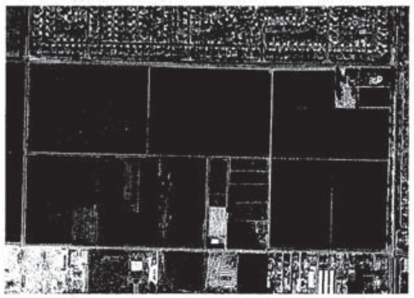
Appendix G

Preliminary Drainage Report

PRELIMINARY DRAINAGE REPORT

FOR

Teal Club Road Project
Oxnard, California



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JN 30-100646.001

October 22, 2007

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PURPOSE OF REPORT

The purpose of this report is to outline the existing drainage conditions of the site and present a description of the post-project drainage conditions, drainage impacts, and proposed drainage improvements. Significant on-site and off-site facilities, as applicable, are described and analyzed. Peak 10-year and 100-year stormwater runoff flow rates were calculated. An analysis and review of proposed storm drain facilities for compliance with local design criteria was performed.

This report assumes direct drainage into the City of Oxnard storm drain system. Specifically excluded from this report is an analysis of the capacity of the existing offsite downstream storm drain system. This report has been prepared in accordance with the requirements of the City of Oxnard and Ventura County regulations based on the proposed grading and drainage improvement plans for the project site.

LOCATION

The project site is located on the north side of Teal Club Road between Ventura Road and Patterson Road in the city of Oxnard, California. The site is also on the west side of the city and just north of the Oxnard Airport. See Figure A below.

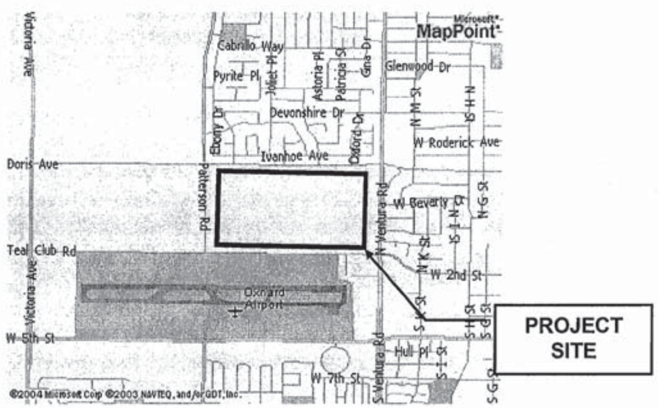


Figure A.

BACKGROUND

The property is planned for development per the Specific Plan, which covers an area of approximately 180 acres, for residential, commercial, school, and park uses. This report will cover only the proposed phase 1 condition of the specific plan, which covers approximately 113 acres. The major features of the proposed master development plan include mass grading of the existing agricultural fields for the construction of new residential housing, drainage improvements, utility services, access roads, open space, a fire station, a school, and a small retail commercial area.

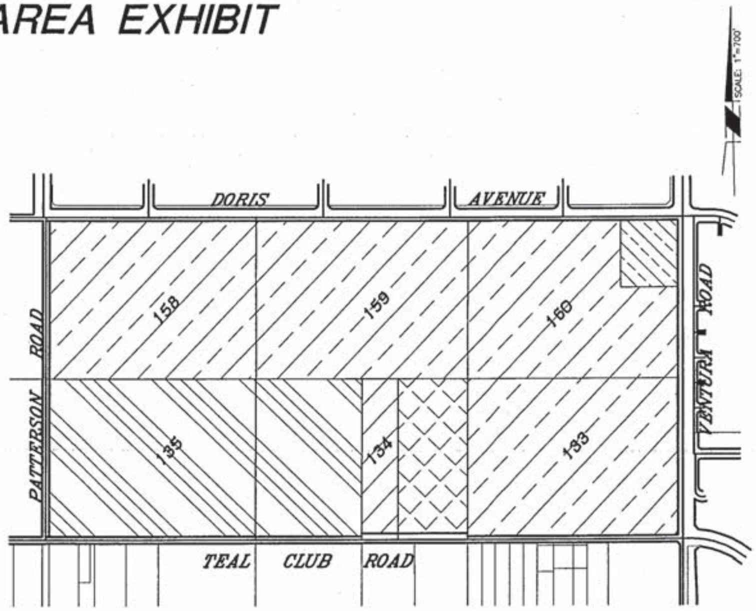
Presently, the site consists primarily of agricultural row crop fields. Onsite there exists dirt and gravel access roads, drainage ditches, and various farm buildings, which support the onsite farming operations. There is also a small rural home and farm site in the northeast corner of the site.

The limits of the drainage study area are roughly defined by Doris Road on the north, Ventura Road on the east, Teal Club Road on the south, and Patterson Road on the west. The site is bound on the north and east by residential and commercial development. The site is bound on the south by the Oxnard Airport and on the west by agricultural fields.

Currently, the project developers do not own three parcels in the southwest corner referred to as Basso, Kohara, and Kawasguchi. See the Area Exhibit on the following page. It is assumed that these parcels will not be purchased for the development. Therefore, the drainage analysis does not include these areas for the proposed condition (Phase 1 of the Specific Plan).

Drainage from new development at the project site is subject to design guidelines of the Ventura County's Technical Guidance Manual for Stormwater Quality Control Measures as part of the Ventura Countywide Storm Water Quality Urban Impact Mitigation Management Plan (SQUIMP). Therefore, the proposed drainage improvements include extended detention basins, which will provide detention and act as treatment measures. A more detailed description of these treatment measures is included within the Appendix A.

AREA EXHIBIT



PARCEL	OWNER	AREA
	BORCHARD	3.4 ACRES
	WINDWEN	113.3 ACRES
	BASSO	43.2 ACRES
	KOHARA	4.9 ACRES
	KAWASGUCHI	9.5 ACRES

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646EX001.DWG 12/13/2004

METHOD OF ANALYSIS

The hydrologic analysis was based on research that included on-site investigations, review of available existing and proposed storm drain plans, and review of aerial and field surveyed topography. Detailed hydrology maps were prepared based on topography and project site plans in the existing and proposed conditions.

Watershed subarea boundaries were defined based on existing drainage patterns and proposed drainage system layouts. The tributary area of each subarea was calculated to the nearest hundredth of an acre. Points of flow concentration based on drainage patterns were identified. Site characteristics such as soil number, rainfall zone, and land use were identified.

The existing and proposed condition peak stormwater runoff flow from the 10-year and 100-yr storm event was calculated using the Ventura County Rational Software Program (VCRAT) and the modified rational method as outlined within the Ventura County Watershed Protection District Hydrology Manual, dated 1991, and updated 2006.

Hydraulic analysis of all drainage facilities began with a definition of drainage patterns and design flows based on the design criteria for those specific facilities. Next, the drainage facility's key dimensions and any hydraulic boundary conditions were identified. These results were then evaluated against design objectives and summarized.

The proposed extended detention basins were defined from examination of the design calculations and the Engineered Site Plan. Hydraulic analysis of the detention basins was performed using the Hydraflow Hydrographs 2004. The program calculates detention volumes based on storm flows tributary to the basin and the outflow based on the existing Q10 Peak Discharge.

FINDINGS

Existing Conditions

The existing site terrain is generally flat with a very gradual slope towards the southwest corner of the site. Runoff flow patterns are defined by the layout of the several separate farm fields and the general slope to the southwest. Drainage from the project site under the existing conditions surface flows along the plowed row crops to shallow above ground unlined drainage ditches. This drainage is conveyed under onsite unpaved access roads by small diameter culverts of various sizes and materials. The cumulative site drainage is directed toward a 24" arched corrugated metal pipe culvert under Patterson Road at the southwest corner of the site. This culvert outlets into an open unlined drainage ditch, which runs west to Victoria Avenue along the north side of Teal Club Road.

Proposed Conditions

Drainage improvement plans include streets with curb and gutter, area inlets, underground drainpipes and extended detention basins. See the attached Engineered Site Plan.

The onsite drainage patterns will be changed slightly by the proposed grading and drainage improvements. However, overall the site drainage discharge quantities and patterns will remain the same as the existing condition.

Time of concentration calculations were based on proposed drainage facilities, drainage patterns, and engineering experience. All of the site discharge will be routed to one of two detention basins and then conveyed to Victoria Avenue via the construction of the Master Planned storm drain in Teal Club Road between Victoria and Ventura Road. See Appendix A for the 2003 City of Oxnard Master Plan of Drainage.

Results of the proposed extended detention basins indicate that the facilities are designed to adequately detain the Storm Quality Design Volume (SQDV) and the runoff hydrograph from the 10-year and 100-year storm event. Peak discharges from the basins are controlled by three separate elements of the outlet control structure. A water quality restrictor plate orifice provides for a 40-hour draw down of the (SQDV). A second restrictor plate orifice and a spillway weir limit the larger outlet flows to match the existing 10-year conditions peak discharge from the site. These results are summarized in the following table.

HYDROLOGICAL CALCULATIONS

SUMMARY

Present Condition (Existing)						Drains towards:	
Sub Name	Land Use	Area ac	Q10 cfs	Q50 cfs	Q100 cfs	South-West	North-East
ONSITE							
1A	Existing	4.11	2.00	4.00	5.52	Yes	
2A	Existing	26.60	13.20	26.40	36.43	Yes	
3B	Existing	30.80	15.30	30.60	42.23	Yes	
5A	Existing	15.50	7.70	15.40	21.25	Yes	
6A	Existing	44.40	22.10	44.20	61.00	Yes	
7C	Existing	30.40	15.10	30.20	41.68	Yes	
8C	Existing	29.80	14.80	29.60	40.85	Yes	
Totals		181.61	90.20	180.40	248.95	Yes	

Future Condition (Proposed)						Drains towards:	
Sub Name	Land Use	Area ac	Q10 cfs	Q50 cfs	Q100 cfs	Basin A	Basin B
ONSITE							
A	Res	45.40	53.99	79.40	95.28	Yes	
B	Res	68.00	101.41	149.13	178.95		Yes
Totals		113.40	155.40	228.53	274.23		

Notes: The Ventura County Public Works Agency hydrology multipliers were used to convert from the existing 10 year storm to all other frequencies and from the proposed 100 year strom for all other frequencies.

DETENSION REQUIREMENTS			
Sub Area Name	100-Yr Detention Acre-Ft	Treatment Detention Acre-Ft	Total Detention Requirments Acre-Ft
A	1.3	4.10	5.40
B	3.1	4.60	7.70

Notes: 100 year detention accounts for the release of the 10 year existing flows during the 100 year event.

CONCLUSIONS

In the preliminary proposed development plans, storm water drainage will be routed to area inlets, then flow through an underground storm drain piped system into extended detention basins and ultimately outlet into existing drainage facilities. The site improvements will not substantially increase discharges or modify existing drainage patterns.

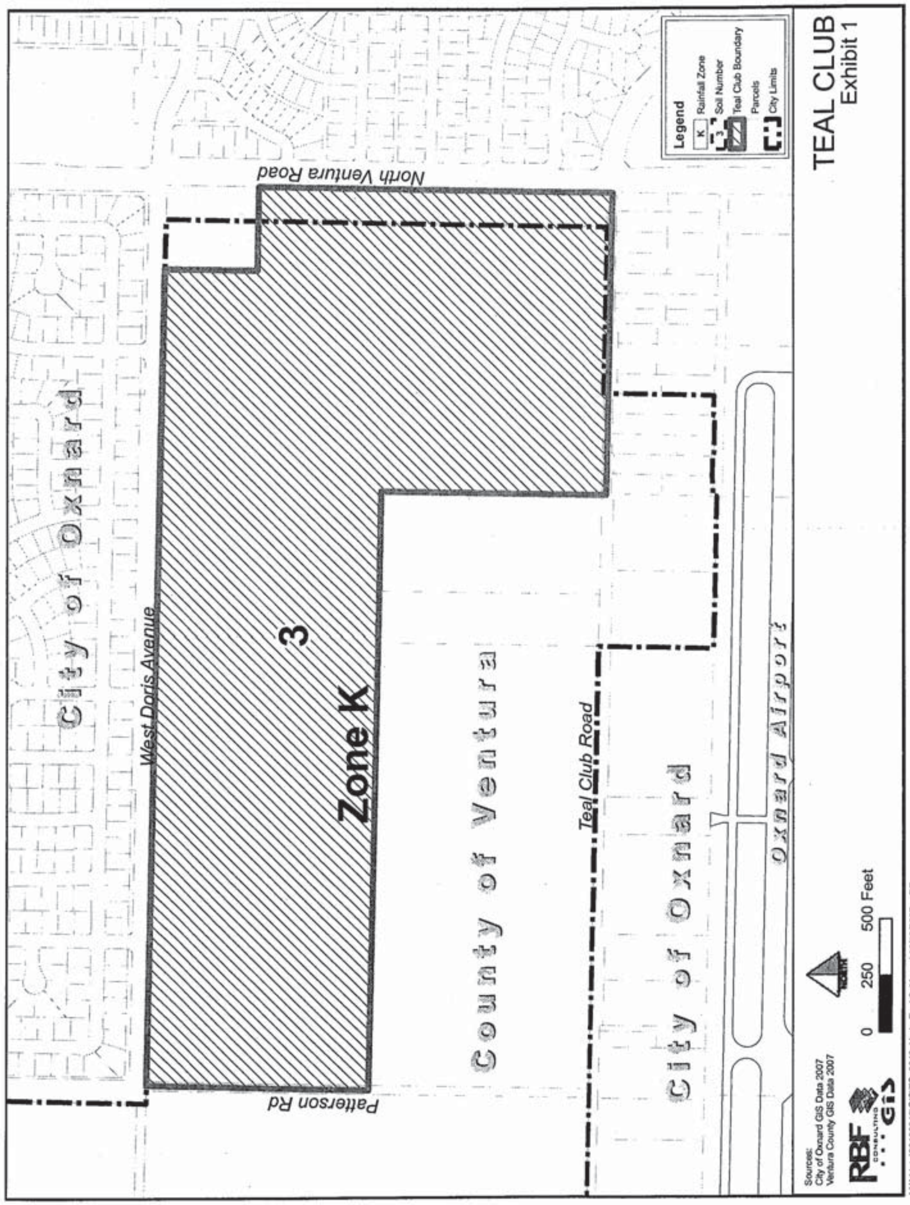
The proposed drainage improvements will provide conveyance for the peak runoff flow from the 10-year and 100-year storm event. These improvements will provide overland escape for the runoff from the 100-year storm event. Proposed condition discharges to offsite facilities will not exceed the 10-year existing event. These improvements have been designed in compliance with City of Oxnard and Ventura County Standards.

REFERENCES

- City of Oxnard Master Plan of Drainage, Department of Public Works, August 2004.
- Ventura County Watershed Protection District Hydrology Manual dated 1991.
- Ventura County Watershed Protection District Design Manual, dated 1968
- Technical Guidance Manual for Stormwater Quality Control Measures, VCWPD, July 2002.
- Ventura Countywide Storm Water Quality Urban Impact Mitigation Management Plan (SQUIMP), dated July 2000.

APPENDIX A

Drainage Calculations and Attachments



VENTURA COUNTY PUBLIC WORKS AGENCY

HYDROLOGIC MULTIPLIERS
STORM DURATION, PRECIP. FREQ.
PEAK FLOW FREQ. DEV., UNDEV.

STORM DURATION

DURATION (HOURS)	1	3	6	9	12	18	24	36	48	72
MULTIPLIER	0.28	0.44	0.58	0.68	0.76	0.89	1.00	1.18	1.32	1.56

PRECIPITATION FREQUENCY

FREQUENCY OF OCCURRENCE (YEARS)	2	5	10	25	50	100
MULTIPLIER	0.43	0.61	0.73	0.88	1.00	1.11

PEAK FLOWS FROM DEVELOPED WATERSHEDS: $P_{FREQ} = Q_{FREQ}$

FREQUENCY OF OCCURRENCE (YEARS)	2	5	10	25	50	100
MULTIPLIER	0.16	0.45	0.68	0.83	1.00	1.20

PEAK FLOWS FROM UNDEVELOPED WATERSHEDS: Q_{FREQ}

FREQUENCY OF OCCURRENCE (YEARS)	2	5	10	25	50	100
MULTIPLIER	0.08	0.23	0.50	0.70	1.00	1.38

TABLE 2.1

VENTURA COUNTY PUBLIC WORKS AGENCY
RUNOFF CURVE NUMBERS
UNDEVELOPED, NATIVE VEGETATION
ANTECEDENT MOISTURE CONDITION II

LAND USE DESCRIPTION POOR: Less than 50% Cover FAIR: From 50% to 75% Cover GOOD: More Than 75% Cover		EFFECTIVE IMPERV %	AVERAGE IMPERV %	HYDROLOGIC SOIL GROUP A 7	A 6	B 5	B 4	C 3	C 2	D 1
GRASSLAND (ANNUAL GRASS)	POOR	0	0	46	54	61	63	68	72	76
GRASSLAND (ANNUAL GRASS)	FAIR	0	0	27	31	51	53	61	65	70
GRASSLAND (ANNUAL GRASS)	GOOD	0	0			43	45	56	60	64
OPEN BRUSH (SAGEBRUSH, FLATOP BUCKWHEAT)	POOR	0	0	37	43	56	58	66	70	75
OPEN BRUSH (SAGEBRUSH, FLATOP BUCKWHEAT)	FAIR	0	0	19	23	45	47	56	60	61
OPEN BRUSH (SAGEBRUSH, FLATOP BUCKWHEAT)	GOOD	0	0	4	4	35	37	48	50	56
Bi.. RUSH (SCRUB OAK, MANZANITA, CEANOTHIS)	FAIR	0	0	13	15	41	43	51	55	59
BIG BRUSH (SCRUB OAK, MANZANITA, CEANOTHIS)	GOOD	0	0	2	2	30	32	44	46	51
CHAMISE (NARROW LEAF CHAPARRAL)	FAIR	0	0			52	54	62	66	75
CHAMISE (NARROW LEAF CHAPARRAL)	GOOD	0	0	12	14	45	47	56	60	64
OAK SAVANNA (SPARSE OAKS & ANNUAL GRASS)	POOR	0	0	40	46	57	59	68	72	-
OAK SAVANNA (SPARSE OAKS & ANNUAL GRASS)	FAIR	0	0	22	26	47	49	57	61	-
ORCHARD	POOR	0	0	45	53	58	60	64	68	71
WOODLAND	FAIR	0	0			36	38	44	46	-
PINON & JUNIPER	FAIR	0	0			44	46	54	58	62
F ST	FAIR	0	0	19	23	46	48	56	60	64

NOTE MODIFIED RATIONAL METHOD USES SOIL TYPES 1-7 AND EFFECTIVE IMPERVIOUS PERCENTAGE

TABLE 2.2
RUNOFF CURVE NUMBERS
URBAN LAND USE
ANTECEDENT MOISTURE CONDITION II

LAND USE DESCRIPTION	EFFECTIVE IMPERV %	AVERAGE IMPERV %	HYDROLOGIC SOIL GROUP A 7	A 6	B 5	B 4	C 3	C 2	D 1
OPEN SPACES, LAWNS, PARKS, GOLF COURSES, CEMETERIES, ETC. GRASS COVER ON 75% OR MORE			37	41	60	62	73	75	80
OPEN SPACES . . . ETC. GRASS COVER ON 50 % TO 75%			48	50	70	71	78	80	84
RESIDENTIAL 1 ACRE LOT	10	20	50	52	67	69	78	80	84
F ENTIAL 1/2 ACRE LOT	13	25	53	55	69	71	79	81	85
RESIDENTIAL 1/3 ACRE LOT	15	30	56	58	71	73	80	82	86
RESIDENTIAL 1/4 ACRE LOT	19	38	60	62	74	76	82	84	87
RESIDENTIAL 1/5 ACRE LOT	23	47	65	67	77	79	84	86	89
RESIDENTIAL 1/6 ACRE LOT	28	56	71	73	81	83	87	89	90
RESIDENTIAL 1/8 ACRE LOT	32	65	76	78	84	86	89	91	92
RESIDENTIAL - CONDOMINIUMS	37	69	78	80	86	88	89	92	93
INDUSTRIAL - UNPAVED YARDS ETC.	36	72	80	82	87	89	90	92	93
	40	79	84	86	89	91	92	94	94
COMMERCIAL & BUSINESS	50	85	88	90	91	93	93	95	95
INDUSTRIAL PARKS PAVED PARKING, ETC.	70	93	93	94	95	96	96	97	97
PA..ING LOTS, ROOFS, ... WAYS PAV.D STREETS WITH CURBS & DRAINS	90	100	98	98	98	98	98	98	98

NOTE MODIFIED RATIONAL METHOD USES SOIL TYPES 1-7 AND EFFECTIVE IMPERVIOUS PERCENTAGE

Existing Hydrology Calculations

Time of Concentration
Ventura County Modified Rational Method
VCRAT Program Input and Output

DRAINAGE CALCULATIONS

FOR

TEAL CLUB ROAD PROJECT
OXNARD, CALIFORNIA

FOR

SUNCAL COMPANIES

REGISTERED PROFESSIONAL ENGINEER
PAUL E. SPILLMAN
No 58249
EXP 6-30-06
CIVIL
STATE OF CALIFORNIA

BY

RBF CONSULTING

PAUL SPILLMAN, P.E.

