 8 rooftops (most runoff contributing to a 12" PVC pipe):

$$Q = CIA = 0.95 \times (7.44 \times 2.8 \times 5^{-0.645}) \times (8 \times 0.03) = 1.7 \text{ cfs}$$

Since the capacity of a 12" PVC pipe flowing at 2% is 5.0 cfs, the proposed 12" PVC pipe is adequate to handle a 100-year storm.

200-1.6.3 Quality Requirements.

Change the second sentence in the first paragraph from "...60 days..." to "...30 days..."

Add the following new subsection:

200-1.7 Selection of Riprap and Filter Blanket Material.

TABLE 200-1.7

Velocity (1)	Rock Class (2)	Rip-Rap Thickness "T"	Filter Blanket Upper Layer(s) (3)				Filter Blanket Lower Layer (7)
			Option 1 (4A)	Option 1 (4B)	Option 2 (5)	Option 3 (6)	
6 – 10 ft/sec	No. 2 Backing	1.1 ft	1/4"		B3	D.G.	
10 – 12 ft/sec	¼ Ton	2.7 ft	3/4"			3/4"- 1-1/2" P.M.B.	SAND
12 – 14 ft/sec	½ Ton	3.5 ft	1"			3/4"- 1-1/2" P.M.B.	SAND
14 – 16 ft/sec	1 Ton	4.4 ft		1-1/2"		TYPE B	SAND
16 – 18 ft/sec	2 Ton	5.4 ft		2"		TYPE B	SAND

Table 200-1.7 Notes:

See Subsection **200-1.6 "Stone for Riprap."** See also **TABLE 200-1.6 (A).**

Practical use of this table is limited to situations where Rip-Rap Thickness "T" is less than inside diameter of the culvert outletting to the energy dissipater.

(1) Average velocity in pipe or bottom velocity in energy dissipater, whichever is greater.

(2) If desired rip rap and filter blanket class is not available, use next larger class.

Light	Rock Class	200 lb.
Facing	Rock Class	75 lb.
No. 2 Backing	Rock Class	5 lb.

(3) Filter blanket thickness = 1 foot or "T", whichever is less..

(4A) **Option 1** shall meet the requirements of Table 200-1.2(A) of the Standard Specifications for Public Works Construction.

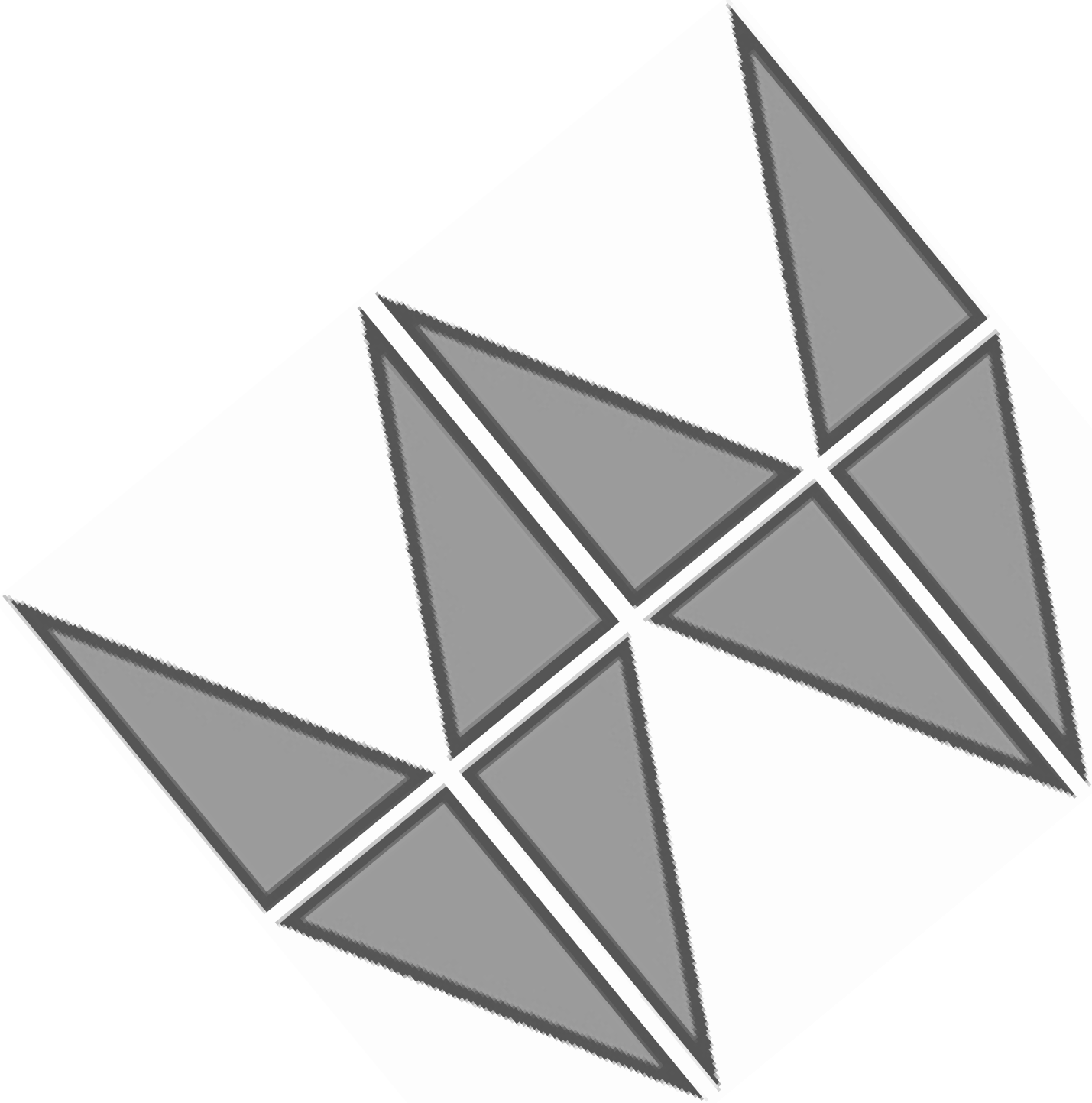
(4B) **Option 1** shall meet the requirements of Table 200-1.4(B) of the Standard Specifications for Public Works Construction.

(5) **Option 2** shall meet the asphalt concrete requirements of Table 400-4.3(C) of the Standard Specifications for Public Works Construction.

(6) D.G. = Disintegrated Granite per Table 200-2.7.2(A) of the Standard Specifications for Public Works Construction [0.04" to 0.39"].

P.M.B. = Processed Miscellaneous Base per Subsection **200-2.5 "Processed Miscellaneous Base."** of the Standard Specifications for Public Works Construction.

