CEQA PRELIMINARY DRAINAGE STUDY

FOR

COUNTY OF SAN DIEGO TRACT 5362
HOMELAND ESTATES

May 20, 2005

~~February 14, 2005~~

TM No: 5362

ER 04-08-010

Prepared for:

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REC Project No 03-485

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1 PURPOSE AND SCOPE

The purpose of this report is to establish the results of a hydrology and hydraulic analysis for the development of the Homeland Estates single-family housing subdivision in the County of San Diego, California. This report is intended to present the findings of a drainage study for the development of a surficial and underground drainage system for the entire site, which will be necessary to convey the drainage flows safely to an appropriate downstream discharge point.

This report is intended to replace the drainage calculations previously submitted to the County in June of 2004 (see References Section).

Computer models (spreadsheet) have been created of the proposed drainage facilities and simulate the performance that is anticipated due to the effects of a 100-year (surficial) and 100 year (underground) storm event. Further descriptions of the areas and computer methodology are contained elsewhere in this report.

2 EXISTING SITE LOCATION AND PHYSICAL DESCRIPTION

The subject site is located on the west side of Miller Avenue between Hamilton Lane and Clarence Street. The site is bordered to the north by the TM4848-1, a 9-lot residential subdivision and to the south by Clarence Street as well as 3-single home 1-2 acre lots. The easterly side of the project is bordered by Alexander Drive and three one to two acre lots with single homes. The site is currently undeveloped with no existing structures or residences on site. Current drainage is surface and approximately three fourths of the site is allowed to drain into an existing D-36 concrete channel built by the 9-lot subdivision to the north. The remainder is draining to an existing drainage earthen channel along the edge of an existing driveway on the south side of the site and out onto Miller Avenue. From there the surface drainage finds it's way into the D-36 drainage channel at an L-Type headwall. From there, all the drainage travels either under or over Miller Avenue (see Existing Hydraulic Calculations for further explanation) and sheet flows into a 100' plus wide channel on the westerly property. From there, all the drainage makes its way into a County flood channel running along the west side of the property and empties into Lake Hodges to the South.

The soils in the study watershed were identified as having relatively slow infiltration rates when thoroughly wetted and fall into the "soil group D". The land slopes range from 5 to 15% with the average being around 10%. This means that the generation of runoff from rainfall events over these native soils can be expected to be high to very high.

3 DEVELOPED SITE AND DRAINAGE DESCRIPTION

Once developed, the site will consist of ~~10~~ 9 lots with a lot size of approximately 1 acre each, and a cul-de-sac that is approximately 700' long. Access to all but two of the lots will be from Miller Avenue. The other two lots will be accessed from Alexander Drive.

The proposed development does not alter the existing drainage pattern of the site and any offsite runoff with the following exceptions: The existing concrete channel along the Miller Avenue frontage is to be demolished and replaced with a continuation of the existing 30" RCP storm drain all the way to the existing 24" culverts under Miller Avenue. A large storm water vault is to be constructed to accommodate this system with 3 additional 18" culverts being constructed adjacent to the 4 existing ones. A 16' B-1 Curb Inlet top is to be attached to the top of said vault. Also, the existing brow ditch along the southerly side of the adjacent 9-lot subdivision is to be diverted into a modified (to accommodate larger flows and a 30" pipe) type F catch basin. From there, a second 30" RCP pipe is runs parallel and easterly of the other 30" pipe but outside of the right-of-way. This diversionary pipe picks up a large portion of the existing flows from easterly of the 9-lot subdivision and diverts them to the storm vault. This 2 pipe system allows for the limited cover and fall demanded by the existing condition while limiting the amount of surface flooding on the public streets (both existing and proposed).

The 3 additional 24" RCP storm drains proposed for carrying all of the on-site flows off-site will actually decrease off-site erosion problems. The existing conditions are under sized and allow for some over-topping and flooding across Miller Avenue. This causes some shoulder erosion as well as higher velocity flow-rates as floodwater exits the pipes. The proposed additional culverts will disperse the water over a wider area as well as decreasing the overall velocity of storm-water exiting the system.

This design will also contain the majority of the 100 year flooding completely underground within the public right-of-way. The Miller Avenue northbound lane will have approximately 13' of dry lane from the center of street. Approximately 7 feet along the edge of the curb line will see approximately 0.1' of flooding near the low point of the street. This is a much improved condition over the amount of overtopping and flooding currently possible in a 100-year storm event.

4 STUDY METHOD

In accordance with the County of San Diego Flood Control Department's Design and Procedures Manual and the County of San Diego Department of Public Works Improvement Standards, rational method hydrology was used to estimate run-off quantities for 100-year design storm. Soil characteristics were determined to be Type "D". Runoff coefficient "C" factors were based on table 3-1 from the County approved hydrology manual (see appendix A). Basin areas are shown on the pre- and post-development hydrology maps in the pockets at the back of this report.

Rainfall intensities were estimated from Figure 3-1 "Intensity – Duration Design Chart – Template" of the approved County hydrology. Times of concentration for each individual basin were estimated using Figure 3-3 "Rational Formula – overland Time of Flow Nomograph". The Maximum overland flow length (L_M)and Initial time of concentration (T_i) Table 3-2 was used to limit these values to a more conservative estimate based on county adopted standards (see approved hydrology manual). Travel time was estimated using the new average flow – velocities iterative solution recently adopted (see Approved Hydrology Manual). These figures were taken from the County of San Diego approved Hydrology Manual and can be found in Appendix A (charts and graphs).

Some of the approved hydraulics routing methodology was abandoned due to the unusual nature of the site. There is one inlet control culvert situations existing in the upper portion of the system being analyzed. The existing 24" under Hamilton Lane will only allow approx. 18 cfs to pass. The remaining storm-water runoff overflows out into the street where it meanders diagonally across the intersection with Miller Avenue and onto the westerly property across the street. The pipe restriction and limited flow invalidates both the dependent and independent watershed junction analyses assumptions. For this reason, hydraulic analysis of the underground system was performed using a straight arithmetic summation of flows rather than the adopted routing methodology. The amount of reduction in estimated flows due to pipe-routing is estimated to have been minimal and less conservative.

5 ON-SITE RECOMMENDATIONS

The storm drain system depicted in the spread sheet model and shown on the drainage study is sized and located to contain the floodwaters of a 100-year storm. These floodwaters are expected to be within the confines of the proposed drainage facility. The Tentative Map plans submitted under the design contract have been prepared to accurately follow the model presented with this report.

Catch basins located in the sump areas are sized to pick up the entire 100-year storm flows.

Development of this project has no adverse effects on upstream and/or downstream properties.

The finished floor of the houses adjacent to the sump areas have been elevated above the 100-year water surface elevation.

LIMITATIONS:

The natural and man-made drainage characteristics present on and off the site are subject to change, either by deliberate or accidental works of man or by natural occurrences. The modeling techniques used in the preparation of this report are based upon sound engineering practices and current technological tools. However, these are subject to change due to advances in knowledge. The agencies involved in the approval, acceptance, and maintenance of proposed improvements are continuously revising their standards to conform to the advances in the field.

6 REFERENCES

San Diego County – Department of Public Works – Flood Control Section
"Hydrology Manual" - June 2003

San Diego County – Department of Public Works
"Design and Procedure Manual" - April 1993

United States - Department of Public Works
"Standard Specifications for Public Works Construction – Greenbook" – 1991

REC Consultants - 7445 Mission Valley Road, Suite 109, San Diego, CA, 92108
"CEQA Preliminary Drainage Study, – Frank Florez, P.E."
June 2004

"Hydraulic Design handbook" McGraw Hill Handbooks
Larry W. Mays Editor in Chief – 1999

Brater, Ernest F. "Handbook of Hydraulics for the Solution of Hydraulic Engineering Programs." p. 3-26 McGraw-Hill, Inc. Sixth Edition. (1976)

DECLARATION OF RESPONSIBLE CHARGE:

I HEREBY DECLARE THAT I AM THE ENGINEER OF WORK FOR THIS PROJECT, THAT I HAVE EXCERCISED 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 CURENT STANDARDS.

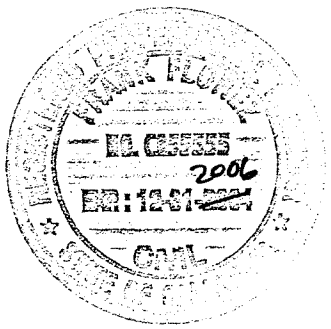
I UNDERSTAND THAT THE CHECK OF PROJECT DRAWINGS AND SPECIFICATIONS BY THE COUNTY OF SAN DIEGO IS CONFINED TO A REVIEW ONLY AND DOES NOT RELIEVE ME, AS ENGINEER OF WORK, OF MY RESPONSIBILITIES FOR PROJECT DESIGN.

ENGINEER OF WORK:

REC CONSULTANTS, INC.
2442 SAN DIEGO
CALIFORNIA, 92101
PHONE: (619) 232-9200

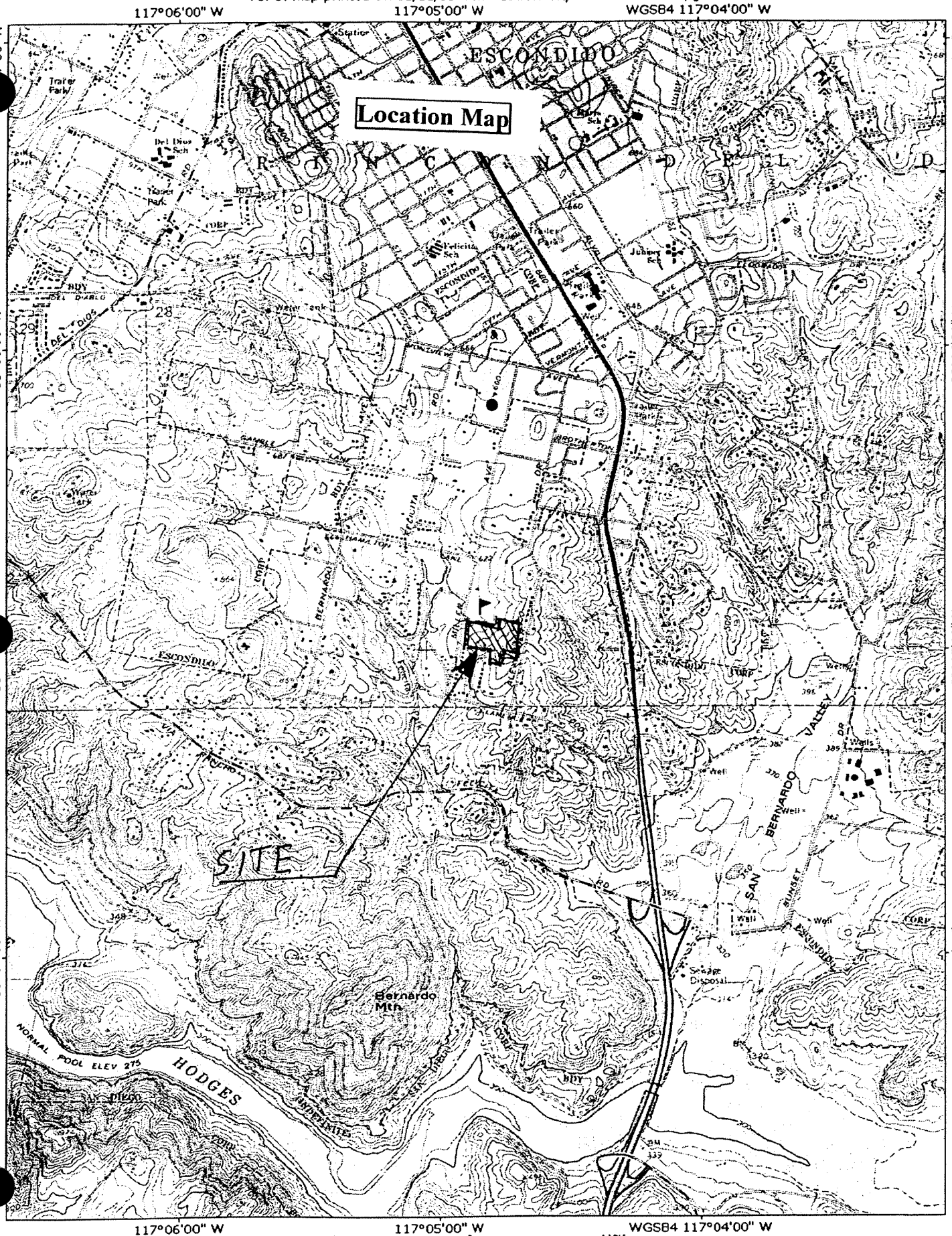
2-14-05

FRANK FLOREZ, R.C.E. 55555 DATE
REGISTRATION EXPIRES DECEMBER 31, 2006



7 LOCATION MAP

TOPO! map printed on 01/18/05 from "California.tpo" and "Untitled.tpg"