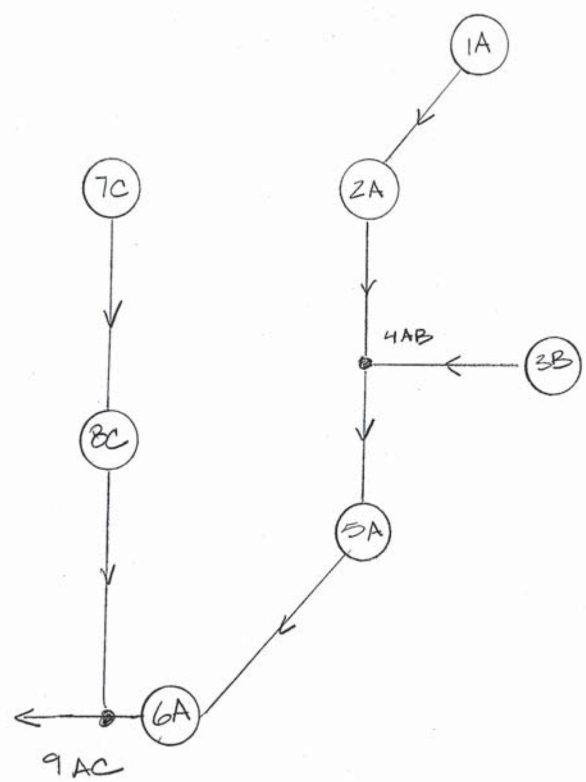
JN 30-100646.001

JANUARY 4, 2005
REVISED MARCH 22, 2005

JN30-100646.001 | TEAL CLUB ROAD | PAUL SPILLMAN 12/22/04

HYDROLOGY - VC RATIONAL - NODE DIAGRAM

EXISTING CONDITION



Area: 1A

Given:

Area: 4.11 (ac)
Zone: K - ref. Plate B-7, VC Hydrology Manual
Soil: 3 - ref. Plate B-7, VC Hydrology Manual
Use: existing, agricultural, row crops
Storm: 10 year event

Assumed:

Tc = 13 (min)
Then:
I = 2.2 - ref. Plate D-8, VC Hydrology Manual
C = 0.72 - ref. Plate E-1, VC Hydrology Manual

Calculations:

Time of Concentration

Flow Desc.	Area Reach	A Length	Elevation(ft) Top	Bot.	Slope	C	I (in/hr)	Area (ac)	Q(cfs) top	bottom	Velocity(fps) Vt	Vb	Vave	Vwave	Time (min)
over	0 to 1	200	50.5	48.2	0.012	0.72	2.2	0.5	0	0.79				0.40	8.33
shallow	1 to 2	200	48.2	47.5	0.004	0.72	2.2	2	0.79	3.17	0.85	1.12	0.99	1.48	2.25
ditch	2 to 3	200	47.5	47.2	0.001	0.72	2.2	4.11	3.17	6.51	0.74	0.87	0.80	1.20	2.77
														Total	13.4

Peak Runoff Flow

		C	I (in/hr)	Area (ac)	Q (cfs)
Rational Formula	**C x I x A = Q**				
		0.72	2.2	4.11	6.51

Notes:

See Hydrology Map for drainage patterns.
Overland Flow Velocity ref. Plate F-1, VC Hydrology Manual
V.ditch = (7+8*(Q^0.352))*(S^0.5), ref. Plate IV-21, VC Hydrology Manual
Vwave = Vave*1.5, in channels and streets, ref. Plate IV-21, VC Hydrology Manual
Time - Travel Length / Velocity
Total - Calculated Time within 0.5 min of Time Assumed or less than 5 minute minimum.

Results:

Tc =	13	(min)	Time of Concentration
Q =	6.51	(cfs)	Peak Runoff Flow

Area: 2A

Given:

Area: 26.6 (ac)
Zone: K - ref. Plate B-7, VC Hydrology Manual
Soil: 3 - ref. Plate B-7, VC Hydrology Manual
Use: existing, agricultural, row crops
Storm: 10 year event

Assumed:

Tc = 22 (min)
Then:
I = 1.68 - ref. Plate D-8, VC Hydrology Manual
C = 0.67 - ref. Plate E-1, VC Hydrology Manual

Calculations:

Time of Concentration

Flow Desc.	Area Reach	A Length	Elevation(ft) Top	Bot.	Slope	C	I (in/hr)	Area (ac)	Q(cfs) top	bottom	Velocity(fps) Vt	Vb	Vave	Vwave	Time (min)
over	0 to 1	100	47.2	47	0.002	0.67	1.68	0.5	0	0.56				0.40	4.17
shallow	1 to 2	950	47	46	0.001	0.67	1.68	13	0.56	14.63	0.44	0.89	0.67	1.00	15.83
ditch	2 to 3	400	46	44.5	0.004	0.67	1.68	26.6	14.63	29.94	1.69	2.05	1.87	2.80	2.38
														Total	22.4

Peak Runoff Flow

Rational Formula **C x I x A = Q**

C	I (in/hr)	Area (ac)	Q (cfs)
0.67	1.68	26.6	29.94

Notes:

See Hydrology Map for drainage patterns.
Overland Flow Velocity ref. Plate F-1, VC Hydrology Manual
V.ditch = (7+8*(Q^0.352))*(S^0.5), ref. Plate IV-21, VC Hydrology Manual
Vwave = Vave*1.5, in channels and streets, ref. Plate IV-21, VC Hydrology Manual
Time - Travel Length / Velocity
Total - Calculated Time within 0.5 min of Time Assumed or less than 5 minute minimum.

Results:

Tc = 22	(min)	Time of Concentration
Q = 29.94	(cfs)	Peak Runoff Flow

Area: 3B

Given:

Area: 30.8 (ac)
Zone: K - ref. Plate B-7, VC Hydrology Manual
Soil: 3 - ref. Plate B-7, VC Hydrology Manual
Use: existing, agricultural, row crops
Storm: 10 year event

Assumed:

Tc = 29 (min)
Then:
I = 1.48 - ref. Plate D-8, VC Hydrology Manual
C = 0.645 - ref. Plate E-1, VC Hydrology Manual

Calculations:

Time of Concentration

Flow Desc.	Area Reach	A Length	Elevation(ft) Top	Bot.	Slope	C	I (in/hr)	Area (ac)	Q(cfs) top	bottom	Velocity(fps) Vt	Vb	Vave	Vwave	Time (min)
over	0 to 1	200	45.7	45.4	0.002	0.65	1.48	0.5	0	0.48				0.40	8.33
shallow	1 to 2	1000	45.4	44	0.001	0.65	1.48	10	0.48	9.55	0.49	0.92	0.71	1.06	15.68
ditch	2 to 3	900	44	39.8	0.005	0.65	1.48	30.8	9.55	29.40	1.69	2.27	1.98	2.97	5.05
														Total	29.1

Peak Runoff Flow

Rational Formula **C x I x A = Q**

C	I (in/hr)	Area (ac)	Q (cfs)
0.65	1.48	30.8	29.40

Notes:

See Hydrology Map for drainage patterns.
Overland Flow Velocity ref. Plate F-1, VC Hydrology Manual
V.ditch = (7+8*(Q^0.352))*(S^0.5), ref. Plate IV-21, VC Hydrology Manual
Vwave = Vave*1.5, in channels and streets, ref. Plate IV-21, VC Hydrology Manual
Time - Travel Length / Velocity
Total - Calculated Time within 0.5 min of Time Assumed or less than 5 minute minimum.

Results:

Tc = 29	(min)	Time of Concentration
Q = 29.40	(cfs)	Peak Runoff Flow

Area: 5A

Given:

Area: 15.5 (ac)
Zone: K - ref. Plate B-7, VC Hydrology Manual
Soil: 3 - ref. Plate B-7, VC Hydrology Manual
Use: existing, agricultural, row crops
Storm: 10 year event

Assumed:

Tc = 21 (min)
Then:
I = 1.73 - ref. Plate D-8, VC Hydrology Manual
C = 0.68 - ref. Plate E-1, VC Hydrology Manual

Calculations:

Time of Concentration

Flow Desc.	Area Reach	A Length	Elevation(ft) Top	Bot.	Slope	C	I (in/hr)	Area (ac)	Q(cfs) top	bottom	Velocity(fps) Vt	Vb	Vave	Vwave	Time (min)
over	0 to 1	200	44.8	44	0.004	0.68	1.73	0.5	0	0.59				0.40	8.33
shallow	1 to 2	700	44	39.1	0.007	0.68	1.73	5	0.59	5.88	1.14	1.83	1.49	2.23	5.23
ditch	2 to 3	650	39.1	38.1	0.002	0.68	1.73	15.5	5.88	18.23	0.86	1.15	1.00	1.50	7.20
														Total	20.8

Peak Runoff Flow

Rational Formula **C x I x A = Q**

C	I (in/hr)	Area (ac)	Q (cfs)
0.68	1.73	15.5	18.23

Notes:

See Hydrology Map for drainage patterns.
Overland Flow Velocity ref. Plate F-1, VC Hydrology Manual
V.ditch = (7+8*(Q^0.352))*(S^0.5), ref. Plate IV-21, VC Hydrology Manual
Vwave = Vave*1.5, in channels and streets, ref. Plate IV-21, VC Hydrology Manual
Time - Travel Length / Velocity
Total - Calculated Time within 0.5 min of Time Assumed or less than 5 minute minimum.

Results:

Tc =	21	(min)	Time of Concentration
Q =	18.23	(cfs)	Peak Runoff Flow

Area: 6A

Given:

Area: 44.4 (ac)
Zone: K - ref. Plate B-7, VC Hydrology Manual
Soil: 3 - ref. Plate B-7, VC Hydrology Manual
Use: existing, agricultural, row crops
Storm: 10 year event

Assumed:

Tc = 27 (min)
Then:
I = 1.53 - ref. Plate D-8, VC Hydrology Manual
C = 0.65 - ref. Plate E-1, VC Hydrology Manual

Calculations:

Time of Concentration

Flow Desc.	Area Reach	A Length	Elevation(ft) Top	Bot.	Slope	C	I (in/hr)	Area (ac)	Q(cfs) top	bottom	Velocity(fps) Vt	Vb	Vave	Vwave	Time (min)
over	0 to 1	200	42.5	41.7	0.004	0.65	1.53	0.5	0	0.50				0.40	8.33
shallow	1 to 2	700	41.7	37.8	0.006	0.65	1.53	15	0.50	14.92	0.99	2.07	1.53	2.29	5.09
ditch	2 to 3	1900	37.8	33.6	0.002	0.65	1.53	44.4	14.92	44.16	1.30	1.76	1.53	2.29	13.80
														Total	27.2

Peak Runoff Flow

Rational Formula **C x I x A = Q**

C	I (in/hr)	Area (ac)	Q (cfs)
0.65	1.53	44.4	44.16

Notes:

See Hydrology Map for drainage patterns.
Overland Flow Velocity ref. Plate F-1, VC Hydrology Manual
V.ditch = (7+8*(Q^0.352))*(S^0.5), ref. Plate IV-21, VC Hydrology Manual
Vwave = Vave*1.5, in channels and streets, ref. Plate IV-21, VC Hydrology Manual
Time - Travel Length / Velocity
Total - Calculated Time within 0.5 min of Time Assumed or less than 5 minute minimum.

Results:

Tc =	27	(min)	Time of Concentration
Q =	44.16	(cfs)	Peak Runoff Flow

Area: 7C

Given:

Area: 30.4 (ac)
Zone: K - ref. Plate B-7, VC Hydrology Manual
Soil: 3 - ref. Plate B-7, VC Hydrology Manual
Use: existing, agricultural, row crops
Storm: 10 year event

Assumed:

Tc = 29 (min)

Then:

I = 1.48 - ref. Plate D-8, VC Hydrology Manual
C = 0.645 - ref. Plate E-1, VC Hydrology Manual

Calculations:

Time of Concentration

Flow Desc.	Area Reach	A Length	Elevation(ft) Top	Bot.	Slope	C	I (in/hr)	Area (ac)	Q(cfs) top	bottom	Velocity(fps) Vt	Vb	Vave	Vwave	Time (min)
over	0 to 1	200	47.9	47.2	0.003	0.65	1.48	0.5	0	0.48				0.40	8.33
shallow	1 to 2	1100	47.2	44.4	0.003	0.65	1.48	6	0.48	5.73	0.66	1.10	0.88	1.32	13.86
ditch	2 to 3	950	44.4	41.5	0.003	0.65	1.48	30.4	5.73	29.02	1.20	1.83	1.52	2.28	6.95
														Total	29.1

Peak Runoff Flow

Rational Formula **C x I x A = Q**

C	I (in/hr)	Area (ac)	Q (cfs)
0.65	1.48	30.4	29.02

Notes:

See Hydrology Map for drainage patterns.
Overland Flow Velocity ref. Plate F-1, VC Hydrology Manual
V.ditch = (7+8*(Q^0.352))*(S^0.5), ref. Plate IV-21, VC Hydrology Manual
Vwave = Vave*1.5, in channels and streets, ref. Plate IV-21, VC Hydrology Manual
Time - Travel Length / Velocity
Total - Calculated Time within 0.5 min of Time Assumed or less than 5 minute minimum.

Results:

Tc =	29	(min)	Time of Concentration
Q =	29.02	(cfs)	Peak Runoff Flow

Area: 8C

Given:

Area: 29.8 (ac)
Zone: K - ref. Plate B-7, VC Hydrology Manual
Soil: 3 - ref. Plate B-7, VC Hydrology Manual
Use: existing, agricultural, row crops
Storm: 10 year event

Assumed:

Tc = 29 (min)

Then:

I = 1.48 - ref. Plate D-8, VC Hydrology Manual
C = 0.645 - ref. Plate E-1, VC Hydrology Manual

Calculations:

Time of Concentration

Flow Desc.	Area Reach	A Length	Elevation(ft) Top	Bot.	Slope	C	I (in/hr)	Area (ac)	Q(cfs) top	bottom	Velocity(fps) Vt	Vb	Vave	Vwave	Time (min)
over	0 to 1	200	44	43	0.005	0.65	1.48	0.5	0	0.48				0.40	8.33
shallow	1 to 2	1100	43	40	0.003	0.65	1.48	6	0.48	5.73	0.69	1.14	0.91	1.37	13.39
ditch	2 to 3	950	40	37.6	0.003	0.65	1.48	29.8	5.73	28.45	1.10	1.66	1.38	2.07	7.67
														Total	29.4

Peak Runoff Flow

Rational Formula **C x I x A = Q**

C	I (in/hr)	Area (ac)	Q (cfs)
0.65	1.48	29.8	28.45

Notes:

See Hydrology Map for drainage patterns.
Overland Flow Velocity ref. Plate F-1, VC Hydrology Manual
V.ditch = (7+8*(Q^0.352))*(S^0.5), ref. Plate IV-21, VC Hydrology Manual
Vwave = Vave*1.5, in channels and streets, ref. Plate IV-21, VC Hydrology Manual
Time - Travel Length / Velocity
Total - Calculated Time within 0.5 min of Time Assumed or less than 5 minute minimum.

Results:

Tc =	29	(min)	Time of Concentration
Q =	28.45	(cfs)	Peak Runoff Flow

VENTURA COUNTY

PUBLIC WORKS AGENCY

FLOOD CONTROL AND WATER RESOURCES DEPARTMENT

HYDROLOGY MANUAL

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FLOOD CONTROL AND WATER RESOURCES DEPARTMENT

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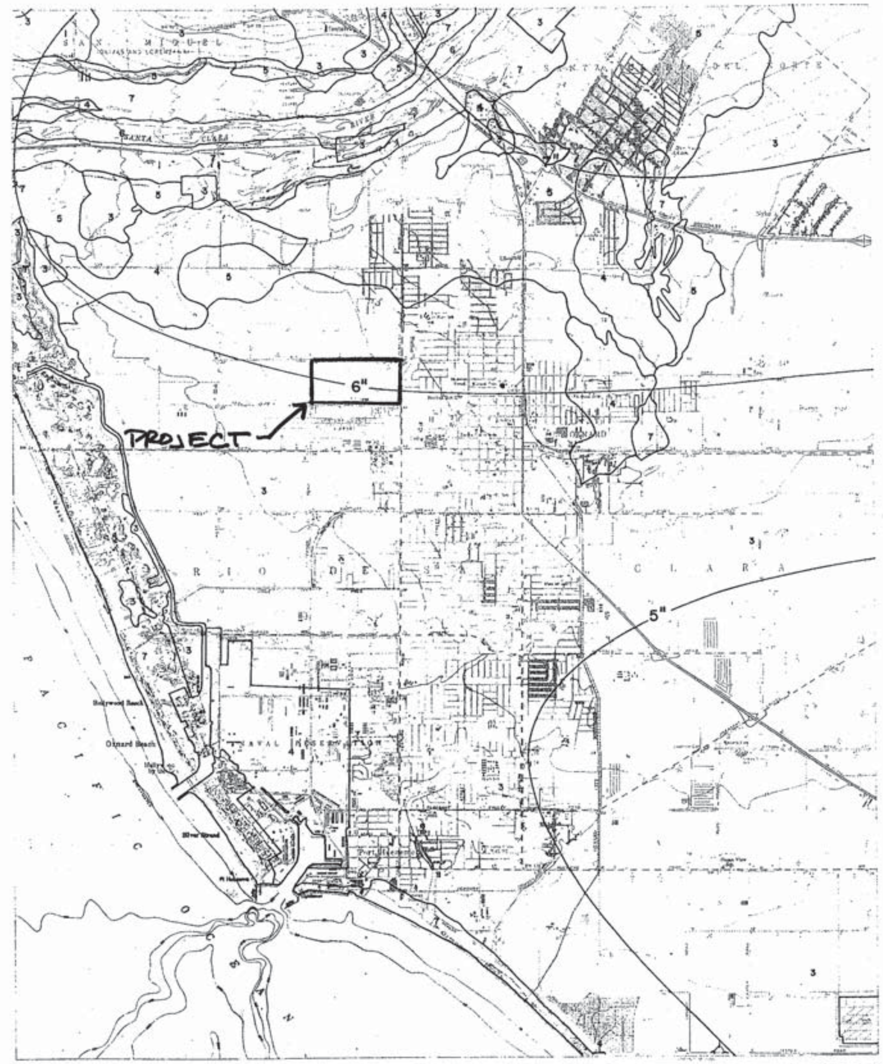


