DRAIN STUDY

LINCOLN MEADOWS

City of Lincoln, California
November 23, 2015

Prepared by:

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I. Introduction

The proposed Lincoln Meadows subdivision will divide 40 acres into 148 low density single family homes. The purpose of this report is to determine the runoff generated by development of the subdivision and the pipe system to convey the runoff to the outfalls.

Location

The Lincoln Meadows project is located on the northwest corner of the intersection of Virginatown Road and Hungry Hollow Road, in the City of Lincoln (See Figure 1).

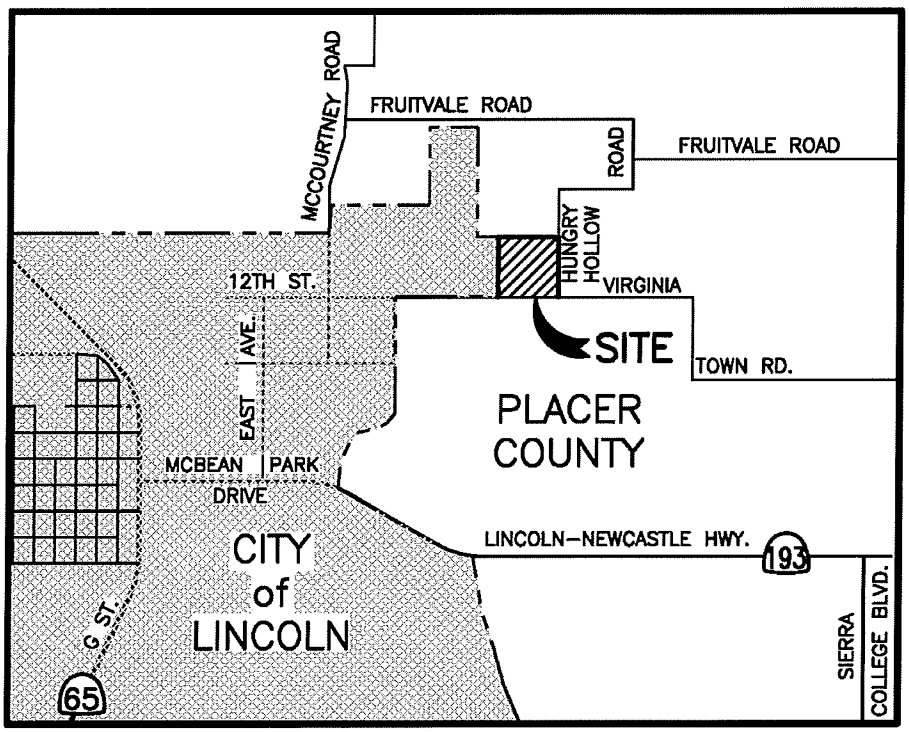


Figure 1 - Vicinity Map

II. Narrative

The Lincoln Meadows project drains into two watersheds; the north portion of the project drains to Markham Ravine and the south portion drains to Auburn Ravine. Lincoln Meadows will be developed according to the City of Lincoln Design Criteria and Procedures Manual. Low Impact Development (LID) measures will be implemented to provide infiltration and evaporation opportunities for the runoff, which will reduce the flows into the drain system and help mitigate increased flows due to development. Two detention basins will be built to maintain the post-project flows at 90% of the pre-project flows, one for each watershed, and will be sized to treat the remaining runoff from the impervious area that has not been treated by the LID measures.

III. Runoff and Flow Projections

The design flow was determined by using the City of Lincoln Design Criteria and Procedures Manual, Section 10-7. The spreadsheet for the drain pipe calculations was also developed from procedures outlined in Section 10-7. The Preliminary Drainage Study Exhibit depicts all of the sheds and pipe sizes comprising the proposed drain system, this exhibit is included in Appendix 'A' and the calculation spreadsheet is in Appendix 'B'.

LID measures will be installed in Lincoln Meadows to reduce the runoff from impervious surfaces. These measures include: disconnected roof drains, interceptor trees, and detached sidewalk.
The runoff reduction worksheet Form D-1e calculates the Water Quality Flow (WQF) created by the project . This worksheet was developed for Sacramento, Roseville and Folsom, but since the site has minimal clay soil and the rainfall intensity is similar to that in Roseville, this worksheet can be used to determine the runoff reduction for Lincoln Meadows. The WQF is generated by the 2 year or less "first flush" storm. The formula to calculate this flow is WQF = ciA, where c is the runoff coefficient, i is the rainfall intensity and A is the adjusted area for treatment , which is reduced due to the LID measures being incorporated into the project. Volume based treatment provided by the detention basins is proposed for Lincoln Meadows, Roseville uses the CASQA volume calculation.
The north and south watersheds each have a Form D-1e worksheet and these have been included in Appendix 'C'.

The two detention basins that will provide flow attenuation and water treatment are currently being designed by West Yost Associates and will be included in Appendix 'D' when available.

IV. Drain System

Lincoln Meadows will construct a storm drain system; the location of the storm drain system will be five feet north or west of the street centerline, as specified in the City of Lincoln Design Criteria and Procedures Manual, Section 10-5. The drain system will be sized to carry the 10 year storm, as specified in the City of Lincoln Design Criteria and Procedures Manual, Section 10-6, pipe sizes vary from 12" diameter to 30" diameter. The flow from larger storm events will travel overland in the streets to outfall points into Lot A; the allowable street encroachments specified in Table 10-1 will be maintained. All lot grading will be designed to have a minimum of one foot of freeboard above the 100 year water surface elevation.

V. Project Phasing

The Lincoln Meadows project is proposed to be broken up in two phases: Phase 1 building 76 lots and Phase 2 building the remaining 72 lots. While phasing is anticipated, this report analyzes the entire project being completely built out.

VI. Conclusions

The development of the Lincoln Meadows will be done utilizing practices and construction methods that will prevent impacting the existing flows and water quality of the Auburn Ravine and Markham Ravine watersheds that will receive drainage from this project.

