AS SUBMITTED TO COSD 1-23-13

Hydrology and Hydraulic Study

APN 267-146-05, 08
APN 267-145-09-12

TPM-17341 & 19618

County of San Diego, California
Prepared for:
Richard D Bagley
28967 Palos Verdes Dr. East
Rancho Palos Verdes, CA 90275

SDE 5445

January 8, 2013

San Dieguito Engineering

Principal

REGISTERED PROFESSIONAL ENGINEER
BARRY L. MUNSON
No. C 40980
Exp. 03-31-15
CIVIL
STATE OF CALIFORNIA

This report summarizes the hydrology and hydraulic calculations for the proposed grading and improvements of 6 single family residential lots at TPM 17341 and TPM 19618. Hydrology calculations have been performed in accordance with the County of San Diego Hydrology Manual, dated June, 2003. Hydraulic calculations were performed in accordance with the San Diego County Drainage design Manual dated July 2005. Rational method calculations, in accordance with San Diego County Hydrology Manual, were performed to determine the anticipated Q values.

Pre and post development Q 100 were performed for the site and contributing areas. The total pre and post Q100 flows were determined to be 64.9 and 66.2 for the entire watershed, including offsite contributing areas. It should be noted that for these calculations , the site was assumed to be an undeveloped natural state for the predevelopment condition and developed for the post development condition. Impervious surface percentages were calculated for the anticipated site development. The calculated impervious percentage was greater than the impervious percentage for this type of land use (1 DU/Acre) shown in Table 3-1. Further, for just the area within the project, the pre and post Q100 flows were determined to be 17.0 and 17.4 cfs. Based on this, there is no significant increase in runoff for this development and detention calculations were not performed.

Hydraulic calculations were performed for proposed drainage facilities using peak flow Q100 values.

DECLARATION OF RESPONSIBLE CHARGE

I HEREBY DECLARE THAT I AM THE ENGINEER OF WORK FOR THIS PROJECT, THAT I HAVE EXERCISED RESPONSIBLE CHARGE OVER THE DESIGN OF THE PROJECT 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 AND SPECIFICATIONS BY THE COUNTY OF SAN DIEGO IS CONFINED TO A REVIEW ONLY AND DOES NOT RELIEVE ME, AS ENGINEER OF WORK, OF MY RESPONSIBILITIES FOR PROJECT DESIGN.

BY: _____ DATE: 8/9/2013

RCE NO.: 40980 EXPIRES: 3-31-2015

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REGISTERED PROFESSIONAL ENGINEER
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CIVIL
STATE OF CALIFORNIA

RATIONAL METHOD HYDROLOGY CALCULATIONS

HYDROLOGY

PROJECT NAME: Bagley
PROJECT NUMBER: 5445
DATE: 1/21/2013
COMMENT:

COORD: N33°01' E117°09'

Q100				Q2			
P6 (in):	2.80	P6/P24:	0.60	P6 (in):	1.60	P6/P24:	0.62
P24 (in):	4.70	JUSTED P6:	2.80	P24 (in):	2.60	ADJUSTED P6:	1.60

WATERSHED DESIGNATION	SOIL TYPE	NODE	EVENT (year)	AREA (sf)	AREA (Ac)	ONSITE IMPERV AREA	IMPERV (%)	C Factor <2>	Tc (min)	I100 (iph)	Q100 (cfs)
A (Pre)	D		100	1715131	39.4	0	0%	0.35	14.3	3.75	51.7
B (Pre)	D		100	373560	8.6	0	0%	0.35	12.6	4.06	12.2
A (Post)	D		100	1739519	39.0	48917	16%	0.44	18.9	3.13	53.6
B (Post)	D		100	372173	9.1	27464	16%	0.44	18.6	3.16	12.6
PRE POST COMPARISON											
A (Pre)	D		100	332300	7.63	0	0%	0.35	14.3	3.75	10.0
B (Pre)	D		100	215523	4.95	0	0%	0.35	12.6	4.06	7.0
A (Post)	D		100	332300	7.63	48917	16%	0.44	18.9	3.13	10.5
B (Post)	D		100	215523	4.95	27464	16%	0.44	18.6	3.16	6.9

TIME OF CONCENTRATION OVERALL BASIN
100 YEAR STORM
PRE-CONSTRUCTION

LOCATION	ELEMENT	SLOPE	LM	Ti <3>	LENGTH	HI PT	LOW PT	DELTA E		Tt	Tc
A (Pre)	Natural	5.0%	70	8.0	1530	466	364	102		6.3	14.3
B (Pre)	Natural	5.0%	70	8.0	1180	452	348	104		4.6	12.6
A (Post)	LDR 1.5	1.0%	70	11.5	1770	466	364	102		7.4	18.9
B (Post)	LDR 1.5	1.0%	70	11.5	1715	452	348	104		7.1	18.6

<3>Ti at upstream end of watershed per Section 3.1.4.1 page 3-12 of County of San Diego Hydrology Manual

HYDROLOGY BROW DITCHES

PROJECT NAME:	Bagley
PROJECT NUMBER:	5445
DATE:	12/20/2012
COMMENT:	
COORD:	N33°01' E117°09'

Q100				Q2			
P6 (in):	2.80	P6/P24:	0.60	P6 (in):	1.60	P6/P24:	0.62
P24 (in):	4.70	USTED P6:	2.80	P24 (in):	2.60	ADJUSTED P6:	1.60

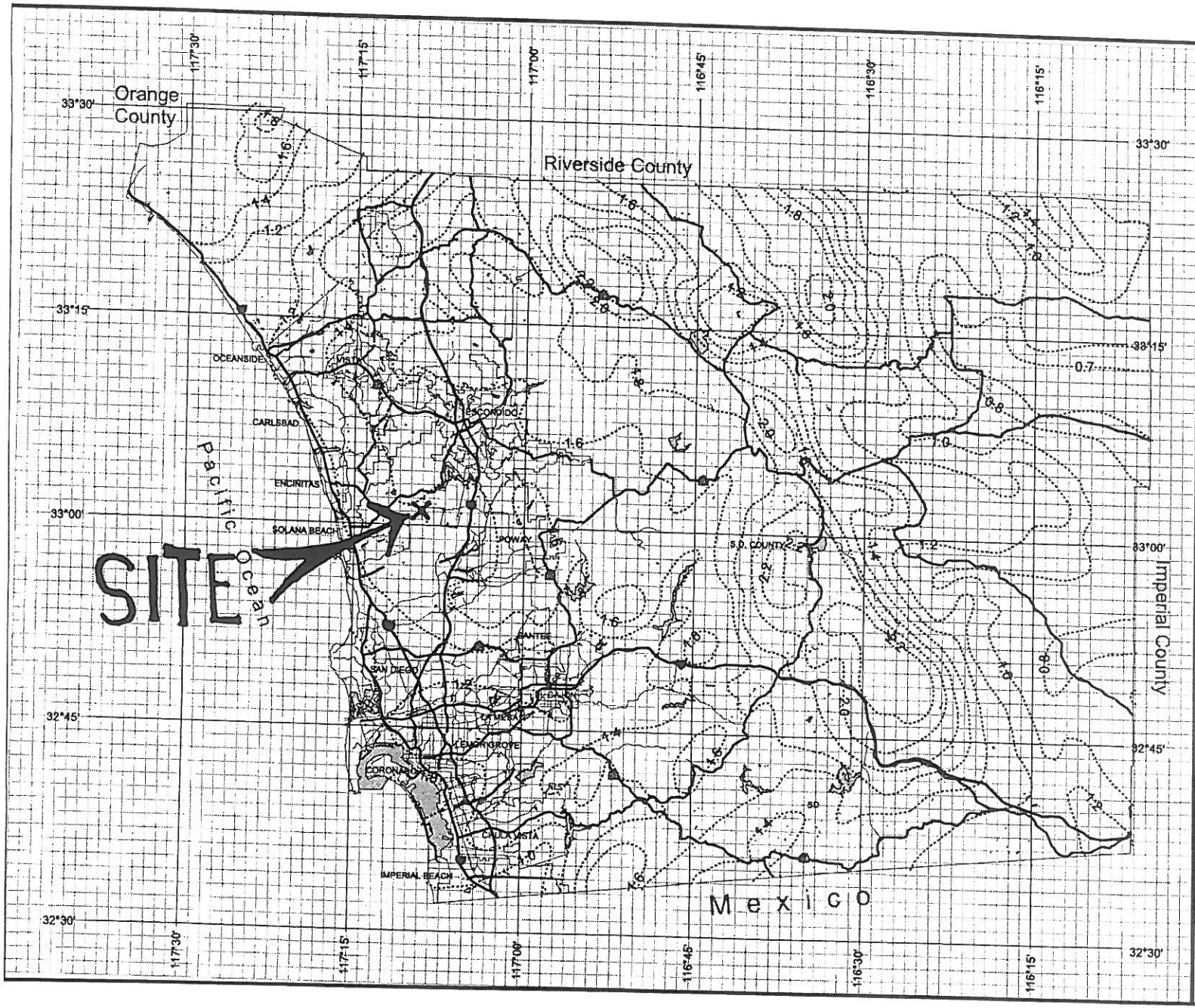
WATERSHED DESIGNATION	SOIL TYPE	NODE	EVENT (year)	AREA (sf)	AREA (Ac)		IMPERV (%)	C Factor <1>	Tc (min)	I100 (iph)	Q100 (cfs)
A-1	D	100-101	100	256820	5.90		16%	0.44	17.2	3.32	8.6
A-2 <1>	D	100-102	100	571931	13.13		16%	0.44	18.4	3.18	18.4
A-3	D		100	121470	2.79		22%	0.47	9.9	4.76	6.2
B-1	D	200-201	100	134627	3.09		16%	0.44	15.4	3.58	4.9
B-2 <2>	D	200-202	100	180046	4.13		16%	0.44	15.8	3.51	6.4
B-3	D		100	104672	2.40		20%	0.46	14.5	3.71	4.1
C	D		100	51778	1.19		16%	0.44	8.9	5.07	2.7

