CEQA
HYDROLOGY AND HYDRAULIC STUDY

Tentative Parcel Map 21054R

5550 Dehesa Road, El Cajon, CA 92019

APN 513-073-14

For

Sam Shorees

Prepared By

Site Design Associates, Inc.
1016 Broadway, Suite A
El Cajon, CA 92021
619-442-8467

April 14, 2003
Revised September 14, 2007
Revised February 28, 2008

J-1503A

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF WORKSHEETS

1 INTRODUCTION

This hydrology study is prepared to determine the pre- and post-construction influence of precipitation on the proposed development of Property located at 5550 Dehesa Road in El Cajon, California.

1.1 Project Location and Description

The 13.91-acre residential Dehesa Valley project is located on the north side of Dehesa Road in the County of San Diego (See Figure 1 - Project Vicinity Map and Location Map). The site Lat-Long coordinates is: N 32° 47' 30", W 116° 50' 10". The project is approximately 2600 feet east of the intersection of Harbison Canyon Road and Dehesa Road. This project proposes four custom residential parcels of two plus acres each.

1.2 Topography and Land Use

The project site is characterized by a west flowing unnamed drainage swale adjacent to Dehesa Road with a north sloping hillside. The project site is designated estate residential and is currently developed with one single family residence. There is single family residential development existing on the east and west sides of the project site and a vacant continuation of the hillside to the north.

1.3 Topographic Source

The topography used for this study is derived from an Aerial Topographic Survey, dated July 25, 2002 by Terravision M.C. with field revisions March 23, 2006, and County of San Diego 200 scale topography maps (sheets 226-1815 and 226-1821).

1.4 Proposed Project

The area is designated residential, and is occupied by one single-family residence.

The proposed project will grade three new residential pads with driveways, each being 2 acres minimum. The proposed project will alter the amount of impervious surface; however, the design proposes natural bio-filters earth swales allowing for infiltration and treatment.