TYPE B = Type B bedding material shall conform to the requirements for ½" crushed



SECTION 4

Hydromodification Management Plan

Tentative Map 5576
Vista De Lamar
(PDS2012-TM-5576)

Prepared For:

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SCSS Development, LLC
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The selection, sizing, and preliminary design of stormwater treatment and other control measures in this plan have been prepared under the direction of the above-stated Registered Civil Engineer and meet the requirements of Regional Water Quality Control Board Order R9-2007-0001 and subsequent amendments.

Hydromodification refers to changes in the magnitude and frequency of stream flows as a result of urbanization and the resulting impacts on receiving channels in terms of erosion, sedimentation, and degradation of in-stream habitat. The degree to which a channel will erode is a function of the increase in driving force (shear stress), the resistance of the channel (critical shear stress), the change in sediment delivery, and the geomorphic condition of the channel. Critical shear stress is the stress threshold above which erosion occurs. Not all flows cause erosion -- only those that generate shear stress in excess of the critical shear stress of the bank and bed materials. Urbanization increases the shear stress exerted on the channel by stream flows and can trigger erosion in the form of incision (channel downcutting), widening (bank erosion), or both. Increases in flow below critical shear stress levels have little or no effect on the channel.

The need to address hydromodification and its influence on water quality is included in the San Diego Regional Water Board Order R9-2007-001, Provision D.1.g of California Regional Water Quality Control Board San Diego Region Order R9-2007-0001, which required the San Diego Stormwater Copermittees, i.e. County of San Diego, to implement a Hydromodification Management Plan (HMP) "*…to manage increases in runoff discharge rates and durations from all Priority Development Projects (PDPs), where such increased rates and durations are likely to cause increased erosion of channel beds and banks, sediment pollutant generation, or other impacts to beneficial uses and stream habitat due to increased erosive force*." The HMP developed standards to control flows within the geomorphically-significant flow range. Supporting analyses were based on continuous hydrologic simulation modeling. The HMP for all applicable PDPs was implemented on January 14, 2011.

Hydromodification management analysis must adhere to the following criteria:

- For flow rates between the pre-project lower flow threshold (see below) and the pre-project 10-year runoff event, the post-project discharge rates, and durations may not deviate above the pre-project discharge rates and durations by more than 10 percent over more than 10 percent of the length of the flow duration curve.
- Lower flow thresholds may be determined using the HMP Decision Matrix (located in Chapter 6) along with a critical flow calculator and channel screening tools developed by the Southern California Coastal Water Research Project (SCCWRP), detailed in Chapter 5. These methods identify lower flow thresholds for a range of channel conditions. The critical flow calculator recommends a lower flow value of 0.1Q2, 0.3Q2, or 0.5Q2 dependent on the receiving channel material and dimensions. This value will be compared to the channel susceptibility rating (High, Medium, or Low) as determined from the SCCWRP screening tools located in Appendix B to determine the final lower flow threshold.
- The lower flow threshold may alternately be determined as 10 percent of the pre-project 2-year runoff event, or 0.1Q2. This approach, which is outlined in the HMP Decision Matrix, is available if the project applicant chooses not to complete the channel screening analysis.

This Hydromodification Management Plan is prepared for the Vista De Lamar Tentative Map 5576 project. The project is located at 3053 & 3055 Bancroft Drive in the Community of Spring Valley, an incorporated area of the County of San Diego. The gross area of the site is approximately 2.8 acres. The owner proposes to construct twenty (20) new single-family

residences, access walkways and a common shared driveway. Reference is hereby made to the Tentative Map 5576, the Preliminary Grading Plan as well as the Drainage Study and Storm Water Management Plan for the proposed development.

This Hydromodification Management Plan analyzes the proposed development which includes the 20 single-family-residences. The developer proposes to use pervious pavement for the proposed private road to minimize the use of impervious surfaces. The only Drainage Management Areas (DMA) is for the roof areas of the proposed residences which is the only proposed impervious surface.

The project contains Type D soil as mapped in the Brown and Caldwell San Diego BMP Sizing Calculator. Soil type D is used for all calculations herein.

Because the project is located on a hillside, there are five (5) small drainage basins, refer to the Drainage Study, that contribute to the project. The developer proposes to keep the flow patterns the same and use flow control and retention to maintain or reduce pre-construction downstream conditions.

The San Diego Hydrodmodifcation (HMP) Sizing Calculator was used to size Low Impact Development (LID) facilities that meet both HMP and treatment-control requirements. See the attached **LID Facility Calculations** for the sizing for the bioretention areas.

Bioretention basins were selected to manage increases in runoff discharge rates and durations in order to mitigate potential hydromodification impacts due to the proposed development. All stormwater runoff from the proposed development will be routed to bioretention basins. Bioretention basins consist of a surface ponding layer, an 18" growing medium, and a storage layer (with an 40% void ratio average). Each of the basins will have an overflow catchment for purposes of routing flows from larger storm events. See the attached **Bioretention Area Exhibit** for details.

Maintenance of the proposed LIDs will be the responsibility of the HOA Management Company. All facilities are proposed in common areas of the site.

A specific plan, design, and maintenance of the LIDs will be implemented during the final engineering phase of the development.

Reference(s):

- Final Hydromodification Management Plan dated January 13, 2011 prepared by Brown and Caldwell

Project Summary

Project Name	VISTA DE LAMAR
Project Applicant	Salim Miro
Jurisdiction	County of San Diego
Parcel (APN)	504-112-36 & 95
Hydrologic Unit	Sweetwater

Compliance Basin Summary

Basin Name:	Bioretention Area #4
Receiving Water:	
Rainfall Basin	Oceanside
Mean Annual Precipitation (inches)	13.3
Project Basin Area (acres):	0.06
Watershed Area (acres):	0.00
SCCWRP Lateral Channel Susceptiblity (H, M, L):	
SCCWRP Vertifical Channel Susceptiblity (H, M, L):	
Overall Channel Susceptibility (H, M, L):	HIGH
Lower Flow Threshold (% of 2-Year Flow):	0.1