The development of Lincoln Meadows will be done according to the City of Lincoln Design Criteria and Procedures Manual Chapter 10 which specifies how to design drainage systems.

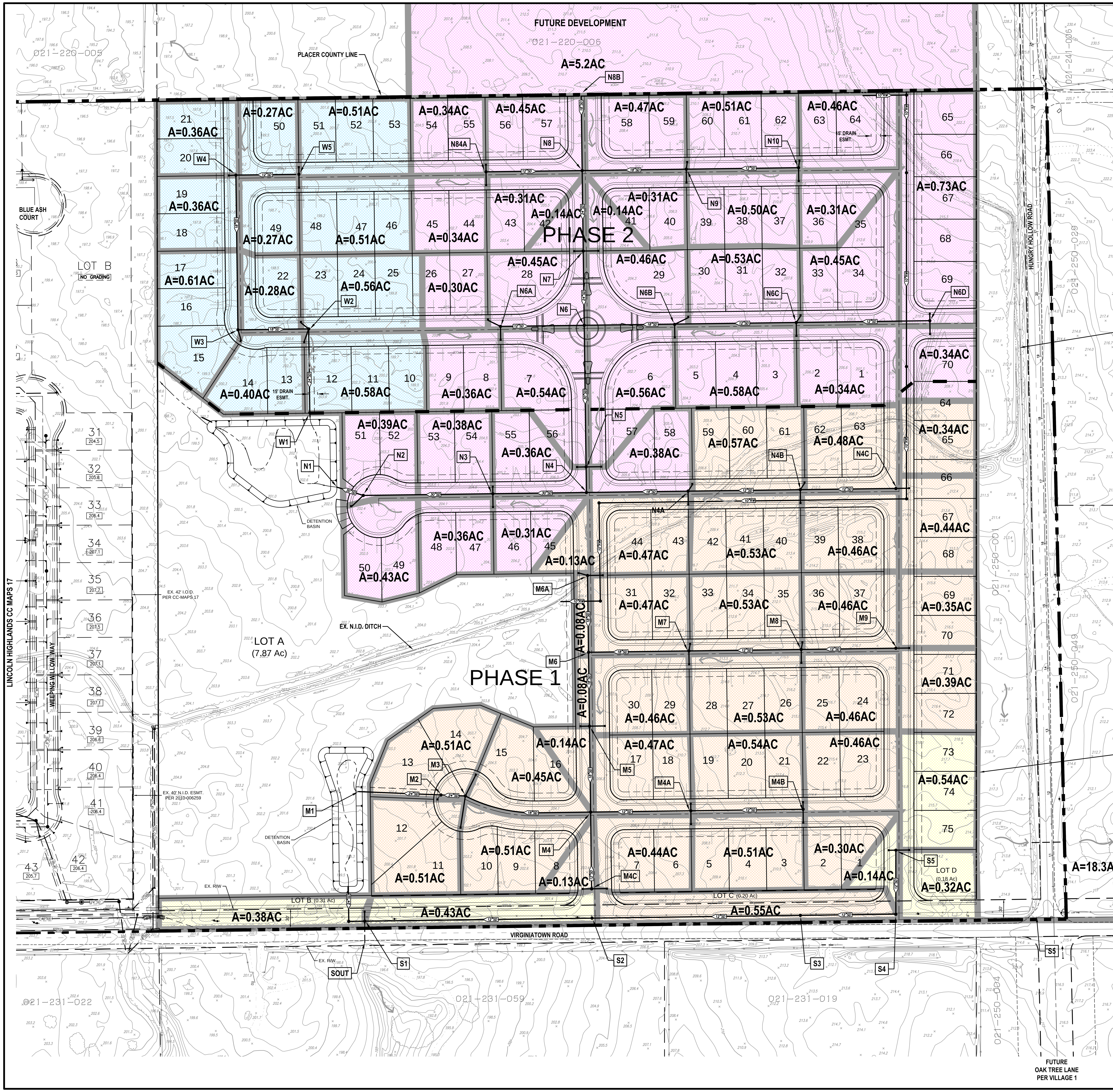
LID measures such as disconnected roof drains, interceptor tree planting and detached sidewalks will be used to reduce the runoff that increases from the impervious surfaces constructed with development.

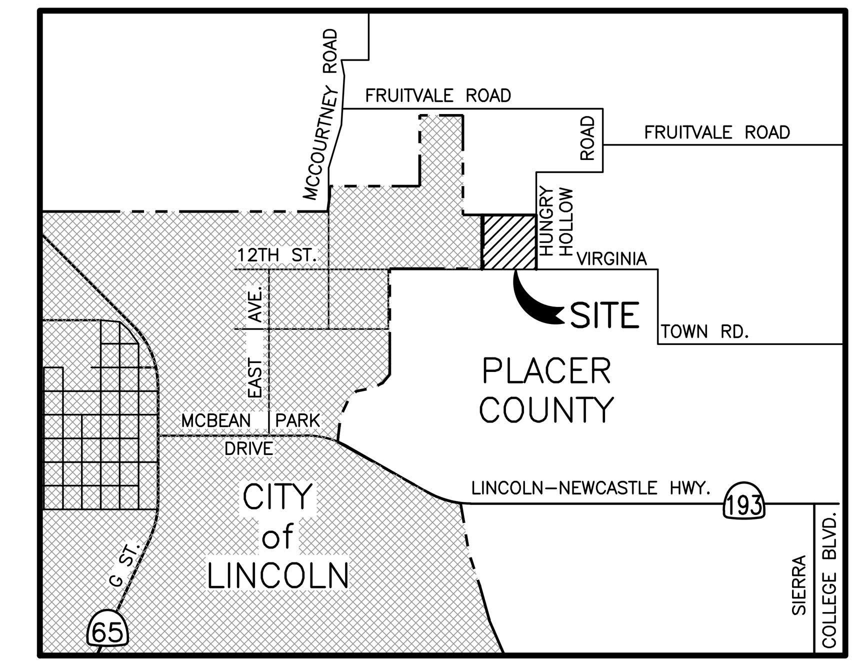
Peak flow increases will be mitigated by the construction of two detention basins, one for each of the watersheds existing on the property.