<1> See Table 3-1 Runoff Coefficients for Urban Areas (attached)
<2> Basin A-2 includes Basin A-1
<3> Basin B-2 includes Basin B-1

TIME OF CONCENTRATION BROW DITCH BASIN
100 YEAR STORM

LOCATION	ELEMENT	SLOPE	LM	Ti <3>	LENGTH	HI PT	LOW PT	DELTA E		Tt	Tc
A-1	LDR 1.5	1.0%	70	11.5	1260	466	394	72		5.7	17.2
A-2 <1>	LDR 1.5	1.0%	70	11.5	1537	466	386	80		6.9	18.4
A-3	LDR 2.5	4.4%	100	7.2	400	388	371	17		2.7	9.9
B-1	LDR 1.5	1.0%	70	11.5	833	452	394	58		3.9	15.4
B-2 <2>	LDR 1.5	1.0%	70	11.5	1000	452	377	75		4.3	15.8
B-3	LDR 1.8	1.0%	70	10.0	430	382.3	377	5.3		4.5	14.5
C	LDR 1.5	7.0%	100	7.2	339	399	368	31		1.7	8.9

<3>Ti at upstream end of watershed per Section 3.1.4.1 page 3-12 of County of San Diego Hydrology Manual



County of San Diego Hydrology Manual

Rainfall Isopluvials

2 Year Rainfall Event - 6 Hours

Isopluvial (Inches)

P6 = 1.6"

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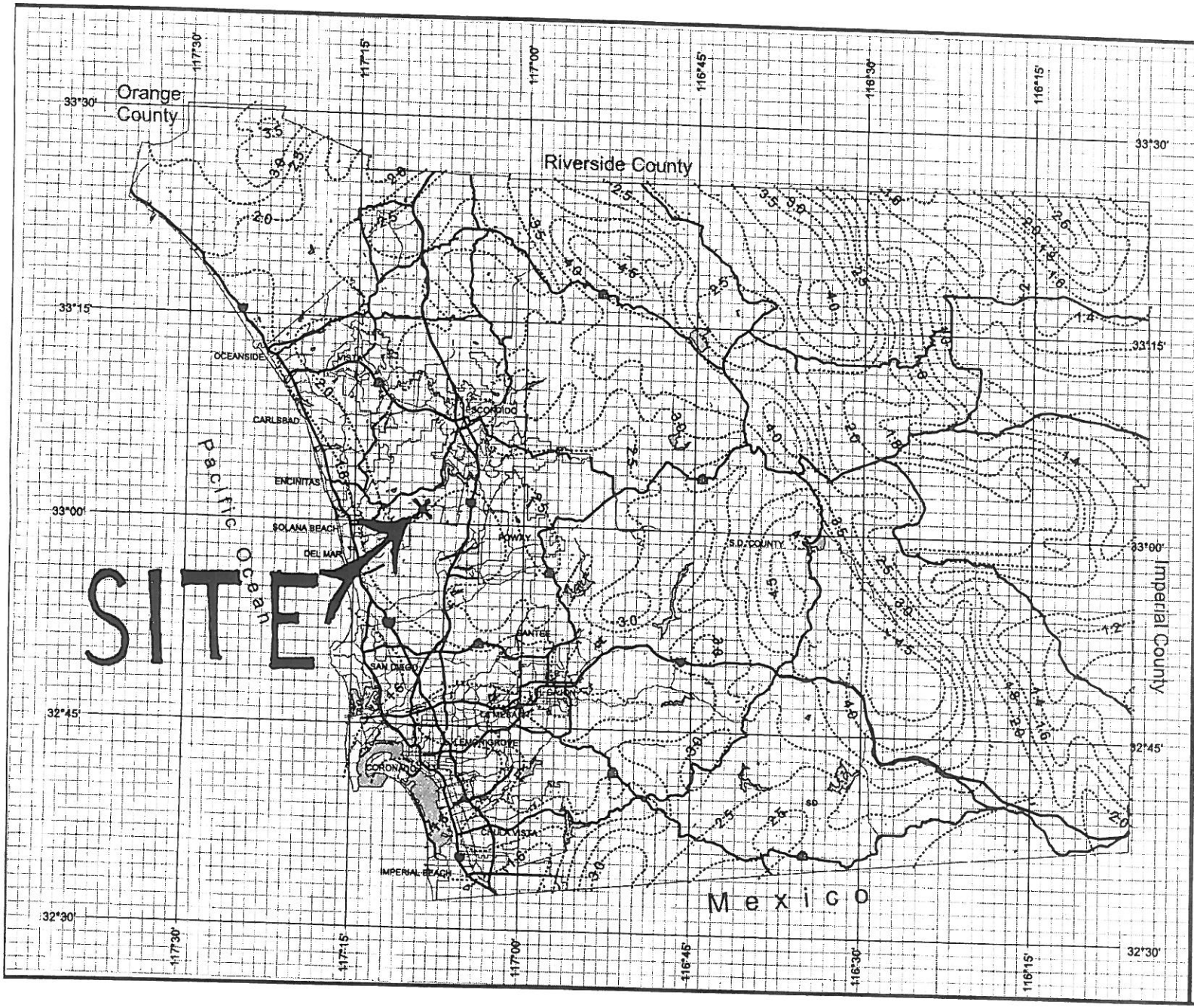

County of San Diego Hydrology Manual

Rainfall Isopluvials

2 Year Rainfall Event - 24 Hours

Isopluvial (inches)

P24 = 2.6"