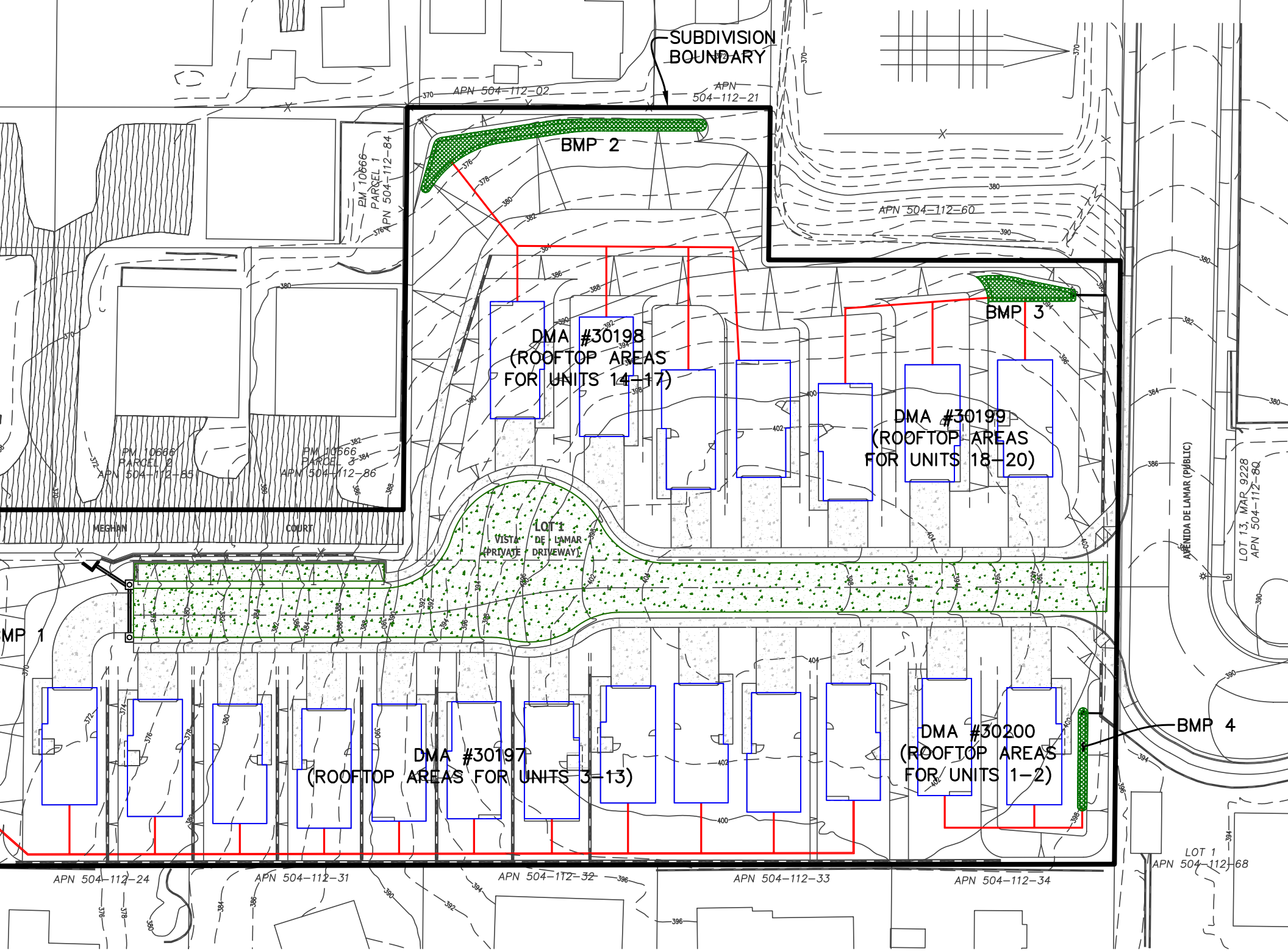
Drainage Management Area Summary

ID	Type	BMP ID	Description	Area (ac)	Pre-Project Cover	Post Surface Type	Drainage Soil	Slope
30197	Drains to LID	BMP 1	Rooftops for Units 3-13	0.28	Pervious (Pre)	Roofs	Type D (high runoff - clay soi...	Steep (greater 10%)
30198	Drains to LID	BMP 2	Rooftops for Units 14-17	0.1	Pervious (Pre)	Roofs	Type D (high runoff - clay soi...	Steep (greater 10%)
30199	Drains to LID	BMP 3	Rooftops for Units 18-20	0.08	Pervious (Pre)	Roofs	Type D (high runoff - clay soi...	Steep (greater 10%)
30200	Drains to LID	BMP 4	Rooftops for Units 1-2	0.06	Pervious (Pre)	Roofs	Type D (high runoff - clay soi...	Steep (greater 10%)

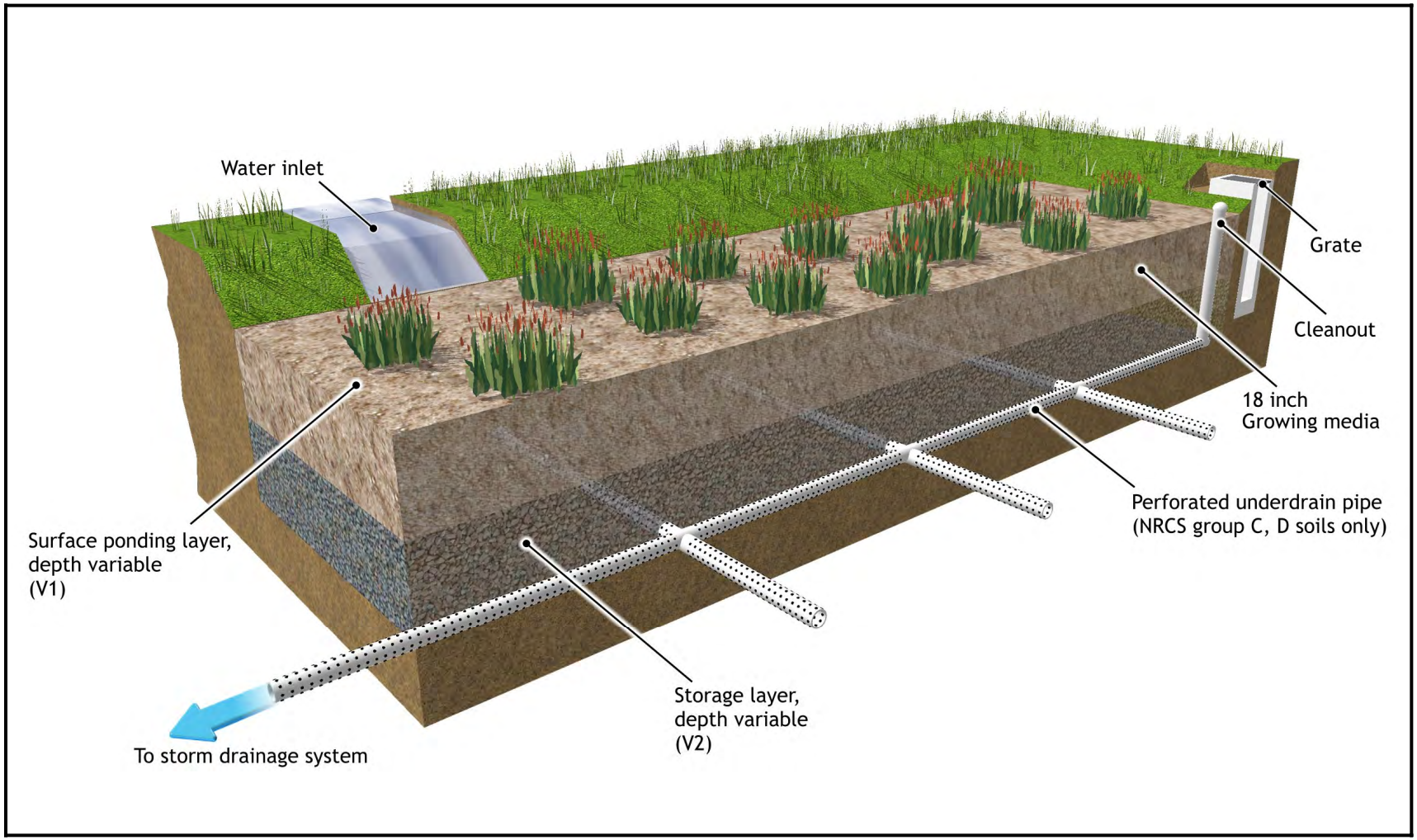
LID Facility Summary

BMP ID	Type	Description	Plan Area (sqft)	Volume 1(cft)	Volume 2(cft)	Orifice Flow (cfs)	Orifice Size (inch)