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8 HYDROLOGY

Existing Conditions

BASIN	AREA	C	C X A	L_O	L_{MAX}	ΔH	S_o	$T_{o\,i}$	L_t	S_t	T_t	T_c	$I_{(100)}$	$Q_{(100)}$
	(AC)			(FT)	(FT)	(FT)	(%)	(MIN.)	(FT)	(%)	(MIN.)	(MIN.)	(IN/HR)	(CFS)
A	6.56	0.41	2.69	300	100	60	20.0%	4.6	500	1%	1	5.6	7.61	20.5
B	0.95	0.41	0.39	150	70	1.5	1.0%	10.4	350	10%	0.6	11.0	4.91	1.9
C	3.98	0.41	1.63	200	70	2	1.0%	10.4	600	6%	0.8	11.2	4.86	7.9
D	1.93	0.41	0.79	150	70	1.5	1.0%	10.4	650	5%	2.2	12.6	4.50	3.6
E	1.72	0.41	0.71	150	70	1.5	1.0%	10.4	650	5%	2.3	12.7	4.48	3.2
F	3.64	0.41	1.49	450	100	45	10.0%	5.8	600	6%	1.1	6.9	6.66	9.9
G	2.81	0.41	1.15	300	100	30	10.0%	5.8	350	10%	0.6	6.4	6.99	8.1
H	3	0.41	1.23	300	100	60	20.0%	4.6	450	1%	1.3	5.9	7.36	9.1
I	2.37	0.41	0.97	450	100	90	20.0%	4.6	150	1%	0.4	5.0	8.17	7.9
J	3.65	0.41	1.50	150	70	1.5	1.0%	10.4	600	16%	0.6	11.0	4.91	7.4
K	5.12	0.41	2.10	150	70	1.5	1.0%	10.4	350	8%	0.8	11.2	4.86	10.2
L	3.5	0.41	1.44	150	100	15	10.0%	5.8	200	6%	0.3	6.1	7.21	10.3
M	1.83	0.79	1.45	10	75	0.2	2.0%	1.4	2000	5%	5.6	7.0	6.57	9.5
N	0.74	0.79	0.58	10	75	0.2	2.0%	1.4	950	2%	4.4	5.8	7.42	4.3
O	0.58	0.41	0.24	220	70	2.2	1.0%	10.4	350	8%	1.0	11.4	4.80	1.1
OS1	2.91	0.35	1.02	300	100	38	12.7%	5.8	300	5%	0.4	6.2	7.12	7.2
OS2	4.75	0.79	3.75	50	75	1	2.0%	3.1	650	7%	1.0	5.0	8.17	30.6
OS3	2.57	0.41	1.05	300	100	42	14.0%	5.2	200	6%	0.2	5.4	7.82	8.2
OS4	6.25	0.41	2.56	400	100	48	12.0%	5.4	250	3%	0.6	6.0	7.24	18.6
E1	4.32	0.41	1.77	450	100	90	20.0%	4.6	150	1%	0.4	5.0	8.17	14.5
E2	9.44	0.41	3.87	1,200	100	120	10.0%	5.8	0	1%	0	5.8	7.45	28.8
E3	7.07	0.41	2.90	450	100	45	10.0%	5.8	1200	10%	1.6	7.4	6.36	18.4
E4	0.49	0.79	0.39	10	75	0.02	0.2%	8.3	650	2%	3.4	11.7	4.73	1.8
E5	0.09	0.79	0.07	10	75	0.02	0.2%	8.3	0	1%	0	8.3	5.91	0.4
E6	3.65	0.41	1.50	150	70	1.5	1.0%	10.4	600	16%	0.5	10.9	4.94	7.4

BASIN E1 TRAVEL TIME - ITERATIVE SOLUTION
NODES: 20 - 19

FIRST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 9.1+(2.5 CFS/ACRE*4.32 ACRE)/2= 14.5 CFS

Lt =	150	FT	C=	0.41	
$S_{(AVG)}$=	0.01	FT/FT	A=	4.32	Acres
$V_{(AVG)}$=	6	FPS	P6=	3.1	in.

$T_t = Lt*(V_{(avg)})*(1min./60sec)$ = 0.4 min.

Tc = To+Tt = 5.9 + 0.4 = 6.3 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.02 in./hr

$Q_{19} = [\Sigma C*A]I_{100}$ = 21.1 CFS

CHECK: $Q_{(AVG)}$ = 9.1+(21.1-9.1)/2 = 15.09 not equal 14.50

SECOND ITERATION: ASSUME q_i= 4.9 CFS/ACRE

$Q_{(AVG)}$= 9.1+(4.9 CFS/ACRE*4.32 ACRE)/2= 15.09 CFS

Lt =	150	FT	C=	0.41	
$S_{(AVG)}$=	0.01	FT/FT	A=	2.37	Acres
$V_{(AVG)}$=	6.2	FPS	P6=	3.1	in.

$T_t = Lt*(V_{(avg)})*(1min./60sec)$ = 0.4 min.

Tc = To+Tt = 5.9 + 0.4 = 6.3 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.03 in./hr

$Q_{19} = [\Sigma C*A]I_{100}$ = 21.1 CFS

CHECK: $Q_{(AVG)}$ = 9.1+(21.1-9.1)/2 = 15.11 approx. 15.09 ok

BASIN E1

NODE 20-19

Channel Calculator

Given Input Data:

Shape	Advanced
Solving for	Depth of Flow
Flowrate	15.0900 cfs Q avg
Slope	0.0100 ft/ft
Manning's n	0.0130
Height	19.2000 in
Bottom width	1.0000 in
Left radius	19.2000 in
Right radius	19.2000 in
Left slope	100000.0000 ft/ft (V/H)
Right slope	10000.0000 ft/ft (V/H)

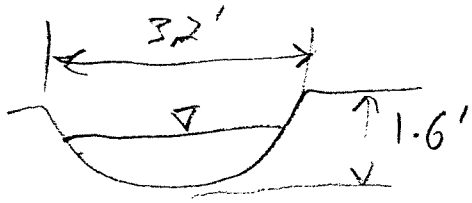
Computed Results:

Depth	12.9455 in
Velocity	6.1761 fps V
Full Flowrate	41.3694 cfs
Flow area	2.4433 ft2
Flow perimeter	73.8234 in
Hydraulic radius	4.7659 in
Top width	39.3993 in
Area	4.1546 ft2
Perimeter	61.3184 in
Percent full	67.4244 %

Critical Information

Critical depth	14.4452 in
Critical slope	0.0056 ft/ft
Critical velocity	5.2880 fps
Critical area	2.8536 ft2
Critical perimeter	70.8240 in
Critical hydraulic radius	5.8020 in
Critical top width	39.3995 in
Specific energy	1.6716 ft
Minimum energy	1.8056 ft
Froude number	1.2622
Flow condition	Supercritical ok

$$T_t = \frac{150'}{6.2} \cdot \frac{1}{60} = \underline{0.4 \text{ min}}$$



MOD. TYPED Terrace Ditch

Earthen Swale Basin E3

tmp#22.txt

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	18.4000 cfs
Slope	0.1000 ft/ft
Manning's n	0.0200
Height	18.0000 in
Bottom width	2.0000 in
Left slope	0.5000 ft/ft (V/H)
Right slope	0.5000 ft/ft (V/H)

Computed Results:

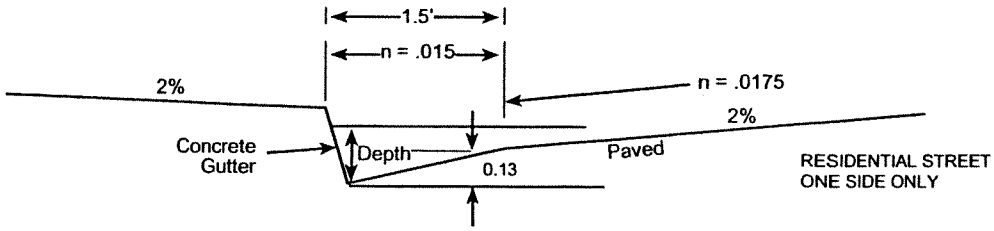
Depth	9.8260 in
Velocity	12.4539 fps
Full Flowrate	87.2238 cfs
Flow area	1.4775 ft2
Flow perimeter	45.9433 in
Hydraulic radius	4.6308 in
Top width	41.3041 in
Area	4.7500 ft2
Perimeter	82.4984 in
Percent full	54.5890 %

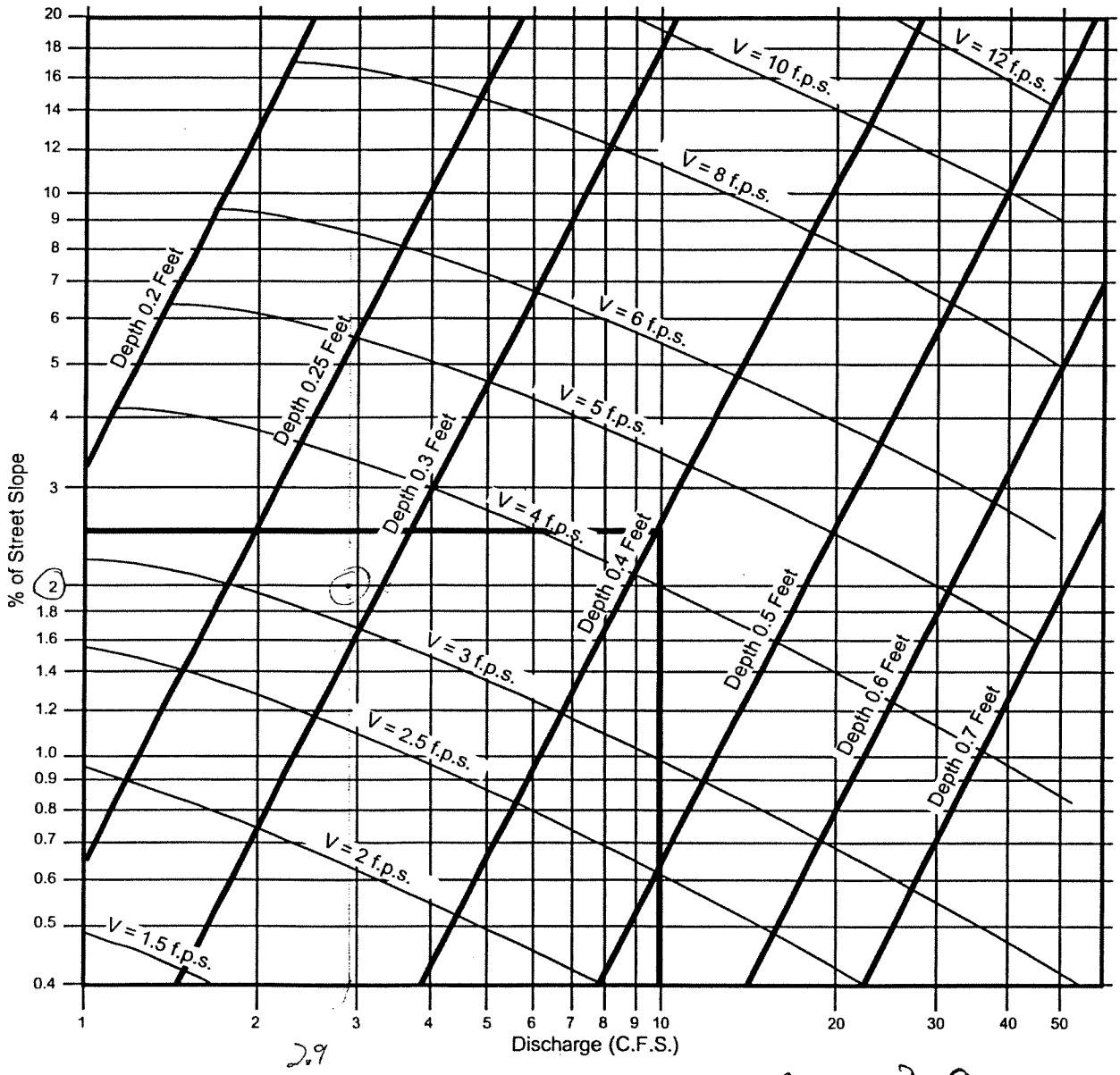
Critical Information

Critical depth	16.2353 in
Critical slope	0.0076 ft/ft
Critical velocity	4.7345 fps
Critical area	3.8864 ft2
Critical perimeter	74.6066 in
Critical hydraulic radius	7.5012 in
Critical top width	66.9413 in
Specific energy	3.2291 ft
Minimum energy	2.0294 ft
Froude number	3.3512
Flow condition	Supercritical

$$T_t = \left|\frac{1200'}{12.5\ FPS}\right| \frac{1}{60} = \underline{1.6\ min}$$