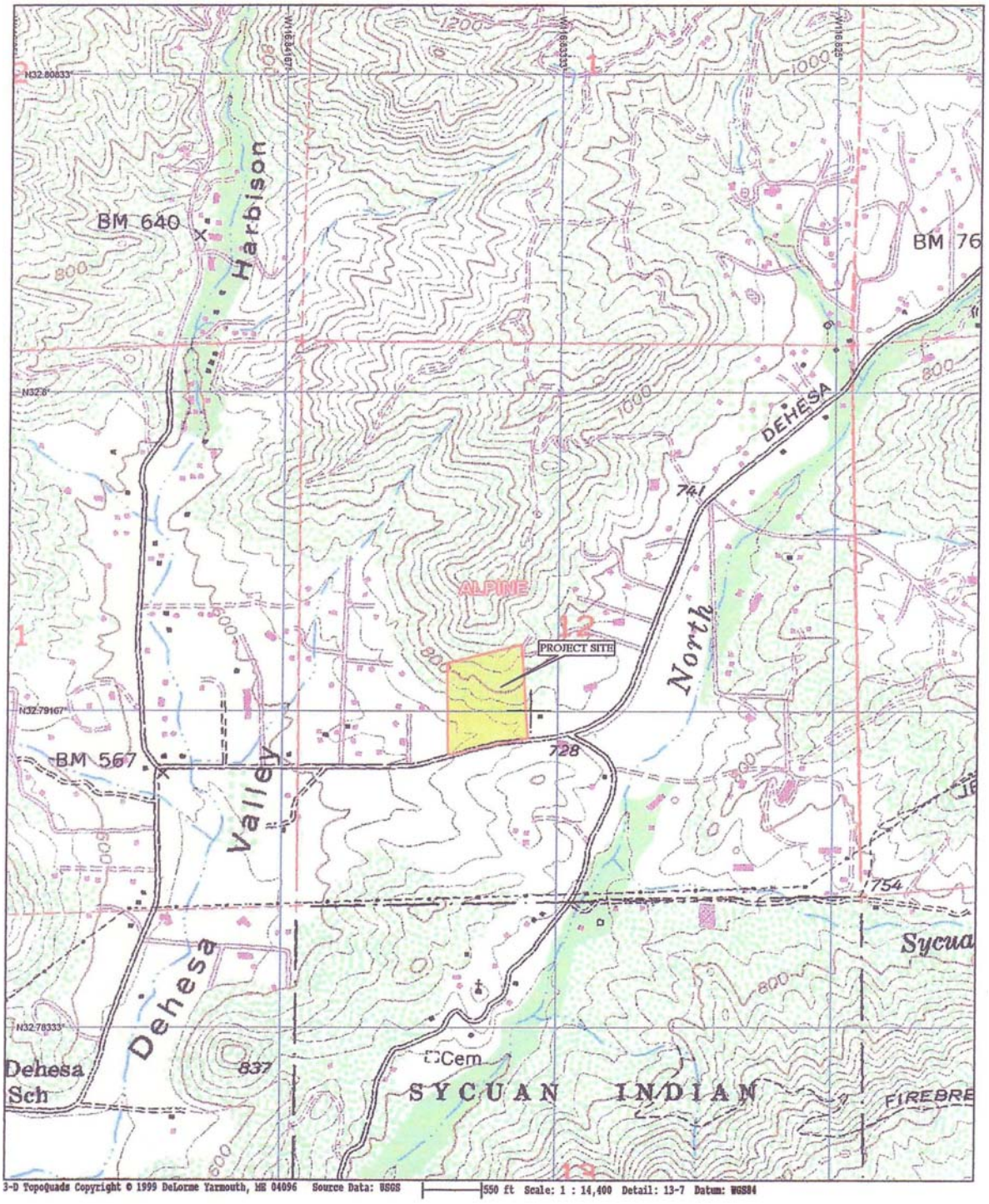


Figure 1 - Project Vicinity Map and Location Map

2 RUNOFF CALCULATIONS

2.1 Design Methodology

The watersheds are rather small; therefore the Rational Method Formula has been selected to calculate runoff.

Q = CIA

Where,

Q = Peak Rate of Flow (cfs)

C = Runoff Coefficient

I = Average rainfall intensity (in/hr)

A = Drainage Area (ac)

2.2 Post-Construction Runoff

The drainage system for this project consists of brow ditches and pipes with riprap to direct the runoff around cut slopes and building sites with bio-filters as treatment control BMP's.

The soil runoff potential for this site is determined by overlaying the site on the Soil Runoff Potential Map, published by the County of San Diego, DPLU. The Soil Runoff Potential Overlay is shown in Figure 3. This site is shown as soil group 'B'. Table 5 shows the runoff coefficient as a function of land use and soil group. The runoff coefficient C for this site is calculated as follows pursuant to section 3.1.2 of the County Hydrology Manual. It is estimated that about 65% of the new pads and driveways could be impervious; therefore this project is adding approximately 0.79-ac of impervious area to the lots. Table 1 shows a summary of the corresponding calculations.

Table 1 - Post-Construction Runoff Coefficient

Land Use Characteristic	C	A (ac)	C x A (ac)
Pervious surface	0.25	13.94	3.48
Impervious surface	0.90	0.79	0.71
Total	**0.28**	14.73	4.20