BMP 1	Bioretention	Bioretention Area #1	792	661	475	0.006	0.4
BMP 2	Bioretention	Bioretention Area #2	283	236	169	0.002	0.2
BMP 3	Bioretention	Bioretention Area #3	226	188	135	0.002	0.2
BMP 4	Bioretention	Bioretention Area #4	169	141	101	0.001	0.2



DMA #	BMP #	VOLUME REQUIRED (CU. FT)	VOLUME PROPOSED (CU. FT)



Bioretention Area Exhibit (typical)

4.1 Bioretention

The bioretention facility consists of a surface ponding layer, a growing medium layer, and a below ground storage layer (Figure 6). The bioretention BMP captures water in the ponding layer, filters it through a growing medium that consists of soil and plant roots, percolates water from the growing medium into a storage layer, and then slowly discharges treated stormwater via exfiltration to surrounding native soils and regulated discharge through an underdrain pipe to the local stormwater drainage system. For applications with well-draining native soils (e.g., NRCS hydrologic group A or B soils), an underdrain pipe would not be included.

For the HMP, we will simulate the bioretention BMP using separate a) ponding layer, b) growing medium, and c) storage layer components. We will assume the following depths for each layer:

- **Ponding layer:** 10-inches active storage, 2-inches of freeboard above overflow relief
- **Growing medium:** 18-inches of soil at 40 percent porosity
- **Storage layer:** 30-inches of gravel at 40 percent porosity

As described above in Section 3.1.2,the plan area of the BMP will be iteratively sized until the BMP controls limit outflows to levels that are less than or equal to pre-project conditions across flow rates ranging from the lower flow control limit ($0.1Q_2$, $0.3Q_2$ or $0.5Q_2$) to the upper flow control limit (Q_{10}). The sizes of the ponding layer and storage layer will be converted into volumes, so that the project designer can flexibly configure the ponding layer and storage layer to meet site constraints. For example, the design engineer could configure the ponding layer with half the depth but twice the plan area called for by the sizing factor if this fits the project site. Additionally, the designer could use commercially-available storage vessels to meet the volume requirements instead of using gravel.

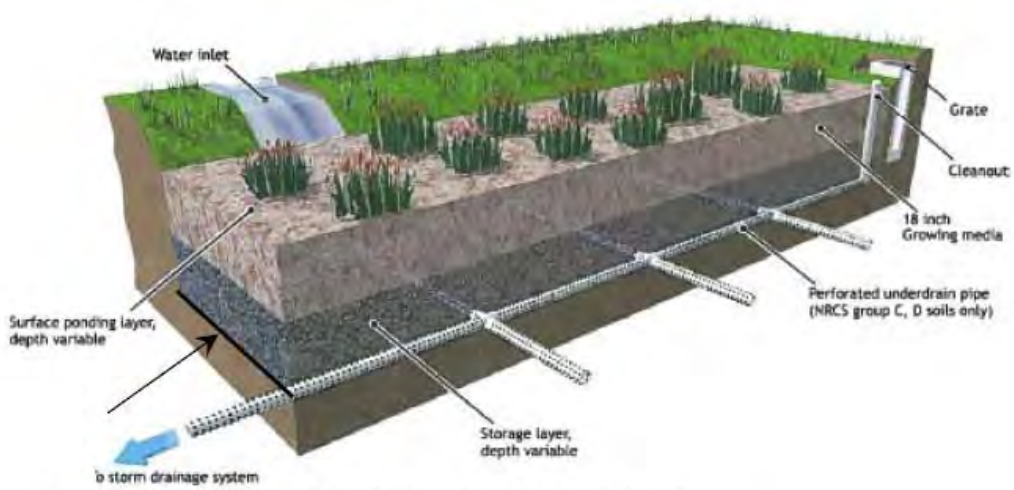


Figure 6. Bioretention BMP Example Illustration

Stormwater Facility Operation and Maintenance Fact Sheet

► BIORETENTION FACILITIES

These facilities remove pollutants primarily by filtering runoff slowly through aerobic, biologically active soil. Routine maintenance is needed to ensure that flow is unobstructed, that erosion is prevented, and that soils are held together by plant roots and are biologically active. Typical maintenance consists of the following:

- Inspect **inlets** for channels, exposure of soils, or other evidence of erosion. Clear any obstructions and remove any accumulation of sediment. Examine rock or other material used as a splash pad and replenish if necessary.

- Inspect **outlets** for erosion or plugging.

- Inspect **side slopes** for evidence of instability or erosion and correct as necessary.

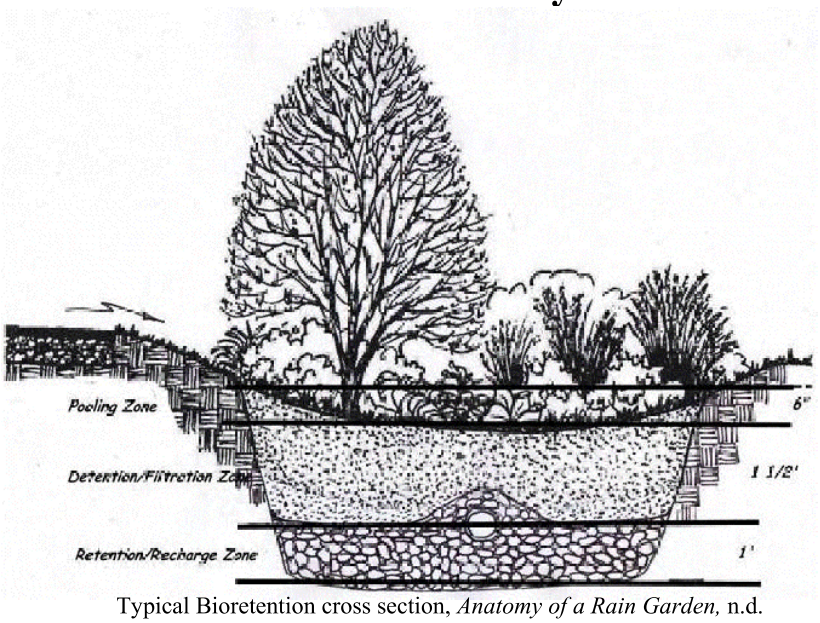
- Observe the surface of bioretention facility soil for uniform **percolation** throughout. If portions of the bioretention facility do not drain within 24 hours after the end of a storm, the soil should be tilled and replanted. Remove any debris or accumulations of sediment.