A Storm Water Pollution Prevention Program (SWPPP) will be developed for Lincoln Meadows and it will include an erosion control plan that indicates where Best Management Practices (BMP) measures will be implemented during construction to prevent soil and pollutants from entering the watersheds.

APPENDIX A

Preliminary Drainage Study Exhibit





VICINITY MAP

NO SCALE

LEGEND:

- NORTH SHED
- WEST SHED
- MIDDLE SHED
- SOUTH SHED

PRELIMINARY DRAINAGE STUDY
LINCOLN MEADOWS

CITY OF LINCOLN - PLACER COUNTY - CALIFORNIA
OCTOBER 19, 2015 SCALE: 1"=60'
BAKER-WILLIAMS ENGINEERING GROUP

BAKER-WILLIAMS ENGINEERING GROUP
Engineering / Surveying / Land Planning / Entitlement Processing / GPS Services
6020 Rutland Drive, Suite 19 ~ Carmichael CA 95608
(916) 331-4336 ~ fax (916) 331-4430 ~ office@bwengineers.com

0301012-PREL-DRAIN STUDY

APPENDIX B

Calculation Spreadsheet

NODE	TO	FROM	AREA (acres)	CUM AREA	*Tr overland (min)	**Tr collector (min)	V (ft/s)	L (ft)	Tr conduit (min)	Total Response (min)	q_{10}	q_{25}	q_{100}	Fi	50%AP	FiAp	Qp_{10}= q_{10}A-FiAp	Qp_{25}= q_{25}A-FiAp	Qp_{100}= q_{100}A-FiAp	STORM DRAIN PIPE DIA	SLOPE	L	Qmax	VEL	10 yr HYD GRADE LINE n	SLOPE	RIM	UPPER MH	LOWER MH
NORTH SHED																													
DI-N10N	N10	OVERLAND	0.46	**0.46**	15.00	5.68	2.8	12	0.07	**20.7**	1.28	1.66	2.04	0.2	0.23	0.0	**0.54**	0.72	**0.89**	12	0.0050	12	**2.19**	2.8	0.015	0.0003			
DI-N10S	N10	OVERLAND	0.31	**0.31**	15.00	5.24	2.8	24	0.14	**20.2**	1.30	1.68	2.06	0.2	0.16	0.0	**0.37**	0.49	**0.61**	12	0.0050	24	**2.19**	2.8	0.015	0.0001			
N10	N9	DI-N10N&DI-N10S	0.00	**0.77**			6.8	180	0.44	**20.4**	1.29	1.67	2.06	0.2	0.39	0.1	**0.92**	1.21	**1.51**	12	0.0300	180	**5.36**	6.8	0.015	0.0009			
N9	N8	N10, DI-N9N&DI-N9S	1.79	**2.56**			2.3	160	1.16	**20.8**	1.27	1.65	2.03	0.2	1.28	0.3	**2.99**	3.97	**4.95**	18	0.0020	160	**4.08**	2.3	0.015	0.0011			
N8	N7	N9, N8A&N8B	0.00	**9.20**			3.7	130	0.59	**22.0**	1.21	1.61	1.98	0.2	4.60	0.9	**10.21**	13.87	**17.29**	24	0.0035	130	**11.62**	3.7	0.015	0.0027			
N7	N6	N8, DI-N7E&DI-N7W	0.28	**9.48**			3.7	120	0.54	**22.6**	1.18	1.59	1.95	0.2	4.74	0.9	**10.26**	14.10	**17.57**	24	0.0035	120	**11.62**	3.7	0.015	0.0027			
N6	N5	N7, N6A&N6B	0.00	**14.02**			3.6	215	0.99	**23.1**	1.16	1.57	1.93	0.2	7.01	1.4	**14.84**	20.59	**25.66**	30	0.0025	215	**17.81**	3.6	0.015	0.0017			
N5	N4	N6, DI-N5E&DI-N5W	1.48	**15.50**			3.6	40	0.18	**24.1**	1.12	1.54	1.89	0.2	7.75	1.6	**15.76**	22.25	**27.75**	30	0.0025	40	**17.81**	3.6	0.015	0.0020			
N4	N3	N5&N4A	0.00	**18.32**			4.3	150	0.58	**24.3**	1.11	1.53	1.88	0.2	9.16	1.8	**18.49**	26.20	**32.67**	30	0.0035	150	**21.08**	4.3	0.015	0.0027			
N3	N2	N4, DI-N3N&DI-N3S	1.41	**19.73**			4.3	210	0.82	**24.9**	1.09	1.51	1.86	0.2	9.87	2.0	**19.47**	27.86	**34.74**	30	0.0035	210	**21.08**	4.3	0.015	0.0030			
N2	N1	N2&DI-N2S	0.82	**20.55**			4.3	40	0.16	**25.7**	1.06	1.49	1.83	0.2	10.28	2.1	**19.66**	28.52	**35.57**	30	0.0035	40	**21.08**	4.3	0.015	0.0031			
N1																													
N8B	N8	OFFSITE	5.20	**5.20**																									
N8																													
DI-N8AN	N8A	OVERLAND	0.79	**0.79**	15.00	9.95	2.8	12	0.07	**25.0**	1.08	1.51	1.86	0.2	0.40	0.1	**0.78**	1.11	**1.39**	12	0.0050	12	**2.19**	2.8	0.015	0.0006			
DI-N8AS	N8A	OVERLAND	0.65	**0.65**	15.00	7.29	2.8	24	0.14	**22.4**	1.19	1.59	1.96	0.2	0.33	0.1	**0.71**	0.97	**1.21**	12	0.0050	24	**2.19**	2.8	0.015	0.0005			
N8A	N8	DI-N8AN&DI-N8AS	0.00	**1.44**			2.8	155	0.93	**26.0**	1.05	1.48	1.82	0.2	0.72	0.1	**1.36**	1.99	**2.48**	12	0.0050	155	**2.19**	2.8	0.015	0.0020			
N8																													
DI-N6AN	N6A	OVERLAND	0.75	**0.75**	15.00	8.48	2.8	12	0.07	**23.5**	1.14	1.55	1.91	0.2	0.38	0.1	**0.78**	1.09	**1.36**	12	0.0050	12	**2.19**	2.8	0.015	0.0006			