BASIN E-4 (TYPE G Curb & Gutter @ 2%)
650 LF





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

$Q_{AVG} = 2.9$
$V_{50} = 3.2$
$J_5 = 3.4$

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

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

BASIN E6 (J)

NODE 19-13

Channel Calculator

Given Input Data:

Shape	Advanced
Solving for	Depth of Flow
Flowrate	25.5800 cfs
Slope	0.1600 ft/ft
Manning's n	0.0130
Height	19.2000 in
Bottom width	12.0000 in
Left radius	12.0000 in
Right radius	12.0000 in
Left slope	100000.0000 ft/ft (V/H)
Right slope	10000.0000 ft/ft (V/H)

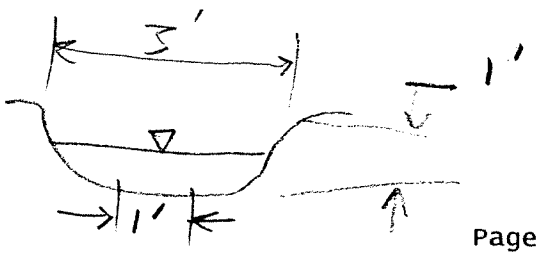
Computed Results:

Depth	7.0746 in
Velocity	19.0972 fps
Full Flowrate	174.8340 cfs
Flow area	1.3395 ft2
Flow perimeter	59.5472 in
Hydraulic radius	3.2392 in
Top width	35.9995 in
Area	4.3708 ft2
Perimeter	64.0991 in
Percent full	36.8471 %

Critical Information

Critical depth	17.4639 in
Critical slope	0.0045 ft/ft
Critical velocity	6.4977 fps
Critical area	3.9368 ft2
Critical perimeter	60.6269 in
Critical hydraulic radius	9.3506 in
Critical top width	36.0006 in
Specific energy	6.2572 ft
Minimum energy	2.1830 ft
Froude number	5.0386
Flow condition	Supercritical

$$T_t = \frac{600'}{19.1 \mid 60} = \underline{0.5 \text{ min}}$$



Type 'D'
Terrace Ditch

BASIN E6 TRAVEL TIME - ITERATIVE SOLUTION
NODES: 19 - 13

FIRST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 21.1+(2.5 CFS/ACRE*3.65 ACRE)/2= 25.67 CFS

Lt =	600	FT	C=	0.41	
$S_{(AVG)}$=	0.16	FT/FT	A=	3.65	Acres
$V_{(AVG)}$=	19.1	FPS	P6=	3.1	in.

T_t = 600'*(1/$V_{(avg)}$)*(1min./60sec) = 0.5 min.

Tc = To+Tt = 6.3 + 0.5 = 6.8 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 6.68 in./hr

Q_{13} = [ΣC*A]I_{100} = 30.1 CFS

CHECK: $Q_{(AVG)}$ = 21.1+(30.1-21.1)/2 = 25.58 not equal 25.67

SECOND ITERATION: ASSUME q_i= 2.46 CFS/ACRE

$Q_{(AVG)}$= 21.1+(2.46 CFS/ACRE*3.65 ACRE)/2= 25.58 CFS

Lt =	600	FT	C=	0.41	
$S_{(AVG)}$=	0.16	FT/FT	A=	3.65	Acres
$V_{(AVG)}$=	19.1	FPS	P6=	3.1	in.

T_t = 600'*(1/$V_{(avg)}$)*(1min./60sec) = 0.5 min.

Tc = To+Tt = 6.3 + 0.5 = 6.8 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 6.68 in./hr

Q_{13} = [ΣC*A]I_{100} = 30.1 CFS

CHECK: $Q_{(AVG)}$ = 21.1+(30.1-21.1)/2 = 25.58 approx. 25.58

Type D TERRACE DITCH @ 1%

BASIN H NODE 21-22

Channel Calculator

Given Input Data:

Shape	Advanced
Solving for	Depth of Flow
Flowrate	9.3000 cfs
Slope	0.0100 ft/ft
Manning's n	0.0130
Height	12.0000 in
Bottom width	12.0000 in
Left radius	12.0000 in
Right radius	12.0000 in
Left slope	100000.0000 ft/ft (V/H)
Right slope	10000.0000 ft/ft (V/H)

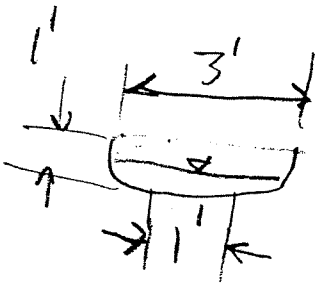
Computed Results:

Depth	8.3116 in
Velocity	5.6408 fps — V
Full Flowrate	21.3834 cfs
Flow area	1.6487 ft2
Flow perimeter	57.0732 in
Hydraulic radius	4.1598 in
Top width	35.9996 in
Area	2.5708 ft2
Perimeter	49.6990 in
Percent full	69.2637 %

Critical Information

Critical depth	9.7383 in
Critical slope	0.0049 ft/ft
Critical velocity	4.6376 fps
Critical area	2.0054 ft2
Critical perimeter	54.2200 in
Critical hydraulic radius	5.3259 in
Critical top width	35.9998 in
Specific energy	1.1871 ft
Minimum energy	1.2173 ft
Froude number	1.3414
Flow condition	Supercritical ok

$$T_T = \frac{450'}{5.6\ FPS} \cdot \frac{1}{60} = 1.3\ min$$



Earthen Swale - "Basin G"

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	8.1000 cfs
Slope	0.1000 ft/ft
Manning's n	0.0200
Height	12.0000 in
Bottom width	2.0000 in
Left slope	0.5000 ft/ft (V/H)
Right slope	0.5000 ft/ft (V/H)

Computed Results:

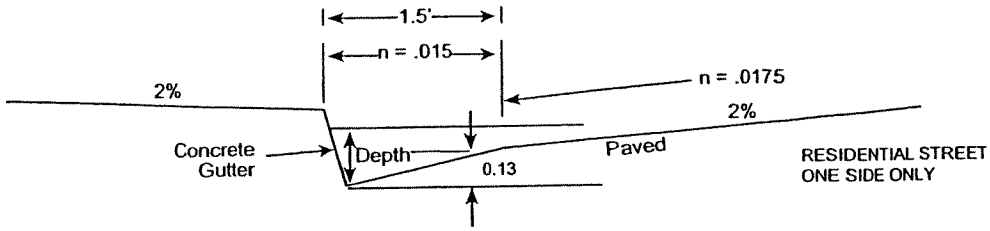
Depth	7.0971 in
Velocity	10.1486 fps
Full Flowrate	30.6459 cfs
Flow area	0.7981 ft2
Flow perimeter	33.7393 in
Hydraulic radius	3.4065 in
Top width	30.3885 in
Area	2.1667 ft2
Perimeter	55.6656 in
Percent full	59.1426 %

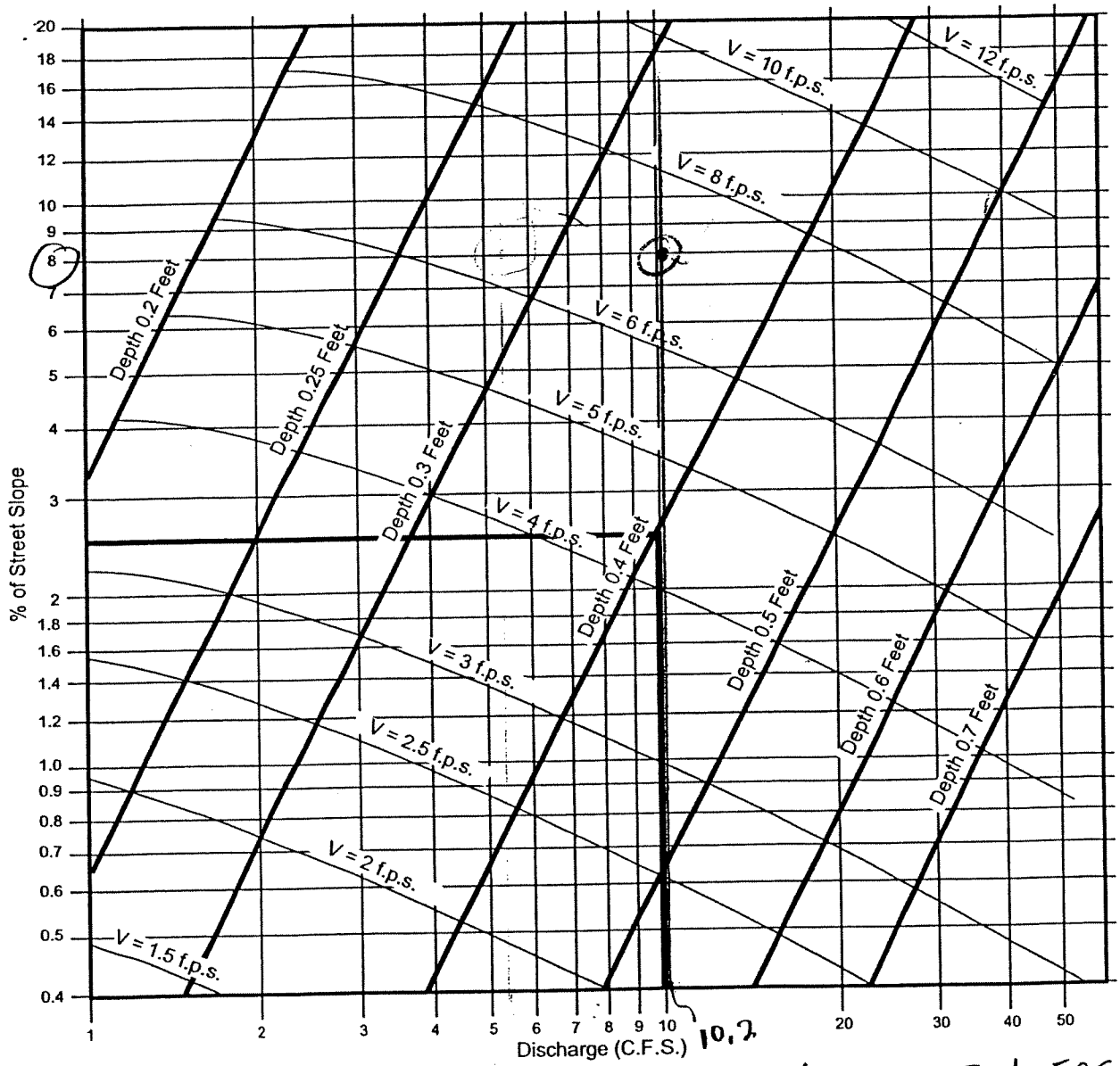
Critical Information

Critical depth	11.5591 in
Critical slope	0.0085 ft/ft
Critical velocity	4.0173 fps
Critical area	2.0163 ft2
Critical perimeter	53.6941 in
Critical hydraulic radius	5.4074 in
Critical top width	48.2366 in
Specific energy	2.1920 ft
Minimum energy	1.4449 ft
Froude number	3.1870
Flow condition	Supercritical

$$T_t = \frac{350'}{10.1\ FPS} \cdot \frac{1\ min}{60\ sec} = 0.6\ min$$

Basin K - Type G Curb & Gutter ~ 350 LF @ 8% avg.





10.2 CFS = Q V_{gutter} = 7.1 FPS

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

T_t = 0.8 min

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

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

BASIN L TRAVEL TIME - ITERATIVE SOLUTION

NODE 14 - 17

FIRST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 27.5+(2.5 CFS/ACRE*3.50 ACRE)/2= 31.9 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	3.50	Acres
$V_{(AVG)}$=	11.8	FPS	P6=	3.1	in.

T_t = 200'*(1/11.8FPS)*(1min./60sec) = 0.3 min.