- Confirm that **check dams** and **flow spreaders** are in place and level and that rivulets and channelization are effectively prevented.

- Examine the **vegetation** to ensure that it is healthy and dense enough to provide filtering and to protect soils from erosion. Replenish mulch as necessary, remove fallen leaves and debris, prune large shrubs or trees, and mow turf areas. When mowing, remove no more than $1/3$ height of grasses. Confirm that irrigation is adequate and not excessive and that sprays do not directly enter overflow grates. Replace dead plants and remove noxious and invasive vegetation.

- Abate any potential **vectors** by filling holes in the ground in and around the bioretention facility and by insuring that there are no areas where water stands longer than 48 hours following a storm. If mosquito larvae are present and persistent, contact the San Diego County Vector Control Program for information and advice. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.

Fact Sheet 7. Bioretention Systems



Typical Bioretention cross section, *Anatomy of a Rain Garden,* n.d.

Bioretention systems are essentially a surface and sub-surface water filtration system. In function they are similar to sand filters. Bioretention systems incorporate both plants and underlying filter soils for removal of contaminants. These facilities normally consist of a treatment train approach: filter strip, sand bed, ponding area, organic layer, planting soil, and plants.

CHARACTERISICS

- Effective in removing sediments and attached pollutants by filtration through surface vegetation, ground cover and underlying filter media layer
- Delay runoff peaks by providing retention capacity and reducing flow velocities.
- Vegetation increases aesthetic value while also enhancing filtration capacity and helping to maintain the porosity of the filter media.
- Can be constructed as either large or small scale devices, with native or amended soils.
- Small scale units are usually located in a residential planter box that filters collected stormwater through the filter media and to an outlet.
- Larger scale devices work on the same methodology, however are generally located along the streetscapes and retarding basins over large open areas.
- In addition, there are two main types of bioretention system: Non-conveyance systems, which generally pond runoff volume, and Conveyance, which generally convey minor storm events along longitudinal channels. Such conveyance systems generally include an amended soil layer under the surface for additional storage and filtration

APPLICATION

- Effective in removing medium to fine size sediments and attached pollutants (such as nutrients, free oils/grease and metals), but typically have higher pollutant

removal efficiencies for a wider range of contaminants due to enhanced filtration/biological processes associated with the surface vegetation.

- Best suited to small residential, commercial, and industrial developments with high percentages of impervious areas, including parking lots, high density residential housing, and roadways.
- Aesthetic benefits due to the surface vegetation make bioretention systems appealing for incorporation into streetscape and general landscape features.

DESIGN

- Provide a gentle slope for overland flow and adequate water storage. No water should be allowed to pond in the bioretention system for longer than 72 hours.
- Usually designed in conjunction with swales and other devices upstream so as to reduce filter clogging and provide water treatment (treatment train).
- Filter media employed is usually the plant growing material, which may comprise soil, sand and peat mixtures.
- "Planting box" type systems should be restricted to very small catchment areas.
- A subdrain system should be included in urban areas along with associated cleanout to facilitate maintenance.
- For more precise design techniques, see: CASQA (2003, January) California Stormwater BMP Handbook: New Development and Redevelopment

MAINTENANCE

- Generally, only routine periodic maintenance typical of any landscaped area (mulching, plant replacement, pruning, weeding) is necessary.
- Regular inspections and maintenance are particularly important during the vegetation establishment period.
- Routine maintenance should include a biannual health evaluation of the trees and shrubs and subsequent removal of any dead or diseased vegetation.
- Other potential tasks include soil pH regulation, erosion repair at inflow points, mulch replenishment, unclogging the under-drain, and repairing overflow structures.

LIMITATIONS

- Adequate sunlight is required for vegetation growth.
- The use of irrigation may not meet State water conservation goals. Appropriate drought-tolerant plants should be considered.
- Placement may be limited by the need for upstream pre-treatment so as to avoid filter clogging (treatment train).
- Contributing drainage area should be less than 1 acre for small-scale, on-lot devices
- Bioretention (a BMP with incidental infiltration) is not an appropriate BMP when:
    - the seasonal high groundwater table is within 6 feet of the ground surface (US EPA 1999)
    - at locations where or where surrounding soil stratum is unstable
- exceptions to the 6 foot separation can be made when:
    - the BMP is designed with an under-drain and approved by a qualified licensed professional, <u>or</u> when:

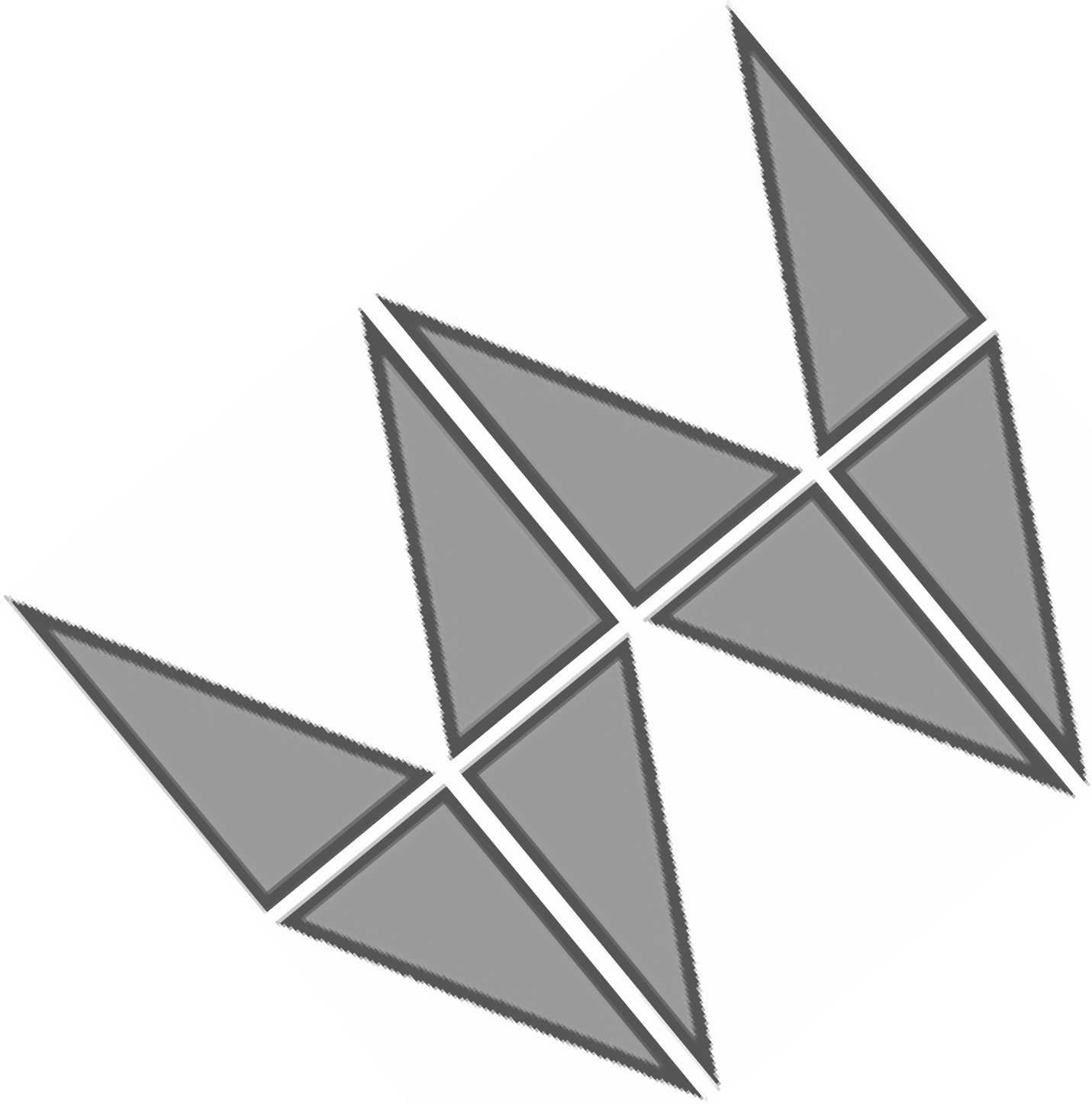
  - written approval of a separation in the interval of 4-6 feet has been obtained by the Regional Water Quality Control Board and the Department of Environmental Health.
- Site must contain sufficient elevation relief so that subdrain system may discharge to receiving swale, curb or storm drain system.

ECONOMICS

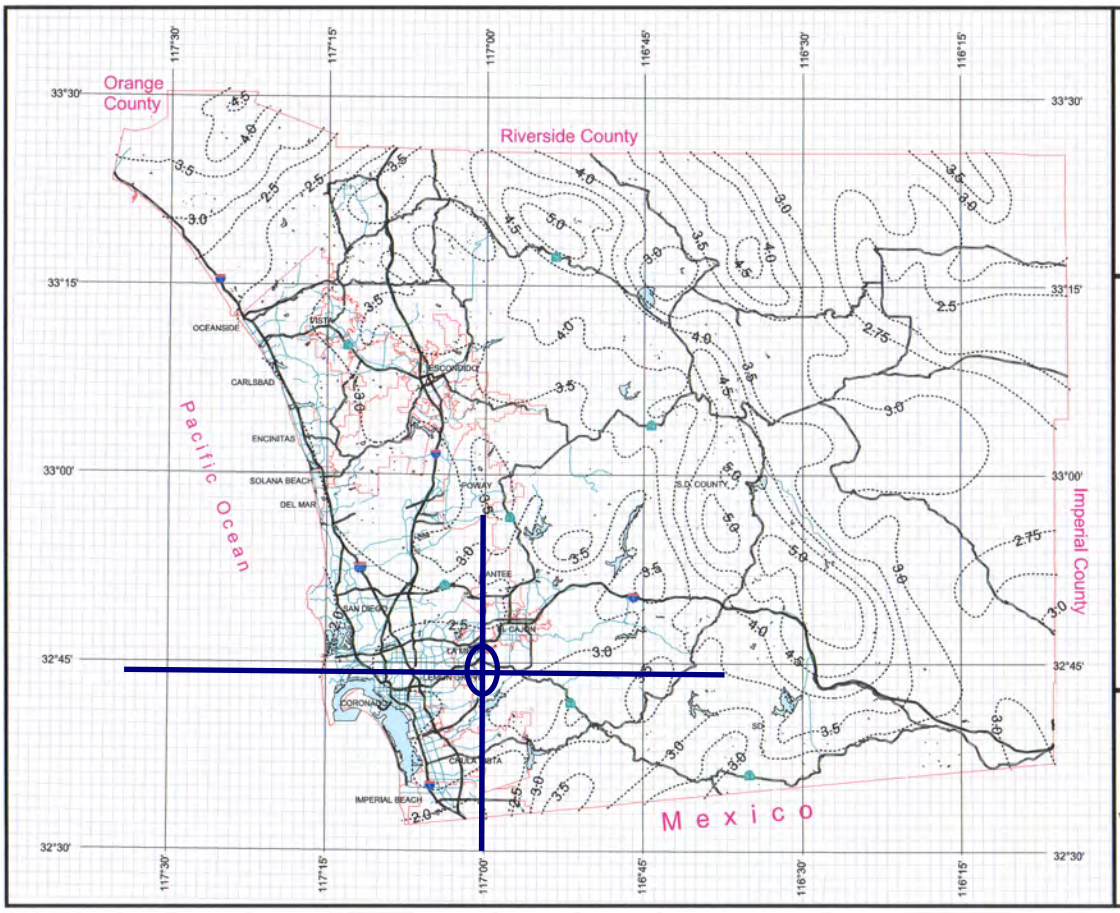
- Construction cost estimates for a bioretention area are slightly greater than those for the required landscaping for a new development (EPA, 1999).
- The operation and maintenance costs for a bioretention facility will be comparable to those of typical landscaping required for a site. (CASQA, 2003)
- Maintenance costs are projected at 5-7% of the construction cost annually.

REFERENCES

- California Stormwater Quality Association. (2003, January) California Stormwater BMP Handbook: New Development and Redevelopment.
- URS Australia Pty Ltd, (2004, May), Water Sensitive Urban Design: Technical Guidelines for Western Sydney, Upper Parramatta River Catchment Trust.
- US EPA (1999, September) BMP Fact Sheet 832-F-99-012. http://www.epa.gov/owm/mtb/biortn.pdf
- US EPA (1999, August) Preliminary Studies: Preliminary Data Summary of Urban Stormwater Best Management Practices. EPA-821-R-99-012 Part D.
- For additional information pertaining to Bioretention Systems, see the works cited in the San Diego County LID Literature Index.