LEGEND

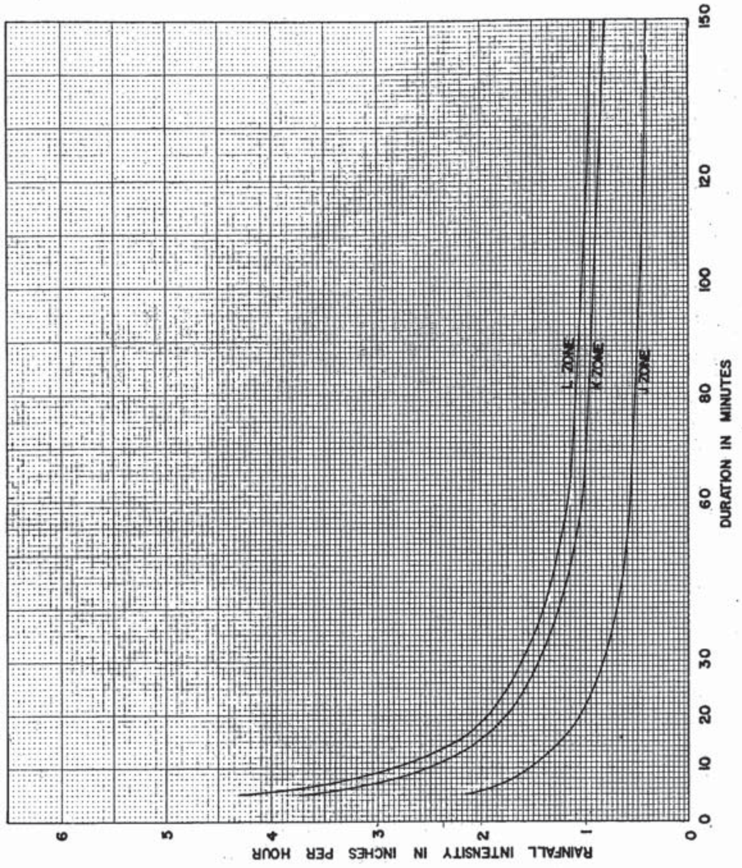
1000 0 1000 2000
SCALE IN FEET

5 SOIL NUMBER
SOIL TYPE BOUNDARY

K RAINFALL ZONE
50-YEAR, 24-HOUR ISOHYET

HYDROLOGIC MAP OXNARD 1967

B

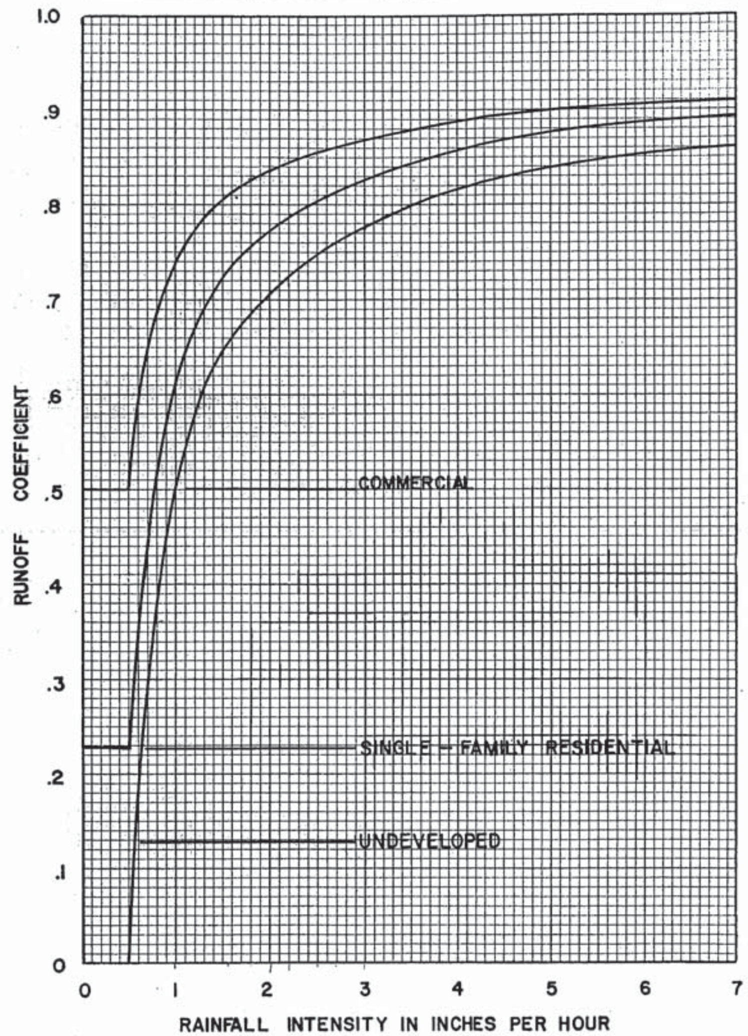


RAINFALL INTENSITY-DURATION CURVE
10-YEAR RECURRENCE INTERVAL

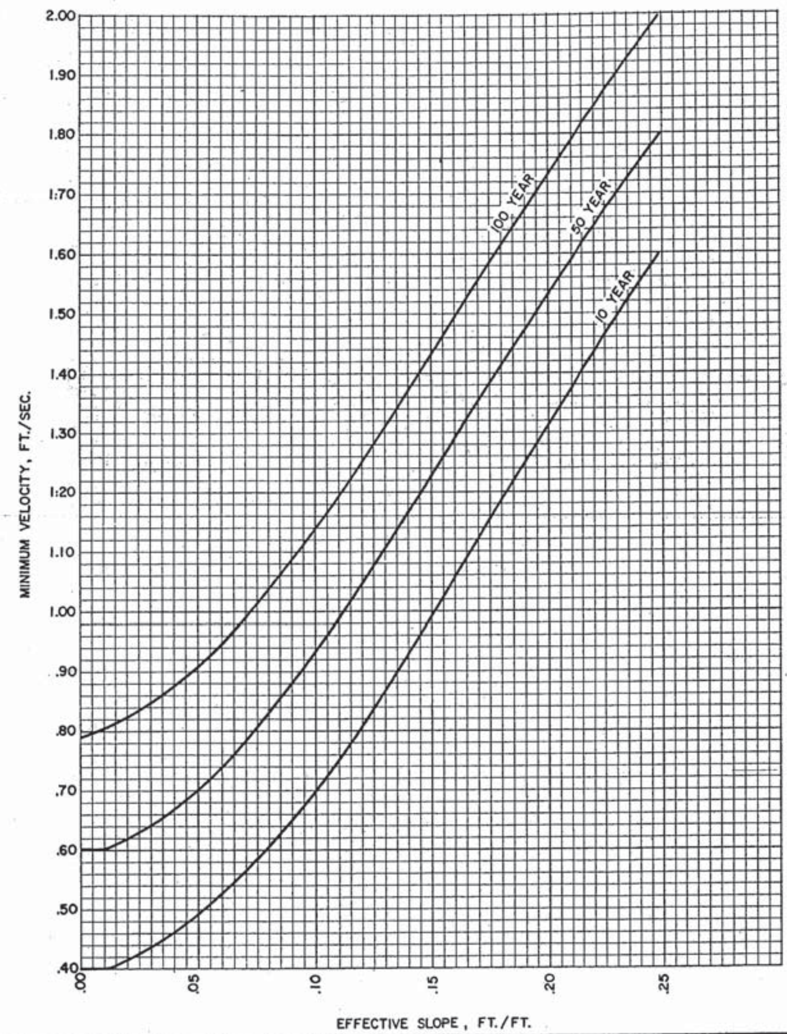
DURATION IN MINUTES

STORM TIME IN MINUTES	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
200	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
400	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10
600	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15
900	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28
1000	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39
1050	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43
1100	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47
1110	.59	.59	.59	.59	.59	.59	.58	.57	.57	.56	.55	.55	.54	.54	.54	.53	.53	.53	.52	.52	.52	.52	.52	.52	.51	.51
1120	.65	.65	.65	.65	.65	.65	.64	.64	.64	.63	.63	.63	.63	.62	.62	.62	.61	.61	.60	.60	.59	.59	.58	.58	.58	.57
1130	.66	.66	.66	.66	.66	.66	.66	.66	.66	.66	.66	.66	.66	.66	.65	.65	.65	.65	.65	.64	.64	.64	.64	.64	.64	.63
1131	.70	.69	.69	.68	.68	.68	.68	.67	.67	.67	.67	.67	.67	.66	.66	.66	.66	.66	.66	.65	.65	.65	.65	.65	.64	.64
1132	.73	.72	.71	.70	.70	.70	.69	.69	.69	.68	.68	.68	.68	.68	.68	.67	.67	.67	.67	.66	.66	.66	.66	.65	.65	.65
1133	.77	.75	.74	.73	.72	.71	.71	.70	.70	.70	.69	.69	.69	.69	.68	.68	.68	.68	.68	.68	.67	.67	.67	.66	.66	.66
1134	.80	.78	.76	.75	.74	.73	.72	.72	.72	.71	.71	.70	.70	.70	.70	.69	.69	.69	.69	.68	.68	.68	.68	.67	.67	.67
1135	.84	.81	.79	.77	.76	.75	.74	.74	.73	.72	.72	.72	.71	.71	.70	.70	.70	.70	.70	.69	.69	.69	.68	.68	.68	.68
1136	.86	.86	.83	.81	.79	.78	.77	.76	.75	.75	.74	.74	.73	.72	.72	.72	.71	.71	.71	.71	.70	.70	.70	.69	.69	.69
1137	.89	.88	.87	.85	.83	.81	.80	.78	.78	.77	.76	.75	.75	.74	.74	.73	.73	.72	.72	.72	.72	.71	.71	.71	.70	.70
1138	.91	.90	.89	.88	.86	.84	.82	.81	.80	.79	.78	.77	.77	.76	.75	.75	.74	.74	.74	.73	.73	.73	.72	.72	.72	.71
1139	.94	.92	.91	.90	.89	.87	.85	.84	.82	.81	.80	.79	.78	.78	.77	.76	.76	.75	.75	.74	.74	.74	.73	.73	.73	.72
1140	.96	.94	.93	.92	.91	.90	.88	.86	.84	.83	.82	.81	.80	.79	.79	.78	.77	.77	.76	.76	.75	.75	.75	.74	.74	.74
1141	.99	.99	.96	.95	.94	.93	.92	.90	.88	.86	.85	.84	.83	.82	.81	.80	.80	.79	.78	.78	.77	.77	.76	.76	.76	.75
1142	1.02	1.01	1.00	.98	.97	.96	.94	.94	.92	.90	.88	.87	.86	.84	.83	.83	.82	.81	.80	.80	.79	.79	.78	.78	.77	.77
1143	1.05	1.04	1.03	1.02	1.00	.98	.97	.96	.95	.93	.91	.90	.88	.87	.86	.85	.84	.83	.82	.82	.81	.80	.80	.79	.79	.78
1144	1.08	1.06	1.05	1.04	1.03	1.01	1.00	.98	.97	.96	.94	.92	.91	.90	.88	.87	.86	.85	.84	.84	.83	.82	.82	.81	.80	.80
1145	1.12	1.09	1.07	1.06	1.05	1.04	1.02	1.00	.99	.98	.97	.95	.94	.92	.91	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81
1146	1.14	1.14	1.11	1.10	1.08	1.07	1.06	1.04	1.02	1.01	1.00	.99	.97	.95	.94	.92	.91	.90	.89	.88	.87	.86	.86	.85	.84	.83
1147	1.17	1.16	1.16	1.13	1.11	1.10	1.08	1.08	1.06	1.04	1.03	1.02	1.01	.99	.97	.95	.94	.93	.92	.90	.90	.89	.88	.87	.86	.86
1148	1.31	1.28	1.26	1.24	1.21	1.18	1.16	1.14	1.13	1.11	1.09	1.08	1.06	1.05	1.03	1.01	.99	.98	.96	.95	.94	.93	.92	.91	.90	.89
1149	1.51	1.44	1.40	1.36	1.33	1.30	1.26	1.24	1.22	1.20	1.18	1.16	1.14	1.12	1.10	1.08	1.06	1.04	1.03	1.01	1.00	.98	.97	.96	.95	.94
1150	1.76	1.66	1.56	1.52	1.46	1.44	1.40	1.36	1.33	1.30	1.28	1.25	1.23	1.21	1.19	1.17	1.15	1.12	1.10	1.08	1.07	1.05	1.04	1.02	1.01	1.00
1151	2.35	2.17	2.02	1.91	1.82	1.75	1.69	1.63	1.58	1.53	1.50	1.46	1.43	1.39	1.36	1.34	1.31	1.28	1.26	1.23	1.21	1.19	1.17	1.15	1.13	1.12
1152	3.30	2.96	2.72	2.52	2.36	2.24	2.14	2.05	1.97	1.89	1.83	1.78	1.73	1.68	1.64	1.60	1.56	1.53	1.49	1.46	1.42	1.39	1.37	1.34	1.32	1.30
1153	3.72	3.40	3.09	2.86	2.67	2.52	2.39	2.28	2.19	2.10	2.03	1.96	1.90	1.85	1.80	1.75	1.71	1.67	1.63	1.59	1.55	1.52	1.49	1.46	1.43	1.40
1154	3.54	3.30	3.09	2.86	2.68	2.52	2.40	2.29	2.20	2.12	2.04	1.98	1.92	1.86	1.82	1.77	1.72	1.68	1.65	1.62	1.57	1.54	1.51	1.48	1.45	1.42
1155	3.24	3.10	2.96	2.81	2.64	2.50	2.38	2.27	2.18	2.11	2.04	1.97	1.91	1.86	1.81	1.77	1.73	1.68	1.65	1.62	1.58	1.55	1.52	1.48	1.46	1.43
1156	2.57	2.44	2.78	2.69	2.59	2.46	2.35	2.25	2.16	2.09	2.02	1.96	1.91	1.85	1.81	1.76	1.73	1.68	1.65	1.62	1.58	1.56	1.52	1.49	1.46	1.44
1157	1.54	2.28	2.55	2.54	2.49	2.42	2.31	2.22	2.14	2.07	2.00	1.95	1.90	1.85	1.80	1.76	1.72	1.68	1.65	1.62	1.58	1.56	1.53	1.50	1.47	1.44
1158	.92	1.42	2.07	2.34	2.35	2.32	2.28	2.19	2.12	2.05	1.98	1.93	1.88	1.84	1.79	1.75	1.71	1.68	1.65	1.62	1.58	1.56	1.53	1.50	1.48	1.45
1159	.85	.91	1.34	1.92	2.17	2.20	2.19	2.16	2.09	2.03	1.97	1.91	1.87	1.82	1.79	1.75	1.71	1.68	1.64	1.62	1.58	1.56	1.53	1.50	1.48	1.45
1160	.84	.85	.90	1.28	1.60	2.04	2.07	2.08	2.05	2.00	1.95	1.90	1.85	1.81	1.77	1.74	1.70	1.67	1.64	1.61	1.58	1.56	1.53	1.50	1.48	1.46
1161	.79	.80	.81	.86	1.20	1.68	1.91	1.95	1.96	1.95	1.90	1.86	1.82	1.78	1.74	1.71	1.68	1.65	1.62	1.59	1.57	1.54	1.52	1.50	1.47	1.45
1162	.73	.75	.76	.76	.83	1.13	1.58	1.80	1.84	1.86	1.86	1.82	1.79	1.75	1.72	1.68	1.66	1.63	1.60	1.58	1.55	1.53	1.51	1.48	1.46	1.44
1163	.68	.70	.72	.74	.76	.80	1.08	1.49	1.70	1.75	1.77	1.78	1.74	1.72	1.69	1.66	1.63	1.61	1.59	1.56	1.54	1.52	1.49	1.48	1.45	1.43
1164	.62	.66	.69	.70	.72	.74	.78	1.04	1.42	1.62	1.67	1.70	1.70	1.68	1.66	1.63	1.61	1.58	1.56	1.54	1.52	1.50	1.48	1.46	1.44	1.42
1165	.57	.62	.65	.67	.69	.70	.72	.76	1.00	1.36	1.55	1.60	1.63	1.64	1.62	1.60	1.58	1.56	1.54	1.52	1.51	1.48	1.47	1.45	1.43	1.42
1166	.57	.57	.61	.64	.66	.68	.69	.71	.75	.97	1.31	1.49	1.54	1.57	1.58	1.57	1.55	1.53	1.52	1.50	1.48	1.47	1.45	1.43	1.42	1.40
1167	.57	.57	.57	.60	.63	.65	.67	.68	.70	.74	.95	1.26	1.44	1.49	1.52	1.53	1.52	1.51	1.49	1.48	1.46	1.45	1.44	1.42	1.40	1.39
1168	.57	.57	.57	.57	.60	.62	.64	.66	.67	.69	.72	.92	1.22	1.39	1.44	1.47	1.49	1.48	1.47	1.45	1.44	1.43	1.42	1.41	1.39	1.38
1169	.57	.57	.57	.57	.57	.60	.62	.64	.65	.67	.68	.71	.90	1.18	1.34	1.40	1.43	1.45	1.44	1.43	1.42	1.41	1.40	1.39	1.38	1.36
1170	.57	.57	.57	.57	.57	.57	.60	.62	.63	.65	.66	.68	.71	.88	1.15	1.30	1.36	1.39	1.41	1.40	1.40	1.39	1.38	1.37	1.36	1.35
1171	.54	.55	.55	.55	.56	.56	.56	.58	.60	.62	.63	.65	.66	.69	.86	1.12	1.26	1.32	1.35	1.37	1.36	1.36	1.35	1.34	1.34	1.33
1172	.52	.53	.53	.54	.54	.54	.55	.55	.57	.59	.61	.62	.63	.65	.68	.84	1.08	1.23	1.28	1.31	1.33	1.33	1.33	1.32	1.31	1.30
1173	.49	.50	.51	.52	.53	.53	.53	.54	.54	.56	.58	.60	.61	.62	.64	.67	.82	1.06	1.19	1.24	1.28	1.30	1.30	1.29	1.29	1.28
1174	.46	.48	.50	.50	.51	.52	.52	.53	.53	.53	.55	.57	.59	.60	.61	.63	.66	.80	1.03	1.16	1.21	1.24	1.26	1.26	1.26	1.26
1175	.44	.46	.48	.49	.50	.50	.51	.52	.52	.52	.53	.55	.56	.58	.59	.60	.62	.64	.79	1.00	1.13	1.18	1.21	1.24	1.24	1.24
1176	.44	.44	.46	.47	.48	.49	.50	.50	.51	.51	.52	.52	.54	.56	.57	.58	.60	.61	.64	.77	.98	1.10	1.15	1.19	1.21	1.21
1177	.44	.44	.44	.46	.47	.48	.49	.49	.50	.50	.51	.51	.52	.53	.55	.56	.58	.59	.60	.63	.76	.96	1.08	1.13	1.16	1.18
1178	.44	.44	.44	.44	.45	.46	.47	.48	.49	.50	.50	.50	.51	.51	.53	.54	.56	.57	.58	.60	.62	.75	.94	1.06	1.10	1.14
1179	.44	.44	.44	.44	.44	.45	.46	.47	.48	.48	.49	.50	.50	.50	.51	.52	.54	.55	.56	.58	.59	.61	.74	.92	1.04	1.08
1180	.44	.44	.44	.44	.44	.44	.45	.46	.47	.48	.48	.49	.49	.50	.50	.50	.52	.54	.55	.56	.57	.58	.61	.72	.91	1.02
1185	.41	.41	.42	.42	.42	.42	.42	.43	.43	.43	.43	.44	.44	.45	.46	.46	.47	.47	.48	.48	.48	.50	.51	.52	.53	.54
1190	.41	.41	.41	.41	.41	.41	.41	.41	.42	.42	.42	.42	.42	.43	.43	.43	.43	.44	.44	.45	.45	.46	.46	.46	.47	.47
1195	.39	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.41	.41	.41	.41	.42	.42	.42	.42	.43	.43	.43	.44	.44
1200	.39	.39	.39	.39	.39	.39	.39	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.41	.41	.41	.41	.41	.41	.41	.41
1225	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.31	.31	.32	.32	.32	.33	.33	.33	.34	.34	.34	.34	.34	.34
1250	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.23	.24	.24	.24	.24	.25	.25	.25	.25	.25
1300	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20
1400	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09
1440	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06	.06

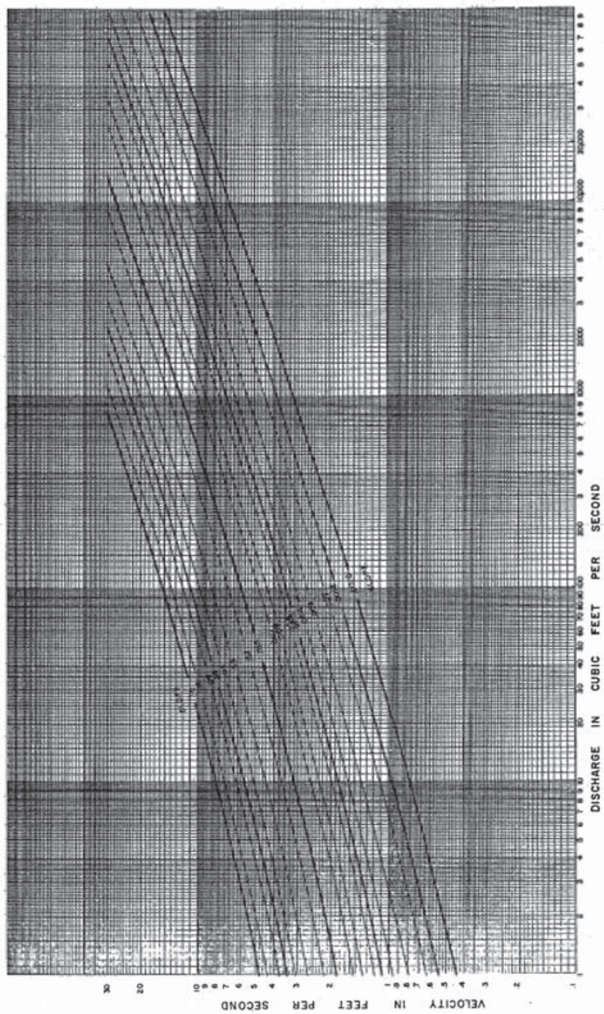
RAINFALL INTENSITY TABLE
10-YEAR FREQUENCY
K ZONE



RUNOFF COEFFICIENT CURVE
SOIL NUMBER 3



MINIMUM VELOCITY–
SLOPE RELATIONSHIPS
OVERLAND FLOW



VELOCITY — DISCHARGE
SLOPE RELATIONSHIPS
NATURAL VALLEY CHANNELS

VENTURA COUNTY HYDROLOGY MANUAL

F

Plate F-3

EX. 10YR VCRAT OUTPUT

VENTURA COUNTY FLOOD CONTROL DISTRICT
MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994

EXISTING 10YR CONDITION

STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	1A	4.	6.	4.	6.	2	1300.	0.00200	0.00	0.00	0.	30	13	K10	0.00
646	2A	27.	30.	31.	31.	2	900.	0.00500	0.00	0.00	0.	30	22	K10	0.00
646	3B	31.	29.	31.	29.	2	10.	0.00200	0.00	0.00	0.	30	29	K10	0.00

CONFLUENCE Q'S

646 4A TA 1169 QA 29. QAB 55. QB 27. 646 4B TB 1160 QB 29. QBA 51. QA 21.
646 4AB TAB 1166 QAB 56. QA 28. QB 28.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	4AB	31.	29.	62.	56.	2	650.	0.00200	0.00	0.00	0.	30	0	K10	0.00
646	5A	15.	17.	77.	62.	2	1900.	0.00200	0.00	0.00	0.	30	21	K10	0.00
646	6A	44.	44.	121.	46.	2	10.	0.00200	0.00	0.00	0.	30	27	K10	0.00
646	7C	30.	28.	30.	28.	2	1100.	0.00300	0.00	0.00	0.	30	29	K10	0.00
646	8C	30.	28.	60.	47.	2	900.	0.00400	0.00	0.00	0.	30	29	K10	0.00

CONFLUENCE Q'S

646 9A TA 1174 QA 46. QAC 89. QC 43. 646 9C TC 1180 QC 46. QCA 76. QA 31.
646 9AC TAC 1176 QAC 90. QA 45. QC 45.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	9AC	60.	46.	181.	90.	2	40.	0.00200	0.00	0.00	0.	30	0	K10	0.00

MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994

LINE A AND B

HYDROGRAPH AT 646 4A STORM DAY 4 REDUCTION FACTOR = 1.000

TIME	Q	TIME	Q	TIME	Q	TIME	Q	TIME	Q
0	0.	100	1.	200	1.	300	1.	400	1.
500	1.	600	1.	700	1.	800	1.	900	1.
1000	1.	1050	1.	1100	1.	1110	1.	1120	3.
1130	6.	1131	6.	1132	7.	1133	7.	1134	8.
1135	8.	1136	9.	1137	9.	1138	10.	1139	10.
1140	11.	1141	11.	1142	12.	1143	13.	1144	14.
1145	15.	1146	16.	1147	17.	1148	18.	1149	20.
1150	22.	1151	26.	1152	32.	1153	36.	1154	38.
1155	39.	1156	41.	1157	43.	1158	46.	1159	49.
1160	51.	1161	52.	1162	54.	1163	54.	1164	55.
1165	56.	1166	56.	1167	56.	1168	55.	1169	55.
1170	54.	1171	54.	1172	53.	1173	52.	1174	51.
1175	50.	1176	48.	1177	46.	1178	43.	1179	39.
1180	34.	1181	26.	1182	20.	1183	17.	1184	15.
1185	13.	1186	11.	1187	10.	1188	9.	1189	8.
1190	8.	1191	7.	1192	7.	1193	6.	1194	6.
1195	6.	1196	5.	1197	5.	1198	5.	1199	5.
1200	4.	1201	4.	1202	4.	1203	4.	1204	4.
1205	4.	1206	3.	1207	3.	1208	3.	1209	3.
1210	3.	1211	3.	1212	3.	1213	3.	1214	3.
1215	3.	1216	2.	1217	2.	1218	2.	1219	2.
1220	2.	1221	2.	1222	2.	1223	2.	1224	2.
1225	2.	1226	2.	1227	2.	1228	2.	1229	2.
1230	2.	1231	2.	1232	2.	1233	2.	1234	2.
1235	2.	1236	2.	1237	2.	1238	2.	1239	2.
1240	1.	1241	1.	1242	1.	1243	1.	1244	1.
1245	1.	1246	1.	1247	1.	1248	1.	1249	1.
1250	1.	1251	1.	1252	1.	1253	1.	1254	1.
1255	1.	1256	1.	1257	1.	1258	1.	1259	1.
1260	1.	1261	1.	1262	1.	1263	1.	1264	1.
1265	1.	1266	1.	1267	1.	1268	1.	1269	1.
1270	1.	1271	1.	1272	1.	1273	1.	1274	1.
1275	1.	1276	1.	1277	1.	1278	1.	1279	1.
1280	1.	1281	1.	1282	1.	1283	1.	1284	1.
1285	1.	1286	1.	1287	1.	1288	1.	1289	1.
1290	1.	1291	1.	1292	1.	1293	1.	1294	1.
1295	1.	1296	1.	1297	1.	1298	1.	1299	1.
1300	1.	1310	1.	1320	1.	1330	1.	1340	1.
1350	1.	1360	1.	1370	1.	1380	1.	1390	1.
1400	1.	1420	1.	1440	1.	1460	1.	1500	1.

MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994

LINE A AND C

HYDROGRAPH AT 646 9A STORM DAY 4 REDUCTION FACTOR = 1.000

TIME	Q	TIME	Q	TIME	Q	TIME	Q	TIME	Q
0	0.	100	1.	200	1.	300	1.	400	1.
500	1.	600	1.	700	1.	800	1.	900	1.
1000	1.	1050	1.	1100	1.	1110	2.	1120	5.
1130	8.	1131	9.	1132	9.	1133	10.	1134	10.
1135	11.	1136	12.	1137	12.	1138	13.	1139	14.
1140	15.	1141	16.	1142	17.	1143	18.	1144	19.
1145	20.	1146	21.	1147	23.	1148	25.	1149	28.
1150	31.	1151	37.	1152	45.	1153	52.	1154	54.
1155	55.	1156	57.	1157	59.	1158	62.	1159	64.
1160	67.	1161	69.	1162	71.	1163	72.	1164	73.
1165	75.	1166	77.	1167	78.	1168	80.	1169	82.
1170	84.	1171	85.	1172	87.	1173	88.	1174	89.
1175	90.	1176	90.	1177	90.	1178	87.	1179	81.
1180	76.	1181	77.	1182	78.	1183	78.	1184	78.
1185	78.	1186	77.	1187	76.	1188	75.	1189	74.
1190	73.	1191	72.	1192	72.	1193	71.	1194	70.
1195	69.	1196	69.	1197	68.	1198	66.	1199	65.
1200	64.	1201	62.	1202	61.	1203	59.	1204	57.
1205	55.	1206	53.	1207	52.	1208	50.	1209	48.
1210	46.	1211	45.	1212	43.	1213	41.	1214	40.
1215	38.	1216	37.	1217	35.	1218	34.	1219	33.
1220	31.	1221	30.	1222	29.	1223	28.	1224	27.
1225	26.	1226	25.	1227	24.	1228	23.	1229	22.
1230	21.	1231	21.	1232	20.	1233	19.	1234	19.
1235	18.	1236	17.	1237	17.	1238	16.	1239	16.
1240	15.	1241	15.	1242	14.	1243	14.	1244	13.
1245	13.	1246	13.	1247	12.	1248	12.	1249	11.
1250	11.	1251	11.	1252	10.	1253	10.	1254	10.
1255	10.	1256	9.	1257	9.	1258	9.	1259	9.
1260	8.	1261	8.	1262	8.	1263	8.	1264	7.
1265	7.	1266	7.	1267	7.	1268	7.	1269	7.
1270	6.	1271	6.	1272	6.	1273	6.	1274	6.
1275	6.	1276	6.	1277	5.	1278	5.	1279	5.
1280	5.	1281	5.	1282	5.	1283	5.	1284	5.
1285	5.	1286	5.	1287	4.	1288	4.	1289	4.
1290	4.	1291	4.	1292	4.	1293	4.	1294	4.
1295	4.	1296	4.	1297	4.	1298	4.	1299	4.
1300	3.	1310	3.	1320	3.	1330	2.	1340	2.
1350	2.	1360	2.	1370	2.	1380	2.	1390	1.
1400	1.	1420	1.	1440	1.	1460	1.	1500	1.