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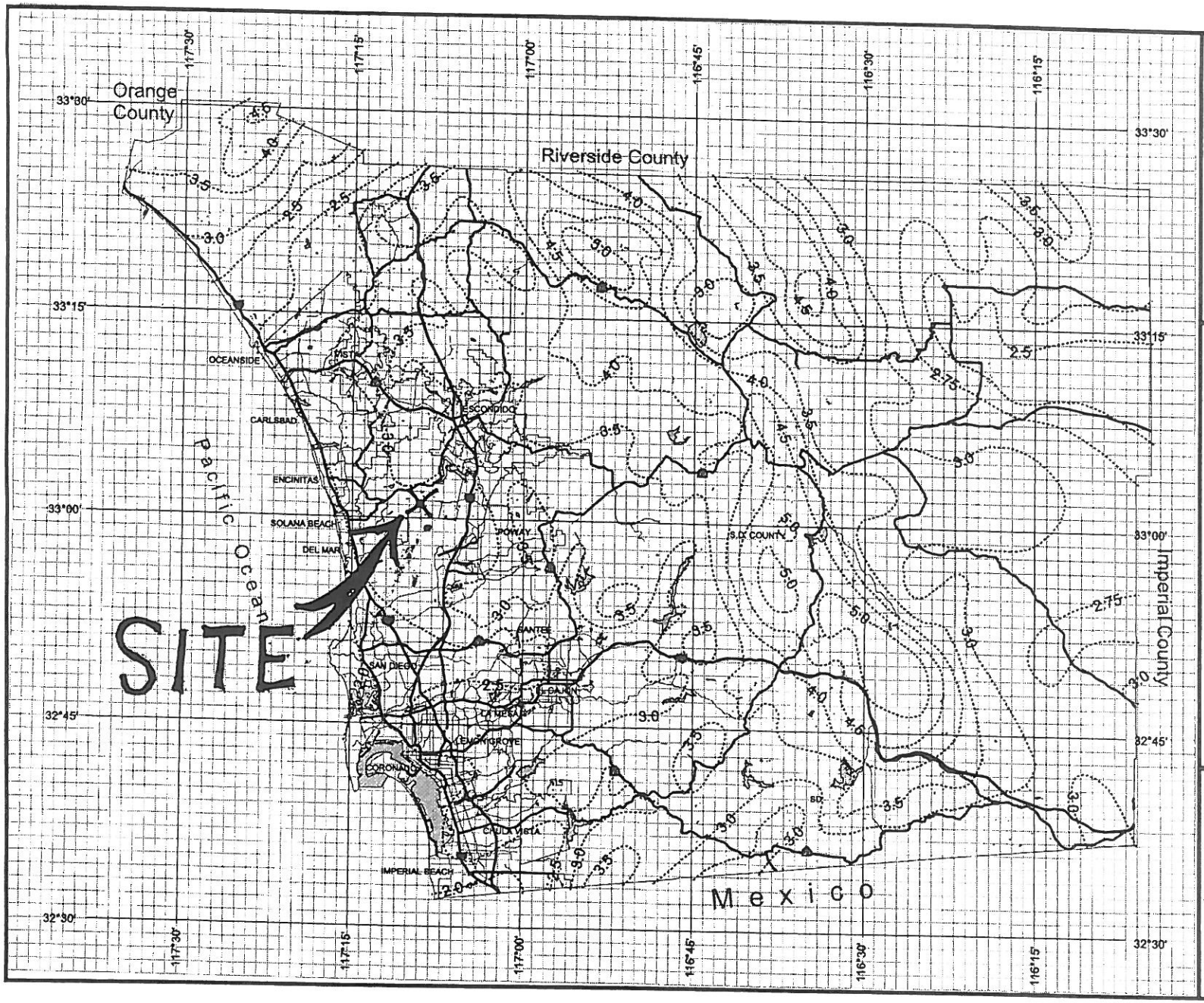

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

P6 = 2.8"

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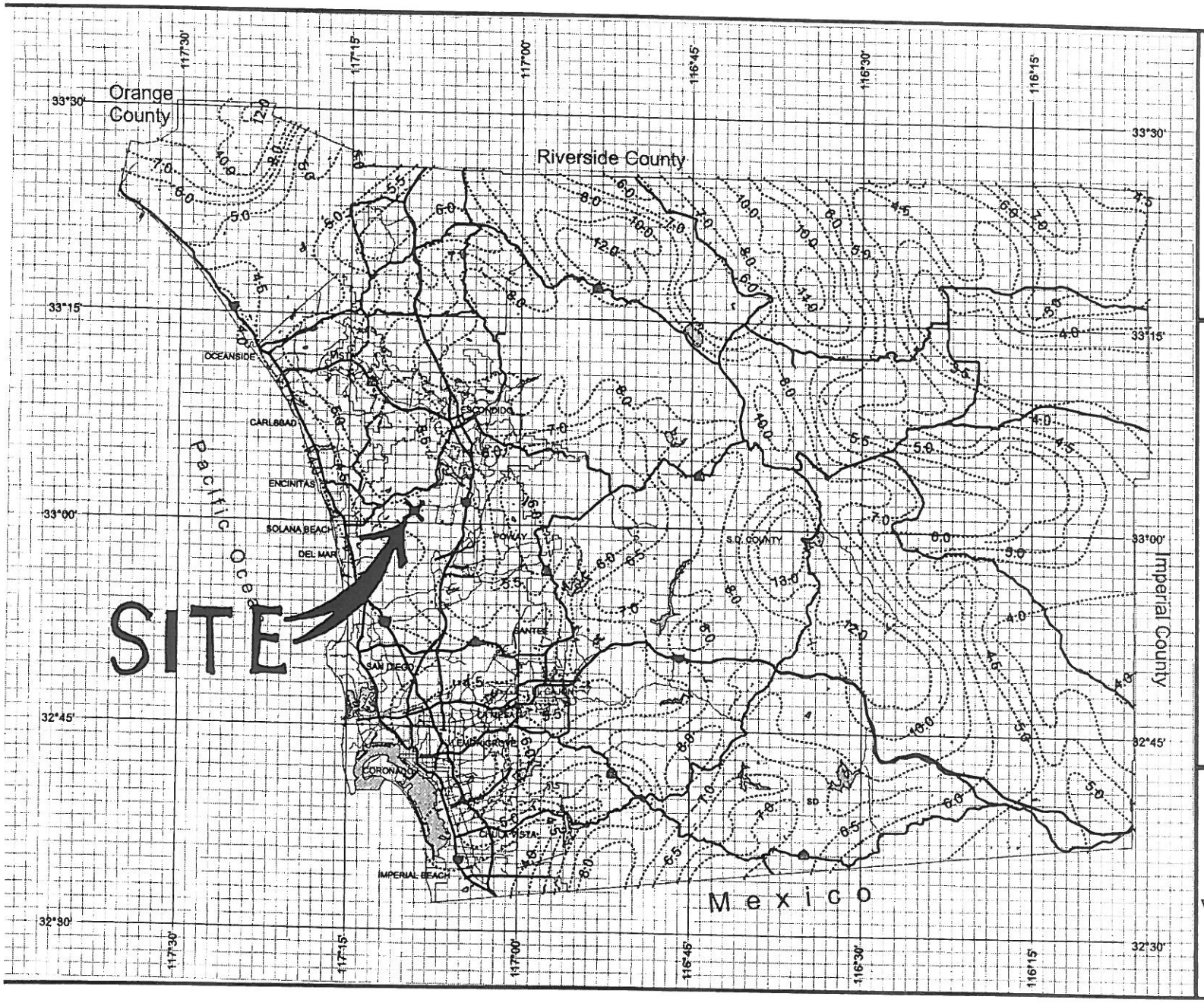

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

P24 = 4.7"

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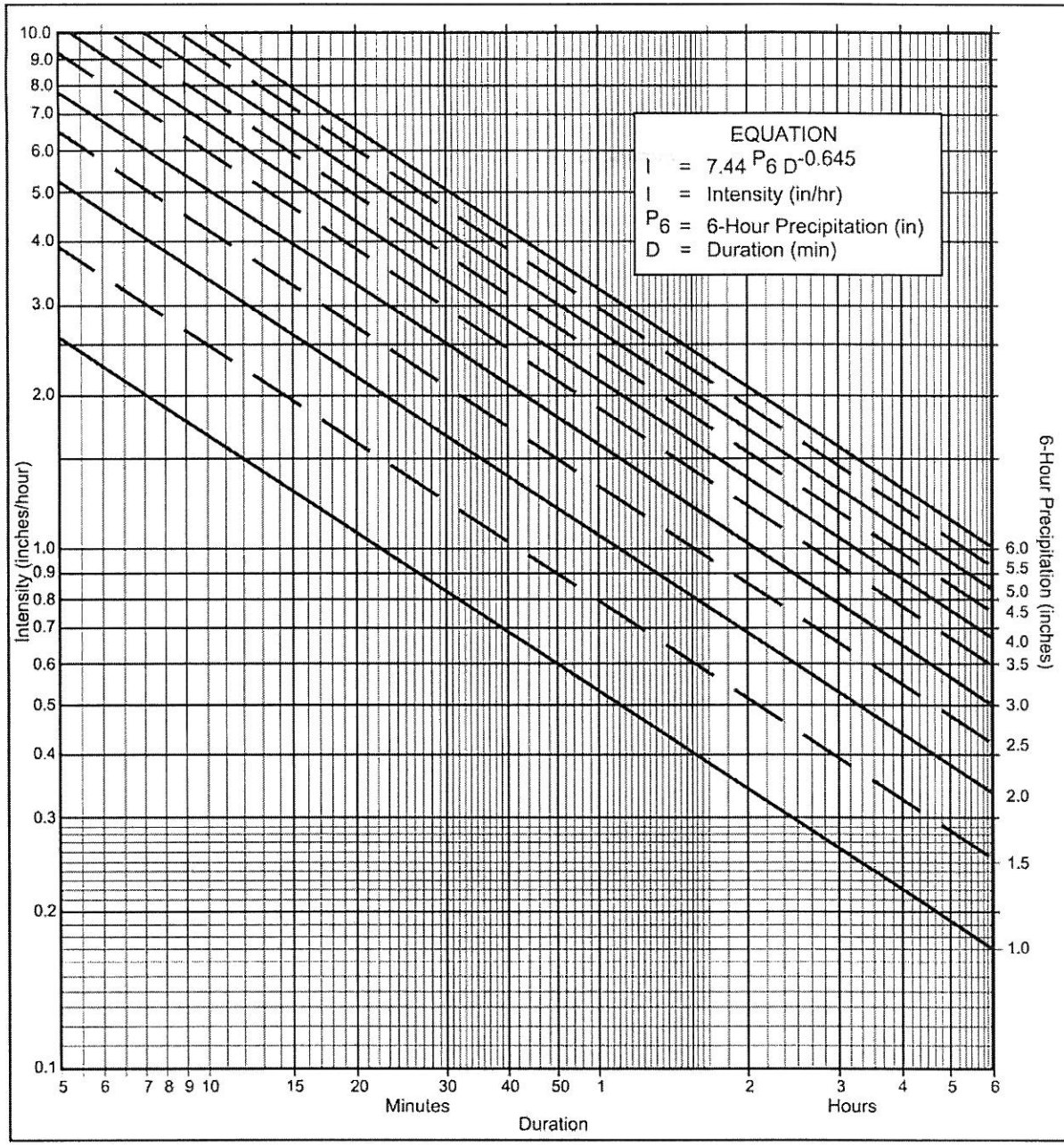