Tc = To_L+Tt_L = 5.8 + 0.3 = 6.1 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.18 in./hr

Q_A = [ΣC*A]I_{100}+18.0 = 38.7 CFS

CHECK: $Q_{(AVG)}$ = 27.5+(38.8-27.5)/2 = 33.10 not equal 31.88

SECOND ITERATION: ASSUME q_i= 8.3 CFS/ACRE

$Q_{(AVG)}$= 27.5+(8.3 CFS/ACRE*3.5 ACRE)/2= 33.10 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	3.50	Acres
$V_{(AVG)}$=	11.9	FPS	P6=	3.1	in.

T_t = 200'*(1/11.9 FPS)*(1min./60sec) = 0.3 min.

Tc = To_L+Tt_L = 5.8 + 0.3 = 6.1 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.18 in./hr

Q_A = [ΣC*A]I_{100}+18.0= 38.7 CFS

CHECK: $Q_{(AVG)}$ = 27.5+(38.7-27.5)/2 = 28.65 not equal 33.10

THIRD ITERATION: ASSUME q_i= 7.8 CFS/ACRE

$Q_{(AVG)}$= 27.5+(7.8 CFS/ACRE*3.5 ACRE)/2= 28.65 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	2.57	Acres
$V_{(AVG)}$=	11.5	FPS	P6=	3.1	in.

T_t = 200'*(1/130 FPS)*(1min./60sec) = 0.3 min.

Tc = To_L+Tt_L = 5.8 + 0.3 = 6.1 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.22 in./hr

Q_A = [ΣC*A]I_{100}+18.0= 38.8 CFS

CHECK: $Q_{(AVG)}$ = 27.5+(38.8-27.5)/2 = 28.70 approx. 28.65 ok

Earthen Channel - Basin L

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	28.6500 cfs
Slope	0.0600 ft/ft
Manning's n	0.0200
Height	48.0000 in
Bottom width	2.0000 in
Left slope	0.5000 ft/ft (V/H)
Right slope	0.5000 ft/ft (V/H)

Computed Results:

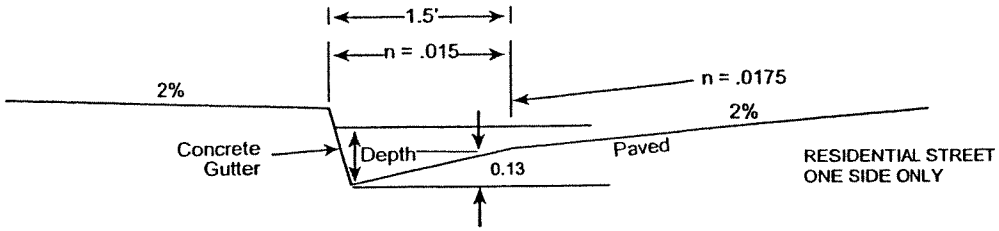
Depth	12.9126 in
Velocity	11.4825 fps
Full Flowrate	882.7494 cfs
Flow area	2.4951 ft2
Flow perimeter	59.7469 in
Hydraulic radius	6.0136 in
Top width	53.6504 in
Area	32.6667 ft2
Perimeter	216.6625 in
Percent full	26.9013 %

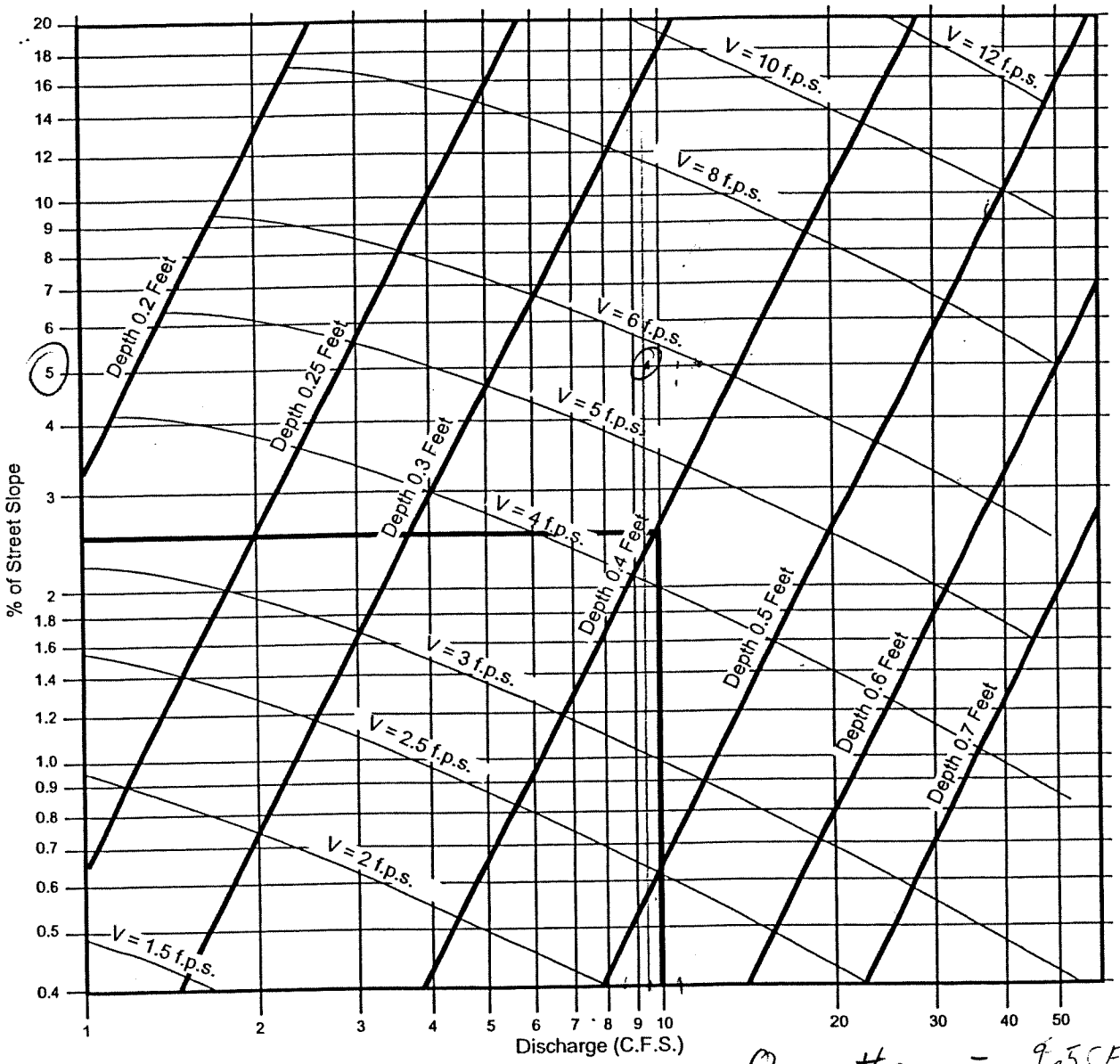
Critical Information

Critical depth	19.4750 in
Critical slope	0.0072 ft/ft
Critical velocity	5.1731 fps
Critical area	5.5382 ft2
Critical perimeter	89.0950 in
Critical hydraulic radius	8.9512 in
Critical top width	79.9001 in
Specific energy	3.1250 ft
Minimum energy	2.4344 ft
Froude number	2.7098
Flow condition	Supercritical

$$T_t = \frac{200}{11.5\,fps} \cdot \frac{1\,min}{60\,sec} = 0.3\,min$$

Basin M – Type G curb & gutter





Q_{gutter} = 9.5 CFS

V_{gutter} 5.9 FPS

T_t = 5.6 min

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

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

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

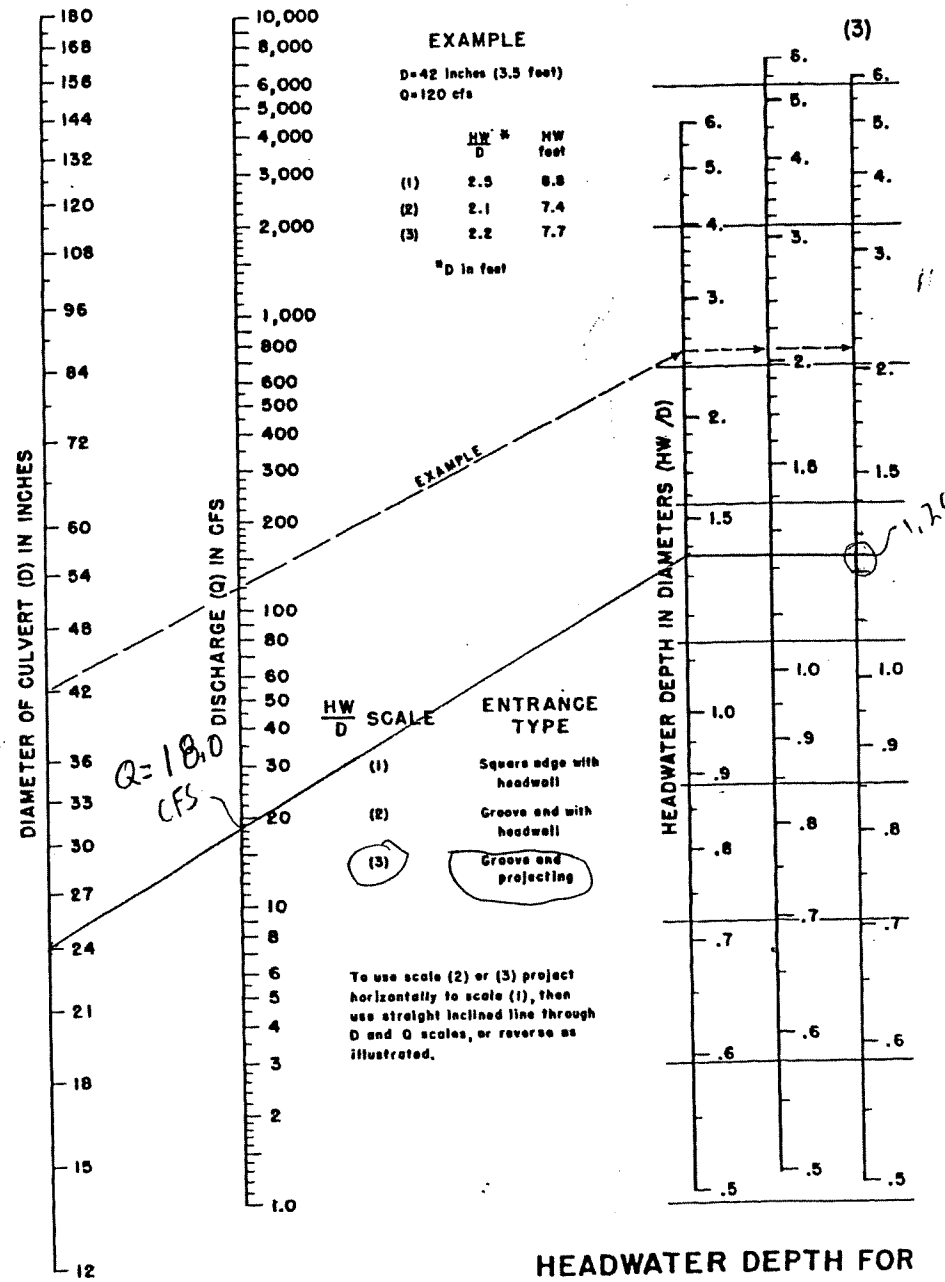
OFFSITE HYDROLOGY CALC'S - EXISTING CONDITIONS

SEE BASIN MAPS

24" RCP SD. - Basin OS1

HODE [14]

CHART 1B



HW/D = 1.25

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

Q = 18 CFS
Max

628 - 625.5 = 2.5' = HW

D = 2.0' HW/D = 1.25

BASIN OS1 TRAVEL TIME - ITERATIVE SOLUTION

FIRST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 57.4+(2.5 CFS/ACRE*2.91 ACRE)/2= 61.0 CFS

Lt =	300	FT	C=	0.41	
$S_{(AVG)}$=	0.047	FT/FT	A=	2.91	Acres
$V_{(AVG)}$=	12.7	FPS	P6=	3.1	in.

T_t = 300'*(1/12.7FPS)*(1min./60sec) = 0.4 min.

Tc = To+Tc = 5.8 + 0.4 = 6.2 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.12 in./hr

Q_B = [ΣC*A]I_{100} = 59.7 CFS

CHECK: $Q_{(AVG)}$ = 57.4+(59.7-57.4)/2 = 58.56 not equal 61.04

SECOND ITERATION: ASSUME q_i= 0.8 CFS/ACRE

$Q_{(AVG)}$= 18.6+(3.7 CFS/ACRE*2.57 ACRE)/2= 58.56 CFS

Lt =	300	FT	C=	0.41	
$S_{(AVG)}$=	0.047	FT/FT	A=	2.91	Acres
$V_{(AVG)}$=	12.5	FPS	P6=	3.1	in.