EXA010HR.I

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005  0646    1A EXISTING 10YR CONDITION
005  0646    4ABLINE A AND B
005  0646    9ACLINE A AND C
999
999
006  0646    1A 0300  4.1113K102 13000002                      G1
006  0646    2A 0300  26.622K102  9000005
006  0646    3B 0300  30.829K102   100002
006  0646    4AB0300        K102  6500002                   11
006  0646    5A 0300  15.521K102 19000002
006  0646    6A 0300  44.427K102   100002
006  0646    7C 0300  30.429K102 11000003
006  0646    8C 0300  29.829K102  9000004
006  0646    9AC03000       K102   400002                   11 2
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EX 100 YR VCRAT OUTPUT

VENTURA COUNTY FLOOD CONTROL DISTRICT
MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994

EXISTING 100YR CONDITION — STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	1A	4.	11.	4.	11.	2	1300.	0.00200	0.00	0.00	0.	30	11	B98	0.00
646	2A	27.	53.	31.	55.	2	900.	0.00500	0.00	0.00	0.	30	18	B98	0.00
646	3B	31.	51.	31.	51.	2	10.	0.00200	0.00	0.00	0.	30	24	B98	0.00

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CONFLUENCE Q'S
646   4A  TA 1166 QA     51. QAB     97. QB     47.     646    4B  TB 1157 QB     51. QBA     85. QA     33.
                         646   4AB TAB 1164 QAB    99. QA     50. QB     49.
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LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	4AB	31.	51.	62.	99.	2	650.	0.00200	0.00	0.00	0.	30	0	B98	0.00
646	5A	15.	31.	77.	110.	2	1900.	0.00200	0.00	0.00	0.	30	17	B98	0.00
646	6A	44.	74.	121.	104.	2	10.	0.00200	0.00	0.00	0.	30	23	B98	0.00
646	7C	30.	50.	30.	50.	2	1100.	0.00300	0.00	0.00	0.	30	24	B98	0.00
646	8C	30.	50.	60.	85.	2	900.	0.00400	0.00	0.00	0.	30	24	B98	0.00

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CONFLUENCE Q'S
646   9A  TA 1171 QA    104. QAC    185. QC     81.     646    9C  TC 1174 QC     83. QCA    183. QA    100.
                         646   9AC TAC 1171 QAC   185. QA    104. QC     81.
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LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	9AC	60.	83.	181.	185.	2	40.	0.00200	0.00	0.00	0.	30	0	B98	0.00

MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994
LINE A AND B
HYDROGRAPH AT 646 4A — STORM DAY 4 — REDUCTION FACTOR = 1.000

TIME	Q	TIME	Q	TIME	Q	TIME	Q	TIME	Q
0	0.	100	1.	200	1.	300	1.	400	1.
500	1.	600	1.	700	1.	800	1.	900	1.
1000	2.	1050	6.	1100	9.	1110	12.	1120	15.
1130	20.	1131	21.	1132	21.	1133	22.	1134	23.
1135	24.	1136	24.	1137	25.	1138	26.	1139	27.
1140	28.	1141	30.	1142	31.	1143	32.	1144	34.
1145	36.	1146	37.	1147	39.	1148	41.	1149	46.
1150	52.	1151	53.	1152	62.	1153	70.	1154	73.
1155	77.	1156	80.	1157	85.	1158	89.	1159	92.
1160	95.	1161	97.	1162	98.	1163	98.	1164	99.
1165	98.	1166	97.	1167	96.	1168	95.	1169	93.
1170	90.	1171	87.	1172	83.	1173	76.	1174	69.
1175	64.	1176	52.	1177	41.	1178	37.	1179	32.
1180	30.	1181	27.	1182	25.	1183	23.	1184	21.
1185	20.	1186	19.	1187	18.	1188	17.	1189	16.
1190	15.	1191	14.	1192	14.	1193	13.	1194	12.
1195	12.	1196	11.	1197	11.	1198	11.	1199	10.
1200	10.	1201	10.	1202	9.	1203	9.	1204	9.
1205	8.	1206	8.	1207	8.	1208	8.	1209	7.
1210	7.	1211	7.	1212	6.	1213	6.	1214	6.
1215	6.	1216	5.	1217	5.	1218	5.	1219	5.
1220	4.	1221	4.	1222	4.	1223	4.	1224	4.
1225	3.	1226	3.	1227	3.	1228	3.	1229	3.
1230	3.	1231	3.	1232	3.	1233	3.	1234	3.
1235	2.	1236	2.	1237	2.	1238	2.	1239	2.
1240	2.	1241	2.	1242	2.	1243	2.	1244	2.
1245	2.	1246	2.	1247	2.	1248	2.	1249	2.
1250	2.	1251	2.	1252	2.	1253	2.	1254	2.
1255	2.	1256	2.	1257	1.	1258	1.	1259	1.
1260	1.	1261	1.	1262	1.	1263	1.	1264	1.
1265	1.	1266	1.	1267	1.	1268	1.	1269	1.
1270	1.	1271	1.	1272	1.	1273	1.	1274	1.
1275	1.	1276	1.	1277	1.	1278	1.	1279	1.
1280	1.	1281	1.	1282	1.	1283	1.	1284	1.
1285	1.	1286	1.	1287	1.	1288	1.	1289	1.
1290	1.	1291	1.	1292	1.	1293	1.	1294	1.
1295	1.	1296	1.	1297	1.	1298	1.	1299	1.
1300	1.	1310	1.	1320	1.	1330	1.	1340	1.
1350	1.	1360	1.	1370	1.	1380	1.	1390	1.
1400	1.	1420	1.	1440	1.	1460	1.	1500	1.

MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994

LINE A AND C

HYDROGRAPH AT 646 9A STORM DAY 4 REDUCTION FACTOR = 1.000

TIME	Q	TIME	Q	TIME	Q	TIME	Q	TIME	Q
0	0.	100	1.	200	1.	300	1.	400	1.
500	1.	600	1.	700	1.	800	1.	900	1.
1000	3.	1050	11.	1100	20.	1110	25.	1120	30.
1130	39.	1131	40.	1132	41.	1133	43.	1134	44.
1135	46.	1136	47.	1137	48.	1138	50.	1139	51.
1140	53.	1141	55.	1142	58.	1143	60.	1144	62.
1145	65.	1146	68.	1147	71.	1148	74.	1149	82.
1150	91.	1151	94.	1152	107.	1153	119.	1154	123.
1155	128.	1156	131.	1157	137.	1158	141.	1159	146.
1160	150.	1161	153.	1162	156.	1163	160.	1164	164.
1165	168.	1166	171.	1167	175.	1168	178.	1169	181.
1170	183.	1171	185.	1172	183.	1173	180.	1174	183.
1175	174.	1176	166.	1177	166.	1178	164.	1179	164.
1180	162.	1181	159.	1182	156.	1183	154.	1184	151.
1185	149.	1186	147.	1187	144.	1188	141.	1189	139.
1190	136.	1191	133.	1192	128.	1193	125.	1194	121.
1195	117.	1196	113.	1197	109.	1198	105.	1199	101.
1200	97.	1201	93.	1202	90.	1203	86.	1204	83.
1205	79.	1206	76.	1207	73.	1208	70.	1209	67.
1210	65.	1211	62.	1212	59.	1213	57.	1214	55.
1215	53.	1216	51.	1217	49.	1218	47.	1219	45.
1220	43.	1221	42.	1222	40.	1223	38.	1224	37.
1225	36.	1226	35.	1227	33.	1228	32.	1229	31.
1230	30.	1231	29.	1232	28.	1233	27.	1234	26.
1235	26.	1236	25.	1237	24.	1238	23.	1239	23.
1240	22.	1241	21.	1242	21.	1243	20.	1244	19.
1245	19.	1246	18.	1247	18.	1248	17.	1249	17.
1250	16.	1251	16.	1252	15.	1253	15.	1254	14.
1255	14.	1256	14.	1257	13.	1258	13.	1259	13.
1260	12.	1261	12.	1262	11.	1263	11.	1264	11.
1265	11.	1266	10.	1267	10.	1268	10.	1269	10.
1270	9.	1271	9.	1272	9.	1273	9.	1274	8.
1275	8.	1276	8.	1277	8.	1278	8.	1279	7.
1280	7.	1281	7.	1282	7.	1283	7.	1284	7.
1285	7.	1286	6.	1287	6.	1288	6.	1289	6.
1290	6.	1291	6.	1292	6.	1293	5.	1294	5.
1295	5.	1296	5.	1297	5.	1298	5.	1299	5.
1300	5.	1310	4.	1320	3.	1330	3.	1340	2.
1350	2.	1360	2.	1370	2.	1380	2.	1390	2.
1400	1.	1420	1.	1440	1.	1460	1.	1500	1.


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005  0646    1A EXISTING 100YR CONDITION
005  0646    4ABLINE A AND B
005  0646    9ACLINE A AND C
999
999
006  0646    1A 0300   4.1111B982 13000002                 G1
006  0646    2A 0300  26.618B982   9000005
006  0646    3B 0300  30.824B982    100002
006  0646    4AB0300        B982   6500002                11
006  0646    5A 0300  15.517B982 19000002
006  0646    6A 0300  44.423B982    100002
006  0646    7C 0300  30.424B982 11000003
006  0646    8C 0300  29.824B982   9000004
006  0646    9AC03000       B982    400002                11 2
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ESTIMATED PEAK EX. 2YR Q

EX: 10YR VCRAT

VENTURA COUNTY FLOOD CONTROL DISTRICT
MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994

EXISTING 10YR CONDITION — STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	1A	4.	6.	4.	6.	2	1300.	0.00200	0.00	0.00	0.	30	13	K10	0.00
646	2A	27.	30.	31.	31.	2	900.	0.00500	0.00	0.00	0.	30	22	K10	0.00
646	3B	31.	29.	31.	29.	2	10.	0.00200	0.00	0.00	0.	30	29	K10	0.00

CONFLUENCE Q'S
646 4A TA 1169 QA 29. QAB 55. QB 27. 646 4B TB 1160 QB 29. QBA 51. QA 21.
646 4AB TAB 1166 QAB 56. QA 28. QB 28.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	4AB	31.	29.	62.	56.	2	650.	0.00200	0.00	0.00	0.	30	0	K10	0.00
646	5A	15.	17.	77.	62.	2	1900.	0.00200	0.00	0.00	0.	30	21	K10	0.00
646	6A	44.	44.	121.	46.	2	10.	0.00200	0.00	0.00	0.	30	27	K10	0.00
646	7C	30.	28.	30.	28.	2	1100.	0.00300	0.00	0.00	0.	30	29	K10	0.00
646	8C	30.	28.	60.	47.	2	900.	0.00400	0.00	0.00	0.	30	29	K10	0.00

CONFLUENCE Q'S
646 9A TA 1174 QA 46. QAC 89. QC 43. 646 9C TC 1180 QC 46. QCA 76. QA 31.
646 9AC TAC 1176 QAC 90. QA 45. QC 45.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	9AC	60.	46.	181.	90.	2	40.	0.00200	0.00	0.00	0.	30	0	K10	0.00

$$\text{Peak } Q_{10-EX} = 90 \text{ CFS}$$

$$\text{Peak } Q_{2YR-EX} = \left(\frac{Q_{10}}{0.5} \times 0.08\right) \text{ per VCWPD Hydrologic Multipliers}$$

$$\text{Peak } Q_{2YR} = 14 \text{ CFS (Existing Condition)}$$

Noben

VENTURA COUNTY PUBLIC WORKS AGENCY

HYDROLOGIC MULTIPLIERS
STORM DURATION, PRECIP. FREQ.
PEAK FLOW FREQ. DEV., UNDEV.

STORM DURATION

DURATION (HOURS)	1	3	6	9	12	18	24	36	48	72
MULTIPLIER	0.28	0.44	0.58	0.68	0.76	0.89	1.00	1.18	1.32	1.56

PRECIPITATION FREQUENCY

FREQUENCY OF OCCURRENCE (YEARS)	2	5	10	25	50	100
MULTIPLIER	0.43	0.61	0.73	0.88	1.00	1.11

PEAK FLOWS FROM DEVELOPED WATERSHEDS: $P_{FREQ} = Q_{FREQ}$

FREQUENCY OF OCCURRENCE (YEARS)	2	5	10	25	50	100
MULTIPLIER	0.16	0.45	0.68	0.83	1.00	1.20

PEAK FLOWS FROM UNDEVELOPED WATERSHEDS: Q_{FREQ}

FREQUENCY OF OCCURRENCE (YEARS)	2	5	10	25	50	100
MULTIPLIER	0.08	0.23	0.50	0.70	1.00	1.38

Proposed Hydrology Calculations

Time of Concentration
Ventura County Modified Rational Method

VENTURA COUNTY WATERSHED PROTECTION DISTRICT
TIME OF CONCENTRATION
TC Program Version: 1.0.2007.2
Project: 30-100646
Date: 12:00:00 AM
Engineer: SUHLES
Consultant: RBF CONSULTING

Watershed Name: Watershed

Sub-Area Name: A
Tc: 20.923 Minutes
DATA FOR SUB AREA 1

SUB AREA TIME OF CONCENTRATION: 20.923 min. = 21 min.

SUB AREA INPUT DATA

Sub Area Name: A
Total Area (ac): 45.36
Flood Zone: 2
Rainfall Zone: K
Storm Frequency (years): 100
Development Type: Residential
Soil Type: 3.00
Percent Impervious: 60
SUB AREA OUTPUT

Intensity (in/hr): 2.426
C Total: 0.866
Sum Q Segments (cfs): 95.28
Q Total (cfs): 95.28
Sum Percent Area (%): 100.0
Sum of Flow Path Travel Times (sec): 1,255.37
Time of Concentration (min): 20.923

DATA FOR FLOW PATH 1

Flow Path Name: 1
FLOW PATH TRAVEL TIME (min): 4.2135
Flow Type: Overland
Length (ft): 200
Top Elevation (ft): 53.2
Bottom Elevation (ft): 53
Contributing Area (acres): 1
Percent of Sub-Area (%): 2.2
Overland Type: Valley
Development Type: Residential
Map Slope: 0.0010
Effective Slope: 0.0010
Q for Flow Path (cfs): 2.10
Avg Velocity (ft/s): 0.79
Passed Scour Check: N/A

DATA FOR FLOW PATH 2

Flow Path Name: 2
FLOW PATH TRAVEL TIME (min): 0.6785
Flow Type: Natural Channel
Length (ft): 137
Top Elevation (ft): 53
Bottom Elevation (ft): 51
Contributing Area (acres): 0.79
Percent of Sub-Area (%): 1.7
Overland Type: Valley
Map Slope: 0.0146
Effective Slope: 0.0146
Q for Flow Path (cfs): 1.66
Q Top (cfs): 2.10
Q Bottom (cfs): 3.76
Velocity Top (ft/s): 2.10
Velocity Bottom (ft/s): 2.39
Avg Velocity (ft/s): 2.24
Wave Velocity (ft/s): 3.37

DATA FOR FLOW PATH 3

Flow Path Name: 3
FLOW PATH TRAVEL TIME (min): 5.5309
Flow Type: Street
Length (ft): 960
Top Elevation (ft): 51
Bottom Elevation (ft): 48
Contributing Area (acres): 11.41
Percent of Sub-Area (%): 25.2
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0031
Q for Flow Path (cfs): 23.97
Q Top (cfs): 3.76
Q Bottom (cfs): 27.73
Velocity Top (ft/s): 1.49
Velocity Bottom (ft/s): 2.37
Avg Velocity (ft/s): 1.93
Wave Velocity (ft/s): 2.89

DATA FOR FLOW PATH 4

Flow Path Name: 4
FLOW PATH TRAVEL TIME (min): 3.5105
Flow Type: Street
Length (ft): 960
Top Elevation (ft): 48
Bottom Elevation (ft): 43.5
Contributing Area (acres): 15.51
Percent of Sub-Area (%): 34.2
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0047
Q for Flow Path (cfs): 32.58
Q Top (cfs): 27.73
Q Bottom (cfs): 60.30
Velocity Top (ft/s): 2.77
Velocity Bottom (ft/s): 3.31
Avg Velocity (ft/s): 3.04
Wave Velocity (ft/s): 4.56

DATA FOR FLOW PATH 5

Flow Path Name: 5
FLOW PATH TRAVEL TIME (min): 4.9548
Flow Type: Street
Length (ft): 960
Top Elevation (ft): 43.5
Bottom Elevation (ft): 42.2
Contributing Area (acres): 12.86
Percent of Sub-Area (%): 28.4
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0014
Q for Flow Path (cfs): 27.01
Q Top (cfs): 60.30
Q Bottom (cfs): 87.32
Velocity Top (ft/s): 2.06
Velocity Bottom (ft/s): 2.25
Avg Velocity (ft/s): 2.15
Wave Velocity (ft/s): 3.23

DATA FOR FLOW PATH 6

Flow Path Name: 6
FLOW PATH TRAVEL TIME (min): 2.0346
Flow Type: Street
Length (ft): 500
Top Elevation (ft): 42.2
Bottom Elevation (ft): 41.1
Contributing Area (acres): 3.79
Percent of Sub-Area (%): 8.4

Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0022
Q for Flow Path (cfs): 7.96
Q Top (cfs): 87.32
Q Bottom (cfs): 95.28
Velocity Top (ft/s): 2.70
Velocity Bottom (ft/s): 2.76
Avg Velocity (ft/s): 2.73
Wave Velocity (ft/s): 4.10
□
Project: 30-100646
Date: 12:00:00 AM
Engineer: SUHLES
Consultant: RBF CONSULTING

Sub-Area Name: B
Tc: 13.620 Minutes
DATA FOR SUB AREA 2

SUB AREA TIME OF CONCENTRATION: 13.620 min. = 14 min.

SUB AREA INPUT DATA

Sub Area Name: B
Total Area (ac): 68.04
Flood Zone: 2
Rainfall Zone: K
Storm Frequency (years): 100
Development Type: Undeveloped
Soil Type: 3.00
Percent Impervious: 60
SUB AREA OUTPUT

Intensity (in/hr): 2.987
C Total: 0.880
Sum Q Segments (cfs): 178.95
Q Total (cfs): 178.95
Sum Percent Area (%): 100.0
Sum of Flow Path Travel Times (sec): 817.19
Time of Concentration (min): 13.620

DATA FOR FLOW PATH 1

Flow Path Name: 1
FLOW PATH TRAVEL TIME (min): 4.1739
Flow Type: Overland
Length (ft): 200
Top Elevation (ft): 53
Bottom Elevation (ft): 51.5
Contributing Area (acres): 1.39
Percent of Sub-Area (%): 2.0
Overland Type: Valley
Development Type: Residential
Map Slope: 0.0075
Effective Slope: 0.0075
Q for Flow Path (cfs): 3.66
Avg Velocity (ft/s): 0.80
Passed Scour Check: N/A

DATA FOR FLOW PATH 2

Flow Path Name: 2
FLOW PATH TRAVEL TIME (min): 1.5121
Flow Type: Natural Channel
Length (ft): 300
Top Elevation (ft): 51.5
Bottom Elevation (ft): 49
Contributing Area (acres): 5.06
Percent of Sub-Area (%): 7.4
Overland Type: Valley
Map Slope: 0.0083
Effective Slope: 0.0083
Q for Flow Path (cfs): 13.31

Q Top (cfs): 3.66
Q Bottom (cfs): 16.96
Velocity Top (ft/s): 1.79
Velocity Bottom (ft/s): 2.62
Avg Velocity (ft/s): 2.20
Wave Velocity (ft/s): 3.31

DATA FOR FLOW PATH 3

Flow Path Name: 3
FLOW PATH TRAVEL TIME (min): 4.0026
Flow Type: Street
Length (ft): 640
Top Elevation (ft): 49
Bottom Elevation (ft): 48
Contributing Area (acres): 7.29
Percent of Sub-Area (%): 10.7
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0016
Q for Flow Path (cfs): 19.17
Q Top (cfs): 16.96
Q Bottom (cfs): 36.14
Velocity Top (ft/s): 1.62
Velocity Bottom (ft/s): 1.93
Avg Velocity (ft/s): 1.78
Wave Velocity (ft/s): 2.66

DATA FOR FLOW PATH 4

Flow Path Name: 4
FLOW PATH TRAVEL TIME (min): 3.3269
Flow Type: Street
Length (ft): 900
Top Elevation (ft): 48
Bottom Elevation (ft): 44.5
Contributing Area (acres): 15.92
Percent of Sub-Area (%): 23.4
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0039
Q for Flow Path (cfs): 41.87
Q Top (cfs): 36.14
Q Bottom (cfs): 78.01
Velocity Top (ft/s): 2.74
Velocity Bottom (ft/s): 3.27
Avg Velocity (ft/s): 3.01
Wave Velocity (ft/s): 4.51

DATA FOR FLOW PATH 5

Flow Path Name: 5
FLOW PATH TRAVEL TIME (min): 0.3201
Flow Type: Street
Length (ft): 200
Top Elevation (ft): 44.5
Bottom Elevation (ft): 40
Contributing Area (acres): 28.3
Percent of Sub-Area (%): 41.6
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0225
Q for Flow Path (cfs): 74.43
Q Top (cfs): 78.01
Q Bottom (cfs): 152.44
Velocity Top (ft/s): 6.40
Velocity Bottom (ft/s): 7.48
Avg Velocity (ft/s): 6.94
Wave Velocity (ft/s): 10.41