Directions for Application:

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

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

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

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

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

Application Form:

(a) Selected frequency _____ year

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

(c) Adjusted P_6(2) = _____ in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

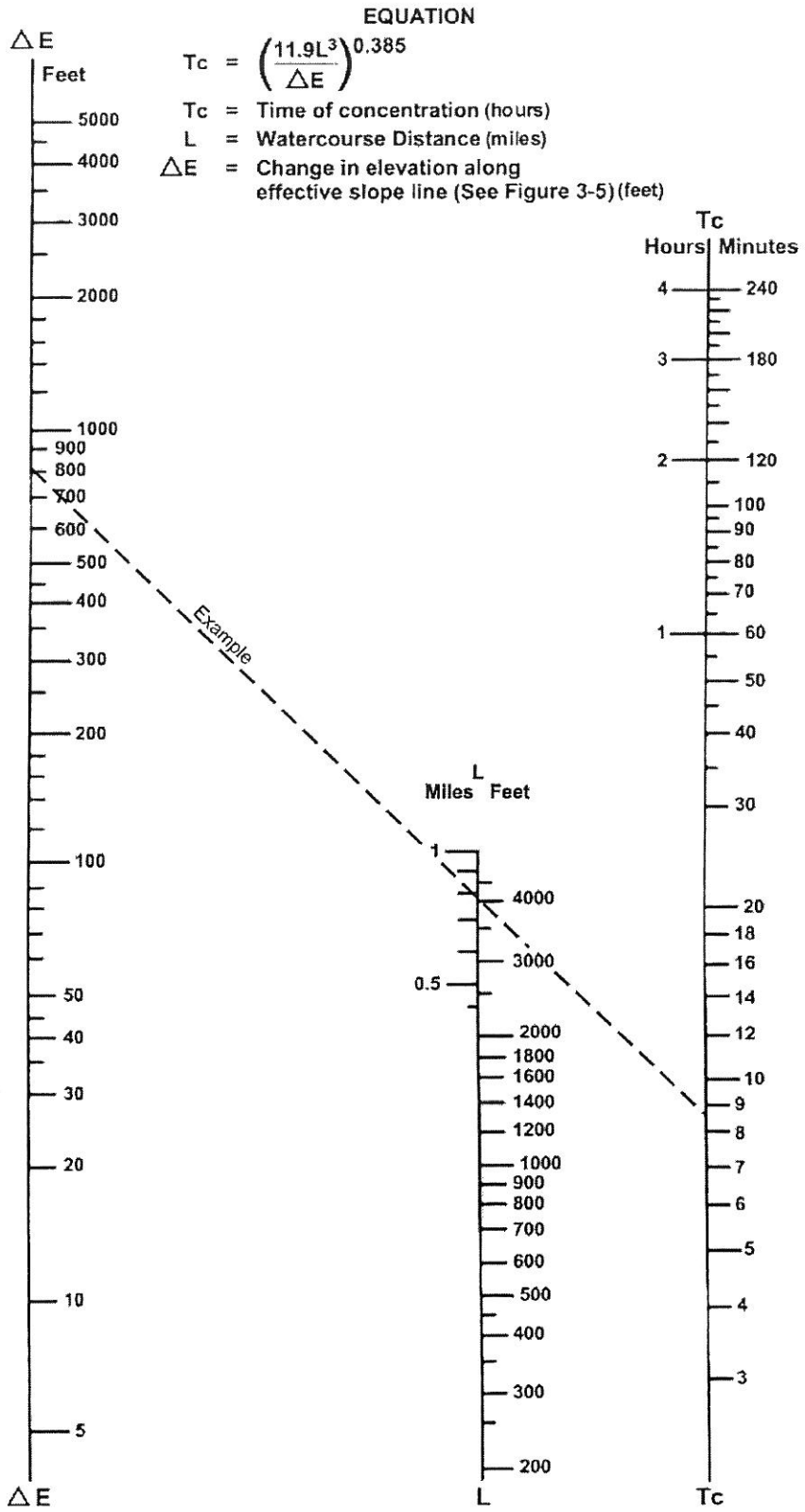
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

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

Intensity-Duration Design Chart - Template

FIGURE

3-1



SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE

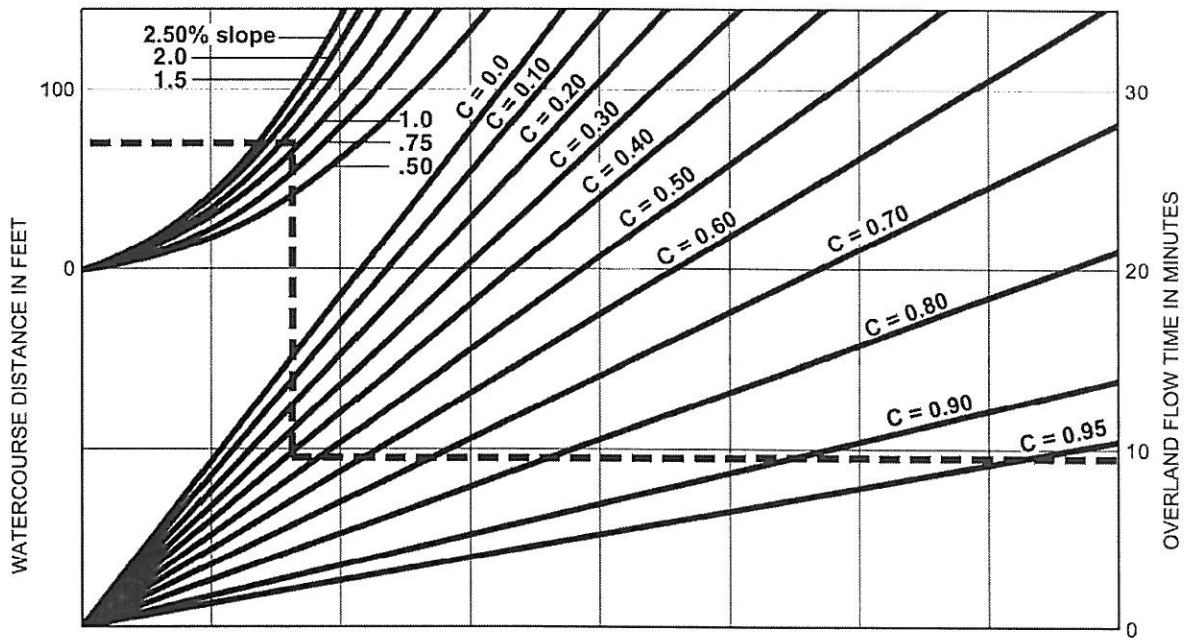
3-4

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

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

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

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



EXAMPLE:

Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE

Rational Formula - Overland Time of Flow Nomograph

3-3

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

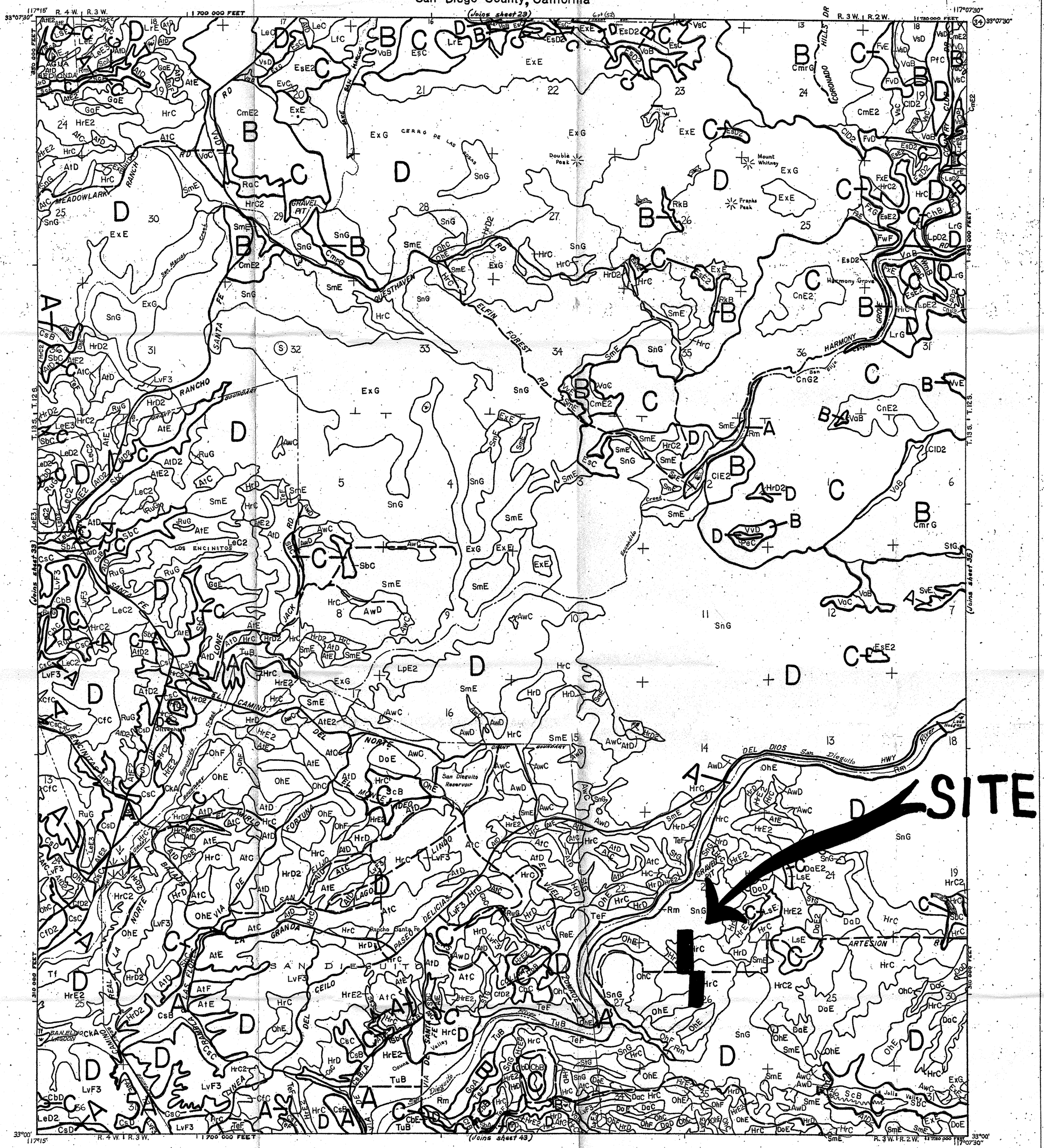
MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

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

*See Table 3-1 for more detailed description

Rho. Santa Fe

San Diego County, California



San Diego County Soils Interpretation Study

HYDROLOGIC SOIL GROUPS - Runoff Potential

SEE CAUTION NOTES

Group A	Group B	Group C	Group D
A — Low Runoff Potential	B — Moderate Runoff Potential	C — High Runoff Potential	D — Very High Runoff Potential

CAUTION NOTES:

1. User is urged to refer to corresponding SUPPLEMENTAL DATA SHEET for assumptions, criteria, map sources, additional legend items, and necessary explanation of ratings shown on map.
2. This map does not eliminate the need for detailed on-site investigation of the soil and site to determine precise soil conditions prior to undertaking any construction, grading, planting, or other soils related activity.

Base Map Source: U. S. Geological Survey with California State Coordinate System, Zone 6 Indicated

Prepared by: U. S. Department of Agriculture, Soil Conservation Service

Published by: San Diego County Planning Department for the Comprehensive Planning Organization — 1969

North

SCALE 1:24000

0 2000 4000 6000 feet

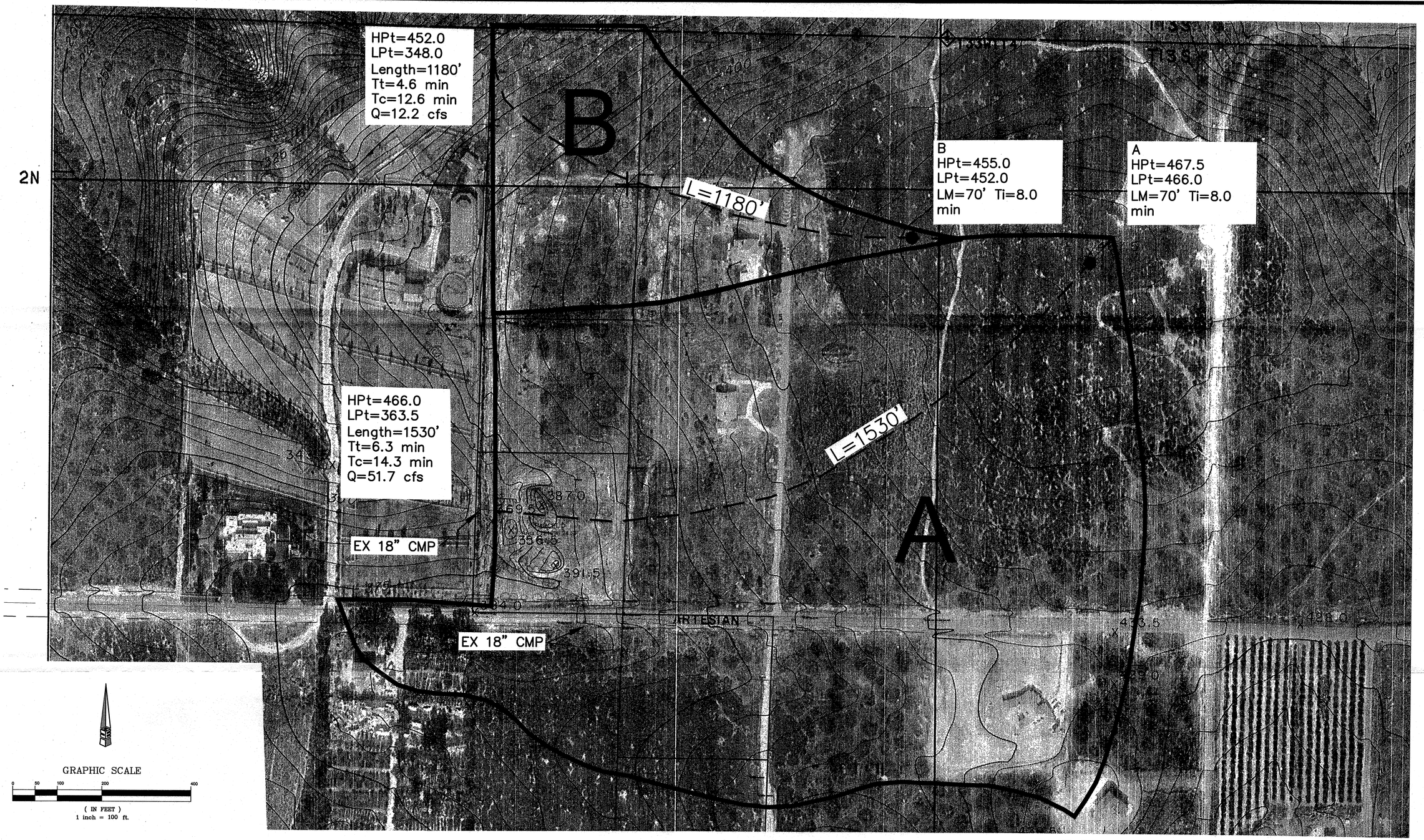
0 ¼ mile ½ mile 1 mile

Represents 40 acres

FEDERAL ASSISTANCE — The preparation of this map was financed in part through a comprehensive planning grant from the Department of Housing and Urban Development.