The storm frequency for this study has a 100-year recurrence interval. The six-hour anticipated precipitation for the project site subject to the design storm frequency; P_6 is shown in Figure 4. The twenty-four hour anticipated precipitation for the project site subjected to the design storm frequency; P_{24} is shown in Figure 5.

P_6 = 2.9 in

P_{24} = 6.1 in

P_6 is in the range of 45% to 65% of P_{24} and therefore doesn't need to be adjusted.

The project hydrologic sub-basins are shown in Figure 7 and the attached County map. Figure 7 shows the on-site sub-basins after construction and the County Map shows the off-site sub-basins.

The time of concentration for each sub-area on site, T_c is determined from the following formula (San Diego County Hydrology Manual, dated June 2003) with the initial lengths and times adjusted per Table 3-2 of the Manual for slope and land use.

$$T_c = \frac{1.8(1.1-C)\sqrt{D}}{\sqrt[3]{S}}$$ (For overland time of flow)

Where,

T_c = Time of Concentration (hours)

D = Watercourse Distance (ft)

S = Slope (%)

C = Runoff Coefficient

$$T_c = \left(\frac{11.9L^3}{\Delta E}\right)^{0.385}$$ (For natural watersheds)

Where,

T_c = Time of Concentration in hours (hours)

L = Watercourse Distance (miles)

ΔE = Change in elevation along effective slope line (ft)

The average rainfall intensity is calculated from the following equation (San Diego County Hydrology Manual, June 2003).

$$I = 7.44 \times P_6 \times D^{-0.645}$$

Where,

I = Rainfall Intensity (in/hr)

P_6 = Six hour precipitation (inches)

D = Duration (min.)