DATA FOR FLOW PATH 6

Flow Path Name: 6
FLOW PATH TRAVEL TIME (min): 0.2841

Flow Type: Natural Channel
Length (ft): 100
Top Elevation (ft): 40
Bottom Elevation (ft): 39.5
Contributing Area (acres): 10.08
Percent of Sub-Area (%): 14.8
Overland Type: Valley
Map Slope: 0.0050
Effective Slope: 0.0050
Q for Flow Path (cfs): 26.51
Q Top (cfs): 152.44
Q Bottom (cfs): 178.95
Velocity Top (ft/s): 3.81
Velocity Bottom (ft/s): 4.01
Avg Velocity (ft/s): 3.91
Wave Velocity (ft/s): 5.87

Proposed Extended Detention Basin Analysis

Design Calculations
Storm Water Quality Design Volume Calculation
Hydraflow Hydrographs Output

Hydrograph Summary Report - 100 YEAR DETENTION REQUIREMENTS

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	Manual	5.100	1	1153	36,047	----	------	------	Unit Hydrograph
2	Manual	95.28	1	1153	673,456	----	------	------	Area A
3	Diversion1	22.55	1	1153	645,067	2	------	------	Q10 EX Outflow
4	Diversion2	72.73	1	1153	28,389	2	------	------	Detention Required
5	Manual	178.95	1	1153	1,264,808	----	------	------	Area B
6	Diversion1	33.83	1	1128	1,197,909	5	------	------	Q10 EX Outflow
7	Diversion2	145.12	1	1153	66,900	5	------	------	Detention Required

*

TTM Basins.gpw	Return Period: 100 Year	Thursday, Oct 18 2007, 11:19 AM

Design Procedure Form for T-3: Extended Detention Basin

Designer: JGK
Company: RBF Consulting
Date: 22-Oct-07
Project: Teal Club
Location: City of Oxnard (Drainage Area A)

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	65	%
b. Effective Imperviousness (Determine using Figure 3-4)	I_{wq} =	60	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u =	0.67	in.
d. Watershed Area Tributary to EDB	Area =	60.9	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	3.40025	acre-ft
f. Calculate Design Volume Design Volume = SQDV x 1.2	Design Volume =	4.0803	acre-ft
2. Outlet Works			
a. Outlet Type (check one)	Single Orifice		
	Multi-orifice Plate		
	Perforated Pipe	X	
	Other		
b. Depth of water above bottom oririce	Depth =	3	feet
c. Single Orifice Outlet			
1) Total Area	A =		square inches
2) Diameter or W x L	D =		inches
d. Multiple Orifice Outlet			
1) Area per row of perforations	A =	1.97	
2) Perforation Diameter (2 inches max.)	D =	3/4	
3) No. of Perforations (columns) per Row	Perforations =	4.5	
4) No. of Rows (4 inch spacing)	Rows =	5.5	
5) Total Orifice Area (Area per row) x (Number of Rows)	Area =	10.835	

Design Procedure Form for T-3: Extended Detention Basin (Page 2 of 2)

Project: Teal Club

3. Trash Rack or Gravel Pack (check one)	Trash Rack ____	Gravel Pack X	
4. Basin Length-Width Ration (2:1 minimum)	Ratio =		L/W
5. Two-Stage Design			
a. Upper Stage			
1) Depth (2 feet minimum)	Depth =		feet
2) Width (30 feet minimum)	Width =		feet
3) Bottom Slope (2% to low flow channel)	Slope =		%
b. Bottom Stage			
1) Depth (1.5 to 3 feet deeper than Upper)	Depth =		feet
2) Storage Volume (5-15% of SQDV min.)	Volume =		acre-ft
6. Forebay Design			
a. Forebay Volume (5-10% of SQDV min.)	Volume =		acre-ft
b. Outlet pipe drainage time (~45 minutes)	Drainage Time		minutes
7. Low Flow Channel			
a. Depth (9 inches min.)	Depth =		feet
b. Flow Capacity (2 x outlet for Forebay)	Flow Capacity =		cfs
8. Vegetation	Native Grasses	X	
	Irrigated Turf		
	Other		
9. Embankment			
a. Interior Slope (4:1 max.)	Interior Slope =	4:01	H/V
b. Exterior Slope (3:1 max.)	Exterior Slope =		H/V
10. Access			
a. Slope (10% max.)	Slope =	10	%
b. Width (16 feet min.)	Width =	16	feet

Notes:

Design Procedure Form for T-3: Extended Detention Basin

Designer: JGK

Company: RBF Consulting

Date: 22-Oct-07

Project: Teal Club

Location: City of Oxnard (Drainage Area B)

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	65	%
b. Effective Imperviousness (Determine using Figure 3-4)	I_{wq} =	60	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u =	0.67	in.
d. Watershed Area Tributary to EDB	Area =	68	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	3.796666667	acre-ft
f. Calculate Design Volume Design Volume = SQDV x 1.2	Design Volume =	4.556	acre-ft
2. Outlet Works			
a. Outlet Type (check one)	Single Orifice		
	Multi-orifice Plate		
	Perforated Pipe	X	
	Other		
b. Depth of water above bottom oririce	Depth =		feet
c. Single Orifice Outlet			
1) Total Area	A =		square inches
2) Diameter or W x L	D =		inches
d. Multiple Orifice Outlet			
1) Area per row of perforations	A =	2.2	
2) Perforation Diameter (2 inches max.)	D =	3/4	
3) No. of Perforations (columns) per Row	Perforations =	5	
4) No. of Rows (4 inch spacing)	Rows =	7	
5) Total Orifice Area (Area per row) x (Number of Rows)	Area =	15.4	

Design Procedure Form for T-3: Extended Detention Basin (Page 2 of 2)

Project: Teal Club

3. Trash Rack or Gravel Pack (check one)	Trash Rack ____	Gravel Pack X	
4. Basin Length-Width Ration (2:1 minimum)	Ratio =	2:01	L/W
5. Two-Stage Design			
a. Upper Stage			
1) Depth (2 feet minimum)	Depth =		feet
2) Width (30 feet minimum)	Width =		feet
3) Bottom Slope (2% to low flow channel)	Slope =		%
b. Bottom Stage			
1) Depth (1.5 to 3 feet deeper than Upper)	Depth =		feet
2) Storage Volume (5-15% of SQDV min.)	Volume =		acre-ft
6. Forebay Design			
a. Forebay Volume (5-10% of SQDV min.)	Volume =		acre-ft
b. Outlet pipe drainage time (~45 minutes)	Drainage Time		minutes
7. Low Flow Channel			
a. Depth (9 inches min.)	Depth =		feet
b. Flow Capacity (2 x outlet for Forebay)	Flow Capacity =		cfs
8. Vegetation	Native Grasses	X	
	Irrigated Turf		
	Other		
9. Embankment			
a. Interior Slope (4:1 max.)	Interior Slope =	4:01	H/V
b. Exterior Slope (3:1 max.)	Exterior Slope =		H/V
10. Access			
a. Slope (10% max.)	Slope =	10	%
b. Width (16 feet min.)	Width =	16	feet

Notes:

Calculation of Stormwater Quality Design Flow and Volume

Introduction

The primary control strategy for all of the treatment control measures specified in this Section is to treat the Stormwater Quality Design Flow (SQDF) or Stormwater Quality Design Volume (SQDV) of the storm water runoff. The following paragraphs present calculation procedures and design criteria necessary to determine the SQDF and SQDV.

The treatment control measure equations specified in this Section are listed in Table 5-2 along with the basis of design, SQDF or SQDV, to be used for the listed control measure.

Table 5-2. Sizing Criteria for Treatment Control Measures

Treatment Control Measure	Design Basis
T-1: Grass Strip Filter	SQDF
T-2: Grass Swale Filter	SQDF
T-3: Dry Detention Basin	SQDV
T-4: Wet Detention Basin	SQDV
T-5: Constructed Wetland	SQDV
T-6: Detention Basin/Sand Filter	SQDV
T-7: Porous Pavement Detention	SQDV
T-8: Porous Landscape Detention	SQDV
T-9: Infiltration Basin	SQDV
T-10: Infiltration Trench	SQDV
T-11: Media Filter	SQDV
T-12: Proprietary Control Measures	SQDV or SQDF

Contributing Impervious Area Determination

The SQDF and SQDV are calculated by determining runoff from the impervious and pervious areas of a site that are connected to the treatment control measure. Impervious areas include sidewalks, roadways, parking areas, staging areas, storage areas, slabs, roofs, and other non-vegetated areas, including compacted soil areas. Off-site areas that could run-on to a site and contribute drainage to the treatment control measure should be included in the impervious area determination. The effective imperviousness of a site can be reduced through implementation of general site design control measures (e.g. G-5.1 and G-5.2) to reduce flow from impervious areas, as described in Section 3. Procedures for calculating effective imperviousness are presented in Section 3, Fact Sheet G-5.

Stormwater Quality Design Flow (SQDF) Calculation

Hydrologic calculations for design of flow-based stormwater treatment control measures in Ventura County shall be in accordance with latest edition of the *Hydrology Manual* produced by Ventura County Public Works Agency, Flood Control Department, together with the procedure set forth herein. The designer is specifically reminded to regard minimum subarea sizes required in the *Hydrology Manual* (p. II-3). Where jurisdictions within Ventura County have approved alternative hydrologic calculation methods, the alternative methods may be utilized if they have been approved by the jurisdiction for use in design of flow-based stormwater quality BMPs. This procedure complies with Regional Board Order No. 00-108, NPDES Permit No. CAS004002, Attachment A – Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan, issued July 27, 2000.

The Stormwater Quality Design Flow (SQDF) is defined to be equal to 10 percent of the peak rate of runoff flow from the 50-year storm as determined using the procedures set forth in the *Hydrology Manual.*

Calculation Procedure

1. The Stormwater Quality Design Flow (SQDF) in Ventura County is defined as $Q_{P,\,SQDF}$.
2. Calculate the peak rate of flow from the 50-year storm ($Q_{P,\,50\,yr.}$) using the procedures set forth in the *Hydrology Manual* or as directed by the local agency Drainage Master Plan.
3. Convert $Q_{P,\,50yr}$ (Step 2) to $Q_{P,\,SQDF}$ (Step 1).

$$Q_{P,\,SQDF} = 0.1 \times Q_{P,\,50yr}$$

Example Stormwater Quality Design Flow Calculation

The steps below illustrate calculation of SQDF:

Step 1: SQDF = $Q_{P,\,SQDF}$

Step 2: Calculate the peak rate of flow from a 50-year storm.

$Q_{p,\,50\,yr.}$ = 10 cfs from the *Hydrology Manual*

Step 3: Convert $Q_{p,50\,yr}$ (Step 2) to $Q_{p,\,SQDF}$ (Step 1)

$Q_{P,\,SQDF} = 0.1 \times 10$ cfs

$Q_{P,\,SQDF} = 1.0$ cfs

Stormwater Quality Design Volume (SQDV) Calculation

Hydrologic calculations for design of volume-based stormwater treatment controls in Ventura County shall be in accordance with the procedures set forth herein. This procedure complies with Regional Board Order No. 00-108, NPDES Permit No. CAS004002, Attachment A – Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan, issued July 27, 2000.

The Stormwater Quality Design Volume (SQDV) is defined as the volume necessary to capture and treat 80 percent or more of the average annual runoff volume from the site at the design drawdown period specified in the Fact Sheet for the proposed treatment control measure.

Calculation Procedure

1. Review the area draining to the proposed treatment control measure. Determine the effective imperviousness (I_{WQ}) of the drainage area using the procedure presented in Section 3, Fact Sheet G-5.
2. Figure 5-1 provides a direct reading of Unit Basin Storage Volumes required for 80% annual capture of runoff for values of "I_{WQ}" determined in Step 1. Enter the horizontal axis of Figure 5-1 with the "I_{WQ}" value from Step 1. Move vertically up Figure 5-1 until the appropriate drawdown period line is intercepted. (The design drawdown period specified in the respective Fact Sheet for the proposed treatment control measure.) Move horizontally across Figure 5-1from this point until the vertical axis is intercepted. Read the Unit Basin Storage Volume along the vertical axis.

   Figure 5-1 is based on Precipitation Gage 168, Oxnard Airport. This gage has a data record of approximately 40 years of hourly readings and is maintained by Ventura County Flood Control District. Figure 5-1 is for use only in the permit area specified in Regional Board Order No. 00-108, NPDES Permit No. CAS004002.
3. The SQDV for the proposed treatment control measure is then calculated by multiplying the Unit Basin Storage Volume by the contributing drainage area. Due to the mixed units that result (e.g., acre-inches, acre-feet) it is recommended that the resulting volume be converted to cubic feet for use during design.

Example Stormwater Quality Design Volume Calculation

1. Determine the drainage area contributing to control measure, A_t. Example: 10 acres.
2. Determine the area of impervious surfaces in the drainage area, A_i. Example: 6.4 acres.
3. Calculate the percentage of impervious, $I_A = (A_i/A_t)*100$

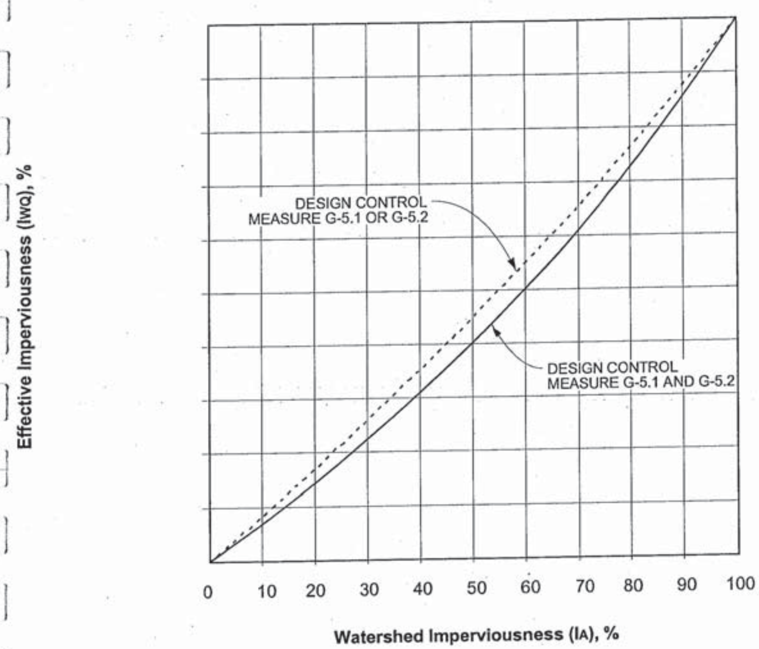
   Example: Percent Imperviousness = $(A_i/A_t)*100$ = (6.4 acres/10 acres)*100 = 64%
4. Determine Effective Imperviousness using Figure 3-4.

   Example: G-5.1 employed → I_{WQ} = 60%
5. Determine design drawdown period for proposed control measure.

   Example: T-3:Extended Detention Basin → Drawdown period = 40 hours
6. Determine the Unit Basin Storage Volume for 80% Annual Capture, V_u using Figure 5-1.

   Example: for $I_{WQ}/100$ = 0.60 and drawdown = 40 hrs, V_u = 0.64 in.
7. Calculate the volume of the basin, V_b, where $V_b = V_u * A_t$.

   Example: V_b = (0.64 in)(10 ac)(ft/12 in(43,560 ft^2 / ac) = 23,232 ft^3.
8. Solution: Size the proposed control measure for 23,232 ft^3 and 40-hour drawdown.



G-5.1: TURF BUFFER
G-5.2: GRASS-LINED CHANNEL

ADAPTED FROM URBAN STORM DRAIN CRITERIA MANUAL VOL. 3 - BEST MANAGEMENT PRACTICES, URBAN DRAINAGE AND FLOOD CONTROL DISTRICT,11/99

Figure 3-4. DETERMINATION OF EFFECTIVE IMPERVIOUSNESS

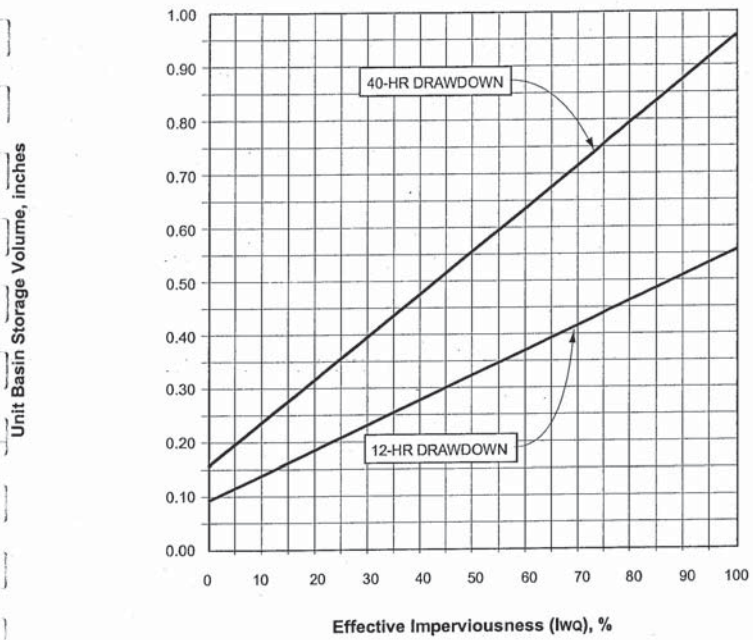


Figure 5-1. Unit Basin Storage Volume vs. Effective Imperviousness

Control Peak Stormwater Runoff Discharge Rates

Purpose

Unless controlled, peak stormwater runoff rates from developed areas are typically higher than those from previously undeveloped areas. Higher peak flows can change stream morphology and increase downstream erosion that can damage stream habitat and impact aesthetic value. In addition, higher flows convey larger pollutant loads to receiving waters. Control of peak stormwater discharge rates is thus required to protect stream habitat and aesthetic value by maintaining non-erosive hydraulic conditions in unlined receiving streams during stormwater runoff events.

Design Criteria

SQUIMP category projects, excluding single family hillside residences, that directly discharge to unlined receiving streams shall implement the following interim criteria:

1. 2-year post development discharge rates shall not exceed the predeveloped discharge rates for the 2-year frequency storm event.
2. Peak flows shall be determined using the procedures set forth in the latest edition of the *Hydrology Manual* and Direct Runoff curves produced by Ventura County Public Works Agency, Flood Control Department. The designer is specifically reminded to regard minimum subarea sizes required in the *Hydrology Manual*. Where jurisdictions within Ventura County have approved alternative hydrologic calculation methods, the alternative methods may be used if they have been approved by the jurisdiction for use in design of flow-based stormwater controls.

The Ventura County Public Works Agency, Flood Control Department is currently developing a modeling procedure to establish peak flow design criteria to avoid erosive conditions. A study in the upper reaches of the Arroyo Simi (Simi Valley) is currently underway to examine the relationship between runoff discharge rates and erosion. The results of the study will be used to revise/finalize the interim peak flow criteria presented in this manual upon approval of the co-permittee cities.

Extended Detention Basin

Description

Extended detention basins (EDB) are permanent basins formed by excavation and/or construction of embankments to temporarily detain the Stormwater Quality Design Volume (SQDV) of stormwater runoff to allow sedimentation of particulates to occur before the runoff is discharged. Extended detention basins are typically dry between storms, although a shallow pool, 1 to 3 feet deep, can be included in the design for aesthetic purposes and to promote biological uptake and conversion of pollutants. A bottom outlet provides controlled slow release of the detained runoff over a specified time period (40 hours for SQDV). The basic elements of an extended detention basin are shown in Figure 5-4. This configuration is most appropriate for large sites.

Surface basins are typical, but underground vaults may be appropriate in a small commercial development. Where irrigation water is available, basins should be vegetated to protect the basin slopes and bottom from erosion. To minimize erosion from inlet flow, basins are to be designed with an inlet energy dissipator and an inlet forebay section divided from the main basin by a secondary berm. The bottom of the basin is sloped toward the outlet end at a grade of approximately two percent. A low flow channel is provided to convey incidental flows directly to the outlet end of the basin.

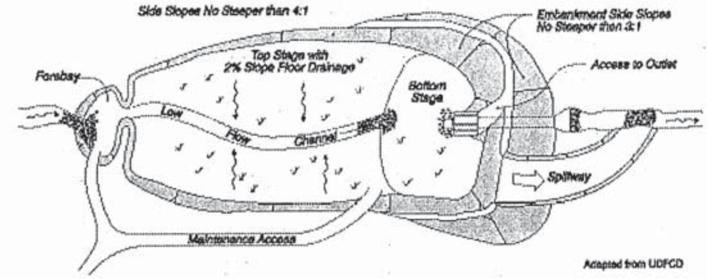
EDBs are sized to detain and release the SQDV. Storm volumes greater than the SQDV are passed through the basin by means of a secondary outlet or spillway. Outlets are designed to include erosion protection.

General Application

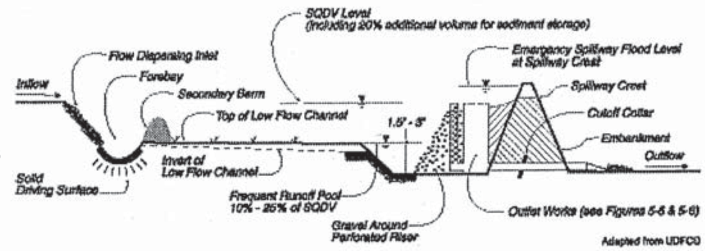
An EDB serves to reduce peak stormwater runoff rates, as well as provide treatment of stormwater runoff. If the basins are constructed early in the development cycle, they can also serve as sediment traps during construction within the tributary area. However, accumulated sediment must be removed after construction activities are complete and before the basin is placed into final long-term use as an EDB. Basins may be designed as dual-use facilities to provide recreational use during the dry season, and can be designed into flood control basins or sometimes retrofitted into existing flood control basins. EDBs that are intended to serve as a flood control basin, as well as a stormwater treatment control measure, must also be designed in accordance with applicable flood control design standards.

EDBs can serve essentially any size tributary area from an individual commercial development to a large residential or regional area, but are typically used for tributary areas greater than 10 acres. They work well in conjunction with other control measures, such as onsite source controls and downstream infiltration basins.

5-2



Plan View



Section View

Figure 5-4. Extended Detention Basin Conceptual Layout

Advantages/Disadvantages

General

EDBs may be designed to provide other benefits such as recreation, wildlife habitat, and open space. Safety issues must be address through proper design.

Site Suitability

Space requirements for EDBs are significant. Land requirements for EDBs typically range from approximately 0.5 to 2.0 percent of the of the tributary development area. Groundwater levels must be considered during site evaluation and design. Vector and vegetation control problems can develop when the seasonal high ground water level is above the basin bottom elevation.

Pollutant Removal

Relative pollutant removal effectiveness of an EDB is presented in Table 5-1. Removal effectiveness of EDBs for sediment and particulate forms of metals, nutrients and other pollutants is considered high to moderate. Removal effectiveness for dissolved pollutants is considered low. EDBs may be used upstream of control measures that are more effective at removing soluble pollutants, such as infiltration basins, filters or wetlands.

Design Criteria and Procedure

Principal design criteria for EDBs are listed in Table 5-5.