SHEET NAME: Rho. Santa Fe

SHEET NUMBER: 34



LEGEND

BASIN AREA

FLOW PATH

PRE CONSTRUCTION WATERSHED BOUNDARY TPM 17341 & 19618

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CIVIL ENGINEERING • PLANNING
LAND SURVEYING

ENGINEER'S NAME: SAN DIEGUITO ENGINEERING (760) 753-5525

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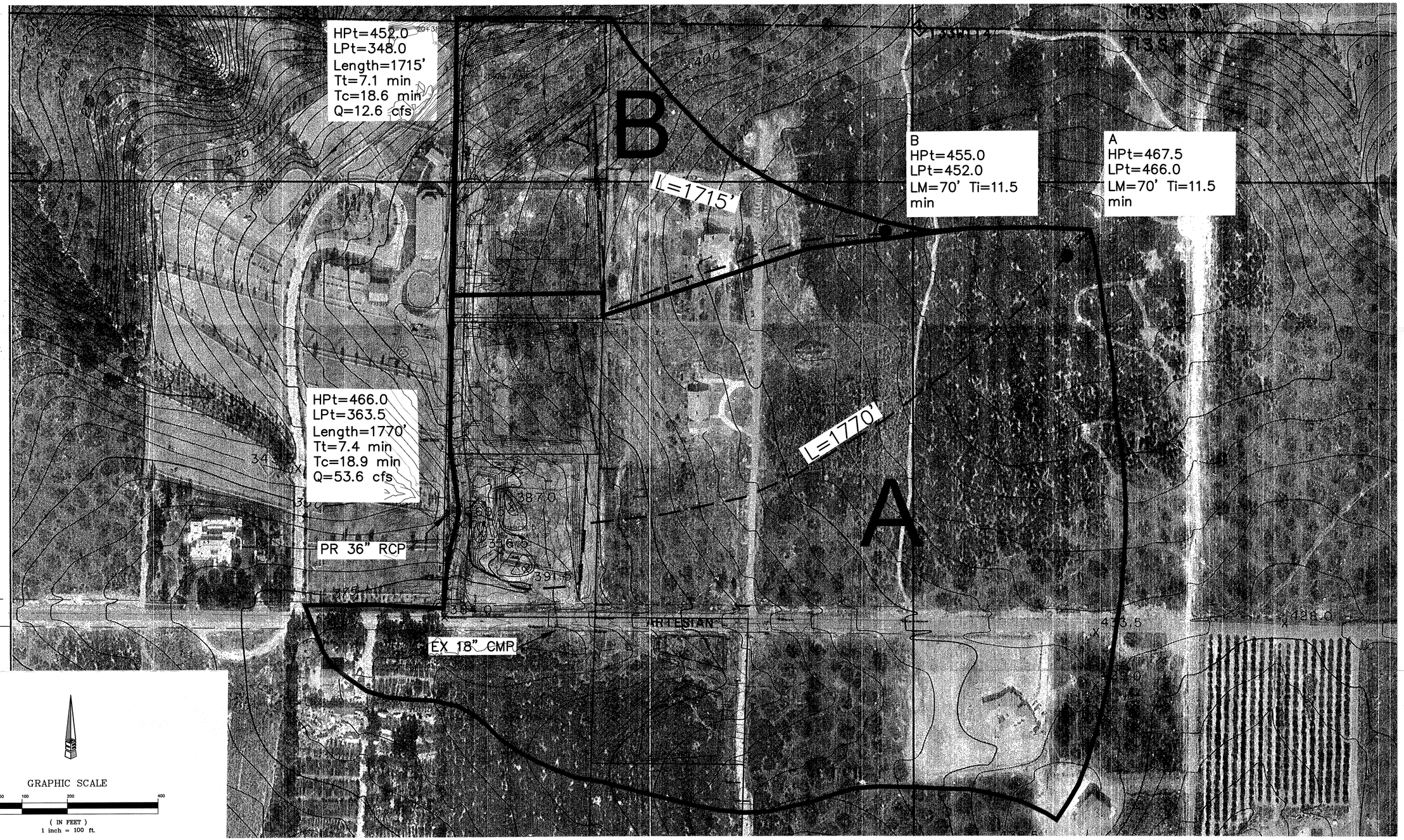

GRAPHIC SCALE

0 50 100 200 400

(IN FEET)
1 inch = 100 ft.

LEGEND

BASIN AREA
FLOW PATH

POST CONSTRUCTION WATERSHED BOUNDARY TPM 17341 & 19618

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LAND SURVEYING

ENGINEER'S NAME: SAN DIEGUITO ENGINEERING (760) 753-5525

FILE NO.5445

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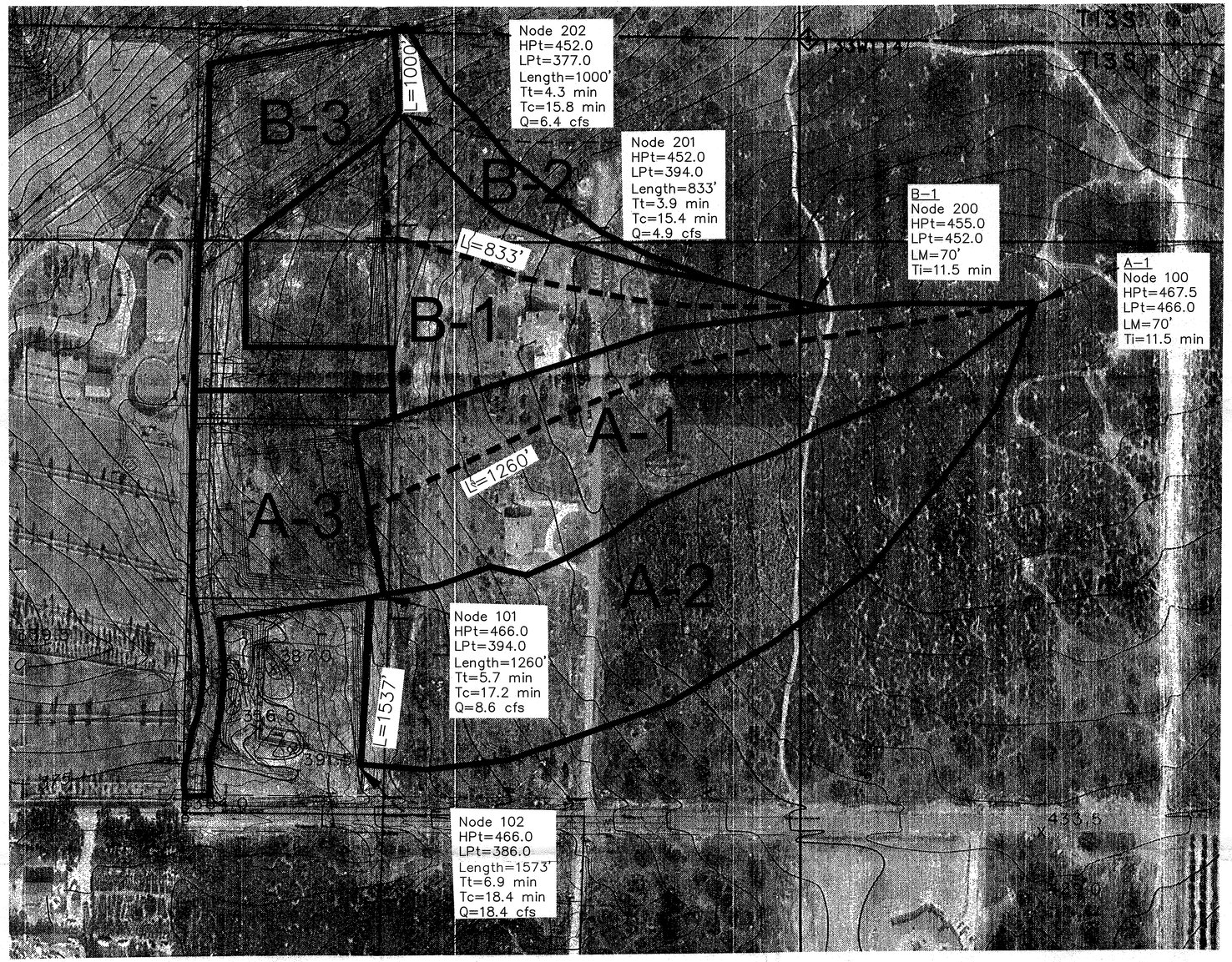


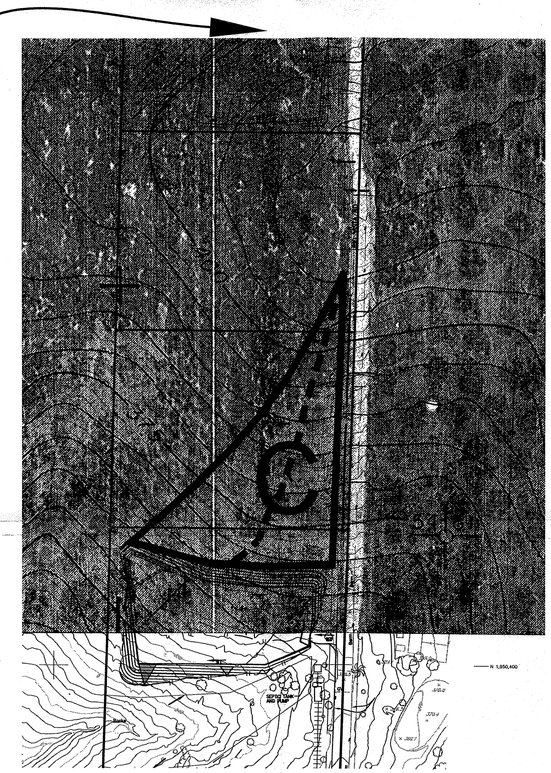
LEGEND

BASIN AREA
FLOW PATH

GRAPHIC SCALE

0 50 100 200 400

(IN FEET)
1 inch = 100 ft.