There is an illustration of this formula in Figure 2, which is per County 2003 Hydrology Manual.

Time of concentration (T_c) is composed of two components: The initial time of concentration (T_i), and the travel time (T_t). T_t is negligible in comparison to T_i and therefore T_t is ignored.

The maximum overland flow length (L_M) is used from Table 4 in calculating the initial time of concentration. The source for this chart is the San Diego County Hydrology Manual (Table 3.2), June 2003.

Table 2 shows the input data and summary of the rational method calculations after development. MRM is used in Table 3 to determine the overall discharge at node 2 from both sub-basins B_1 and B_2.

ΔE in this table is not the difference between the upstream and downstream nodes. It is the change in elevation along the effective slope line for the subarea as discussed in section 3.1.4.2(a) and figure 3-5 of the County Hydrology Manual.

Table 2 - Input Data & Summary of RM after Development

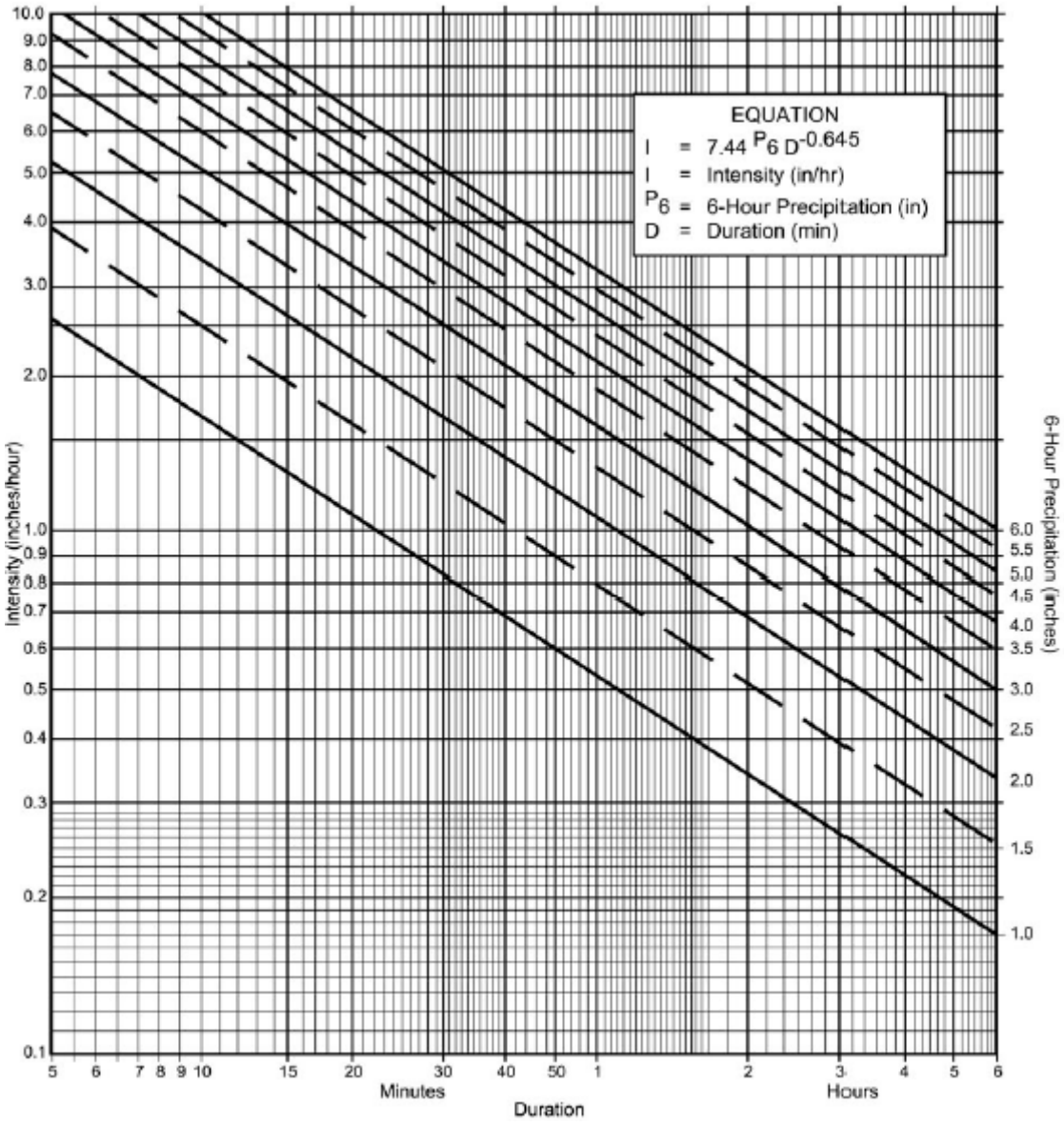
BASIN	U/S NODE	D/S NODE	A (ac)	C	U/S EL. (ft)	D/S EL. (ft)	ΔE (ft)	L (ft)	S (%)	P_6 (in)	L_M (ft)	T_C (min)	I (in/hr)	Q (cfs)
B_1	1	2	12.45	0.25	1100	720	380	1500	25	2.9	100	20.2	3.1	9.7
B_2	1	3	14.73	0.28	1100	665	435	1500	29		100	18.5	3.3	13.8