Table 5-5. Extended Detention Basin Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV / 50% SQDV	hrs	40 / 12 (minimum)
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 40-h drawdown
Basin design volume	acre-ft	1.2 x SQDV (privide 20% sediment storage volume)
Inlet/outlet erosion control	–	Energy dissipator to reduce inlet/outlet velocity
Forebay volume/ drain time	%/min.	5 to 15 % of SQDV / Drain time < 45 minutes
Low-flow channel depth/ flow capacity	in/–	9 / 2 x forebay outlet rate
Bottom slope of upper stage	%	2.0
Length to width ratio (minimum)	–	2:1 (larger preferred)
Upper stage depth/width (minimum)	ft	2.0/30
Bottom stage volume	%	10 to 25 % of SQDV
Bottom stage depth	ft	1.5 to 3 ft deeper than top stage
Freeboard (minimum)	ft	1.0
Embankment side slope (H:V)	–	≥ 4:1 inside/ ≥3:1 outside (without retaining walls)
Maintenance access ramp slope (H:V)	hrs	10:1 or flatter
Maintenance access ramp width	ft	16.0 – approach paved with asphalt concrete

Design procedure and application of design criteria are outlined in the following steps:

a) Basin Storage Volume

Provide a storage volume equal to 120 percent of the SQDV, based on a 40-hr drawdown time, above the lowest outlet (i.e. perforation or orifice) in the basin. The additional 20 percent provides an allowance for sediment accumulation.

a. Determine the percent imperviousness of the tributary area (I_a).

b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 40-hr drawdown and I_{wq} value from Step 1.b.

d. Calculate the SQDV in acre-ft as follows:

$$SQDV = (V_u / 12) \times Area$$

where

Area = Watershed area tributary to EDB in acre-ft

e. Calculate Design Volume in acre-ft as follows:

$$\text{Design Volume} = SQDV \times 1.2$$

where

1.2 factor = Multiplier to provide for sediment accumulation

2. Outlet Works

The Outlet Works are to be designed to release the SQDV (i.e. not Design Volume) over a 40-hour period, with no more than 50 percent released in 12 hours. Refer to Figures 5-5 and 5-6 for schematics pertaining to structure geometry; grates, trash racks, and screens; outlet type: orifice plate or perforated riser pipe.

a. For perforated pipe outlets or vertical plates with multiple orifices (see Figure 5-5), use the following equation to determine required area per row of perforations, based on the SQDV(ft^2) and depth of water above the centerline of the bottom perforation D_{BS} (ft).

$$\text{Area/row } (in^2) = SQDV/K_{40}$$

where

$$K_{40} = 0.013D_{BS}^2 + 0.22D_{BS} - 0.10$$

Select appropriate perforation diameter and number of perforations per row (i.e. columns) with the objective of minimizing the number of columns and using a maximum perforation diameter of 2 inches. Rows are spaced at 4 inches on center from the bottom perforation. Thus, there will be 3 rows for each foot of depth plus the top row. The number of rows (nr) may be determined as follows:

$$nr = 1 + (D_{BS} X\ 3)$$

Calculate total outlet area by multiplying the area per row by number of rows.

Total orifice area = area/row x nr

b. For single orifice outlet control or single row of orifices at the basin bottom surface elevation (see Figures 5-6), use the following equation based on the SQDV (ft^3) and depth of water above orifice centerline D_{BS} (ft) to determine total orifice area (in^2):

$$\text{Total orifice area} = (SQDV) \div [(60.19)(D_{BS}^{0.5})(T)]$$

where

T = drawdown period (hrs)= 40 hrs

3. Trash Rack/Gravel Pack — A trash rack or gravel pack around perforated risers shall be provided to protect outlet orifices from clogging. Trash racks are better suited for use with perforated vertical plates for outlet control and allow easier access to outlet orifices for purposes of inspection and cleaning. Trash rack shall be sized to prevent clogging of the primary water quality outlet without restricting with the hydraulic capacity of the outlet control orifices.

4. Basin Shape — Whenever possible, shape the basin with a gradual expansion from the inlet toward the middle and a gradual contraction from middle toward the outlet. The length to width ratio should be a minimum of 2:1. Internal baffling with berms may be necessary to achieve this ratio.

5. Two-Stage Design — A two-stage design with a pool that fills often with frequently occurring runoff minimizes standing water and sediment deposition in the remainder of the basin.

a. Upper Stage: The upper stage should be a minimum of 2 feet deep with the bottom sloped at 2 percent toward the low flow channel. Minimum width of the upper stage should be 30 ft.

b. Bottom Stage: The active storage basin of the bottom stage should be 1.5 to 3 feet deeper than the top stage and store 10 to 25 pecent of the SQDV. A mico-pool below the active storage volume of the bottom stage, if provided, should be one-half the depth of the top stage or 2 feet, which ever is greater.

6. Forebay Design — The forebay provides a location for sedimentation of larger particles that has a solid bottom surface to facilitate mechanical removal of accumulated sediment. The forebay volume should be 5 to 10 percent of the SQDV. A berm should separate the forebay from the upper stage of the basin. The outlet pipe from

be 5 to 10 percent of the SQDV. A berm should separate the forebay from the upper stage of the basin. The outlet pipe from the forebay to the lowflow channel should be sized to drain the forebay volume in 45 minutes. The outlet pipe entrance should be offset from the forebay inlet to prevent short circuiting.

7. Low-flow Channel — The low flow channel conveys flow from the forebay to the bottom stage. Erosion protection should be provided where the low-flow channel enters the bottom stage. Lining of the low flow channel with concrete is recommended. The depth of the channel should be at least 9 inches. The flow capacity of the channel should be twice the release capacity of the forebay outlet.

8. Inlet/Outlet Design — Basin inlet and outlet points should be provided with an energy dissipation structure and/or erosion protection.

9. Vegetation — Bottom vegetation provides erosion protection and sediment entrapment. Basin bottoms, berms, and side slopes may be planted with native grasses or with irrigated turf.

10. Embankment — Design embankments to conform to requirements State of California Division of Safety of Dams, if the basin dimensions cause it to fall under that agency's jurisdiction. Interior slopes should be no steeper than 4:1 and exterior slopes no steeper than 3:1. Flatter slopes are preferable.

11. Access — All-weather access to the bottom, forebay, and outlet works shall be provided for maintenance vehicles. Maximum grades of access ramps should be 10 percent and minimum width should be 16 feet. Ramps should be paved with concrete.

12. Bypass — Provide for bypass or overflow of runoff volumes in excess of the SQDV. Spillway and overflow structures should be designed in accordance with applicable standards of the Ventura County Flood Control District.

13. Geotextile Fabric — Non-woven geotextile fabric used in conjunction with gravel packs around perforated risers shall conform the specifications listed in Table 5-6.

Table 5-6. Non-woven Geotextile Fabric Specifications

Property	Test Reference	Minimum Specification
Grab Strength	ASTM D4632	90 lbs
Elongation at peak load	ASTM D4632	50 %
Puncture Strength	ASTM D3787	45 lbs
Permitivity	ASTM D4491	0.7 sec^{-1}
Burst Strength	ASTM D3786	180 psi
Toughness	% Elongation x Grab Strength	5,500 lbs
Ultraviolet Resistance (Percent strength retained at 500 Weatherometer hours)	ASTM D4355	70%

Adapted from SSPWC, 1997.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

City of Oxnard Master Plan of Drainage

October 2003

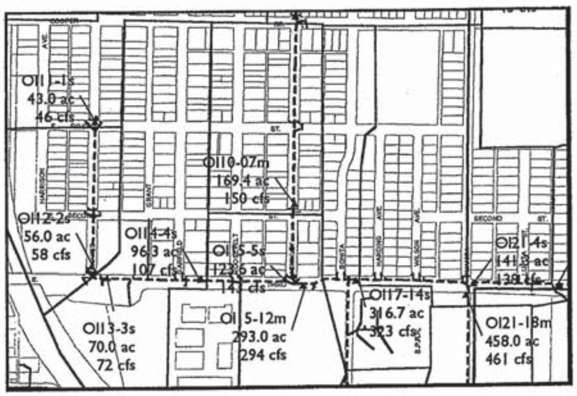
Printed Aug, 2004

City of Oxnard

"The City That Cares"

MASTER PLAN OF DRAINAGE

OCTOBER 2003



Hawks & Associates
2259 Portola Rd. Suite B
Ventura, CA 93003

```
005   0646    1A EXISTING 10YR CONDITION
005   0646    4ABLINE A AND B
005   0646    9ACLINE A AND C
999
999
006   0646    1A 0300   4.1113K102 13000002               G1
006   0646    2A 0300  26.622K102   9000005
006   0646    3B 0300  30.829K102    100002
006   0646    4AB0300        K102   6500002              11
006   0646    5A 0300  15.521K102 19000002
006   0646    6A 0300  44.427K102    100002
006   0646    7C 0300  30.429K102 11000003
006   0646    8C 0300  29.829K102   9000004
006   0646    9AC03000       K102    400002              11 2
```

EX 100 YR VCRAT OUTPUT

VENTURA COUNTY FLOOD CONTROL DISTRICT
MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994

EXISTING 100YR CONDITION — STORM DAY 4

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	1A	4.	11.	4.	11.	2	1300.	0.00200	0.00	0.00	0.	30	11	B98	0.00
646	2A	27.	53.	31.	55.	2	900.	0.00500	0.00	0.00	0.	30	18	B98	0.00
646	3B	31.	51.	31.	51.	2	10.	0.00200	0.00	0.00	0.	30	24	B98	0.00

CONFLUENCE Q'S

646 4A TA 1166 QA 51. QAB 97. QB 47. 646 4B TB 1157 QB 51. QBA 85. QA 33.
646 4AB TAB 1164 QAB 99. QA 50. QB 49.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	4AB	31.	51.	62.	99.	2	650.	0.00200	0.00	0.00	0.	30	0	B98	0.00
646	5A	15.	31.	77.	110.	2	1900.	0.00200	0.00	0.00	0.	30	17	B98	0.00
646	6A	44.	74.	121.	104.	2	10.	0.00200	0.00	0.00	0.	30	23	B98	0.00
646	7C	30.	50.	30.	50.	2	1100.	0.00300	0.00	0.00	0.	30	24	B98	0.00
646	8C	30.	50.	60.	85.	2	900.	0.00400	0.00	0.00	0.	30	24	B98	0.00

CONFLUENCE Q'S

646 9A TA 1171 QA 104. QAC 185. QC 81. 646 9C TC 1174 QC 83. QCA 183. QA 100.
646 9AC TAC 1171 QAC 185. QA 104. QC 81.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	9AC	60.	83.	181.	185.	2	40.	0.00200	0.00	0.00	0.	30	0	B98	0.00

MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994
LINE A AND B
HYDROGRAPH AT 646 4A STORM DAY 4 REDUCTION FACTOR = 1.000

TIME	Q	TIME	Q	TIME	Q	TIME	Q	TIME	Q
0	0.	100	1.	200	1.	300	1.	400	1.
500	1.	600	1.	700	1.	800	1.	900	1.
1000	2.	1050	6.	1100	9.	1110	12.	1120	15.
1130	20.	1131	21.	1132	21.	1133	22.	1134	23.
1135	24.	1136	24.	1137	25.	1138	26.	1139	27.
1140	28.	1141	30.	1142	31.	1143	32.	1144	34.
1145	36.	1146	37.	1147	39.	1148	41.	1149	46.
1150	52.	1151	53.	1152	62.	1153	70.	1154	73.
1155	77.	1156	80.	1157	85.	1158	89.	1159	92.
1160	95.	1161	97.	1162	98.	1163	98.	1164	99.
1165	98.	1166	97.	1167	96.	1168	95.	1169	93.
1170	90.	1171	87.	1172	83.	1173	76.	1174	69.
1175	64.	1176	52.	1177	41.	1178	37.	1179	32.
1180	30.	1181	27.	1182	25.	1183	23.	1184	21.
1185	20.	1186	19.	1187	18.	1188	17.	1189	16.
1190	15.	1191	14.	1192	14.	1193	13.	1194	12.
1195	12.	1196	11.	1197	11.	1198	11.	1199	10.
1200	10.	1201	10.	1202	9.	1203	9.	1204	9.
1205	8.	1206	8.	1207	8.	1208	8.	1209	7.
1210	7.	1211	7.	1212	6.	1213	6.	1214	6.
1215	6.	1216	5.	1217	5.	1218	5.	1219	5.
1220	4.	1221	4.	1222	4.	1223	4.	1224	4.
1225	3.	1226	3.	1227	3.	1228	3.	1229	3.
1230	3.	1231	3.	1232	3.	1233	3.	1234	3.
1235	2.	1236	2.	1237	2.	1238	2.	1239	2.
1240	2.	1241	2.	1242	2.	1243	2.	1244	2.
1245	2.	1246	2.	1247	2.	1248	2.	1249	2.
1250	2.	1251	2.	1252	2.	1253	2.	1254	2.
1255	2.	1256	2.	1257	1.	1258	1.	1259	1.
1260	1.	1261	1.	1262	1.	1263	1.	1264	1.
1265	1.	1266	1.	1267	1.	1268	1.	1269	1.
1270	1.	1271	1.	1272	1.	1273	1.	1274	1.
1275	1.	1276	1.	1277	1.	1278	1.	1279	1.
1280	1.	1281	1.	1282	1.	1283	1.	1284	1.
1285	1.	1286	1.	1287	1.	1288	1.	1289	1.
1290	1.	1291	1.	1292	1.	1293	1.	1294	1.
1295	1.	1296	1.	1297	1.	1298	1.	1299	1.
1300	1.	1310	1.	1320	1.	1330	1.	1340	1.
1350	1.	1360	1.	1370	1.	1380	1.	1390	1.
1400	1.	1420	1.	1440	1.	1460	1.	1500	1.

MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994

LINE A AND C

HYDROGRAPH AT 646 9A STORM DAY 4 REDUCTION FACTOR = 1.000

TIME	Q	TIME	Q	TIME	Q	TIME	Q	TIME	Q
0	0.	100	1.	200	1.	300	1.	400	1.
500	1.	600	1.	700	1.	800	1.	900	1.
1000	3.	1050	11.	1100	20.	1110	25.	1120	30.
1130	39.	1131	40.	1132	41.	1133	43.	1134	44.
1135	46.	1136	47.	1137	48.	1138	50.	1139	51.
1140	53.	1141	55.	1142	58.	1143	60.	1144	62.
1145	65.	1146	68.	1147	71.	1148	74.	1149	82.
1150	91.	1151	94.	1152	107.	1153	119.	1154	123.
1155	128.	1156	131.	1157	137.	1158	141.	1159	146.
1160	150.	1161	153.	1162	156.	1163	160.	1164	164.
1165	168.	1166	171.	1167	175.	1168	178.	1169	181.
1170	183.	1171	185.	1172	183.	1173	180.	1174	183.
1175	174.	1176	166.	1177	166.	1178	164.	1179	164.
1180	162.	1181	159.	1182	156.	1183	154.	1184	151.
1185	149.	1186	147.	1187	144.	1188	141.	1189	139.
1190	136.	1191	133.	1192	128.	1193	125.	1194	121.
1195	117.	1196	113.	1197	109.	1198	105.	1199	101.
1200	97.	1201	93.	1202	90.	1203	86.	1204	83.
1205	79.	1206	76.	1207	73.	1208	70.	1209	67.
1210	65.	1211	62.	1212	59.	1213	57.	1214	55.
1215	53.	1216	51.	1217	49.	1218	47.	1219	45.
1220	43.	1221	42.	1222	40.	1223	38.	1224	37.
1225	36.	1226	35.	1227	33.	1228	32.	1229	31.
1230	30.	1231	29.	1232	28.	1233	27.	1234	26.
1235	26.	1236	25.	1237	24.	1238	23.	1239	23.
1240	22.	1241	21.	1242	21.	1243	20.	1244	19.
1245	19.	1246	18.	1247	18.	1248	17.	1249	17.
1250	16.	1251	16.	1252	15.	1253	15.	1254	14.
1255	14.	1256	14.	1257	13.	1258	13.	1259	13.
1260	12.	1261	12.	1262	11.	1263	11.	1264	11.
1265	11.	1266	10.	1267	10.	1268	10.	1269	10.
1270	9.	1271	9.	1272	9.	1273	9.	1274	8.
1275	8.	1276	8.	1277	8.	1278	8.	1279	7.
1280	7.	1281	7.	1282	7.	1283	7.	1284	7.
1285	7.	1286	6.	1287	6.	1288	6.	1289	6.
1290	6.	1291	6.	1292	6.	1293	5.	1294	5.
1295	5.	1296	5.	1297	5.	1298	5.	1299	5.
1300	5.	1310	4.	1320	3.	1330	3.	1340	2.
1350	2.	1360	2.	1370	2.	1380	2.	1390	2.
1400	1.	1420	1.	1440	1.	1460	1.	1500	1.

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005  0646    4ABLINE A AND B
005  0646    9ACLINE A AND C
999
999
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006  0646    2A 0300  26.618B982   9000005
006  0646    3B 0300  30.824B982    100002
006  0646    4AB0300        B982   6500002                     11
006  0646    5A 0300  15.517B982 19000002
006  0646    6A 0300  44.423B982    100002
006  0646    7C 0300  30.424B982 11000003
006  0646    8C 0300  29.824B982   9000004
006  0646    9AC03000       B982    400002                     11 2
```

ESTIMATED PEAK EX. 2YR Q

EX: 10YR VCRAT

VENTURA COUNTY FLOOD CONTROL DISTRICT
MODIFIED RATIONAL METHOD HYDROLOGY / PC 1.0-994

STORM DAY 4

EXISTING 10YR CONDITION

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	1A	4.	6.	4.	6.	2	1300.	0.00200	0.00	0.00	0.	30	13	K10	0.00
646	2A	27.	30.	31.	31.	2	900.	0.00500	0.00	0.00	0.	30	22	K10	0.00
646	3B	31.	29.	31.	29.	2	10.	0.00200	0.00	0.00	0.	30	29	K10	0.00

CONFLUENCE Q'S

646 4A TA 1169 QA 29. QAB 55. QB 27. 646 4B TB 1160 QB 29. QBA 51. QA 21.
646 4AB TAB 1166 QAB 56. QA 28. QB 28.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	4AB	31.	29.	62.	56.	2	650.	0.00200	0.00	0.00	0.	30	0	K10	0.00
646	5A	15.	17.	77.	62.	2	1900.	0.00200	0.00	0.00	0.	30	21	K10	0.00
646	6A	44.	44.	121.	46.	2	10.	0.00200	0.00	0.00	0.	30	27	K10	0.00
646	7C	30.	28.	30.	28.	2	1100.	0.00300	0.00	0.00	0.	30	29	K10	0.00
646	8C	30.	28.	60.	47.	2	900.	0.00400	0.00	0.00	0.	30	29	K10	0.00

CONFLUENCE Q'S

646 9A TA 1174 QA 46. QAC 89. QC 43. 646 9C TC 1180 QC 46. QCA 76. QA 31.
646 9AC TAC 1176 QAC 90. QA 45. QC 45.

LOCATION		SUBAREA AREA	SUBAREA Q	TOTAL AREA	TOTAL Q	CONV TYPE	CONV LNGTH	CONV SLOPE	CONV SIZE	CONV Z	CONTROL Q	SOIL NAME	TC	RAIN ZONE	PCT IMPV
646	9AC	60.	46.	181.	90.	2	40.	0.00200	0.00	0.00	0.	30	0	K10	0.00

Peak Q_{10-Ex} = 90 cfs

Peak $Q_{2yr-Ex} = \left(\frac{Q_{10}}{0.5} \times 0.08\right)$ per VCWPD Hydrologic Multipliers

Peak Q_{2yr} = 14 cfs (Existing Condition)

Noben

VENTURA COUNTY PUBLIC WORKS AGENCY

HYDROLOGIC MULTIPLIERS
STORM DURATION, PRECIP. FREQ.
PEAK FLOW FREQ. DEV., UNDEV.

STORM DURATION

DURATION (HOURS)	1	3	6	9	12	18	24	36	48	72
MULTIPLIER	0.28	0.44	0.58	0.68	0.76	0.89	1.00	1.18	1.32	1.56

PRECIPITATION FREQUENCY

FREQUENCY OF OCCURRENCE (YEARS)	2	5	10	25	50	100
MULTIPLIER	0.43	0.61	0.73	0.88	1.00	1.11

PEAK FLOWS FROM DEVELOPED WATERSHEDS: $P_{FREQ} = Q_{FREQ}$

FREQUENCY OF OCCURRENCE (YEARS)	2	5	10	25	50	100
MULTIPLIER	0.16	0.45	0.68	0.83	1.00	1.20

PEAK FLOWS FROM UNDEVELOPED WATERSHEDS: Q_{FREQ}

FREQUENCY OF OCCURRENCE (YEARS)	2	5	10	25	50	100
MULTIPLIER	0.08	0.23	0.50	0.70	1.00	1.38

Proposed Hydrology Calculations

Time of Concentration
Ventura County Modified Rational Method

VENTURA COUNTY WATERSHED PROTECTION DISTRICT
TIME OF CONCENTRATION
TC Program Version: 1.0.2007.2
Project: 30-100646
Date: 12:00:00 AM
Engineer: SUHLES
Consultant: RBF CONSULTING

Watershed Name: Watershed

Sub-Area Name: A
Tc: 20.923 Minutes
DATA FOR SUB AREA 1

SUB AREA TIME OF CONCENTRATION: 20.923 min. = 21 min.

SUB AREA INPUT DATA

Sub Area Name: A
Total Area (ac): 45.36
Flood Zone: 2
Rainfall Zone: K
Storm Frequency (years): 100
Development Type: Residential
Soil Type: 3.00
Percent Impervious: 60
SUB AREA OUTPUT

Intensity (in/hr): 2.426
C Total: 0.866
Sum Q Segments (cfs): 95.28
Q Total (cfs): 95.28
Sum Percent Area (%): 100.0
Sum of Flow Path Travel Times (sec): 1,255.37
Time of Concentration (min): 20.923

DATA FOR FLOW PATH 1

Flow Path Name: 1
FLOW PATH TRAVEL TIME (min): 4.2135
Flow Type: Overland
Length (ft): 200
Top Elevation (ft): 53.2
Bottom Elevation (ft): 53
Contributing Area (acres): 1
Percent of Sub-Area (%): 2.2
Overland Type: Valley
Development Type: Residential
Map Slope: 0.0010
Effective Slope: 0.0010
Q for Flow Path (cfs): 2.10
Avg Velocity (ft/s): 0.79
Passed Scour Check: N/A

DATA FOR FLOW PATH 2

Flow Path Name: 2
FLOW PATH TRAVEL TIME (min): 0.6785
Flow Type: Natural Channel
Length (ft): 137
Top Elevation (ft): 53
Bottom Elevation (ft): 51
Contributing Area (acres): 0.79
Percent of Sub-Area (%): 1.7
Overland Type: Valley
Map Slope: 0.0146
Effective Slope: 0.0146
Q for Flow Path (cfs): 1.66
Q Top (cfs): 2.10
Q Bottom (cfs): 3.76
Velocity Top (ft/s): 2.10
Velocity Bottom (ft/s): 2.39
Avg Velocity (ft/s): 2.24
Wave Velocity (ft/s): 3.37

DATA FOR FLOW PATH 3

Flow Path Name: 3
FLOW PATH TRAVEL TIME (min): 5.5309
Flow Type: Street
Length (ft): 960
Top Elevation (ft): 51
Bottom Elevation (ft): 48
Contributing Area (acres): 11.41
Percent of Sub-Area (%): 25.2
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0031
Q for Flow Path (cfs): 23.97
Q Top (cfs): 3.76
Q Bottom (cfs): 27.73
Velocity Top (ft/s): 1.49
Velocity Bottom (ft/s): 2.37
Avg Velocity (ft/s): 1.93
Wave Velocity (ft/s): 2.89

DATA FOR FLOW PATH 4

Flow Path Name: 4
FLOW PATH TRAVEL TIME (min): 3.5105
Flow Type: Street
Length (ft): 960
Top Elevation (ft): 48
Bottom Elevation (ft): 43.5
Contributing Area (acres): 15.51
Percent of Sub-Area (%): 34.2
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0047
Q for Flow Path (cfs): 32.58
Q Top (cfs): 27.73
Q Bottom (cfs): 60.30
Velocity Top (ft/s): 2.77
Velocity Bottom (ft/s): 3.31
Avg Velocity (ft/s): 3.04
Wave Velocity (ft/s): 4.56

DATA FOR FLOW PATH 5

Flow Path Name: 5
FLOW PATH TRAVEL TIME (min): 4.9548
Flow Type: Street
Length (ft): 960
Top Elevation (ft): 43.5
Bottom Elevation (ft): 42.2
Contributing Area (acres): 12.86
Percent of Sub-Area (%): 28.4
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0014
Q for Flow Path (cfs): 27.01
Q Top (cfs): 60.30
Q Bottom (cfs): 87.32
Velocity Top (ft/s): 2.06
Velocity Bottom (ft/s): 2.25
Avg Velocity (ft/s): 2.15
Wave Velocity (ft/s): 3.23

DATA FOR FLOW PATH 6

Flow Path Name: 6
FLOW PATH TRAVEL TIME (min): 2.0346
Flow Type: Street
Length (ft): 500
Top Elevation (ft): 42.2
Bottom Elevation (ft): 41.1
Contributing Area (acres): 3.79
Percent of Sub-Area (%): 8.4

Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0022
Q for Flow Path (cfs): 7.96
Q Top (cfs): 87.32
Q Bottom (cfs): 95.28
Velocity Top (ft/s): 2.70
Velocity Bottom (ft/s): 2.76
Avg Velocity (ft/s): 2.73
Wave Velocity (ft/s): 4.10

□
Project: 30-100646
Date: 12:00:00 AM
Engineer: SUHLES
Consultant: RBF CONSULTING

Sub-Area Name: B
Tc: 13.620 Minutes
DATA FOR SUB AREA 2

SUB AREA TIME OF CONCENTRATION: 13.620 min. = 14 min.

SUB AREA INPUT DATA

Sub Area Name: B
Total Area (ac): 68.04
Flood Zone: 2
Rainfall Zone: K
Storm Frequency (years): 100
Development Type: Undeveloped
Soil Type: 3.00
Percent Impervious: 60
SUB AREA OUTPUT

Intensity (in/hr): 2.987
C Total: 0.880
Sum Q Segments (cfs): 178.95
Q Total (cfs): 178.95
Sum Percent Area (%): 100.0
Sum of Flow Path Travel Times (sec): 817.19
Time of Concentration (min): 13.620

DATA FOR FLOW PATH 1

Flow Path Name: 1
FLOW PATH TRAVEL TIME (min): 4.1739
Flow Type: Overland
Length (ft): 200
Top Elevation (ft): 53
Bottom Elevation (ft): 51.5
Contributing Area (acres): 1.39
Percent of Sub-Area (%): 2.0
Overland Type: Valley
Development Type: Residential
Map Slope: 0.0075
Effective Slope: 0.0075
Q for Flow Path (cfs): 3.66
Avg Velocity (ft/s): 0.80
Passed Scour Check: N/A

DATA FOR FLOW PATH 2

Flow Path Name: 2
FLOW PATH TRAVEL TIME (min): 1.5121
Flow Type: Natural Channel
Length (ft): 300
Top Elevation (ft): 51.5
Bottom Elevation (ft): 49
Contributing Area (acres): 5.06
Percent of Sub-Area (%): 7.4
Overland Type: Valley
Map Slope: 0.0083
Effective Slope: 0.0083
Q for Flow Path (cfs): 13.31