DI-N6AS	N6A	OVERLAND	0.36	**0.36**	15.00	8.18	2.8	24	0.14	**23.3**	1.15	1.56	1.92	0.2	0.18	0.0	**0.38**	0.53	**0.66**	12	0.0050	24	**2.19**	2.8	0.015	0.0001			
N6A	N6A	DI-N6AN&DI-N6AS	0.00	**1.11**			2.8	130	0.78	**24.3**	1.11	1.53	1.88	0.2	0.56	0.1	**1.12**	1.59	**1.98**	12	0.0050	130	**2.19**	2.8	0.015	0.0013			
N6																													
DI-N6DN	N6D	OVERLAND	0.73	**0.73**	15.00	5.24	2.8	12	0.07	**20.3**	1.30	1.67	2.06	0.2	0.37	0.1	**0.87**	1.15	**1.43**	12	0.0050	12	**2.19**	2.8	0.015	0.0008			
DI-N6DS	N6D	OVERLAND	0.13	**0.34**	15.00	4.02	2.8	24	0.14	**19.2**	1.32	1.72	2.12	0.2	0.17	0.0	**0.42**	0.55	**0.69**	12	0.0050	24	**2.19**	2.8	0.015	0.0002			
N6D	N6C	DI-N6DN&DI-N6DS	0.00	**1.07**			2.8	155	0.93	**21.2**	1.25	1.64	2.01	0.2	0.54	0.1	**1.23**	1.64	**2.05**	12	0.0050	200	**2.19**	2.8	0.015	0.0016			
N6C	N6B	N6D, DI-N6CN&DI-N6CS	0.79	**1.86**			2.8	190	1.14	**22.4**	1.19	1.59	1.96	0.2	0.93	0.2	**2.03**	2.78	**3.46**	12	0.0050	190	**2.19**	2.8	0.015	0.0043			
N6B	N6	N6C, DI-N6BN&DI-N6BS	1.57	**3.43**			3.6	140	0.64	**23.0**	1.16	1.57	1.93	0.2	1.72	0.3	**3.64**	5.05	**6.29**	18	0.0050	140	**6.45**	3.6	0.015	0.0016			
N6																													
DI-N4CE	N4C	OVERLAND	0.78	**0.78**	15.00	5.24	2.8	12	0.07	**20.3**	1.30	1.67	2.06	0.2	0.39	0.1	**0.93**	1.23	**1.53**	12	0.0050	12	**2.19**	2.8	0.015	0.0009			
N4C	N4B	DI-N4CE	0.00	**0.78**			2.8	150	0.90	**21.2**	1.25	1.64	2.01	0.2	0.39	0.1	**0.90**	1.20	**1.49**	12	0.0050	150	**2.19**	2.8	0.015	0.0008			
N4B	N4A	N4C, DI-N4BN&DI-N4BS	0.94	**1.72**			3.6	180	0.82	**22.0**	1.21	1.61	1.98	0.2	0.86	0.2	**1.90**	2.59	**3.23**	18	0.0050	180	**6.45**	3.6	0.015	0.0004			
N4A	N4	N4B, DI-N4AN&DI-N4AS	1.10	**2.82**			3.6	160	0.73	**22.8**	1.17	1.58	1.94	0.2	1.41	0.3	**3.03**	4.17	**5.20**	18	0.0050	160	**6.45**	3.6	0.015	0.0011			
N4																													
MILDDE SHED																													
DI-M9E	M9	OVERLAND	0.74	**0.74**	15.00	5.24	2.8	24	0.14	**20.2**	1.30	1.68	2.06	0.2	0.37	0.1	**0.89**	1.17	**1.45**	12	0.0050	24	**2.19**	2.8	0.015	0.0008			
M9	M8	DI-N9E	0.00	**0.74**			2.8	140	0.84	**20.4**	1.29	1.67	2.06	0.2	0.37	0.1	**0.88**	1.16	**1.45**	12	0.0050	140	**2.19**	2.8	0.015	0.0008			
M8	M7	M9, DI-M8N&DI-M8S	0.92	**1.66**			2.8	180	1.08	**21.2**	1.25	1.64	2.01	0.2	0.83	0.2	**1.90**	2.55	**3.18**	12	0.0050	180	**2.19**	2.8	0.015	0.0038			
M7	M6	M8, DI-M7N&DIM7S	1.06	**2.72**			5.1	160	0.52	**22.3**	1.19	1.60	1.96	0.2	1.36	0.3	**2.98**	4.07	**5.07**	18	0.0100	160	**9.12**	5.1	0.015	0.0011			
M3	M2	M4, DI-M3N&DI-M3S	0.96	**8.90**			6.2	35	0.09	**24.4**	1.11	1.53	1.88	0.2	4.45	0.9	**8.96**	12.70	**15.84**	24	0.0100	35	**19.65**	6.2	0.015	0.0021			
M2	M1	M3&DI-M22	1.02	**9.92**			6.2	135	0.36	**24.5**	1.10	1.52	1.88	0.2	4.96	1.0	**9.95**	14.13	**17.62**	24	0.0100	135	**19.65**	6.2	0.015	0.0026			
M1																													
M6A	M6	DI-M6AE&DI-M6AW	1.14	**1.14**	15.00	9.95	2.8	125	0.75	**25.7**	1.06	1.49	1.83	0.2	0.57	0.1	**1.09**	1.58	**1.97**	12	0.0050	125	**2.19**	2.8	0.015	0.0012			
M6																													
DI-M4CE	M4C	OVERLAND	0.99	**0.99**	15.00	9.95	2.8	12	0.07	**25.0**	1.08	1.51	1.86	0.2	0.50	0.1	**0.97**	1.39	**1.74**	12	0.0050	12	**2.19**	2.8	0.015	0.0010			
DI-M4CW	M4C	OVERLAND	0.13	**0.13**	15.00	7.29	2.8	24	0.14	**22.4**	1.19	1.59	1.96	0.2	0.07	0.0	**0.14**	0.19	**0.24**	12	0.0050	24	**2.19**	2.8	0.015	0.0000			
M4C	M4	DI-M4CE&DI-M4CW	0.00	**1.12**			2.8	120	0.72	**25.7**	1.05	1.49	1.83	0.2	0.56	0.1	**1.07**	1.55	**1.94**	12	0.0050	120	**2.19**	2.8	0.015	0.0012			
M4C																													
DI-M4BN	M4B	OVERLAND	0.46	**0.46**	15.00	5.24	2.8	12	0.07	**20.3**	1.30	1.67	2.06	0.2	0.23	0.0	**0.55**	0.72	**0.90**	12	0.0050	12	**2.19**	2.8	0.015	0.0003			
DI-M4BS	M4B	OVERLAND	0.30	**0.30**	15.00	4.02	2.8	24	0.14	**19.2**	1.32	1.72	2.12	0.2	0.15	0.0	**0.37**	0.49	**0.61**	12	0.0050	24	**2.19**	2.8	0.015	0.0001			