Table 3 - MRM for Post-Development

System	Q (cfs)	T_C (min)	I (in/hr)	A (ac)	Σ CxA (ac)	Q_T (cfs)
B_2	13.79	18.50	3.29	14.73	3.68	22.66
B_1	9.67	20.18	3.11	12.45	3.11	22.71
J 3	*22.71*	*18.50*	*3.29*	*27.18*	*6.80*	

Table 4 - Maximum Overland Flow Length (L_M) & Initial Time of Concentration (T_i)

Element	DU/ Acre	0.50%		1%		2%		3%		5%		10%	
		L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		*50*	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	*85*	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	103.0	70	10.0	*85*	8.8	*95*	8.1	100	7.0	100	*5.6*
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	*6.5*	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	*5.3*	*65*	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com.		50	*5.3*	60	*4.5*	*75*	4.0	85	3.8	95	3.4	100	2.7
G. Com.		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com.		50	41.0	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9



(Source: Figure 3-1 San Diego County Hydrology Manual, June 2003)

Figure 2 - Intensity-Duration Design Chart

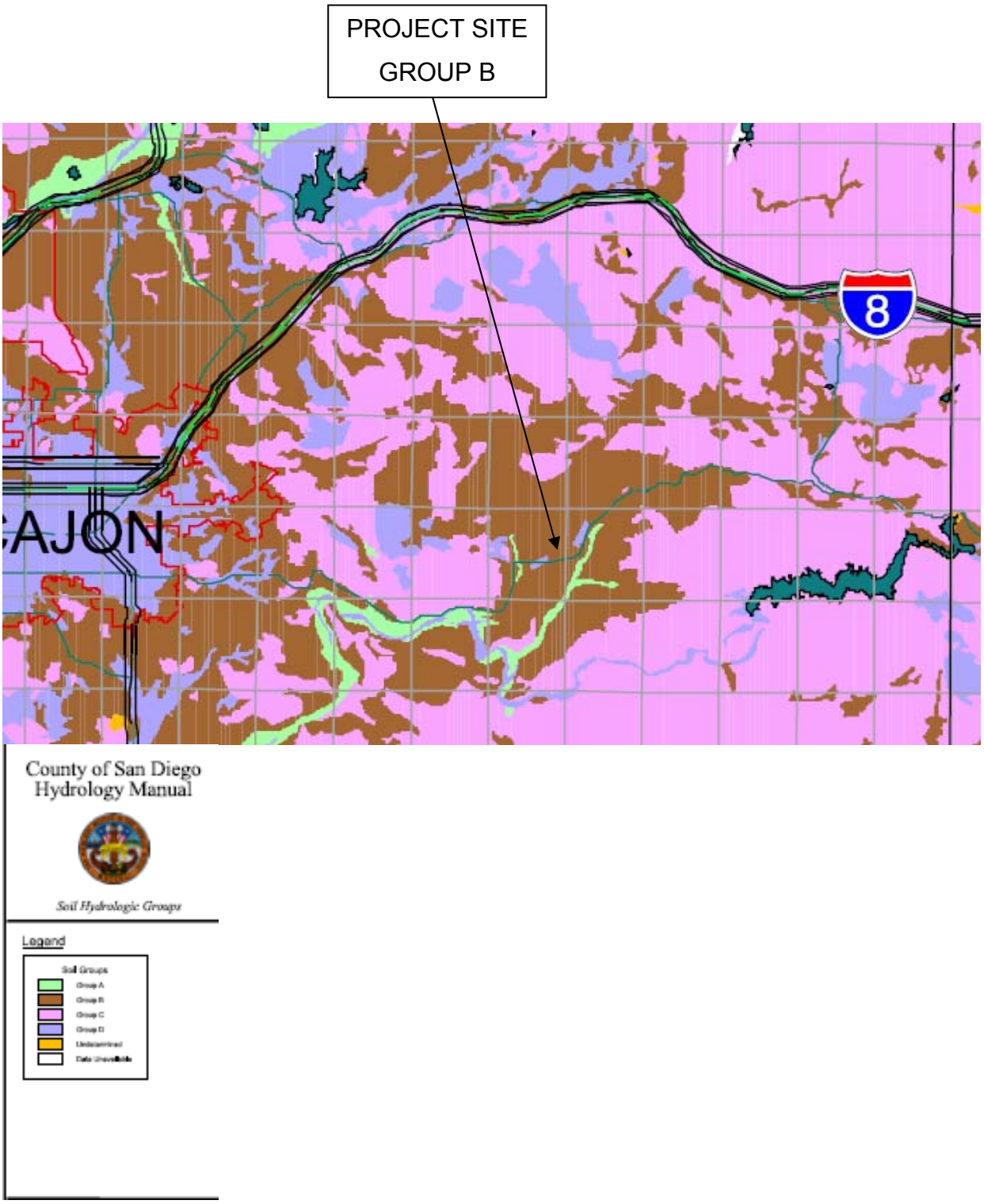


Figure 3 - Overlay of the Soil Runoff Potential Map on the Project Site

Table 5 - Runoff Coefficients as a function of Land use and Soil Group

Runoff Coefficients for Urban Areas						
Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	*County Elements*	*% Impervious*	*A*	*B*	*C*	*D*
Undisturbed Natural Terrain	Permanent Open space	0	0.2	0.25	0.3	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.6
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.6	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.8	0.8	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.97	0.87	0.87	0.87