MATCH

BROW DITCH HYDROLOGY
WATERSHED BOUNDARY
TPM 17341 & 19618

SAN DIEGUITO ENGINEERING, INC
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CIVIL ENGINEERING • PLANNING
LAND SURVEYING

ENGINEER'S NAME: SAN DIEGUITO ENGINEERING (760) 753-5525

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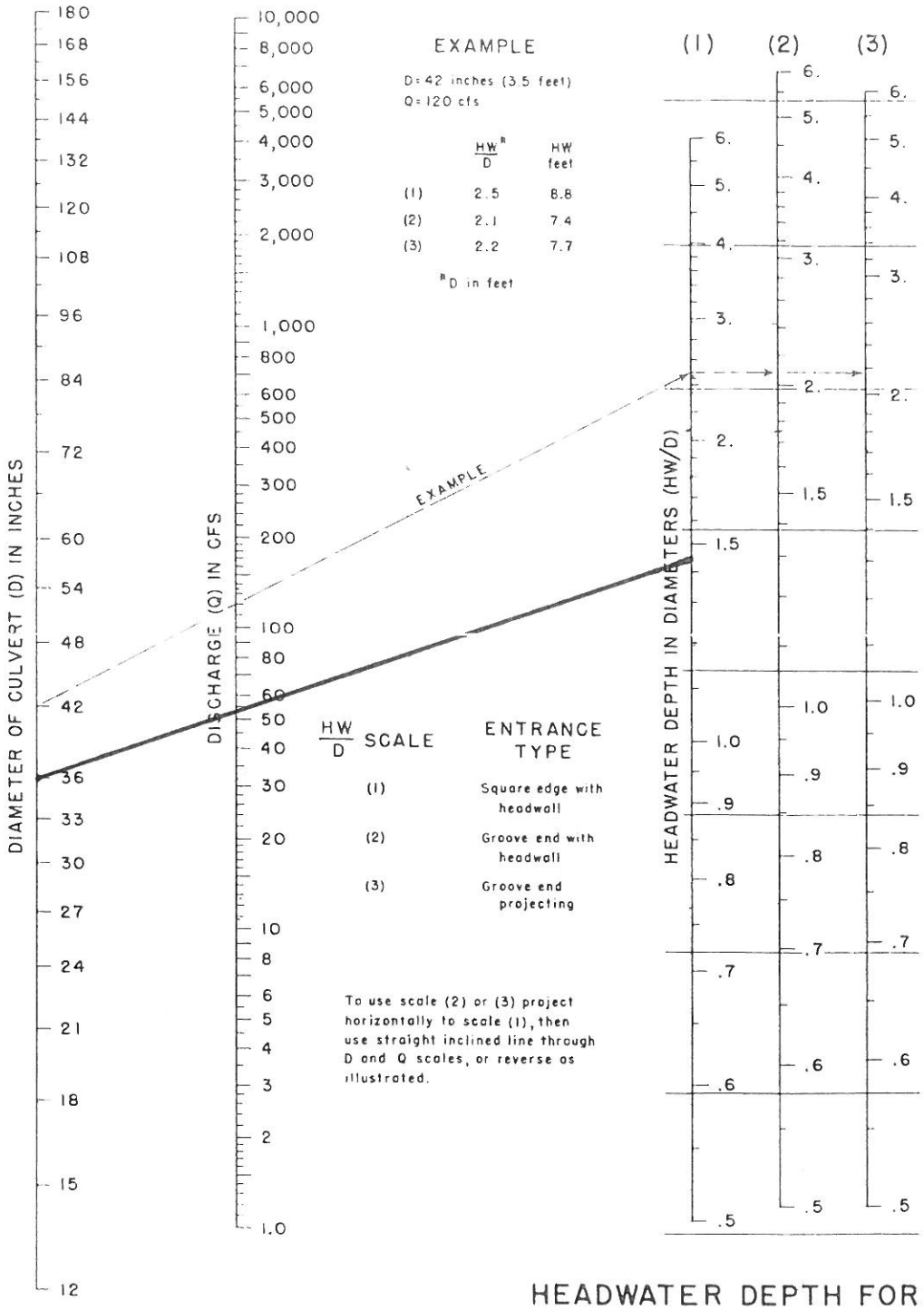
HYDRAULIC CALCULATIONS

36" RCP Culvert



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN 1963

Q100=53.6 cfs

D= 3 ft

HW/D= 1.45

HW/D=4.35 ft OK < 6 ft available

Worksheet for 36" RCP CULVERT

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	3.00	ft
Discharge	53.60	ft^3/s

Results

Normal Depth	2.04	ft
Flow Area	5.11	ft^2
Wetted Perimeter	5.81	ft
Hydraulic Radius	0.88	ft
Top Width	2.80	ft
Critical Depth	2.38	ft
Percent Full	67.9	%
Critical Slope	0.00688	ft/ft
Velocity	10.49	ft/s
Velocity Head	1.71	ft
Specific Energy	3.75	ft
Froude Number	1.37	
Maximum Discharge	71.74	ft^3/s
Discharge Full	66.69	ft^3/s
Slope Full	0.00646	ft/ft
Flow Type	SuperCritical	

Rip Rap: Q100=53.6 cfs V=10.5 Type=1
Size=1/4 ton L=12' W=9' T=2.7'

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	67.89	%
Downstream Velocity	Infinity	ft/s

Worksheet for 36" RCP CULVERT

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	2.04	ft
Critical Depth	2.38	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00688	ft/ft

Worksheet for Brow Ditch A-1 Outlet

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.05800	ft/ft
Diameter	2.00	ft
Discharge	8.60	ft^3/s

Results

Normal Depth	0.54	ft
Flow Area	0.68	ft^2
Wetted Perimeter	2.18	ft
Hydraulic Radius	0.31	ft
Top Width	1.77	ft
Critical Depth	1.05	ft
Percent Full	26.9	%
Critical Slope	0.00497	ft/ft
Velocity	12.66	ft/s
Velocity Head	2.49	ft
Specific Energy	3.03	ft
Froude Number	3.60	
Maximum Discharge	58.60	ft^3/s
Discharge Full	54.48	ft^3/s
Slope Full	0.00145	ft/ft
Flow Type	SuperCritical	

Rip Rap: Q100= 8.6 cfs V=12.7 Type=1
Size=1/2 ton L=10' W=6' T=3.5'

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	26.86	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch A-1 Outlet

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.54	ft
Critical Depth	1.05	ft
Channel Slope	0.05800	ft/ft
Critical Slope	0.00497	ft/ft

Worksheet for Brow Ditch A-1 Capacity

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02600	ft/ft
Diameter	2.00	ft
Discharge	8.60	ft^3/s

Results

Normal Depth	0.66	ft
Flow Area	0.91	ft^2
Wetted Perimeter	2.45	ft
Hydraulic Radius	0.37	ft
Top Width	1.88	ft
Critical Depth	1.05	ft
Percent Full	33.0	%
Critical Slope	0.00497	ft/ft
Velocity	9.50	ft/s
Velocity Head	1.40	ft
Specific Energy	2.06	ft
Froude Number	2.41	
Maximum Discharge	39.24	ft^3/s
Discharge Full	36.48	ft^3/s
Slope Full	0.00145	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	33.03	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch A-1 Capacity

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.66	ft
Critical Depth	1.05	ft
Channel Slope	0.02600	ft/ft
Critical Slope	0.00497	ft/ft

Worksheet for Brow Ditch A-2 Outlet & Capacity

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01600	ft/ft
Diameter	3.00	ft
Discharge	18.40	ft^3/s

Results

Normal Depth	0.95	ft
Flow Area	1.93	ft^2
Wetted Perimeter	3.59	ft
Hydraulic Radius	0.54	ft
Top Width	2.79	ft
Critical Depth	1.37	ft
Percent Full	31.7	%
Critical Slope	0.00412	ft/ft
Velocity	9.55	ft/s
Velocity Head	1.42	ft
Specific Energy	2.37	ft
Froude Number	2.03	
Maximum Discharge	90.75	ft^3/s
Discharge Full	84.36	ft^3/s
Slope Full	0.00076	ft/ft
Flow Type	SuperCritical	