T_t = 300'*(1/~~12.7~~ 12.5FPS)*(1min./60sec) = 0.4 min.

Tc = ~~To+Tc = 5.2 + 0.2~~ 5.8+0.4 = 6.2 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.12 in./hr

$Q_{\cancel{19}\,B}$ = [ΣC*A]I_{100} = 59.7 CFS

CHECK: $Q_{(AVG)}$ = 9.3+(18.0-9.3)/2 = 58.54 approx. 58.56 ok

Earthen Channel - Basin OS1

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	58.5600 cfs
Slope	0.0470 ft/ft
Manning's n	0.0200
Height	30.0000 in
Bottom width	12.0000 in
Left slope	0.5000 ft/ft (V/H)
Right slope	0.5000 ft/ft (V/H)

Computed Results:

Depth	15.5856 in
Velocity	12.5327 fps
Full Flowrate	277.5984 cfs
Flow area	4.6726 ft2
Flow perimeter	81.7011 in
Hydraulic radius	8.2355 in
Top width	74.3425 in
Area	15.0000 ft2
Perimeter	146.1641 in
Percent full	51.9521 %

Critical Information

Critical depth	23.7797 in
Critical slope	0.0064 ft/ft
Critical velocity	5.9540 fps
Critical area	9.8354 ft2
Critical perimeter	118.3460 in
Critical hydraulic radius	11.9675 in
Critical top width	107.1187 in
Specific energy	3.7397 ft
Minimum energy	2.9725 ft
Froude number	2.5441
Flow condition	Supercritical

JUNCTION CALC'S

NODE C (ADD BASINS 052, 053, 054

$T_1 = 5.0$ min
$Q_1 = 30.6$ CFS } 052
$I_1 = 8.17$

$T_2 = 5.4$ min
$Q_2 = 28.2$ CFS } 053 + 054
$I_2 = 7.81$

$$Q_{J1} = Q_1 + \frac{T_1}{T_2} Q_2 = 30.6 + \frac{5}{5.4}(28.2) = 56.7 \text{ CFS}$$

$$Q_{J2} = Q_2 + \frac{I_2}{I_1} Q_1 = 28.2 + \frac{7.81}{8.17}(30.6) = 57.4$$

$$\boxed{Q_C = 57.4 \text{ CFS}}$$

Earth swale - Basin OS2

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	30.6000 cfs
Slope	0.0700 ft/ft
Manning's n	0.0200
Height	60.0000 in
Bottom width	12.0000 in
Left slope	0.2500 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	8.7202 in
Velocity	10.7786 fps
Full Flowrate	~~3788.1925 cfs~~
Flow area	2.8390 ft2
Flow perimeter	83.9088 in
Hydraulic radius	4.8721 in
Top width	81.7617 in
Area	105.0000 ft2
Perimeter	506.7727 in
Percent full	14.5337 %

Critical Information

Critical depth	14.1230 in
Critical slope	0.0070 ft/ft
Critical velocity	4.5553 fps
Critical area	6.7174 ft2
Critical perimeter	128.4611 in
Critical hydraulic radius	7.5300 in
Critical top width	124.9839 in
Specific energy	2.5321 ft
Minimum energy	1.7654 ft
Froude number	2.9438
Flow condition	Supercritical

$$T_t = \frac{650'}{10.8\,FPS} \cdot \frac{1\,min}{60\,sec} = 1.0\,min$$

BASIN OS3 TRAVEL TIME - ITERATIVE SOLUTION

.RST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 18.6+(2.5 CFS/ACRE*2.57 ACRE)/2= 21.8 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	2.57	Acres
$V_{(AVG)}$=	15.9	FPS	P6=	3.1	in.

T_t = 200'*(1/15.9FPS)*(1min./60sec) = 0.2 min.

Tc = To+Tc = 5.2 + 0.2 = 5.4 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.81 in./hr

$Q_{\cancel{19}\,D}$ = [ΣC*A]I_{100} = 28.2 CFS

HECK: $Q_{(AVG)}$ = 18.6+(28.2-18.6)/2 = 23.42 not equal 21.81

SECOND ITERATION: ASSUME q_i= 3.7 CFS/ACRE

$Q_{(AVG)}$= 18.6+(3.7 CFS/ACRE*2.57 ACRE)/2= 23.42 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	2.57	Acres
$V_{(AVG)}$=	16.2	FPS	P6=	3.1	in.

T_t = 200'*(1/16.2 FPS)*(1min./60sec) = 0.2 min.

Tc = To+Tc = 5.2 + 0.2 = 5.4 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.81 in./hr

$Q_{\cancel{19}\,D}$ = [ΣC*A]I_{100} = 28.2 CFS

HECK: $Q_{(AVG)}$ = 9.3+(18.0-9.3)/2 = 23.42 approx. 23.42 ok

Conc. Browdith Basin 053

tmp#28.txt

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	23.4200 cfs Q average
Slope	0.0600 ft/ft
Manning's n	0.0130
Height	24.0000 in
Bottom width	12.0000 in
Left slope	1.0000 ft/ft (V/H)
Right slope	1.0000 ft/ft (V/H)

Computed Results:

Depth	9.6101 in
Velocity	16.2392 fps
Full Flowrate	156.7559 cfs
Flow area	1.4422 ft2
Flow perimeter	39.1814 in
Hydraulic radius	5.3003 in
Top width	31.2202 in
Area	6.0000 ft2
Perimeter	79.8823 in
Percent full	40.0420 %

Critical Information

Critical depth	19.1744 in
Critical slope	0.0036 ft/ft
Critical velocity	5.6419 fps
Critical area	4.1511 ft2
Critical perimeter	66.2335 in
Critical hydraulic radius	9.0249 in
Critical top width	50.3489 in
Specific energy	4.8991 ft
Minimum energy	2.3968 ft
Froude number	3.8453
Flow condition	Supercritical

$$T_t = \frac{200'}{16.2\ FPS} \cdot \frac{1\ min}{60\ sec} = 0.2\ min$$

Earth swale - Basin 054

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	18.6000 cfs
Slope	0.0320 ft/ft
Manning's n	0.0200
Height	24.0000 in
Bottom width	6.0000 in
Left slope	0.2500 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	8.9787 in
Velocity	7.1169 fps
Full Flowrate	226.0174 cfs
Flow area	2.6135 ft2
Flow perimeter	80.0405 in
Hydraulic radius	4.7019 in
Top width	77.8298 in
Area	17.0000 ft2
Perimeter	203.9091 in
Percent full	37.4114 %

Critical Information

Critical depth	12.0076 in
Critical slope	0.0075 ft/ft
Critical velocity	4.1284 fps
Critical area	4.5054 ft2
Critical perimeter	105.0173 in
Critical hydraulic radius	6.1778 in
Critical top width	102.0609 in
Specific energy	1.5354 ft
Minimum energy	1.5010 ft
Froude number	1.9766
Flow condition	Supercritical

$$T_J = \frac{250'}{7.1\,FPS} \cdot \frac{1\,min}{60\,sec} = \underline{0.6\,min}$$

BASIN	AREA	C	C X A	L_O	L_{MAX}	ΔH	S_o	T_o	L_t	S_t	T_t	T_c	$I_{(100)}$	$Q_{(100)}$
	(AC)			(FT)	(FT)	(FT)	(%)	(MIN.)	(FT)	(%)	(MIN.)	(MIN.)	(IN/HR)	(CFS)
A	6.56	0.41	2.69	300	100	60	20.0%	4.6	500	1%	1	5.6	7.61	20.5
B	0.95	0.41	0.39	150	70	1.5	1.0%	10.4	350	10%	0.6	11.0	4.91	1.9
C	3.98	0.41	1.63	200	70	2	1.0%	10.4	600	6%	0.8	11.2	4.86	7.9
D	1.93	0.41	0.79	150	70	1.5	1.0%	10.4	650	5%	2.2	12.6	4.50	3.6
E	1.72	0.41	0.71	150	70	1.5	1.0%	10.4	650	5%	2.3	12.7	4.48	3.2
F	3.64	0.41	1.49	450	100	45	10.0%	5.8	600	6%	1.1	6.9	6.66	9.9
G	2.81	0.41	1.15	300	100	30	10.0%	5.8	350	10%	0.6	6.4	6.99	8.1
H	3	0.41	1.23	300	100	60	20.0%	4.6	450	1%	1.3	5.9	7.36	9.1
I	2.37	0.41	0.97	450	100	90	20.0%	4.6	150	1%	0.4	5.0	8.17	7.9
J	3.65	0.41	1.50	150	70	1.5	1.0%	10.4	600	16%	0.6	11.0	4.91	7.4
K	5.12	0.41	2.10	150	70	1.5	1.0%	10.4	350	8%	0.8	11.2	4.86	10.2
L	3.5	0.41	1.44	150	100	15	10.0%	5.8	200	6%	0.3	6.1	7.21	10.3
M	1.83	0.79	1.45	10	75	0.2	2.0%	1.4	2000	5%	5.6	7.0	6.57	9.5
N	0.74	0.79	0.58	10	75	0.2	2.0%	1.4	950	2%	4.4	5.8	7.42	4.3
O	0.58	0.41	0.24	220	70	2.2	1.0%	10.4	350	8%	1.0	11.4	4.80	1.1
OS1	2.91	0.35	1.02	300	100	38	12.7%	5.8	300	5%	0.4	6.2	7.12	7.2
OS2	4.75	0.79	3.75	50	75	1	2.0%	3.1	650	7%	1.0	5.0	8.17	30.6
OS3	2.57	0.41	1.05	300	100	42	14.0%	5.2	200	6%	0.2	5.4	7.82	8.2
OS4	6.25	0.41	2.56	400	100	48	12.0%	5.4	250	3%	0.6	6.0	7.24	18.6
E1	4.32	0.41	1.77	450	100	90	20.0%	4.6	150	1%	0.4	5.0	8.17	14.5
E2	9.44	0.41	3.87	1,200	100	120	10.0%	5.8	0	1%	0	5.8	7.45	28.8
E3	7.07	0.41	2.90	450	100	45	10.0%	5.8	1200	10%	1.6	7.4	6.36	18.4
E4	0.49	0.79	0.39	10	75	0.02	0.2%	8.3	650	2%	3.4	11.7	4.73	1.8
E5	0.09	0.79	0.07	10	75	0.02	0.2%	8.3	0	1%	0	8.3	5.91	0.4
E6	3.65	0.41	1.50	150	70	1.5	1.0%	10.4	600	16%	0.5	10.9	4.94	7.4

OD. Type 'D' Brow Ditch - "BASIN A"

tmp#15.txt

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	24.0000 in
Flowrate	20.5000 cfs
Slope	0.0100 ft/ft
Manning's n	0.0130

Computed Results:

Depth	17.9037 in
Area	3.1416 ft2
Wetted Area	2.5135 ft2
Wetted Perimeter	50.0437 in
Perimeter	75.3982 in
Velocity	8.1560 fps
Hydraulic Radius	7.2325 in
Percent Full	74.5988 %
Full flow Flowrate	22.6224 cfs
Full flow velocity	7.2009 fps

Critical Information

Critical depth	20.3783 in
Critical slope	0.0064 ft/ft
Critical velocity	6.9089 fps
Critical area	2.9672 ft2
Critical perimeter	54.4557 in
Critical hydraulic radius	7.8463 in
Critical top width	24.0000 in
Specific energy	2.5144 ft
Minimum energy	2.5473 ft
Froude number	1.3041
Flow condition	Supercritical

$$T_t = \frac{500'}{8.2\ FPS} \cdot \frac{1\ min}{60\ sec} = 1.0\ min$$

Type 'B' Brow Ditch - Basin 'B'

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	24.0000 in
Flowrate	1.9000 cfs
Slope	0.1000 ft/ft
Manning's n	0.0130

Computed Results:

Depth	2.6919 in
Area	3.1416 ft2
Wetted Area	0.1935 ft2
Wetted Perimeter	16.3923 in
Perimeter	75.3982 in
Velocity	9.8212 fps
Hydraulic Radius	1.6995 in
Percent Full	11.2163 %
Full flow Flowrate	71.5383 cfs
Full flow velocity	22.7714 fps