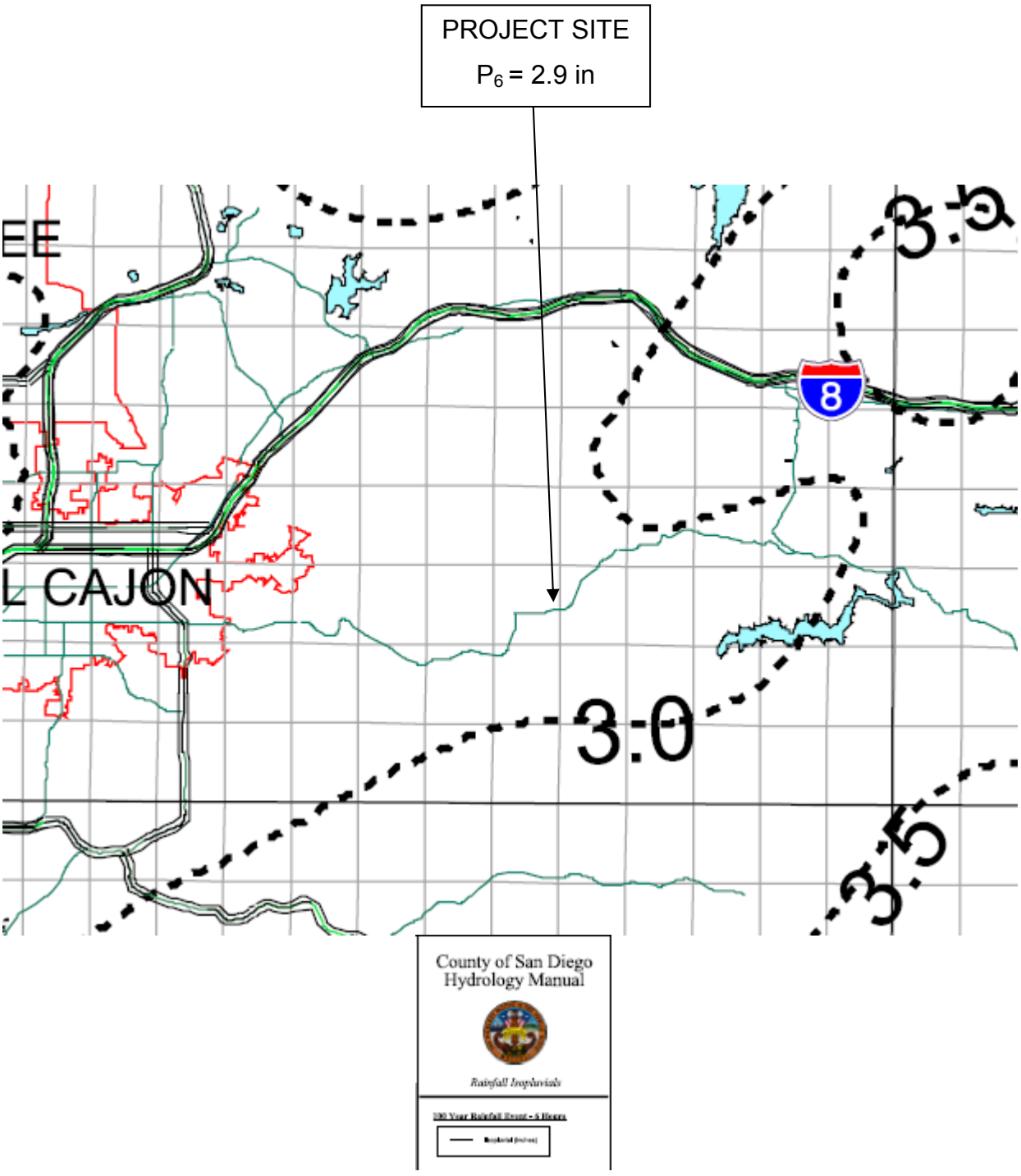


Figure 4 - 6-Hour Precipitation for 100-Year Storm Frequency

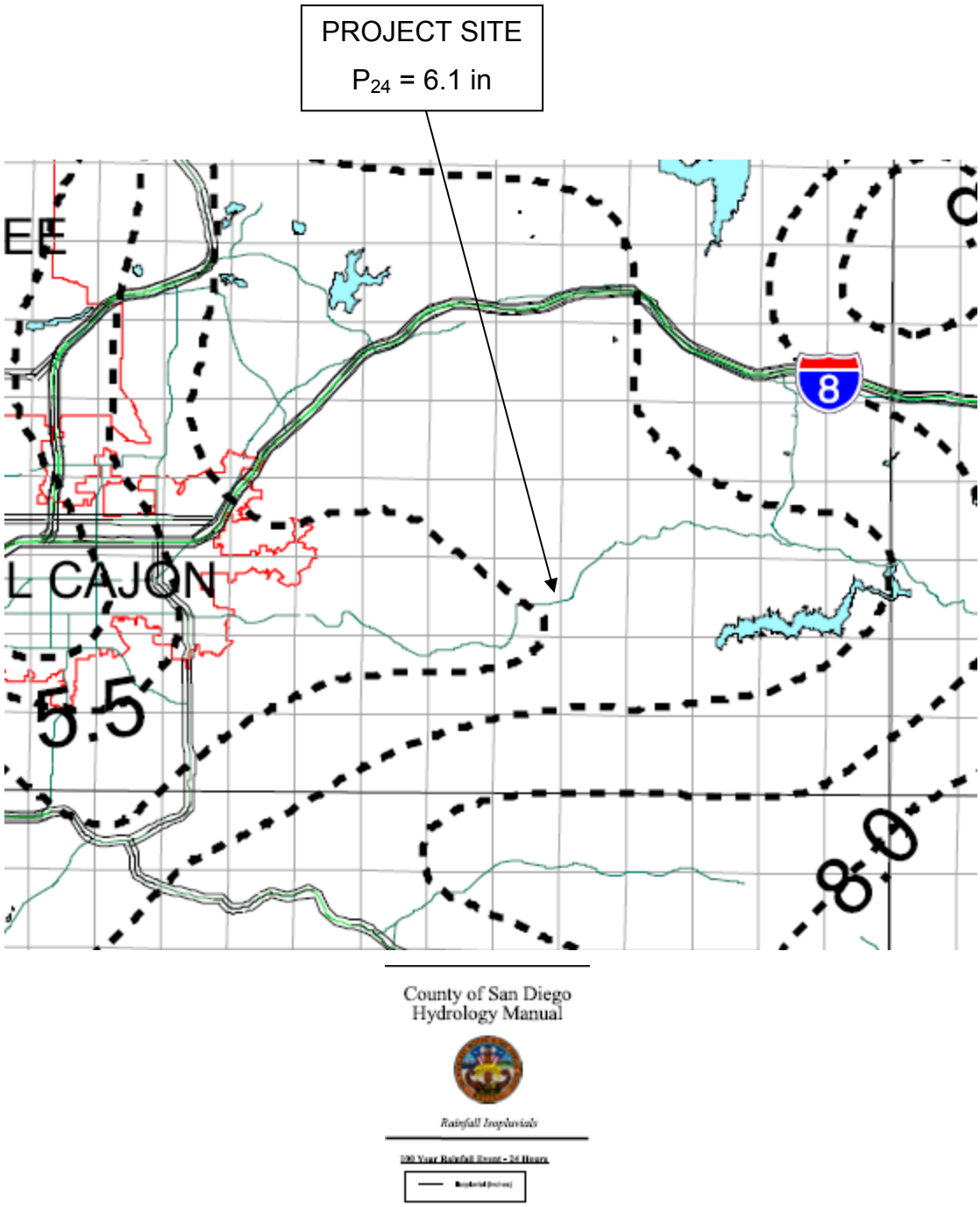


Figure 5 - 24-Hour Precipitation for 100-Year Storm Frequency

FIGURE 6

PRE-DEVELOPMENT
ON-SITE HYDROLOGIC SUB-BASINS

(11 X 17)

(ATTACHED SEPARATELY)

FIGURE 7

POST-DEVELOPMENT
ON-SITE HYDROLOGIC SUB-BASINS

(11 X 17)

(ATTACHED SEPARATELY)

2.3 Pre-Construction Runoff

Figure 6 and the attached County map show the hydrologic sub-basin limits.

Table 6 shows the summary of rational method performed on pre-development conditions. MRM is used in Table 7 to determine the overall discharge at node 3 from both sub-basins A_1 and A_2. The third row in Table 6 shows the total flow discharging to node 4 as 26.1 cfs. This is the total flow passing through the 36" CMP crossing Dehesa Road before this development.

Table 6 - Input Data & Summary of RM before Development

BASIN	U/S NODE	D/S NODE	A (ac)	C	U/S EL. (ft)	D/S EL. (ft)	ΔE (ft)	L (ft)	S (%)	P_6 (in)	L_M (ft)	T_C (min)	I (in/hr)	Q (cfs)
A_1	1	2	12.00	0.25	1100	720	380	1500	25	2.9	100	20.2	3.1	9.3
A_2	1	3	15.18		1100	665	435	1500	29		100	19.3	3.2	12.1
A_3*	1	4	45.98		1100	600	500	3000	17		100	32.8	2.3	26.1

* A_3 is the total area draining to the off-site 36" CMP at node 4 crossing Dehesa Road.

Table 7 - MRM for Pre-Development

System	Q (cfs)	T_C (min)	I (in/hr)	A (ac)	Σ CxA (ac)	Q_T (cfs)
A_2	12.14	19.29	3.20	15.18	3.80	21.05
A_1	9.32	20.18	3.11	12.00	3.00	21.11
J 3	*21.11*	*20.18*	*3.11*	*27.18*	*6.80*	

3 SUMMARY AND CONCLUSIONS

- The current method of off-site discharge is natural sheet flow. This project proposes no off-site development and off-site discharge will continue to sheet flow after construction. This flow passes through a 36" CMP across Dehesa Road.
- There has been neither diversion nor concentration of storm water flows in this project, because the basin limits haven't changed and the basin areas before and after development are identical.
- Table 8 shows a comparison between pre & post development hydrologic discharges. This table shows 14% increase in discharge after construction. Therefore bio-filters are considered as part of the drainage system. They will perform as BMP's to exterminate the undesirable effects of the discharge increase after development.