Rip Rap: Q100=18.4 cfs V=9.6 Type=2
Size=No. 2 Backing L=12' W=9'
T=1.1'

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	31.72	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch A-2 Outlet & Capacity

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.95	ft
Critical Depth	1.37	ft
Channel Slope	0.01600	ft/ft
Critical Slope	0.00412	ft/ft

Worksheet for Brow Ditch A-3 Outlet & Capacity

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.04000	ft/ft
Diameter	2.00	ft
Discharge	6.20	ft^3/s

Results

Normal Depth	0.50	ft
Flow Area	0.61	ft^2
Wetted Perimeter	2.09	ft
Hydraulic Radius	0.29	ft
Top Width	1.73	ft
Critical Depth	0.88	ft
Percent Full	25.0	%
Critical Slope	0.00467	ft/ft
Velocity	10.09	ft/s
Velocity Head	1.58	ft
Specific Energy	2.08	ft
Froude Number	2.99	
Maximum Discharge	48.67	ft^3/s
Discharge Full	45.24	ft^3/s
Slope Full	0.00075	ft/ft
Flow Type	SuperCritical	

Rip Rap: Q100=6.2 cfs V=10.1 Type=1
Size=1/4 ton L=10' W=6' T=2.7'

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	25.01	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch A-3 Outlet & Capacity

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.50	ft
Critical Depth	0.88	ft
Channel Slope	0.04000	ft/ft
Critical Slope	0.00467	ft/ft

Worksheet for Brow Ditch B-1 Outlet

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.10000	ft/ft
Diameter	2.00	ft
Discharge	4.90	ft^3/s

Results

Normal Depth	0.35	ft
Flow Area	0.38	ft^2
Wetted Perimeter	1.74	ft
Hydraulic Radius	0.22	ft
Top Width	1.53	ft
Critical Depth	0.78	ft
Percent Full	17.7	%
Critical Slope	0.00455	ft/ft
Velocity	13.03	ft/s
Velocity Head	2.64	ft
Specific Energy	2.99	ft
Froude Number	4.63	
Maximum Discharge	76.95	ft^3/s
Discharge Full	71.53	ft^3/s
Slope Full	0.00047	ft/ft
Flow Type	SuperCritical	

Rip Rap: Q100=4.9 cfs V=13.0 Type=1
Size=1/2 ton L=10' W=6' T=3.5'

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	17.72	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch B-1 Outlet

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.35	ft
Critical Depth	0.78	ft
Channel Slope	0.10000	ft/ft
Critical Slope	0.00455	ft/ft

Worksheet for Brow Ditch B-1 Capacity

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00700	ft/ft
Diameter	2.00	ft
Discharge	4.90	ft^3/s

Results

Normal Depth	0.69	ft
Flow Area	0.97	ft^2
Wetted Perimeter	2.52	ft
Hydraulic Radius	0.38	ft
Top Width	1.90	ft
Critical Depth	0.78	ft
Percent Full	34.7	%
Critical Slope	0.00455	ft/ft
Velocity	5.06	ft/s
Velocity Head	0.40	ft
Specific Energy	1.09	ft
Froude Number	1.25	
Maximum Discharge	20.36	ft^3/s
Discharge Full	18.93	ft^3/s
Slope Full	0.00047	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	34.71	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch B-1 Capacity

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.69	ft
Critical Depth	0.78	ft
Channel Slope	0.00700	ft/ft
Critical Slope	0.00455	ft/ft

Worksheet for Brow Ditch B-2 Outlet

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.10000	ft/ft
Diameter	2.00	ft
Discharge	6.40	ft^3/s

Results

Normal Depth	0.40	ft
Flow Area	0.45	ft^2
Wetted Perimeter	1.87	ft
Hydraulic Radius	0.24	ft
Top Width	1.61	ft
Critical Depth	0.90	ft
Percent Full	20.2	%
Critical Slope	0.00469	ft/ft
Velocity	14.09	ft/s
Velocity Head	3.09	ft
Specific Energy	3.49	ft
Froude Number	4.67	
Maximum Discharge	76.95	ft^3/s
Discharge Full	71.53	ft^3/s
Slope Full	0.00080	ft/ft
Flow Type	SuperCritical	

Rip Rap: Q100=6.4 cfs V=14.1 Type=1
Size=1/2 ton L=10' W=6' T=3.5'

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	20.21	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch B-2 Outlet

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.40	ft
Critical Depth	0.90	ft
Channel Slope	0.10000	ft/ft
Critical Slope	0.00469	ft/ft

Worksheet for Brow Ditch B-2 Capacity

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02600	ft/ft
Diameter	2.00	ft
Discharge	6.40	ft^3/s

Results

Normal Depth	0.57	ft
Flow Area	0.73	ft^2
Wetted Perimeter	2.25	ft
Hydraulic Radius	0.33	ft
Top Width	1.80	ft
Critical Depth	0.90	ft
Percent Full	28.3	%
Critical Slope	0.00469	ft/ft
Velocity	8.74	ft/s
Velocity Head	1.19	ft
Specific Energy	1.75	ft
Froude Number	2.42	
Maximum Discharge	39.24	ft^3/s
Discharge Full	36.48	ft^3/s
Slope Full	0.00080	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	28.34	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch B-2 Capacity

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.57	ft
Critical Depth	0.90	ft
Channel Slope	0.02600	ft/ft
Critical Slope	0.00469	ft/ft

Worksheet for Brow Ditch B-3 Outlet & Capacity

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.11000	ft/ft
Diameter	2.00	ft
Discharge	4.10	ft^3/s

Results

Normal Depth	0.32	ft
Flow Area	0.32	ft^2
Wetted Perimeter	1.64	ft
Hydraulic Radius	0.20	ft
Top Width	1.46	ft
Critical Depth	0.71	ft
Percent Full	15.9	%
Critical Slope	0.00449	ft/ft
Velocity	12.78	ft/s
Velocity Head	2.54	ft
Specific Energy	2.85	ft
Froude Number	4.81	
Maximum Discharge	80.71	ft^3/s
Discharge Full	75.03	ft^3/s
Slope Full	0.00033	ft/ft
Flow Type	SuperCritical	

Rip Rap: Q100=4.1 cfs V=12.8 Type=1
Size=1/2 ton L=10' W=6' T=3.5'

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	15.88	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch B-3 Outlet & Capacity

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.32	ft
Critical Depth	0.71	ft
Channel Slope	0.11000	ft/ft
Critical Slope	0.00449	ft/ft

Worksheet for Brow Ditch C Outlet

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.07500	ft/ft
Diameter	2.00	ft
Discharge	2.70	ft^3/s

Results

Normal Depth	0.28	ft
Flow Area	0.27	ft^2
Wetted Perimeter	1.55	ft
Hydraulic Radius	0.18	ft
Top Width	1.40	ft
Critical Depth	0.57	ft
Percent Full	14.2	%
Critical Slope	0.00445	ft/ft
Velocity	9.86	ft/s
Velocity Head	1.51	ft
Specific Energy	1.80	ft
Froude Number	3.93	
Maximum Discharge	66.64	ft^3/s
Discharge Full	61.95	ft^3/s
Slope Full	0.00014	ft/ft
Flow Type	SuperCritical	

Rip Rap: Q100=2.7 cfs V=9.9 Type=2
Size=No. 2 Backing L=10' W=6
T=1.1'

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	14.23	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch C Outlet

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.28	ft
Critical Depth	0.57	ft
Channel Slope	0.07500	ft/ft
Critical Slope	0.00445	ft/ft

Worksheet for Brow Ditch C Capacity

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.03400	ft/ft
Diameter	2.00	ft
Discharge	2.70	ft^3/s

Results

Normal Depth	0.34	ft
Flow Area	0.36	ft^2
Wetted Perimeter	1.71	ft
Hydraulic Radius	0.21	ft
Top Width	1.51	ft
Critical Depth	0.57	ft
Percent Full	17.2	%
Critical Slope	0.00446	ft/ft
Velocity	7.47	ft/s
Velocity Head	0.87	ft
Specific Energy	1.21	ft
Froude Number	2.69	
Maximum Discharge	44.87	ft^3/s
Discharge Full	41.71	ft^3/s
Slope Full	0.00014	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	17.24	%
Downstream Velocity	Infinity	ft/s

Worksheet for Brow Ditch C Capacity

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.34	ft
Critical Depth	0.57	ft
Channel Slope	0.03400	ft/ft
Critical Slope	0.00446	ft/ft