* From Fig. 5-1 Placer County
Drainage Manual
** From Fig. 5-2 Placer County Drainage Manual

NODE	TO	FROM	AREA	CUM AREA	*Tr	**Tr	V	L	Tr	Total	q_{10}	q_{25}	q_{100}	Fi	50%AP	FiAp	Qp_{10}=	Qp_{25}=	Qp_{100}=	STORM DRAIN PIPE					10 yr HYD GRADE LINE				
			(acres)		overland (min)	collector (min)	(ft/s)	(ft)	conduit (min)	Response (min)							q_{10}A-FiAp	q_{25}A-FiAp	q_{100}A-FiAp	DIA	SLOPE	L	Qmax	VEL	n	SLOPE	RIM	UPPER MH	LOWER MH
M4B	M4A	DI-M4BN&DI-M4BS	0.00	**0.76**			2.8	180	1.08	**21.4**	1.24	1.63	2.01	0.2	0.38	0.1	**0.87**	1.16	**1.45**	12	0.0050	180	**2.19**	2.8	0.015	0.0008			
M4A	M4	M4B,DI-M4AN&DI-M4AS	1.05	**1.81**			2.8	160	0.96	**22.4**	1.19	1.59	1.96	0.2	0.91	0.2	**1.98**	2.71	**3.37**	12	0.0050	160	**2.19**	2.8	0.015	0.0041			
M4																													
SOUTH SHED																													
DI-S5E	S5	OVERLAND	0.86	**0.86**	15.00	9.95	2.8	24	0.14	**25.1**	1.08	1.51	1.85	0.2	0.43	0.1	**0.84**	1.21	**1.51**	12	0.0050	24	**2.19**	2.8	0.015	0.0007			
DI-S5S	S5	OVERLAND	0.14	**0.14**	15.00	7.29	2.8	12	0.07	**22.4**	1.19	1.59	1.96	0.2	0.07	0.0	**0.15**	0.21	**0.26**	12	0.0050	12	**2.19**	2.8	0.015	0.0000			
S5	S4	DI-S4AE&DI-S4AW	0.00	**1.00**			2.8	105	0.63	**25.7**	1.06	1.49	1.83	0.2	0.50	0.1	**0.96**	1.39	**1.73**	12	0.0050	105	**2.19**	2.8	0.015	0.0010			
S4	S3	S5&S4A	0.00	**1.00**			3.9	155	0.66	**23.0**	1.16	1.57	1.93	0.2	0.50	0.1	**1.06**	1.47	**1.83**	12	0.0100	155	**3.09**	3.9	0.015	0.0012			
S3	S2	S4	0.00	**1.00**			3.9	330	1.40	**27.1**	1.01	1.45	1.78	0.2	0.50	0.1	**0.91**	1.35	**1.68**	12	0.0100	330	**3.09**	3.9	0.015	0.0009			
S2	S1	S3	0.00	**1.00**			3.9	365	1.55	**24.6**	1.10	1.52	1.87	0.2	0.50	0.1	**1.00**	1.42	**1.77**	12	0.0100	365	**3.09**	3.9	0.015	0.0010			
S1	SOUT	M1, S2&DI-S1N	0.81	**11.73**			8.2	45	0.09	**27.2**	1.00	1.45	1.78	0.2	5.87	1.2	**10.61**	15.78	**19.69**	36	0.0100	45	**57.93**	8.2	0.015	0.0003			
SOUT																													
WEST SHED																													
DI-W5N	W5	OVERLAND	0.78	**0.78**	15.00	5.68	2.8	12	0.07	**20.7**	1.28	1.66	2.04	0.2	0.39	0.1	**0.92**	1.22	**1.51**	12	0.0050	12	**2.19**	2.8	0.015	0.0009			
DIW5S	W5	OVERLAND	0.78	**0.78**	15.00	5.24	2.8	24	0.14	**20.2**	1.30	1.68	2.06	0.2	0.39	0.1	**0.94**	1.23	**1.53**	12	0.0050	24	**2.19**	2.8	0.015	0.0009			
W5	W4	DI-W5N&DI-W5S	0.00	**1.56**			2.8	100	0.60	**21.3**	1.24	1.63	2.01	0.2	0.78	0.2	**1.79**	2.39	**2.98**	12	0.0050	100	**2.19**	2.8	0.015	0.0033			
W4	W3	W4, W4A&DI-W4W	0.72	**2.28**			3.6	245	1.12	**22.4**	1.19	1.59	1.96	0.2	1.14	0.2	**2.49**	3.40	**4.24**	18	0.0050	245	**6.45**	3.6	0.015	0.0007			
W3	W2	W3&DI-W3S	0.61	**2.89**			3.6	120	0.55	**23.0**	1.17	1.57	1.94	0.2	1.45	0.3	**3.08**	4.26	**5.31**	18	0.0050	120	**6.45**	3.6	0.015	0.0011			
W2	W1	W2, DI-W2N&DI-W3S	1.82	**4.71**			4.4	150	0.57	**23.5**	1.14	1.55	1.91	0.2	2.36	0.5	**4.90**	6.85	**8.54**	24	0.0050	150	**13.89**	4.4	0.015	0.0006			
W1																													