SECTION 5



County of San Diego Hydrology Manual

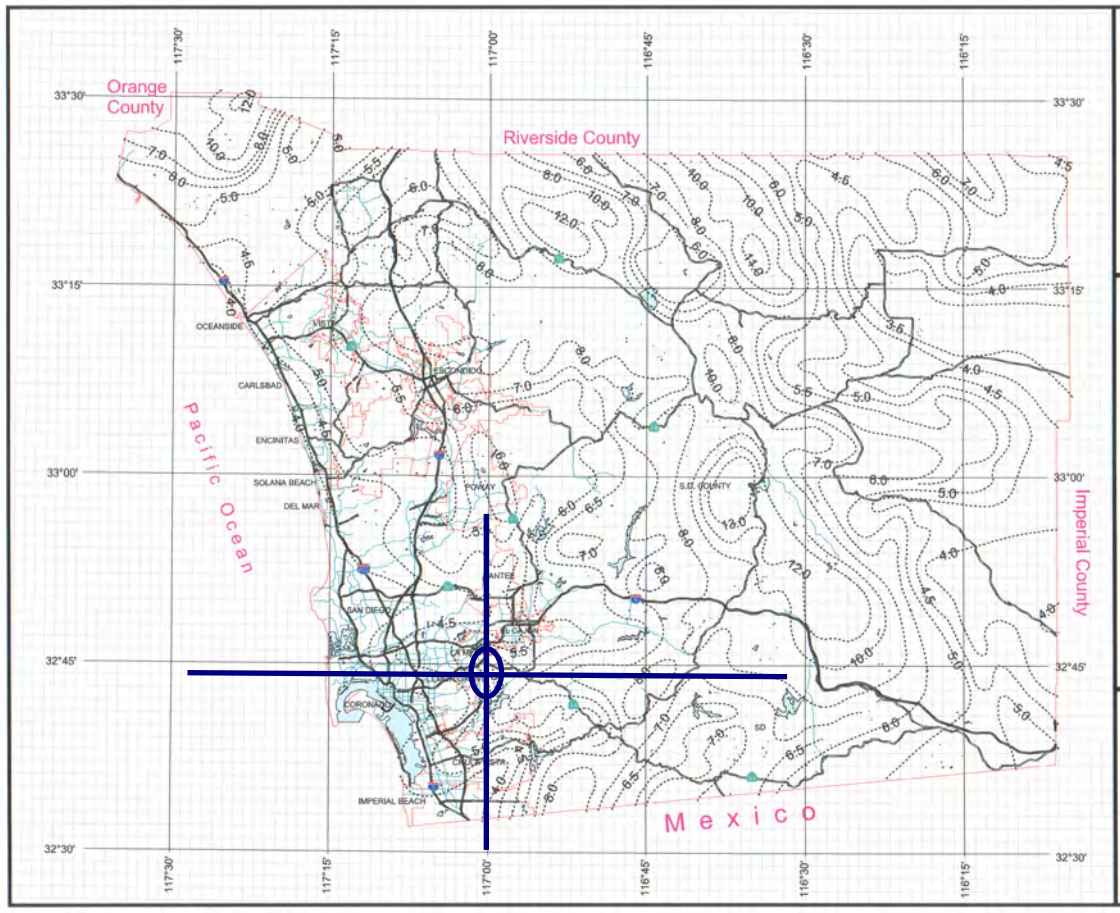
Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

Lat: 32°44'
Long: 117°00'

P6 = 2.8 in



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

Lat: 32°44'
Long: 117°00'