Critical Information

Critical depth	5.7355 in
Critical slope	0.0045 ft/ft
Critical velocity	3.2969 fps
Critical area	0.5763 ft2
Critical perimeter	24.5174 in
Critical hydraulic radius	3.3848 in
Critical top width	20.4701 in
Specific energy	1.7233 ft
Minimum energy	0.7169 ft
Froude number	4.4227
Flow condition	Supercritical

$$T_t = \frac{350' \mid 1\,min}{9.8\,FPS \mid 60\,sec} = 0.6\,min$$

Type 'D' Brow Ditch - Basin "C"

tmp#17.txt

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	24.0000 in
Flowrate	7.9000 cfs
Slope	0.0600 ft/ft
Manning's n	0.0130

Computed Results:

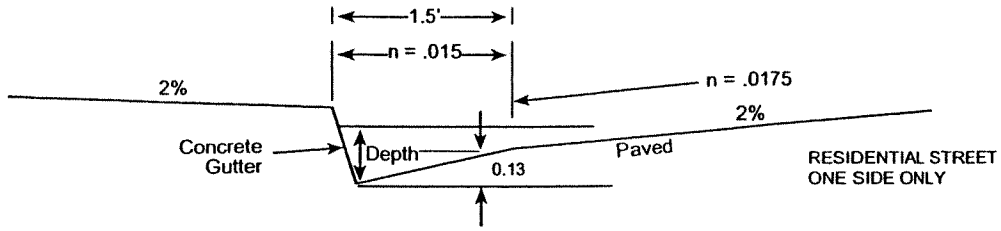
Depth	6.1223 in
Area	3.1416 ft2
Wetted Area	0.6319 ft2
Wetted Perimeter	25.4142 in
Perimeter	75.3982 in
Velocity	12.5021 fps
Hydraulic Radius	3.5804 in
Percent Full	25.5095 %
Full flow Flowrate	55.4133 cfs
Full flow velocity	17.6386 fps

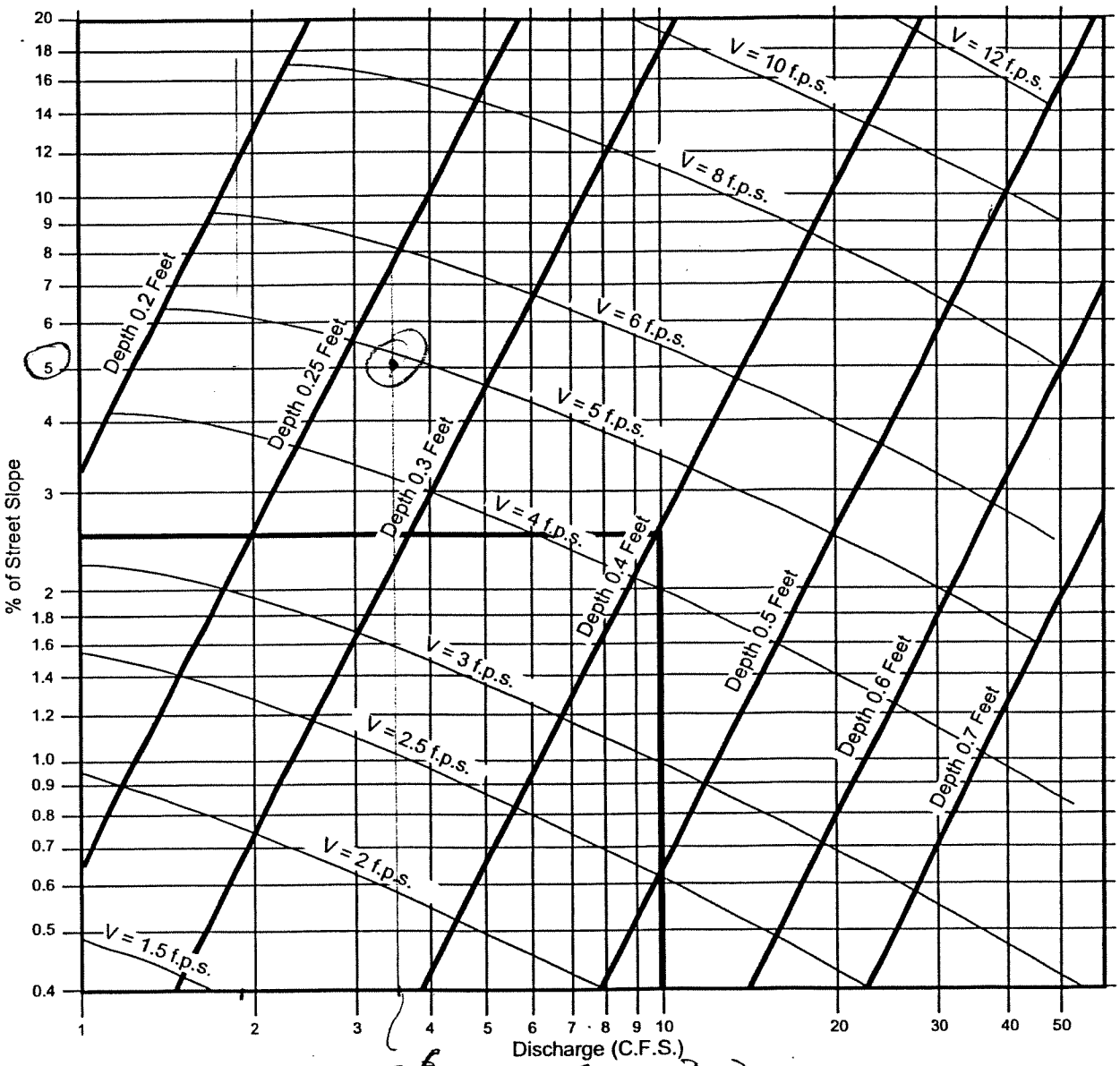
Critical Information

Critical depth	12.0030 in
Critical slope	0.0049 ft/ft
Critical velocity	5.0277 fps
Critical area	1.5713 ft2
Critical perimeter	37.7052 in
Critical hydraulic radius	6.0010 in
Critical top width	24.0000 in
Specific energy	2.9392 ft
Minimum energy	1.5004 ft
Froude number	3.6613
Flow condition	Supercritical

$$T_t = \frac{600'}{} \Big| \frac{1}{12.5\ FPS} \Big| \frac{1\ min}{60\ sec} = \underline{0.8\ min}$$

Basin D - Type G Curb & Gutter @ 5% ~650LF





3.6

$T_T = 2.2$

$V_{gutter} = 4.9$

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

$Q_{gutter} = 3.6$ CFS

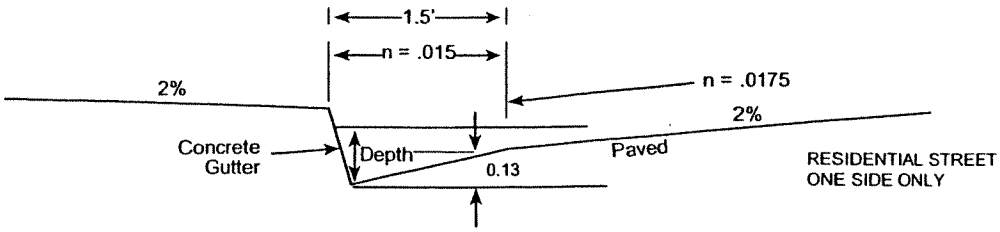
SOURCE: San Diego County Department of Special District Services Design Manual

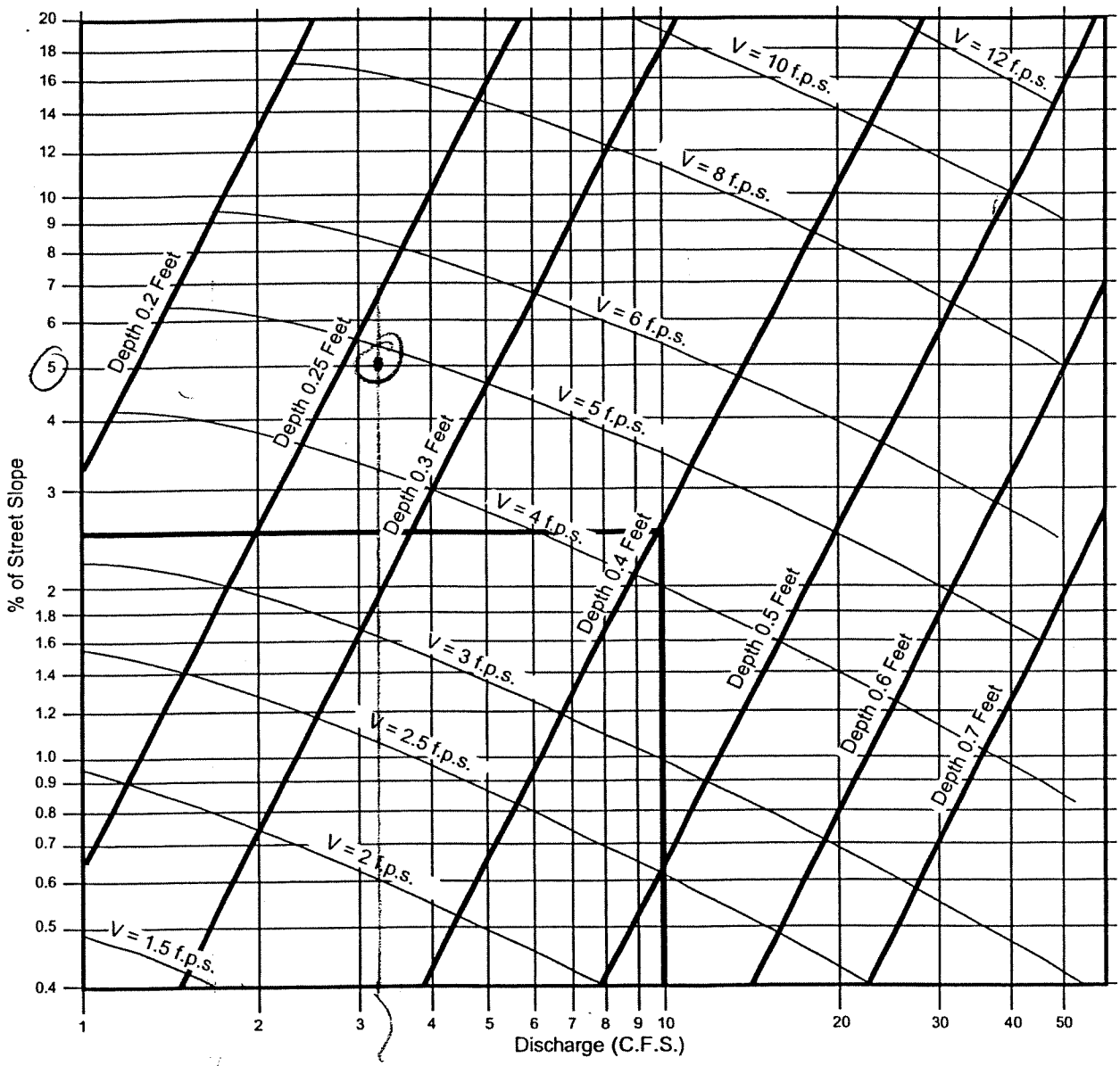
FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

Basin E - Type G Curb & Gutter ~ 650 LF @ 5%





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

V = 4.8 FPS
T_t = 2.3 min
Q_{gutter} = 3.2 CFS

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

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

Earthen Swale - "Basin F"

tmp#18.txt

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	9.9000 cfs
Slope	0.0600 ft/ft
Manning's n	0.0200
Height	13.0000 in
Bottom width	2.0000 in
Left slope	0.5000 ft/ft (V/H)
Right slope	0.5000 ft/ft (V/H)

Computed Results:

Depth	8.5096 in
Velocity	8.8084 fps
Full Flowrate	29.1509 cfs
Flow area	1.1239 ft2
Flow perimeter	40.0560 in
Hydraulic radius	4.0405 in
Top width	36.0383 in
Area	2.5278 ft2
Perimeter	60.1378 in
Percent full	65.4583 %

Critical Information

Critical depth	12.5650 in
Critical slope	0.0082 ft/ft
Critical velocity	4.1820 fps
Critical area	2.3673 ft2
Critical perimeter	58.1925 in
Critical hydraulic radius	5.8580 in
Critical top width	52.2601 in
Specific energy	1.9149 ft
Minimum energy	1.5706 ft
Froude number	2.5385
Flow condition	Supercritical

$$\frac{600'}{} \Big| \frac{}{8.8\,\text{FPS}} \Big| \frac{1\,\text{min}}{60\,\text{sec}} = \underline{1.1\,\text{min}}$$