* From Fig. 5-1 Placer County
Drainage Manual
** From Fig. 5-2 Placer County Drainage Manual

APPENDIX C

Form D-1e
LID Worksheets

Appendix D-1: Residential Sites: Runoff Reduction Credits and Treatment BMP Sizing Calculations

Name of Drainage Shed: Markham Ravine-North Shed

Fill in Highlighted Boxes

Project Located in Roseville

Step 1 - Calculate Area Requiring Treatment

Drainage Shed Area		24.8	acres	A
Open Space and Parks Acreage*		4.2		A_{OS}
Treatment Area	$A - A_{OS}$ =	20.6		A_T
Number of Units in A_T		100		
Number of units per acre in A_T	DU/A_T =	5		
Assumed Initial Impervious Fraction (determine using Table D-1a)		0.35		I

See Area Example Below

*. Includes all areas maintained in a natural state and planned for landscaped park areas

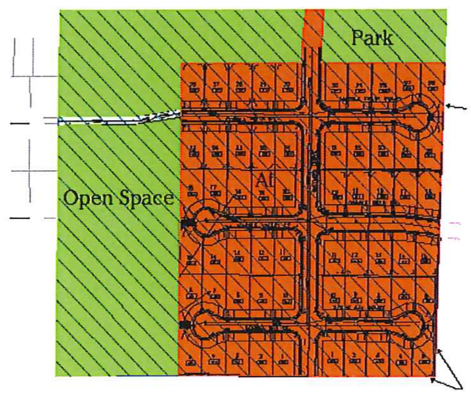
Table D-1a

Dwelling units per acre	Imperviousness
1	0.17
2	0.25
3,4	0.35
5,6	0.40
7	0.50
8,9	0.55
10-14	0.60
15-20	0.70

A - Drainage Shed Area

Aos - Parks and Open Space

AT - Area with Runoff Reduction Potential



Step 2 - Calculate Impervious Area Treatments

Runoff Reduction Measures			Effective Area Managed (A_C)	
Disconnected Roof Drains (see Fact Sheet)	use Form D-1a for credits	→	3.52	acres
Disconnected Pavement (see Fact Sheet)	use Form D-1b for credits	→	0.77	acres
Interceptor Trees (see Fact Sheet)	use Form D-1c for credits	→	0.69	acres
Alternative Driveway Design (see Fact Sheet)	use Form D-1d for credits	→	0.00	acres
Total Effective Area Managed (Credit Area)		A_C	4.98	acres

Adjusted Area for Flow-Based Treatment	$A_T - A_C$ =	15.57	acres	A_{AT}
Adjusted Impervious Fraction for A	$(A_T(I) - A_C) / A$ =	0.09		I_A

Form D-1a: Disconnected Roof Drains Worksheet

See Fact Sheet for more information regarding Disconnected Roof Drain credit guidelines

Effective Area Managed (A_c)

1. Determine efficiency Multiplier

Runoff is directed to a dispersal trench or dry well (Type A and B soils only)		1.00
Runoff is directed across landscaping, determine setback		
25 ft +	Use multiplier of	1.00
≥ 20 and < 25 ft	Use multiplier of	0.90
≥ 15 and < 20 ft	Use multiplier of	0.70
≥ 10 and < 15 ft	Use multiplier of	0.45
≥ 5 and < 10 ft	Use multiplier of	0.25

Efficiency Multiplier → 0.90 Box J1

2. Determine percentage of roof drains disconnected → 100.0% Box J2

3. Select project density in dwelling units per acre:

1	Use reduction factor of	0.08
2	Use reduction factor of	0.13
3,4	Use reduction factor of	0.19
5,6	Use reduction factor of	0.23
7	Use reduction factor of	0.29
8,9	Use reduction factor of	0.33
10-14	Use reduction factor of	0.37
15-20	Use reduction factor of	0.44

Reduction Factor → 0.19 Box J3

4. Determine Area Managed

Multiply Box J3 by A_T, and enter the result in Box J4 — 3.9 acres — Box J4

5. Multiply Boxes J1, J2 and J4, and enter the Result in Box J — 3.5 acres — Box J

This is the amount of area credit to enter into the "Disconnected Roof Drains" Box of Form D-1

Form D-1b: Disconnected Pavement Worksheet

See Fact Sheet for more information regarding NDC Pavement credit guidelines

Effective Area Managed (A_c)

Divided Sidewalks

1. Determine percentage of units with divided Sidewalks — 94.0% — Box K1

Multiply Box K1, A_T, and 0.04 and enter the result in Box K — 0.77 acres — Box K

This is the amount of area credit to enter into the "Disconnected Pavement" Box of Form D-1

Form D-1c: Interceptor Tree Worksheet

See Fact Sheet for more information regarding Interceptor Tree credit guidelines

Effective Area Managed (A_c)

New Evergreen Trees

1. Enter number of new evergreen trees that qualify as Interceptor Trees in Box L1.	100	trees	Box L1
2. Multiply Box L1 by 200 and enter result in Box L2	20000	sq. ft.	Box L2