```
Q Top (cfs): 3.66
Q Bottom (cfs): 16.96
Velocity Top (ft/s): 1.79
Velocity Bottom (ft/s): 2.62
Avg Velocity (ft/s): 2.20
Wave Velocity (ft/s): 3.31
----------------------------------------------------------------------
DATA FOR FLOW PATH 3
----------------------------------------------------------------------
Flow Path Name: 3
FLOW PATH TRAVEL TIME (min): 4.0026
Flow Type: Street
Length (ft): 640
Top Elevation (ft): 49
Bottom Elevation (ft): 48
Contributing Area (acres): 7.29
Percent of Sub-Area (%): 10.7
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0016
Q for Flow Path (cfs): 19.17
Q Top (cfs): 16.96
Q Bottom (cfs): 36.14
Velocity Top (ft/s): 1.62
Velocity Bottom (ft/s): 1.93
Avg Velocity (ft/s): 1.78
Wave Velocity (ft/s): 2.66
----------------------------------------------------------------------
DATA FOR FLOW PATH 4
----------------------------------------------------------------------
Flow Path Name: 4
FLOW PATH TRAVEL TIME (min): 3.3269
Flow Type: Street
Length (ft): 900
Top Elevation (ft): 48
Bottom Elevation (ft): 44.5
Contributing Area (acres): 15.92
Percent of Sub-Area (%): 23.4
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0039
Q for Flow Path (cfs): 41.87
Q Top (cfs): 36.14
Q Bottom (cfs): 78.01
Velocity Top (ft/s): 2.74
Velocity Bottom (ft/s): 3.27
Avg Velocity (ft/s): 3.01
Wave Velocity (ft/s): 4.51
----------------------------------------------------------------------
DATA FOR FLOW PATH 5
----------------------------------------------------------------------
Flow Path Name: 5
FLOW PATH TRAVEL TIME (min): 0.3201
Flow Type: Street
Length (ft): 200
Top Elevation (ft): 44.5
Bottom Elevation (ft): 40
Contributing Area (acres): 28.3
Percent of Sub-Area (%): 41.6
Street Width (ft): 40
Curb Height (in): 6
Map Slope: 0.0225
Q for Flow Path (cfs): 74.43
Q Top (cfs): 78.01
Q Bottom (cfs): 152.44
Velocity Top (ft/s): 6.40
Velocity Bottom (ft/s): 7.48
Avg Velocity (ft/s): 6.94
Wave Velocity (ft/s): 10.41
----------------------------------------------------------------------
DATA FOR FLOW PATH 6
----------------------------------------------------------------------
Flow Path Name: 6
FLOW PATH TRAVEL TIME (min): 0.2841
```

Flow Type: Natural Channel
Length (ft): 100
Top Elevation (ft): 40
Bottom Elevation (ft): 39.5
Contributing Area (acres): 10.08
Percent of Sub-Area (%): 14.8
Overland Type: Valley
Map Slope: 0.0050
Effective Slope: 0.0050
Q for Flow Path (cfs): 26.51
Q Top (cfs): 152.44
Q Bottom (cfs): 178.95
Velocity Top (ft/s): 3.81
Velocity Bottom (ft/s): 4.01
Avg Velocity (ft/s): 3.91
Wave Velocity (ft/s): 5.87

Proposed Extended Detention Basin Analysis

Design Calculations
Storm Water Quality Design Volume Calculation
Hydraflow Hydrographs Output

Hydrograph Summary Report – 100 YEAR DETENTION REQUIREMENTS

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	Manual	5.100	1	1153	36,047	----	------	------	Unit Hydrograph
2	Manual	95.28	1	1153	673,456	----	------	------	Area A
3	Diversion1	22.55	1	1153	645,067	2	------	------	Q10 EX Outflow
4	Diversion2	72.73	1	1153	28,389	2	------	------	Detention Required
5	Manual	178.95	1	1153	1,264,808	----	------	------	Area B
6	Diversion1	33.83	1	1128	1,197,909	5	------	------	Q10 EX Outflow
7	Diversion2	145.12	1	1153	66,900	5	------	------	Detention Required

*

TTM Basins.gpw	Return Period: 100 Year	Thursday, Oct 18 2007, 11:19 AM

Design Procedure Form for T-3: Extended Detention Basin

Designer: JGK

Company: RBF Consulting

Date: 22-Oct-07

Project: Teal Club

Location: City of Oxnard (Drainage Area A)

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	65	%
b. Effective Imperviousness (Determine using Figure 3-4)	I_{wq} =	60	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u =	0.67	in.
d. Watershed Area Tributary to EDB	Area =	60.9	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	3.40025	acre-ft
f. Calculate Design Volume Design Volume = SQDV x 1.2	Design Volume =	4.0803	acre-ft
2. Outlet Works			
a. Outlet Type (check one)	Single Orifice		
	Multi-orifice Plate		
	Perforated Pipe	X	
	Other		
b. Depth of water above bottom oririce	Depth =	3	feet
c. Single Orifice Outlet			
1) Total Area	A =		square inches
2) Diameter or W x L	D =		inches
d. Multiple Orifice Outlet			
1) Area per row of perforations	A =	1.97	
2) Perforation Diameter (2 inches max.)	D =	3/4	
3) No. of Perforations (columns) per Row	Perforations =	4.5	
4) No. of Rows (4 inch spacing)	Rows =	5.5	
5) Total Orifice Area (Area per row) x (Number of Rows)	Area =	10.835	

Design Procedure Form for T-3: Extended Detention Basin (Page 2 of 2)

Project: Teal Club

3. Trash Rack or Gravel Pack (check one)	Trash Rack ____	Gravel Pack X	
4. Basin Length-Width Ration (2:1 minimum)	Ratio =		L/W
5. Two-Stage Design			
a. Upper Stage			
1) Depth (2 feet minimum)	Depth =		feet
2) Width (30 feet minimum)	Width =		feet
3) Bottom Slope (2% to low flow channel)	Slope =		%
b. Bottom Stage			
1) Depth (1.5 to 3 feet deeper than Upper)	Depth =		feet
2) Storage Volume (5-15% of SQDV min.)	Volume =		acre-ft
6. Forebay Design			
a. Forebay Volume (5-10% of SQDV min.)	Volume =		acre-ft
b. Outlet pipe drainage time (~45 minutes)	Drainage Time		minutes
7. Low Flow Channel			
a. Depth (9 inches min.)	Depth =		feet
b. Flow Capacity (2 x outlet for Forebay)	Flow Capacity =		cfs
8. Vegetation	Native Grasses	X	
	Irrigated Turf		
	Other		
9. Embankment			
a. Interior Slope (4:1 max.)	Interior Slope =	4:01	H/V
b. Exterior Slope (3:1 max.)	Exterior Slope =		H/V
10. Access			
a. Slope (10% max.)	Slope =	10	%
b. Width (16 feet min.)	Width =	16	feet

Notes:

Design Procedure Form for T-3: Extended Detention Basin

Designer: JGK

Company: RBF Consulting

Date: 22-Oct-07

Project: Teal Club

Location: City of Oxnard (Drainage Area B)

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	65	%
b. Effective Imperviousness (Determine using Figure 3-4)	I_{wq} =	60	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u =	0.67	in.
d. Watershed Area Tributary to EDB	Area =	68	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	3.796666667	acre-ft
f. Calculate Design Volume Design Volume = SQDV x 1.2	Design Volume =	4.556	acre-ft
2. Outlet Works			
a. Outlet Type (check one)	Single Orifice		
	Multi-orifice Plate		
	Perforated Pipe	X	
	Other		
b. Depth of water above bottom oririce	Depth =		feet
c. Single Orifice Outlet			
1) Total Area	A =		square inches
2) Diameter or W x L	D =		inches
d. Multiple Orifice Outlet			
1) Area per row of perforations	A =	2.2	
2) Perforation Diameter (2 inches max.)	D =	3/4	
3) No. of Perforations (columns) per Row	Perforations =	5	
4) No. of Rows (4 inch spacing)	Rows =	7	
5) Total Orifice Area (Area per row) x (Number of Rows)	Area =	15.4	

Design Procedure Form for T-3: Extended Detention Basin (Page 2 of 2)

Project: **Teal Club**

3. Trash Rack or Gravel Pack (check one)	Trash Rack ___ Gravel Pack X
4. Basin Length-Width Ration (2:1 minimum)	Ratio = 2:01 L/W
5. Two-Stage Design	
a. Upper Stage	
1) Depth (2 feet minimum)	Depth = ___ feet
2) Width (30 feet minimum)	Width = ___ feet
3) Bottom Slope (2% to low flow channel)	Slope = ___ %
b. Bottom Stage	
1) Depth (1.5 to 3 feet deeper than Upper)	Depth = ___ feet
2) Storage Volume (5-15% of SQDV min.)	Volume = ___ acre-ft
6. Forebay Design	
a. Forebay Volume (5-10% of SQDV min.)	Volume = ___ acre-ft
b. Outlet pipe drainage time (~45 minutes)	Drainage Time ___ minutes
7. Low Flow Channel	
a. Depth (9 inches min.)	Depth = ___ feet
b. Flow Capacity (2 x outlet for Forebay)	Flow Capacity = ___ cfs
8. Vegetation	Native Grasses X Irrigated Turf ___ Other ___
9. Embankment	
a. Interior Slope (4:1 max.)	Interior Slope = 4:01 H/V
b. Exterior Slope (3:1 max.)	Exterior Slope = ___ H/V
10. Access	
a. Slope (10% max.)	Slope = 10 %
b. Width (16 feet min.)	Width = 16 feet

Notes:

Calculation of Stormwater Quality Design Flow and Volume

Introduction

The primary control strategy for all of the treatment control measures specified in this Section is to treat the Stormwater Quality Design Flow (SQDF) or Stormwater Quality Design Volume (SQDV) of the storm water runoff. The following paragraphs present calculation procedures and design criteria necessary to determine the SQDF and SQDV.

The treatment control measure equations specified in this Section are listed in Table 5-2 along with the basis of design, SQDF or SQDV, to be used for the listed control measure.

Table 5-2. Sizing Criteria for Treatment Control Measures

Treatment Control Measure	Design Basis
T-1: Grass Strip Filter	SQDF
T-2: Grass Swale Filter	SQDF
T-3: Dry Detention Basin	SQDV
T-4: Wet Detention Basin	SQDV
T-5: Constructed Wetland	SQDV
T-6: Detention Basin/Sand Filter	SQDV
T-7: Porous Pavement Detention	SQDV
T-8: Porous Landscape Detention	SQDV
T-9: Infiltration Basin	SQDV
T-10: Infiltration Trench	SQDV
T-11: Media Filter	SQDV
T-12: Proprietary Control Measures	SQDV or SQDF

Contributing Impervious Area Determination

The SQDF and SQDV are calculated by determining runoff from the impervious and pervious areas of a site that are connected to the treatment control measure. Impervious areas include sidewalks, roadways, parking areas, staging areas, storage areas, slabs, roofs, and other non-vegetated areas, including compacted soil areas. Off-site areas that could run-on to a site and contribute drainage to the treatment control measure should be included in the impervious area determination. The effective imperviousness of a site can be reduced through implementation of general site design control measures (e.g. G-5.1 and G-5.2) to reduce flow from impervious areas, as described in Section 3. Procedures for calculating effective imperviousness are presented in Section 3, Fact Sheet G-5.

Stormwater Quality Design Flow (SQDF) Calculation

Hydrologic calculations for design of flow-based stormwater treatment control measures in Ventura County shall be in accordance with latest edition of the *Hydrology Manual* produced by Ventura County Public Works Agency, Flood Control Department, together with the procedure set forth herein. The designer is specifically reminded to regard minimum subarea sizes required in the *Hydrology Manual* (p. II-3). Where jurisdictions within Ventura County have approved alternative hydrologic calculation methods, the alternative methods may be utilized if they have been approved by the jurisdiction for use in design of flow-based stormwater quality BMPs. This procedure complies with Regional Board Order No. 00-108, NPDES Permit No. CAS004002, Attachment A – Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan, issued July 27, 2000.

The Stormwater Quality Design Flow (SQDF) is defined to be equal to 10 percent of the peak rate of runoff flow from the 50-year storm as determined using the procedures set forth in the *Hydrology Manual.*

Calculation Procedure

1. The Stormwater Quality Design Flow (SQDF) in Ventura County is defined as $Q_{P, SQDF}$.

2. Calculate the peak rate of flow from the 50-year storm ($Q_{P, 50 yr.}$) using the procedures set forth in the *Hydrology Manual* or as directed by the local agency Drainage Master Plan.

3. Convert $Q_{P, 50yr}$ (Step 2) to $Q_{P, SQDF}$ (Step 1).

$$Q_{P, SQDF} = 0.1 \times Q_{P, 50yr}$$

Example Stormwater Quality Design Flow Calculation

The steps below illustrate calculation of SQDF:

Step 1: SQDF = $Q_{P, SQDF}$

Step 2: Calculate the peak rate of flow from a 50-year storm.

$Q_{p, 50 yr.} = 10$ cfs from the *Hydrology Manual*

Step 3: Convert $Q_{p,50 yr}$ (Step 2) to $Q_{p, SQDF}$ (Step 1)

$$Q_{P, SQDF} = 0.1 \times 10 \text{ cfs}$$

$$Q_{P, SQDF} = 1.0 \text{ cfs}$$

Stormwater Quality Design Volume (SQDV) Calculation

Hydrologic calculations for design of volume-based stormwater treatment controls in Ventura County shall be in accordance with the procedures set forth herein. This procedure complies with Regional Board Order No. 00-108, NPDES Permit No. CAS004002, Attachment A – Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan, issued July 27, 2000.

The Stormwater Quality Design Volume (SQDV) is defined as the volume necessary to capture and treat 80 percent or more of the average annual runoff volume from the site at the design drawdown period specified in the Fact Sheet for the proposed treatment control measure.

Calculation Procedure

1. Review the area draining to the proposed treatment control measure. Determine the effective imperviousness (I_{WQ}) of the drainage area using the procedure presented in Section 3, Fact Sheet G-5.
2. Figure 5-1 provides a direct reading of Unit Basin Storage Volumes required for 80% annual capture of runoff for values of "I_{WQ}" determined in Step 1. Enter the horizontal axis of Figure 5-1 with the "I_{WQ}" value from Step 1. Move vertically up Figure 5-1 until the appropriate drawdown period line is intercepted. (The design drawdown period specified in the respective Fact Sheet for the proposed treatment control measure.) Move horizontally across Figure 5-1from this point until the vertical axis is intercepted. Read the Unit Basin Storage Volume along the vertical axis.

   Figure 5-1 is based on Precipitation Gage 168, Oxnard Airport. This gage has a data record of approximately 40 years of hourly readings and is maintained by Ventura County Flood Control District. Figure 5-1 is for use only in the permit area specified in Regional Board Order No. 00-108, NPDES Permit No. CAS004002.
3. The SQDV for the proposed treatment control measure is then calculated by multiplying the Unit Basin Storage Volume by the contributing drainage area. Due to the mixed units that result (e.g., acre-inches, acre-feet) it is recommended that the resulting volume be converted to cubic feet for use during design.

Example Stormwater Quality Design Volume Calculation

1. Determine the drainage area contributing to control measure, A_t. Example: 10 acres.
2. Determine the area of impervious surfaces in the drainage area, A_i. Example: 6.4 acres.
3. Calculate the percentage of impervious, $I_A = (A_i / A_t)*100$

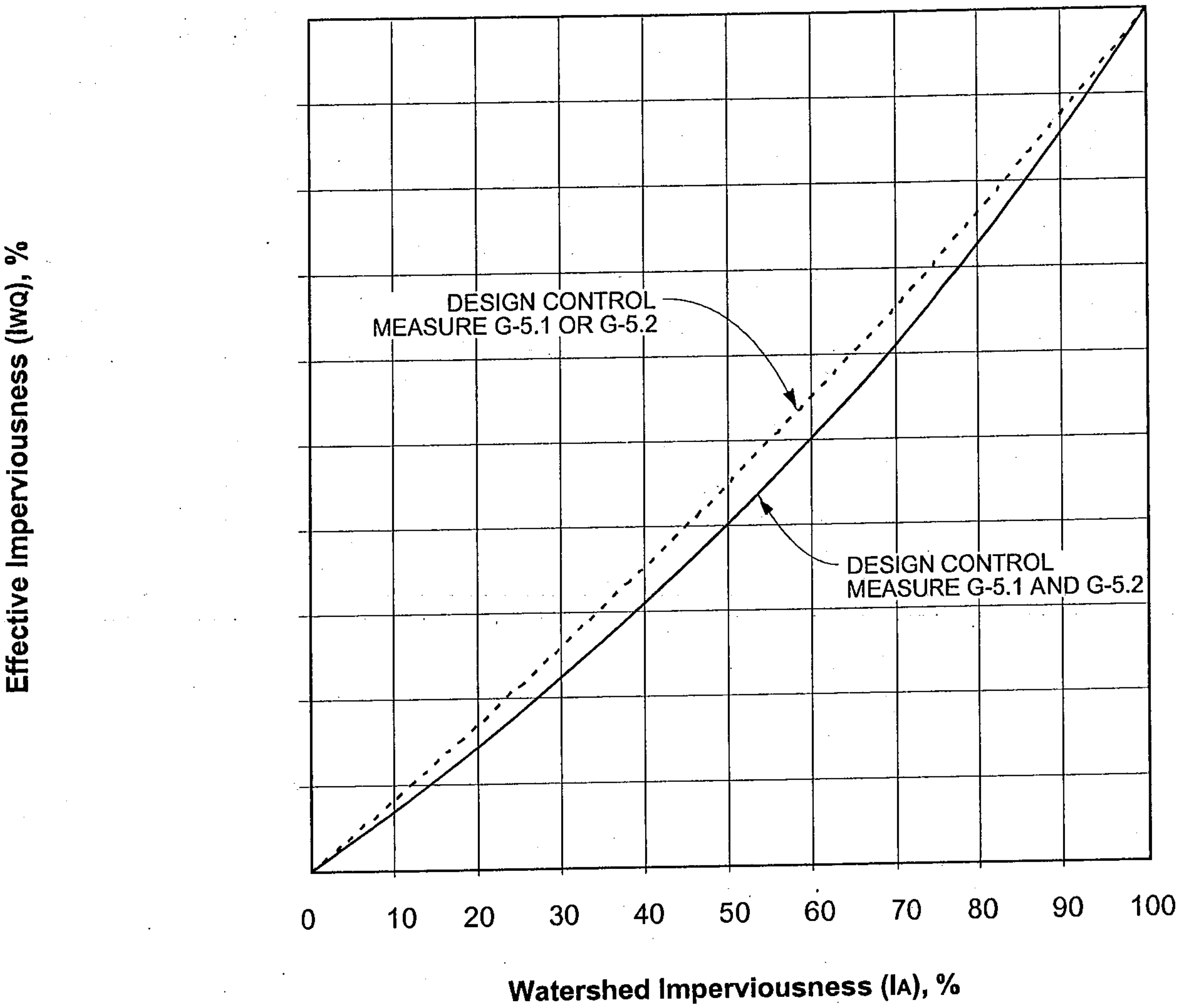
   Example: Percent Imperviousness = $(A_i / A_t)*100$ = (6.4 acres/10 acres)*100 = 64%
4. Determine Effective Imperviousness using Figure 3-4.

   Example: G-5.1 employed → $I_{WQ} = 60\%$
5. Determine design drawdown period for proposed control measure.

   Example: T-3:Extended Detention Basin → Drawdown period = 40 hours
6. Determine the Unit Basin Storage Volume for 80% Annual Capture, V_u using Figure 5-1.

   Example: for $I_{WQ}/100 = 0.60$ and drawdown = 40 hrs, $V_u = 0.64$ in.
7. Calculate the volume of the basin, V_b, where $V_b = V_u * A_t$.