Table 8 - Comparison Table

Node	Q_{pre} (cfs)	Q_{post} (cfs)	Adjustment (cfs)	Adjustment Percentage
2	9.3	9.7	0.35	4%
3	12.1	13.8	1.65	14%

- Worksheet 1 shows the capacity of 24" CMP pipes proposed for use in the on-site private drainage systems.
- Worksheet 2 shows the capacity of the existing 36" CMP crossing Dehesa Road with a slope of 8.5% as 105.33 cfs. This pipe is the only drainage facility impacted by proposed development. Table 6 shows that the flow passing through this pipe before development is 26.1 cfs. Based on Table 8 in a worst case scenario this flow will be increased by 1.6 cfs to 27.7cfs. The project development has only a minimal effect on this basin and the pipe has the existing capacity to handle the minor increase in flows.

Worksheet 1 - Rating Table for 24" CMP

Project Description	
Project File	n:\haestad\fmw\j-1503a.fm2
Worksheet	24" CMP
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Constant Data		
Mannings Coefficient	0.024	
Diameter	24	in

Input Data			
	Minimum	Maximum	Increment
Channel Slope	5.00	9.00	0.50 %

Rating Table

Channel Slope (%)	Depth (ft)	Discharge (cfs)	Velocity (ft/s)
5.00	2.00	27.40	8.72
5.50	2.00	28.74	9.15
6.00	2.00	30.01	9.55
6.50	2.00	31.24	9.94
7.00	2.00	32.42	10.32
7.50	2.00	33.56	10.68
8.00	2.00	34.66	11.03
8.50	2.00	35.72	11.37
9.00	2.00	36.76	11.70

Worksheet 2 - 36" CMP @ 8.5%

Project Description	
Project File	n:\haestad\fmw\j-1503a.fm2
Worksheet	36" CMP
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data		
Mannings Coefficient	0.024	
Channel Slope	8.5	%
Diameter	36	in

Results		
Depth	3.00	ft
Discharge	105.33	cfs
Flow Area	7.07	ft^2
Wetted Perimeter	9.42	ft
Top Width	0.00	ft
Critical Depth	2.91	ft
Percent Full	100.00	
Critical Slope	0.074985	ft/ft
Velocity	14.90	ft/s
Velocity Head	3.45	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	113.30	cfs
Full Flow Capacity	105.33	cfs
Full Flow Slope	0.085000	ft/ft

4 REFERENCES AND ABBREVIATIONS

4.1 References

- San Diego County Hydrology Manual by Department of Public Works – Flood Control Section, dated June 2003
- San Diego County Drainage Design Manual by Department of Public Works – Flood Control Section, dated May 2005
- San Diego County Soils Interpretation Study, Hydrology Soil Groups – Runoff Potential by DPLU 1969
- San Diego Area Regional Standard Drawings
- Standard Specifications for Public Works Construction (Green Book)

4.2 Abbreviations

Table 9 shows a list of abbreviations used in this report.

Table 9 - List of Abbreviations

Abbreviation	Meaning
A	Area
ac	Acres
ΔE	Change in elevation along effective slope line
in	inches
DPLU	Department of Planning and Land Use
C	Runoff Coefficient
DU/I	Dwelling Unit per Acre
ft	Feet
cfs	Cubic Feet per second
D	Duration
S	Slope
fps	Feet per second
I	Rainfall Intensity

Abbreviation	Meaning
in/hr	Inches per hour
RCP	Reinforced Concrete Pipe
BMP	Best Management Practice
CMP	Corrugated Metal Pipe
L	Watercourse Distance
P_{24}	Twenty four hour precipitation
P_6	Six hour precipitation
Q	Discharge
T_i	Initial Time of Concentration
T_t	Travel Time
T_c	Time of Concentration

5 DECLARATION OF RESPONSIBLE CHARGE

I, hereby declare that I am the engineer of work for this Hydrology and Hydraulic Study. That I have exercised responsible charge over the design of the project with respect to this study as defined in section 6703 of the Business and Professions Code, and that the design is consistent with current standards.

I understand that the check of project drawings specifications, studies and reports by the County of San Diego is confined to a review only and does not relieve me, as engineer in responsible charge, of my responsibilities for project design.

Kenneth J. Discenza RCE 29930 Expires 06/30/09

2/28/08
Date

PAGE 24

OFF-SITE HYDROLOGIC SUB-BASINS

(11 X 17)

(ATTACHED SEPARATELY)