New Deciduous Trees

3. Enter number of new deciduous trees that qualify as Interceptor Trees in Box L3.	100	trees	Box L3
4. Multiply Box L3 by 100 and enter result in Box L4	10000	sq. ft.	Box L4

Existing Tree Canopy

5. Enter square footage of existing tree canopy that qualifies as Existing Tree canopy in Box L5.	0	sq. ft.	Box L5
6. Multiply Box L5 by 0.5 and enter the result in Box L6	0	sq. ft.	Box L6

Total Interceptor Tree Credits

Add Boxes L2, L4, and L6 and enter it into Box L7	30000	sq. ft.	Box L7
Divide Box L7 by 43,560 to get the number of acres effectively managed and enter the result in Box L8	0.69	acres	Box L8

This is the amount of area credit to enter into the "Interceptor Trees" Box of Form D-1

Form D-1d: Alternative Driveway Design

See Fact Sheet for more information regarding Alternative Driveway Design credit guidelines

1. Select type of driveway

Pervious Driveway:	Multiplier:
Cobblestone Block Porous Pavement	0.40
Pervious Concrete/Asphalt Pavement	0.60
Modular Block Porous Pavement Porous Gravel Pavement & Hollywood Driveway	0.75
Not Directly-connected Driveway	1.00

[ ] Box M1

2. Determine percentage of units with Alternative Driveways: [ ] Box M2

4. Multiply Boxes M1, M2, A_T and 0.04, and enter the result in Box M
This is the amount of area credit to enter into the "Alternative Driveway Design" Box of Form D-1

0.00 acres Box M

Step 3 - Calculate Flow or Volume Requiring Treatment

Form D-1e Treatment - Flow-Based (Rational Method)

Calculate treatment flow (cfs): Flow = Runoff Coefficient x Rainfall Intensity x Adjusted Treatment Area

Determine C Factor using Table D-1b	0.50	C
Determine i using Table D-1c (Rainfall Intensity)	0.20	i
A_{AT} from Step 2	15.57	A_{AT}
Flow = C * i * A_{AT}	1.56	cfs

TABLE D-1b

Runoff Coefficient (Rational), C	
Single-family areas	0.50
Multi-units, detached	0.60
Apartment dwelling areas	0.70
Multi-units, attached	0.75
User Specified	0.00

Table D-1c

Rainfall Intensity			
Roseville	i =	0.20	in/hr
Sacramento	i =	0.18	in/hr
Folsom	i =	0.20	in/hr

Form D-1f Treatment - Volume-Based (CASQA)

use this method for Rosevill Volume Calculations

Calculate treatment volume (Acre-Feet): Treatment Volume = Area x (Storage Volume ÷ Conversion Factor)

Determine Adjusted C_A using Table D-2d (for CASQA Method) and the Adjusted Impervious Fraction (I_A) from Step 2	0.10	C_A
Determine Unit Basin Storage Volume (Fig. D-2A) using C_A	0.06	SV
A from Step 1	24.75	A
Treatment volume = A_T x (SV / 12)	0.12	Acre-Feet

48 hrs Specified Draw Down time

Form D-1g Treatment - Volume-Based (ASCE-WEF)

Calculate water quality volume (Acre-Feet): WQV = Area x Maximized Detention Volume (P_0)

A from Step 1	24.75	A
Obtain P_0: Maximized Detention Volume from figures E-1 to E-4 in Appendix E of this manual using I_A from Step 2.	0.11	P_0
Treatment volume = A x (P_0 / 12)	0.22	Acre-Feet

48 hrs Specified Draw Down time

Appendix D-1: Residential Sites: Runoff Reduction Credits and Treatment BMP Sizing Calculations

Name of Drainage Shed: Auburn Ravine-South Shed

Fill in Highlighted Boxes

Project Located in Roseville

Step 1 - Calculate Area Requiring Treatment

Drainage Shed Area		15.3	acres	A
Open Space and Parks Acreage*		3.5		A_{OS}
Treatment Area	$A - A_{OS} =$	11.8		A_T
Number of Units in A_T		48		
Number of units per acre in A_T	$DU/A_T =$	4		
Assumed Initial Impervious Fraction (determine using Table D-1a)		0.35		I

See Area Example Below

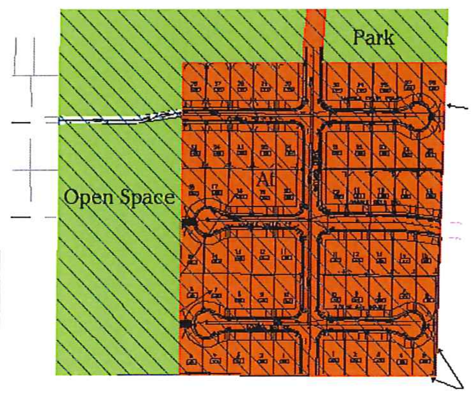
*. Includes all areas maintained in a natural state and planned for landscaped park areas

Table D-1a	
Dwelling units per acre	Imperviousness
1	0.17
2	0.25
3,4	0.35
5,6	0.40
7	0.50
8,9	0.55
10-14	0.60
15-20	0.70

A - Drainage Shed Area

Aos - Parks and Open Space

AT - Area with Runoff Reduction Potential



Step 2 - Calculate Impervious Area Treatments

Runoff Reduction Measures			Effective Area Managed (A_C)	
Disconnected Roof Drains (see Fact Sheet)	use Form D-1a for credits	→	2.01	acres
Disconnected Pavement (see Fact Sheet)	use Form D-1b for credits	→	0.42	acres
Interceptor Trees (see Fact Sheet)	use Form D-1c for credits	→	0.33	acres
Alternative Driveway Design (see Fact Sheet)	use Form D-1d for credits	→	0.00	acres
Total Effective Area Managed (Credit Area)		A_C	2.77	acres

Adjusted Area for Flow-Based Treatment	$A_T - A_C =$	8.98	acres	A_{AT}
Adjusted Impervious Fraction for A	$(A_T(I) - A_C) / A =$	0.09		I_A