   Example: V_b = (0.64 in)(10 ac)(ft/12 in(43,560 ft^2 / ac) = 23,232 ft^3.
8. Solution: Size the proposed control measure for 23,232 ft^3 and 40-hour drawdown.



G-5.1: TURF BUFFER
G-5.2: GRASS-LINED CHANNEL

ADAPTED FROM URBAN STORM DRAIN CRITERIA MANUAL VOL. 3 - BEST MANAGEMENT PRACTICES, URBAN DRAINAGE AND FLOOD CONTROL DISTRICT,11/99

Figure 3-4. DETERMINATION OF EFFECTIVE IMPERVIOUSNESS

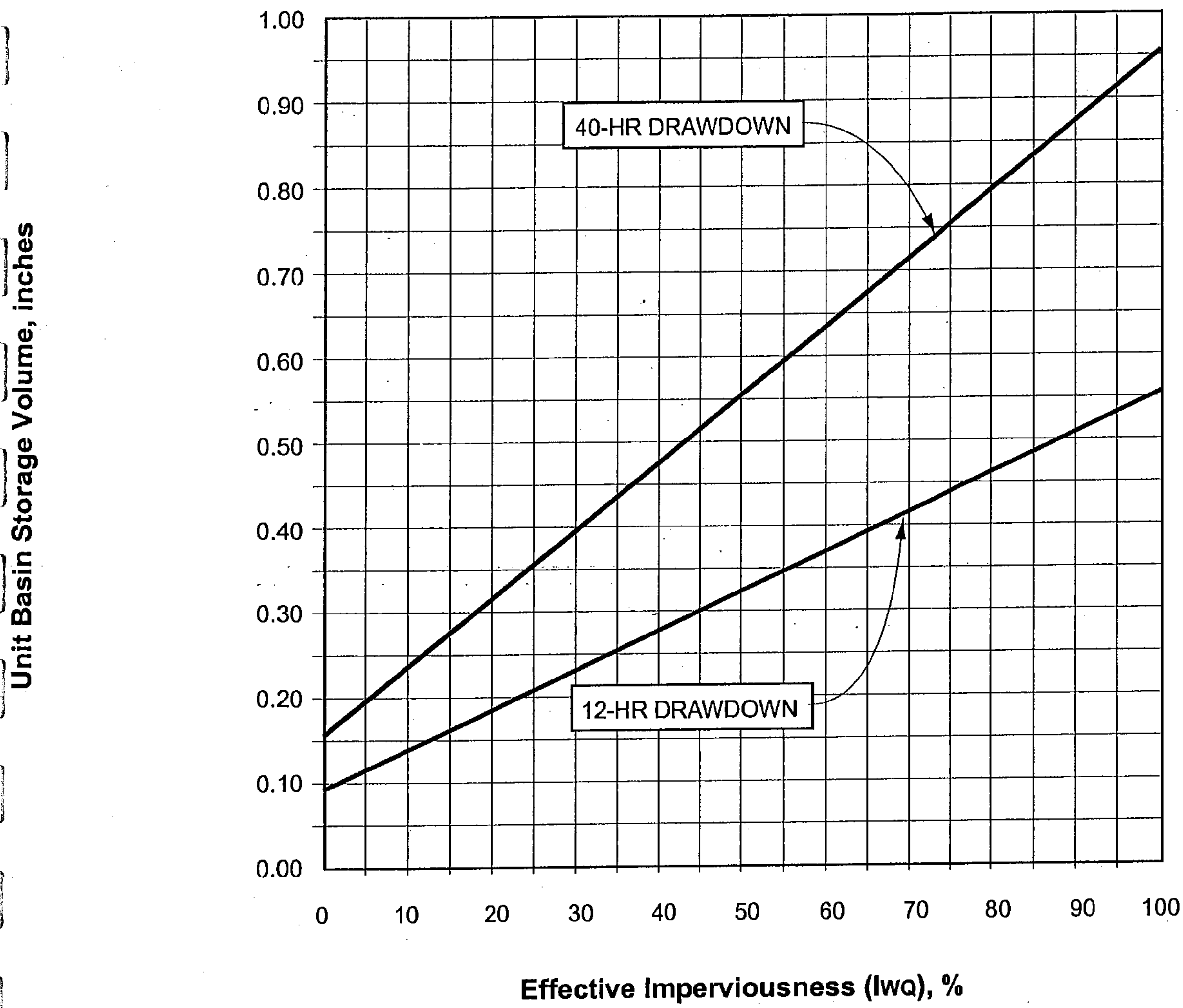


Figure 5-1. Unit Basin Storage Volume vs. Effective Imperviousness

General Site Design Control Measure G-3:

Control Peak Stormwater Runoff Discharge Rates

Purpose

Unless controlled, peak stormwater runoff rates from developed areas are typically higher than those from previously undeveloped areas. Higher peak flows can change stream morphology and increase downstream erosion that can damage stream habitat and impact aesthetic value. In addition, higher flows convey larger pollutant loads to receiving waters. Control of peak stormwater discharge rates is thus required to protect stream habitat and aesthetic value by maintaining non-erosive hydraulic conditions in unlined receiving streams during stormwater runoff events.

Design Criteria

SQUIMP category projects, excluding single family hillside residences, that directly discharge to unlined receiving streams shall implement the following interim criteria:

1. 2-year post development discharge rates shall not exceed the predeveloped discharge rates for the 2-year frequency storm event.
2. Peak flows shall be determined using the procedures set forth in the latest edition of the *Hydrology Manual* and Direct Runoff curves produced by Ventura County Public Works Agency, Flood Control Department. The designer is specifically reminded to regard minimum subarea sizes required in the *Hydrology Manual*. Where jurisdictions within Ventura County have approved alternative hydrologic calculation methods, the alternative methods may be used if they have been approved by the jurisdiction for use in design of flow-based stormwater controls.

The Ventura County Public Works Agency, Flood Control Department is currently developing a modeling procedure to establish peak flow design criteria to avoid erosive conditions. A study in the upper reaches of the Arroyo Simi (Simi Valley) is currently underway to examine the relationship between runoff discharge rates and erosion. The results of the study will be used to revise/finalize the interim peak flow criteria presented in this manual upon approval of the co-permittee cities.

Extended Detention Basin

Description

Extended detention basins (EDB) are permanent basins formed by excavation and/or construction of embankments to temporarily detain the Stormwater Quality Design Volume (SQDV) of stormwater runoff to allow sedimentation of particulates to occur before the runoff is discharged. Extended detention basins are typically dry between storms, although a shallow pool, 1 to 3 feet deep, can be included in the design for aesthetic purposes and to promote biological uptake and conversion of pollutants. A bottom outlet provides controlled slow release of the detained runoff over a specified time period (40 hours for SQDV). The basic elements of an extended detention basin are shown in Figure 5-4. This configuration is most appropriate for large sites.

Surface basins are typical, but underground vaults may be appropriate in a small commercial development. Where irrigation water is available, basins should be vegetated to protect the basin slopes and bottom from erosion. To minimize erosion from inlet flow, basins are to be designed with an inlet energy dissipator and an inlet forebay section divided from the main basin by a secondary berm. The bottom of the basin is sloped toward the outlet end at a grade of approximately two percent. A low flow channel is provided to convey incidental flows directly to the outlet end of the basin.

EDBs are sized to detain and release the SQDV. Storm volumes greater than the SQDV are passed through the basin by means of a secondary outlet or spillway. Outlets are designed to include erosion protection.

General Application

An EDB serves to reduce peak stormwater runoff rates, as well as provide treatment of stormwater runoff. If the basins are constructed early in the development cycle, they can also serve as sediment traps during construction within the tributary area. However, accumulated sediment must be removed after construction activities are complete and before the basin is placed into final long-term use as an EDB. Basins may be designed as dual-use facilities to provide recreational use during the dry season, and can be designed into flood control basins or sometimes retrofitted into existing flood control basins. EDBs that are intended to serve as a flood control basin, as well as a stormwater treatment control measure, must also be designed in accordance with applicable flood control design standards.

EDBs can serve essentially any size tributary area from an individual commercial development to a large residential or regional area, but are typically used for tributary areas greater than 10 acres. They work well in conjunction with other control measures, such as onsite source controls and downstream infiltration basins.

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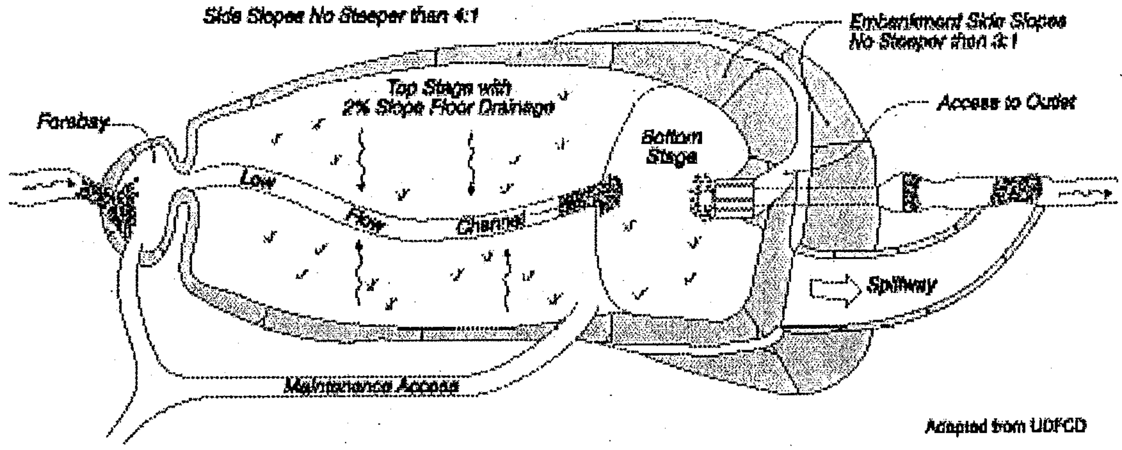
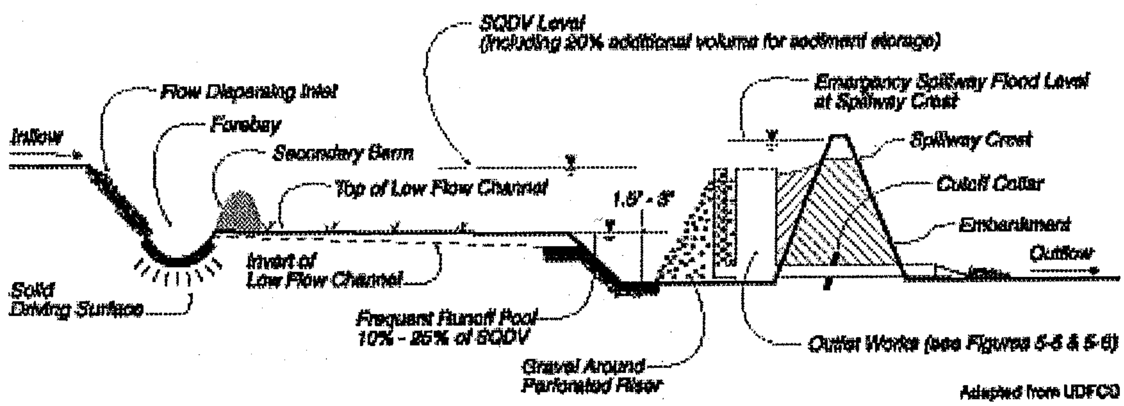


Plan View



Section View

Figure 5-4. Extended Detention Basin Conceptual Layout

Advantages/Disadvantages

General

EDBs may be designed to provide other benefits such as recreation, wildlife habitat, and open space. Safety issues must be address through proper design.

Site Suitability

Space requirements for EDBs are significant. Land requirements for EDBs typically range from approximately 0.5 to 2.0 percent of the of the tributary development area. Groundwater levels must be considered during site evaluation and design. Vector and vegetation control problems can develop when the seasonal high ground water level is above the basin bottom elevation.

Pollutant Removal

Relative pollutant removal effectiveness of an EDB is presented in Table 5-1. Removal effectiveness of EDBs for sediment and particulate forms of metals, nutrients and other pollutants is considered high to moderate. Removal effectiveness for dissolved pollutants is considered low. EDBs may be used upstream of control measures that are more effective at removing soluble pollutants, such as infiltration basins, filters or wetlands.

Design Criteria and Procedure

Principal design criteria for EDBs are listed in Table 5-5.

Table 5-5. Extended Detention Basin Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV / 50% SQDV	hrs	40 / 12 (minimum)
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 40-h drawdown
Basin design volume	acre-ft	1.2 x SQDV (privide 20% sediment storage volume)
Inlet/outlet erosion control	–	Energy dissipator to reduce inlet/outlet velocity
Forebay volume/ drain time	%/min.	5 to 15 % of SQDV / Drain time < 45 minutes
Low-flow channel depth/ flow capacity	in/–	9 / 2 x forebay outlet rate
Bottom slope of upper stage	%	2.0
Length to width ratio (minimum)	–	2:1 (larger preferred)
Upper stage depth/width (minimum)	ft	2.0/30
Bottom stage volume	%	10 to 25 % of SQDV
Bottom stage depth	ft	1.5 to 3 ft deeper than top stage
Freeboard (minimum)	ft	1.0
Embankment side slope (H:V)	–	≥ 4:1 inside/ ≥3:1 outside (without retaining walls)
Maintenance access ramp slope (H:V)	hrs	10:1 or flatter
Maintenance access ramp width	ft	16.0 – approach paved with asphalt concrete

Design procedure and application of design criteria are outlined in the following steps:

a) Basin Storage Volume

Provide a storage volume equal to 120 percent of the SQDV, based on a 40-hr drawdown time, above the lowest outlet (i.e. perforation or orifice) in the basin. The additional 20 percent provides an allowance for sediment accumulation.

a. Determine the percent imperviousness of the tributary area (I_a).

b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 40-hr drawdown and I_{wq} value from Step 1.b.

d. Calculate the SQDV in acre-ft as follows:

$$SQDV = (V_u / 12) \times Area$$

where

Area = Watershed area tributary to EDB in acre-ft

e. Calculate Design Volume in acre-ft as follows:

$$Design\ Volume = SQDV \times 1.2$$

where

1.2 factor = Multiplier to provide for sediment accumulation

2. Outlet Works

The Outlet Works are to be designed to release the SQDV (i.e. not Design Volume) over a 40-hour period, with no more than 50 percent released in 12 hours. Refer to Figures 5-5 and 5-6 for schematics pertaining to structure geometry; grates, trash racks, and screens; outlet type: orifice plate or perforated riser pipe.

a. For perforated pipe outlets or vertical plates with multiple orifices (see Figure 5-5), use the following equation to determine required area per row of perforations, based on the SQDV(ft^2) and depth of water above the centerline of the bottom perforation D_{BS} (ft).

$$Area/row\ (in^2) = SQDV/K_{40}$$

where

$$K_{40} = 0.013D_{BS}^2 + 0.22D_{BS} - 0.10$$

Select appropriate perforation diameter and number of perforations per row (i.e. columns) with the objective of minimizing the number of columns and using a maximum perforation diameter of 2 inches. Rows are spaced at 4 inches on center from the bottom perforation. Thus, there will be 3 rows for each foot of depth plus the top row. The number of rows (nr) may be determined as follows:

$$nr = 1 + (D_{BS} X 3)$$

Calculate total outlet area by multiplying the area per row by number of rows.

$$\text{Total orifice area} = \text{area/row} \times nr$$

b. For single orifice outlet control or single row of orifices at the basin bottom surface elevation (see Figures 5-6), use the following equation based on the SQDV (ft^3) and depth of water above orifice centerline D_{BS} (ft) to determine total orifice area (in^2):

$$\text{Total orifice area} = (SQDV) \div [(60.19)(D_{BS}^{0.5})(T)]$$

where

T = drawdown period (hrs)= 40 hrs

3. **Trash Rack/Gravel Pack**

A trash rack or gravel pack around perforated risers shall be provided to protect outlet orifices from clogging. Trash racks are better suited for use with perforated vertical plates for outlet control and allow easier access to outlet orifices for purposes of inspection and cleaning. Trash rack shall be sized to prevent clogging of the primary water quality outlet without restricting with the hydraulic capacity of the outlet control orifices.

4. **Basin Shape**

Whenever possible, shape the basin with a gradual expansion from the inlet toward the middle and a gradual contraction from middle toward the outlet. The length to width ratio should be a minimum of 2:1. Internal baffling with berms may be necessary to achieve this ratio.

5. **Two-Stage Design**

A two-stage design with a pool that fills often with frequently occurring runoff minimizes standing water and sediment deposition in the remainder of the basin.

a. Upper Stage: The upper stage should be a minimum of 2 feet deep with the bottom sloped at 2 percent toward the low flow channel. Minimum width of the upper stage should be 30 ft.

b. Bottom Stage: The active storage basin of the bottom stage should be 1.5 to 3 feet deeper than the top stage and store 10 to 25 pecent of the SQDV. A mico-pool below the active storage volume of the bottom stage, if provided, should be one-half the depth of the top stage or 2 feet, which ever is greater.

6. **Forebay Design**

The forebay provides a location for sedimentation of larger particles that has a solid bottom surface to facilitate mechanical removal of accumulated sediment. The forebay volume should be 5 to 10 percent of the SQDV. A berm should separate the forebay from the upper stage of the basin. The outlet pipe from be 5 to 10 percent of the SQDV. A berm should separate the forebay from the upper stage of the basin. The outlet pipe from the forebay to the lowflow channel should be sized to drain the forebay volume in 45 minutes. The outlet pipe entrance should be offset from the forebay inlet to prevent short circuiting.

7. **Low-flow Channel** — The low flow channel conveys flow from the forebay to the bottom stage. Erosion protection should be provided where the low-flow channel enters the bottom stage. Lining of the low flow channel with concrete is recommended. The depth of the channel should be at least 9 inches. The flow capacity of the channel should be twice the release capacity of the forebay outlet.

8. **Inlet/Outlet Design** — Basin inlet and outlet points should be provided with an energy dissipation structure and/or erosion protection.

9. **Vegetation** — Bottom vegetation provides erosion protection and sediment entrapment. Basin bottoms, berms, and side slopes may be planted with native grasses or with irrigated turf.

10. **Embankment** — Design embankments to conform to requirements State of California Division of Safety of Dams, if the basin dimensions cause it to fall under that agency's jurisdiction. Interior slopes should be no steeper than 4:1 and exterior slopes no steeper than 3:1. Flatter slopes are preferable.

11. **Access** — All-weather access to the bottom, forebay, and outlet works shall be provided for maintenance vehicles. Maximum grades of access ramps should be 10 percent and minimum width should be 16 feet. Ramps should be paved with concrete.

12. **Bypass** — Provide for bypass or overflow of runoff volumes in excess of the SQDV. Spillway and overflow structures should be designed in accordance with applicable standards of the Ventura County Flood Control District.

13. **Geotextile Fabric** — Non-woven geotextile fabric used in conjunction with gravel packs around perforated risers shall conform the specifications listed in Table 5-6.

Table 5-6. Non-woven Geotextile Fabric Specifications

Property	Test Reference	Minimum Specification
Grab Strength	ASTM D4632	90 lbs
Elongation at peak load	ASTM D4632	50 %
Puncture Strength	ASTM D3787	45 lbs
Permitivity	ASTM D4491	0.7 sec^{-1}
Burst Strength	ASTM D3786	180 psi
Toughness	% Elongation x Grab Strength	5,500 lbs
Ultraviolet Resistance (Percent strength retained at 500 Weatherometer hours)	ASTM D4355	70%

Adapted from SSPWC, 1997.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

City of Oxnard Master Plan of Drainage

October 2003

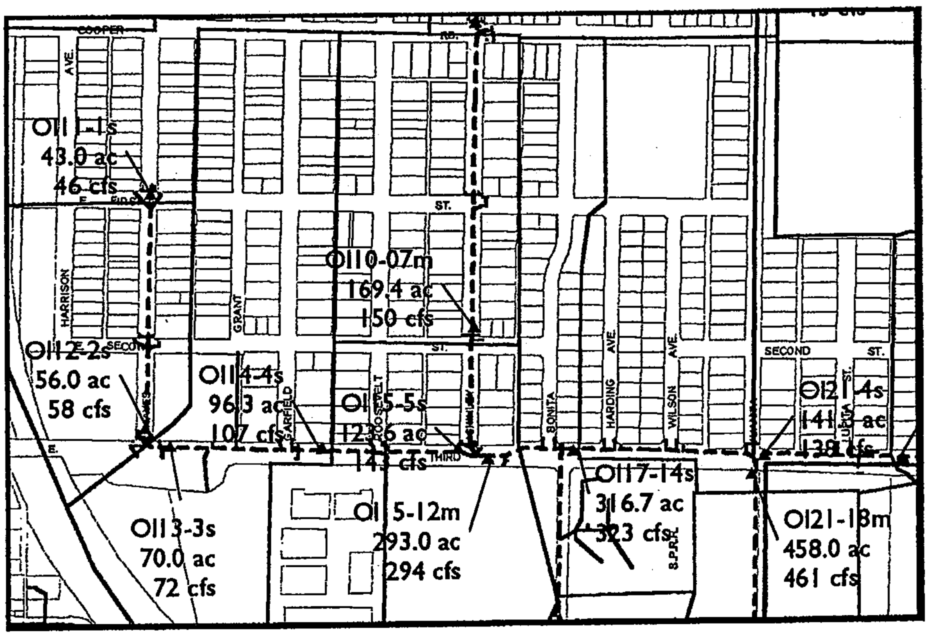
PRINTED AUG, 2004

City of Oxnard

"The City That Cares"

MASTER PLAN OF DRAINAGE

OCTOBER 2003



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