Earthen Swale - "Basin G"

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	8.1000 cfs
Slope	0.1000 ft/ft
Manning's n	0.0200
Height	12.0000 in
Bottom width	2.0000 in
Left slope	0.5000 ft/ft (V/H)
Right slope	0.5000 ft/ft (V/H)

Computed Results:

Depth	7.0971 in
Velocity	10.1486 fps
Full Flowrate	30.6459 cfs
Flow area	0.7981 ft2
Flow perimeter	33.7393 in
Hydraulic radius	3.4065 in
Top width	30.3885 in
Area	2.1667 ft2
Perimeter	55.6656 in
Percent full	59.1426 %

Critical Information

Critical depth	11.5591 in
Critical slope	0.0085 ft/ft
Critical velocity	4.0173 fps
Critical area	2.0163 ft2
Critical perimeter	53.6941 in
Critical hydraulic radius	5.4074 in
Critical top width	48.2366 in
Specific energy	2.1920 ft
Minimum energy	1.4449 ft
Froude number	3.1870
Flow condition	Supercritical

$$T_T = \frac{350'}{10.1\ FPS} \cdot \frac{1\ min}{60\ sec} = \underline{0.6\ min}$$

TYPE D TERRACE DITCH @ 1%

BASIN H NODE 21-22

tmp#8.txt

Channel Calculator

Given Input Data:

Shape	Advanced
Solving for	Depth of Flow
Flowrate	9.3000 cfs
Slope	0.0100 ft/ft
Manning's n	0.0130
Height	12.0000 in
Bottom width	12.0000 in
Left radius	12.0000 in
Right radius	12.0000 in
Left slope	100000.0000 ft/ft (V/H)
Right slope	10000.0000 ft/ft (V/H)

Computed Results:

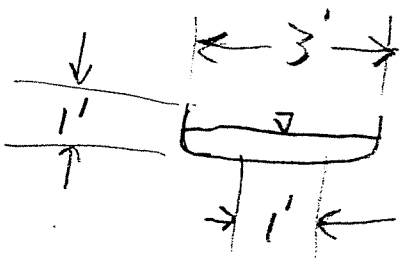
Depth	8.3116 in
Velocity	5.6408 fps
Full Flowrate	21.3834 cfs
Flow area	1.6487 ft2
Flow perimeter	57.0732 in
Hydraulic radius	4.1598 in
Top width	35.9996 in
Area	2.5708 ft2
Perimeter	49.6990 in
Percent full	69.2637 %

Critical Information

Critical depth	9.7383 in
Critical slope	0.0049 ft/ft
Critical velocity	4.6376 fps
Critical area	2.0054 ft2
Critical perimeter	54.2200 in
Critical hydraulic radius	5.3259 in
Critical top width	35.9998 in
Specific energy	1.1871 ft
Minimum energy	1.2173 ft
Froude number	1.3414
Flow condition	Supercritical

OK

$$T_t = \frac{450'}{5.6\ \text{FPS}} \cdot \frac{1}{60} = 1.3\ \text{MIN}$$



Basin I
MODE 20-19

Channel Calculator

Given Input Data:

Shape	Advanced
Solving for	Depth of Flow
Flowrate	12.2800 cfs — Qavg
Slope	0.0100 ft/ft
Manning's n	0.0130
Height	19.2000 in
Bottom width	1.0000 in
Left radius	19.2000 in
Right radius	19.2000 in
Left slope	100000.0000 ft/ft (V/H)
Right slope	10000.0000 ft/ft (V/H)

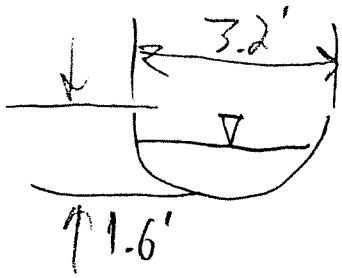
Computed Results:

Depth	11.9882 in
Velocity	5.6295 fps
Full Flowrate	41.3694 cfs
Flow area	2.1814 ft2
Flow perimeter	75.7380 in
Hydraulic radius	4.1474 in
Top width	39.3992 in
Area	4.1546 ft2
Perimeter	61.3184 in
Percent full	62.4384 %

Critical Information

Critical depth	13.1065 in
Critical slope	0.0062 ft/ft
Critical velocity	4.9370 fps
Critical area	2.4873 ft2
Critical perimeter	73.5014 in
Critical hydraulic radius	4.8730 in
Critical top width	39.3993 in
Specific energy	1.4915 ft
Minimum energy	1.6383 ft
Froude number	1.2176
Flow condition	Supercritical OK

$$T_t = \frac{150}{5.6 \cdot 60} = 0.4 \text{ min}$$



MOD, TYPE D
Terrace Ditch

BASIN I TRAVEL TIME - ITERATIVE SOLUTION
NODES: 20 - 19

FIRST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 9.1+(2.5 CFS/ACRE*2.37 ACRE)/2= 12.1 CFS

Lt =	150	FT	C=	0.41	
$S_{(AVG)}$=	0.01	FT/FT	A=	2.37	Acres
$V_{(AVG)}$=	5.6	FPS	P6=	3.1	in.

$T_t = Lt*(V_{(avg)})*(1min./60sec)$ = 0.4 min.

Tc = To+Tt = 5.9+0.4= 6.3 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.02 in./hr

$Q_{19} = [\Sigma C*A]I_{100}$ = 15.5 CFS

CHECK: $Q_{(AVG)}$ = 9.1+(15.5-9.1)/2 = 12.38 not equal 12.06

SECOND ITERATION: ASSUME q_i= 2.6 CFS/ACRE

$Q_{(AVG)}$= 9.1+(2.6 CFS/ACRE*2.37 ACRE)/2= 12.38 CFS

Lt =	150	FT	C=	0.41	
$S_{(AVG)}$=	0.01	FT/FT	A=	2.37	Acres
$V_{(AVG)}$=	5.7	FPS	P6=	3.1	in.

$T_t = Lt*(V_{(avg)})*(1min./60sec)$ = 0.4 min.

Tc = To+Tt = 5.9+0.2 6.3 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.03 in./hr

$Q_{19} = [\Sigma C*A]I_{100}$ = 15.5 CFS

CHECK: $Q_{(AVG)}$ = 9.1+(15.5-9.1)/2 = 12.28 not equal 12.38

THIRD ITERATION: ASSUME q_i= 2.52 CFS/ACRE

$Q_{(AVG)}$= 9.1+(2.5 CFS/ACRE*2.37 ACRE)/2= 12.28 CFS

Lt =	150	FT	C=	0.41	
$S_{(AVG)}$=	0.01	FT/FT	A=	2.37	Acres
$V_{(AVG)}$=	5.6	FPS	P6=	3.1	in.

$T_t = Lt*(V_{(avg)})*(1min./60sec)$ = 0.4 min.

Tc = To+Tt = 5.9+0.2 6.3 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.02 in./hr

$Q_{19} = [\Sigma C*A]I_{100}$ = 15.5 CFS

CHECK: $Q_{(AVG)}$ = 9.1+(15.5-9.1)/2 = 12.28 approx. 12.28 ok

---

BASIN J

NODE 19-13

Channel Calculator

Given Input Data:

Shape	Advanced
Solving for	Depth of Flow
Flowrate	20.0400 cfs — Q_{AVG}
Slope	0.1600 ft/ft
Manning's n	0.0130
Height	19.2000 in
Bottom width	12.0000 in
Left radius	12.0000 in
Right radius	12.0000 in
Left slope	100000.0000 ft/ft (V/H)
Right slope	10000.0000 ft/ft (V/H)

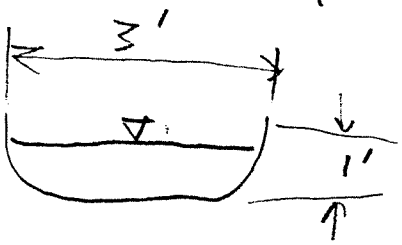
Computed Results:

Depth	6.3872 in ✓
Velocity	17.1634 fps ✓
Full Flowrate	174.8340 cfs
Flow area	1.1676 ft2
Flow perimeter	60.9221 in
Hydraulic radius	2.7598 in
Top width	35.9994 in
Area	4.3708 ft2
Perimeter	64.0991 in
Percent full	33.2665 %

Critical Information

Critical depth	15.0991 in
Critical slope	0.0043 ft/ft
Critical velocity	5.9900 fps
Critical area	3.3456 ft2
Critical perimeter	55.8974 in
Critical hydraulic radius	8.6187 in
Critical top width	36.0003 in
Specific energy	5.1102 ft
Minimum energy	1.8874 ft
Froude number	4.8502
Flow condition	Supercritical ok

$$T_t = \frac{600}{17.2 \mid 60} = 0.6 \text{ MIN.}$$



TYPE D
Terrace DITCH

BASIN J TRAVEL TIME - ITERATIVE SOLUTION
NODES: 19 - 13

FIRST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 15.5+(2.5 CFS/ACRE*3.65 ACRE)/2= 20.06 CFS

Lt =	600	FT	C=	0.41	
$S_{(AVG)}$=	0.16	FT/FT	A=	3.65	Acres
$V_{(AVG)}$=	18.7	FPS	P6=	3.1	in.

T_t = 600'*(1/$V_{(avg)}$)*(1min./60sec) = 0.5 min.

Tc = To+Tt = 6.3 + 0.7 = 6.8 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 6.68 in./hr

Q_{13} = [ΣC*A]I_{100} = 24.7 CFS

CHECK: $Q_{(AVG)}$ = 15.5+(24.7-15.5)/2 = 20.10 not equal 20.06

SECOND ITERATION: ASSUME q_i= 2.52 CFS/ACRE

$Q_{(AVG)}$= 15.5+(1.1 CFS/ACRE*3.65 ACRE)/2= 20.10 CFS

Lt =	600	FT	C=	0.41	
$S_{(AVG)}$=	0.16	FT/FT	A=	3.65	Acres
$V_{(AVG)}$=	17.2	FPS	P6=	3.1	in.

T_t = 600'*(1/$V_{(avg)}$)*(1min./60sec) = 0.6 min.

Tc = To+Tt = 6.3 + 0.6 = 6.9 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 6.65 in./hr

Q_{13} = [ΣC*A]I_{100} = 24.6 CFS

CHECK: $Q_{(AVG)}$ = 15.5+(24.6-15.5)/2 = 20.04 not equal 20.10

THIRD ITERATION: ASSUME q_i= 2.49 CFS/ACRE

$Q_{(AVG)}$= 15.5+(1.1 CFS/ACRE*3.65 ACRE)/2= 20.04 CFS

Lt =	600	FT	C=	0.41	
$S_{(AVG)}$=	0.16	FT/FT	A=	3.65	Acres
$V_{(AVG)}$=	17.2	FPS	P6=	3.1	in.

T_t = 600'*(1/$V_{(avg)}$)*(1min./60sec) = 0.6 min.

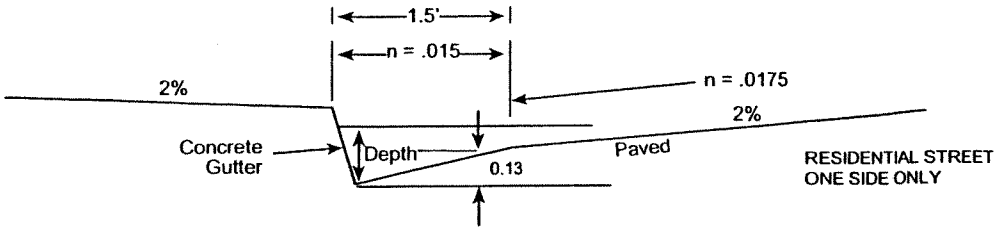
Tc = To+Tt = 6.3 + 0.6 = 6.9 min.