P24 = 5.6 in

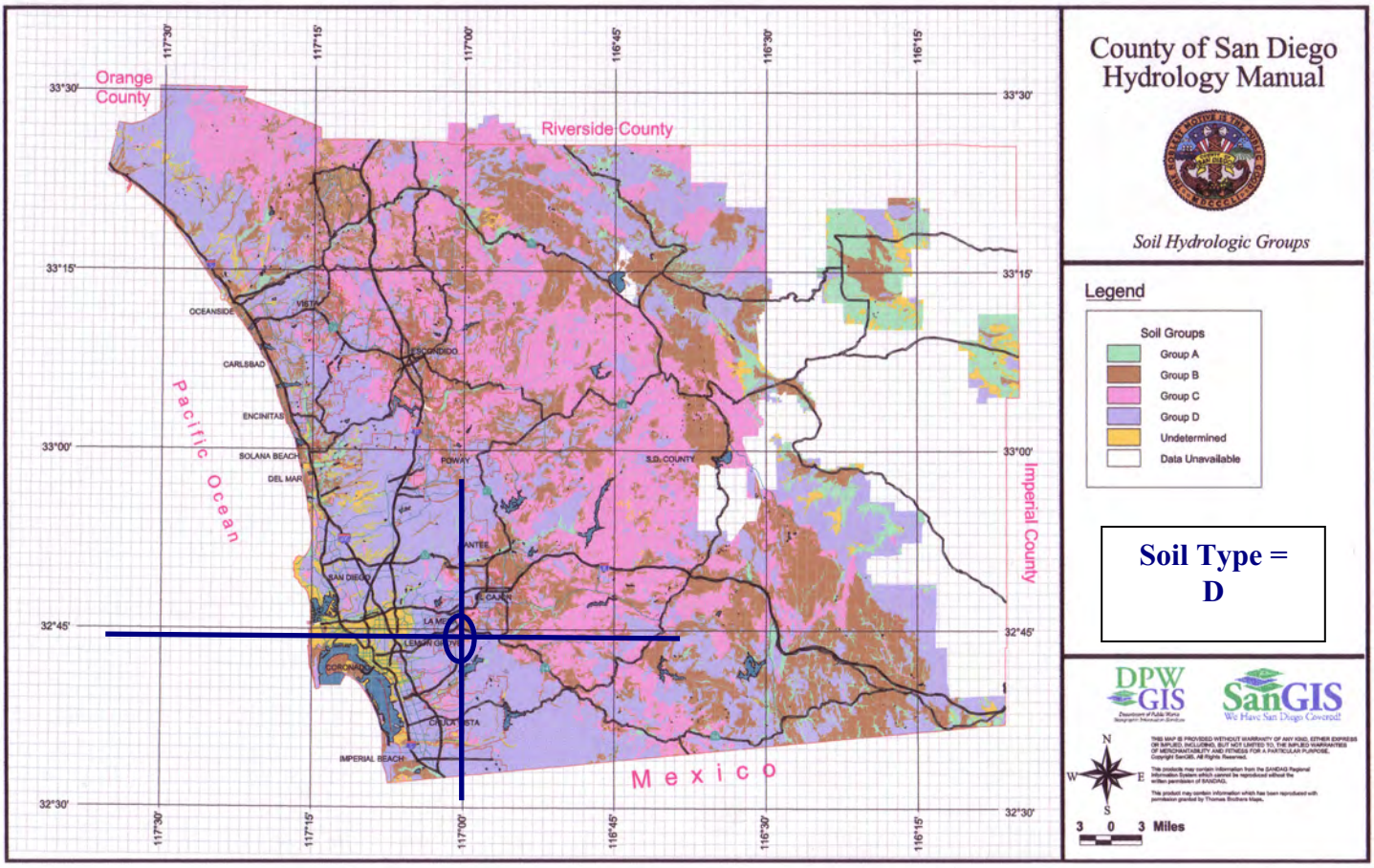


Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description

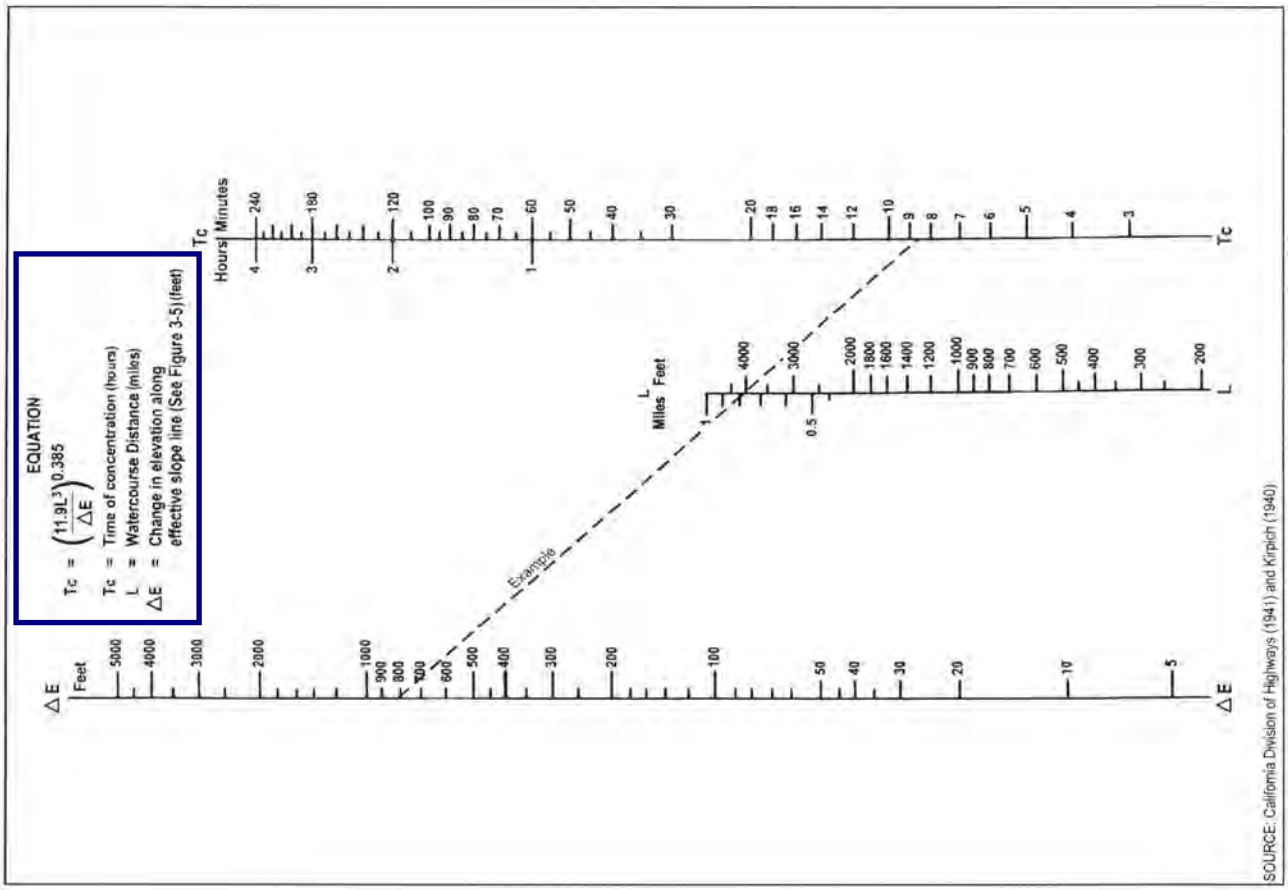
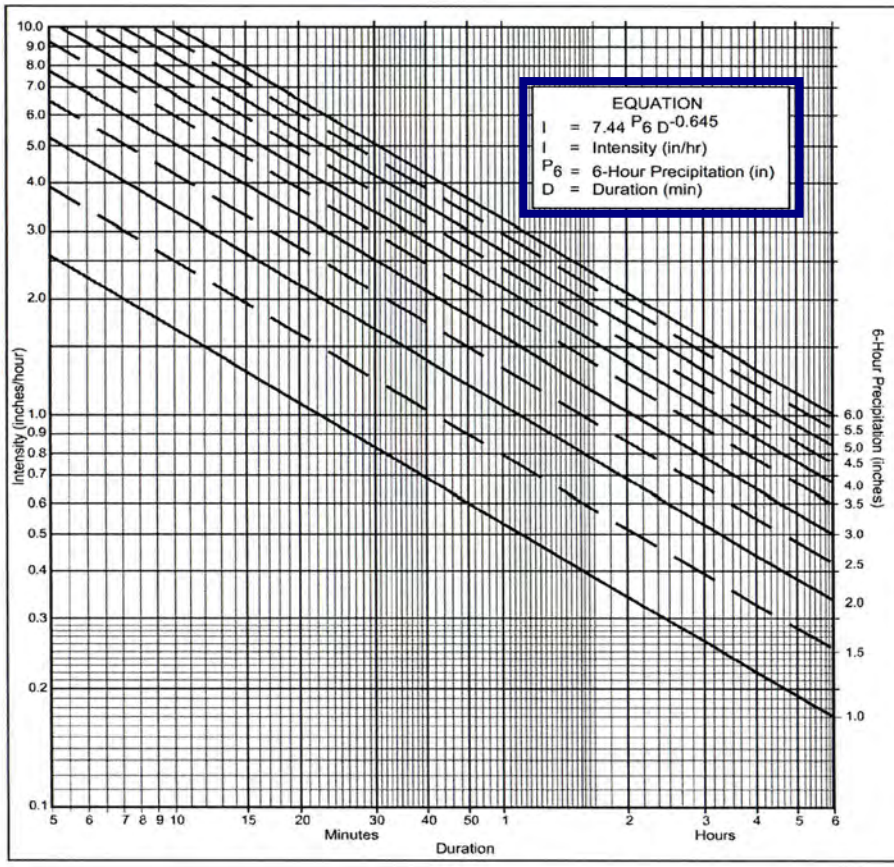


FIGURE 3-4

Nomograph for Determination of Time of Concentration (Tc) or Travel Time (Ti) for Natural Watersheds



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 2.8 in., P_{24} = 5.6, $\frac{P_6}{P_{24}}$ = 50 %(2)

(c) Adjusted $P_6^{(2)}$ = 2.8 in.

(d) t_x = *** min. *** - See Calculation Summary

(e) I = *** in./hr. *** - See Calculation Summary

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6 / Duration	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
	I	I	I	I	I	I	I	I	I	I	I
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template

FIGURE

3-1