Form D-1a: Disconnected Roof Drains Worksheet

See Fact Sheet for more information regarding Disconnected Roof Drain credit guidelines

Effective Area Managed (A_c)

1. Determine efficiency Multiplier

Runoff is directed to a dispersal trench or dry well (Type A and B soils only) — 1.00

Runoff is directed across landscaping, determine setback

25 ft +	Use multiplier of	1.00
≥ 20 and < 25 ft	Use multiplier of	0.90
≥ 15 and < 20 ft	Use multiplier of	0.70
≥ 10 and < 15 ft	Use multiplier of	0.45
≥ 5 and < 10 ft	Use multiplier of	0.25

Efficiency Multiplier → 0.90 — Box J1

2. Determine percentage of roof drains disconnected → 100.0% — Box J2

3. Select project density in dwelling units per acre:

1	Use reduction factor of	0.08
2	Use reduction factor of	0.13
3,4	Use reduction factor of	0.19
5,6	Use reduction factor of	0.23
7	Use reduction factor of	0.29
8,9	Use reduction factor of	0.33
10-14	Use reduction factor of	0.37
15-20	Use reduction factor of	0.44

Reduction Factor → 0.19 — Box J3

4. Determine Area Managed

Multiply Box J3 by A_T, and enter the result in Box J4 — 2.2 acres — Box J4

5. Multiply Boxes J1, J2 and J4, and enter the Result in Box J — 2.0 acres — Box J

This is the amount of area credit to enter into the "Disconnected Roof Drains" Box of Form D-1

Form D-1b: Disconnected Pavement Worksheet

See Fact Sheet for more information regarding NDC Pavement credit guidelines

Effective Area Managed (A_C)

Divided Sidewalks

1. Determine percentage of units with divided Sidewalks — 90.0% — Box K1

Multiply Box K1, A_T, and 0.04 and enter the result in Box K — 0.42 acres — Box K

This is the amount of area credit to enter into the "Disconnected Pavement" Box of Form D-1

Form D-1c: Interceptor Tree Worksheet

See Fact Sheet for more information regarding Interceptor Tree credit guidelines

Effective Area Managed (A_C)

New Evergreen Trees

1. Enter number of new evergreen trees that qualify as Interceptor Trees in Box L1. — 48 trees — Box L1

2. Multiply Box L1 by 200 and enter result in Box L2 — 9600 sq. ft. — Box L2

New Deciduous Trees

3. Enter number of new deciduous trees that qualify as Interceptor Trees in Box L3. — 48 trees — Box L3

4. Multiply Box L3 by 100 and enter result in Box L4 — 4800 sq. ft. — Box L4

Existing Tree Canopy

5. Enter square footage of existing tree canopy that qualifies as Existing Tree canopy in Box L5. — 0 sq. ft. — Box L5

6. Multiply Box L5 by 0.5 and enter the result in Box L6 — 0 sq. ft. — Box L6

Total Interceptor Tree Credits

Add Boxes L2, L4, and L6 and enter it into Box L7 — 14400 sq. ft. — Box L7

Divide Box L7 by 43,560 to get the number of acres effectively managed and enter the result in Box L8 — 0.33 acres — Box L8

This is the amount of area credit to enter into the "Interceptor Trees" Box of Form D-1

Form D-1d: Alternative Driveway Design

See Fact Sheet for more information regarding Alternative Driveway Design credit guidelines

1. Select type of driveway

Pervious Driveway:	Multiplier:
Cobblestone Block Porous Pavement	0.40
Pervious Concrete/Asphalt Pavement	0.60
Modular Block Porous Pavement Porous Gravel Pavement & Hollywood Driveway	0.75
Not Directly-connected Driveway	1.00

[ ] Box M1

2. Determine percentage of units with Alternative Driveways: [ ] Box M2

4. Multiply Boxes M1, M2, A_T and 0.04, and enter the result in Box M
This is the amount of area credit to enter into the "Alternative Driveway Design" Box of Form D-1

0.00 acres Box M

Step 3 - Calculate Flow or Volume Requiring Treatment

Form D-1e Treatment - Flow-Based (Rational Method)

Calculate treatment flow (cfs): Flow = Runoff Coefficient x Rainfall Intensity x Adjusted Treatment Area

Determine C Factor using Table D-1b	0.50	C
Determine i using Table D-1c (Rainfall Intensity)	0.20	i
A_{AT} from Step 2	8.98	A_{AT}
Flow = C * i * A_{AT}	0.90	cfs

TABLE D-1b

Runoff Coefficient (Rational), C	
Single-family areas	0.50
Multi-units, detached	0.60
Apartment dwelling areas	0.70
Multi-units, attached	0.75
User Specified	0.00

Table D-1c

Rainfall Intensity			
Roseville	i =	0.20	in/hr
Sacramento	i =	0.18	in/hr
Folsom	i =	0.20	in/hr

Form D-1f Treatment - Volume-Based (CASQA)

use this method for Rosevill Volume Calculations

Calculate treatment volume (Acre-Feet): Treatment Volume = Area x (Storage Volume ÷ Conversion Factor)

48 hrs Specified Draw Down time

Determine Adjusted C_A using Table D-2d (for CASQA Method) and the Adjusted Impervious Fraction (I_A) from Step 2	0.10	C_A
Determine Unit Basin Storage Volume (Fig. D-2A) using C_A	0.06	SV
A from Step 1	15.25	A
Treatment volume = A_T x (SV / 12)	0.07	Acre-Feet

Form D-1g Treatment - Volume-Based (ASCE-WEF)

Calculate water quality volume (Acre-Feet): WQV = Area x Maximized Detention Volume (P_0)

48 hrs Specified Draw Down time

A from Step 1	15.25	A
Obtain P_0: Maximized Detention Volume from figures E-1 to E-4 in Appendix E of this manual using I_A from Step 2.	0.11	P_0
Treatment volume = A x (P_0 / 12)	0.13	Acre-Feet

APPENDIX D

Detention Basins