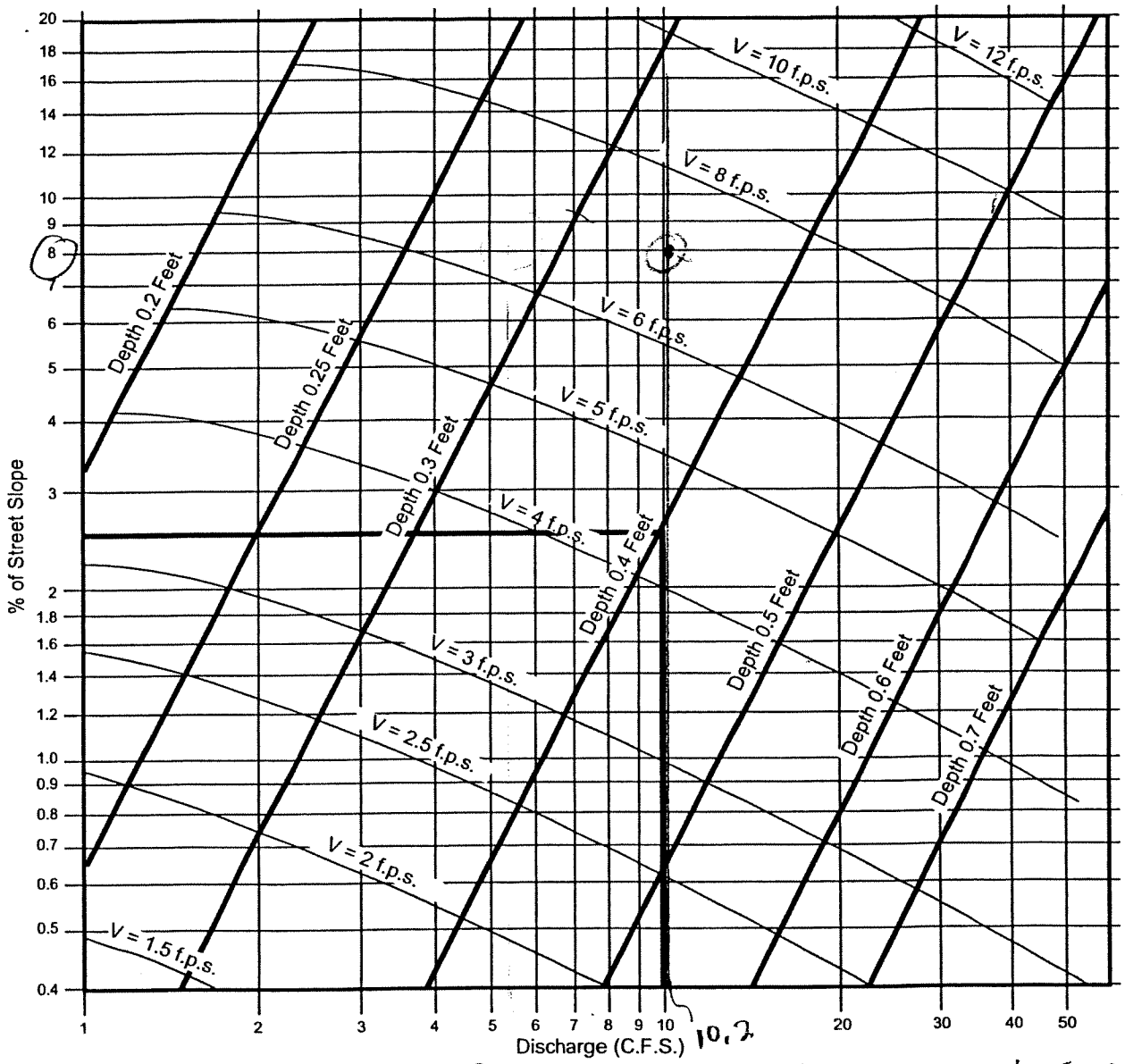
I_{100} = 7.44 * P6 * Tc^(-0.645) = 6.65 in./hr

Q_{13} = [ΣC*A]I_{100} = 24.6 CFS

CHECK: $Q_{(AVG)}$ = 15.5+(24.6-15.5)/2 = 20.04 approx. 20.04 ok

Basin K - Type G Curb & Gutter ~ 350 LF @ 8% avg.





10.2 CFS = Q V_{gutter} = 7.1 FPS

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

T_t = 0.8 min

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

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

BASIN L TRAVEL TIME - ITERATIVE SOLUTION

NODE 14-17

FIRST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 27.5+(2.5 CFS/ACRE*3.50 ACRE)/2= 31.9 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	3.50	Acres
$V_{(AVG)}$=	11.8	FPS	P6=	3.1	in.

T_t = 200'*(1/11.8FPS)*(1min./60sec) = 0.3 min.

Tc = To_L+Tt_L = 5.8 + 0.3 = 6.1 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.18 in./hr

Q_A = [ΣC*A]I_{100}+18.0 = 38.7 CFS

CHECK: $Q_{(AVG)}$ = 27.5+(38.8-27.5)/2 = 33.10 not equal 31.88

SECOND ITERATION: ASSUME q_i= 8.3 CFS/ACRE

$Q_{(AVG)}$= 27.5+(8.3 CFS/ACRE*3.5 ACRE)/2= 33.10 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	3.50	Acres
$V_{(AVG)}$=	11.9	FPS	P6=	3.1	in.

T_t = 200'*(1/11.9 FPS)*(1min./60sec) = 0.3 min.

Tc = To_L+Tt_L = 5.8 + 0.3 = 6.1 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.18 in./hr

Q_A = [ΣC*A]I_{100}+18.0= 38.7 CFS

CHECK: $Q_{(AVG)}$ = 27.5+(38.7-27.5)/2 = 28.65 not equal 33.10

THIRD ITERATION: ASSUME q_i= 7.8 CFS/ACRE

$Q_{(AVG)}$= 27.5+(7.8 CFS/ACRE*3.5 ACRE)/2= 28.65 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	2.57	Acres
$V_{(AVG)}$=	11.5	FPS	P6=	3.1	in.

T_t = 200'*(1/130 FPS)*(1min./60sec) = 0.3 min.

Tc = To_L+Tt_L = 5.8 + 0.3 = 6.1 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.22 in./hr

Q_A = [ΣC*A]I_{100}+18.0= 38.8 CFS

CHECK: $Q_{(AVG)}$ = 27.5+(38.8-27.5)/2 = 28.70 approx. 28.65 ok

Earthen Channel - Basin L

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	28.6500 cfs
Slope	0.0600 ft/ft
Manning's n	0.0200
Height	48.0000 in
Bottom width	2.0000 in
Left slope	0.5000 ft/ft (V/H)
Right slope	0.5000 ft/ft (V/H)

Computed Results:

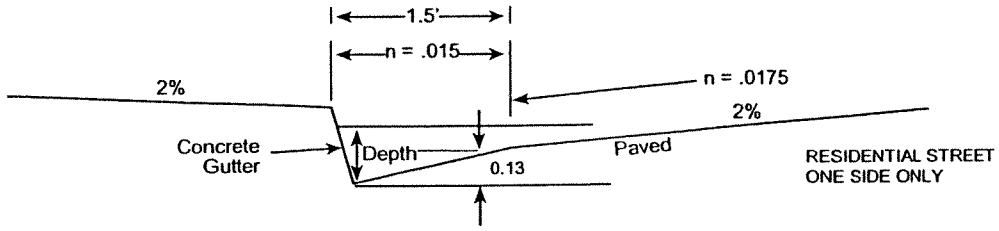
Depth	12.9126 in
Velocity	11.4825 fps
Full Flowrate	882.7494 cfs
Flow area	2.4951 ft2
Flow perimeter	59.7469 in
Hydraulic radius	6.0136 in
Top width	53.6504 in
Area	32.6667 ft2
Perimeter	216.6625 in
Percent full	26.9013 %

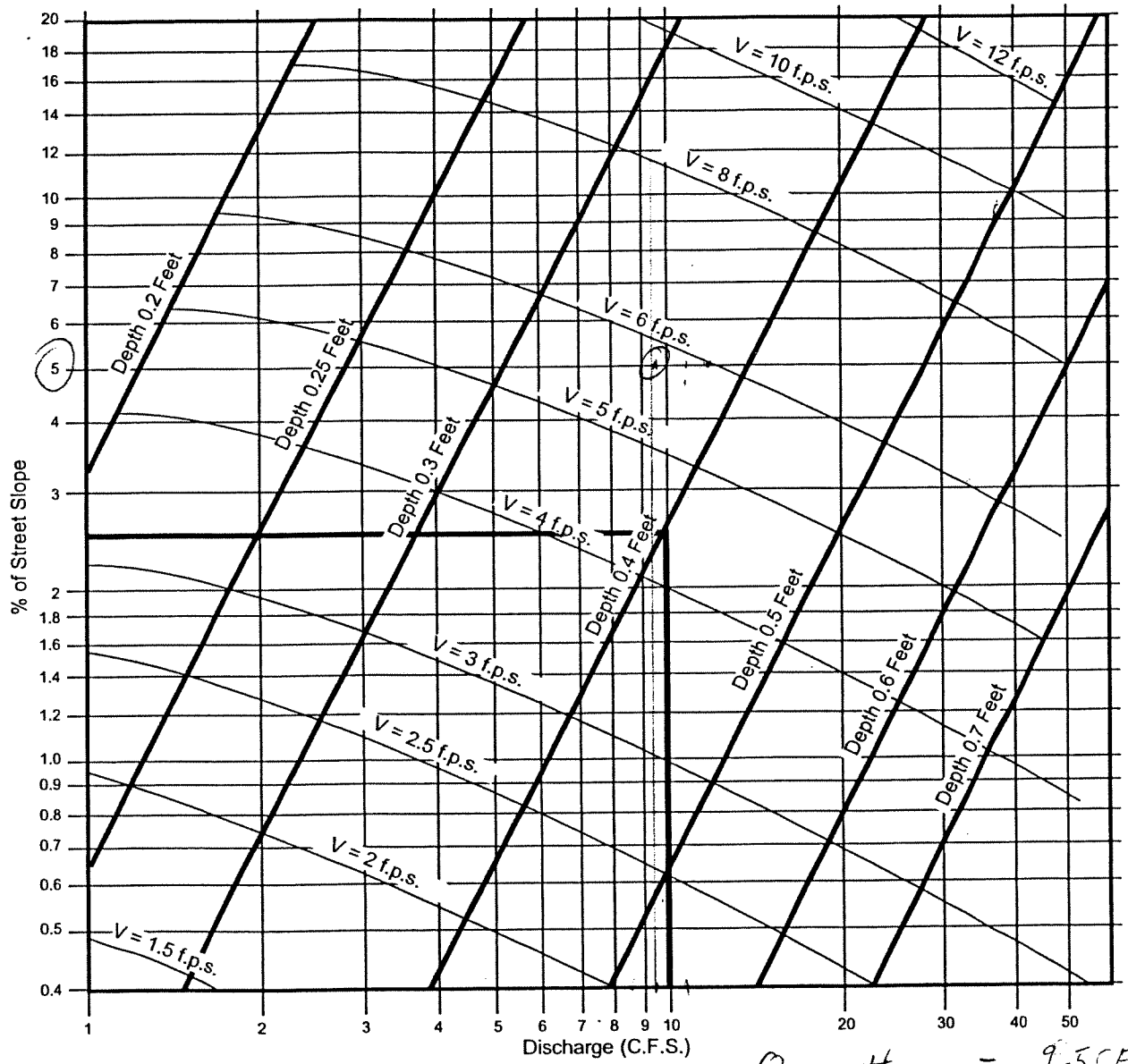
Critical Information

Critical depth	19.4750 in
Critical slope	0.0072 ft/ft
Critical velocity	5.1731 fps
Critical area	5.5382 ft2
Critical perimeter	89.0950 in
Critical hydraulic radius	8.9512 in
Critical top width	79.9001 in
Specific energy	3.1250 ft
Minimum energy	2.4344 ft
Froude number	2.7098
Flow condition	Supercritical

$$T_t = \frac{200}{11.5\,fps} \cdot \frac{1\,min}{60\,sec} = 0.3\,min$$

Basin M – Type G curb & gutter





Q_{gutter} = 9.5 CFS

V_{gutter} 5.9 FPS

T_t = 5.6 min

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

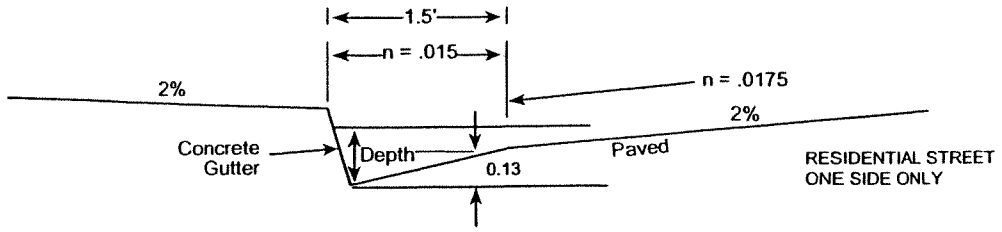
SOURCE: San Diego County Department of Special District Services Design Manual

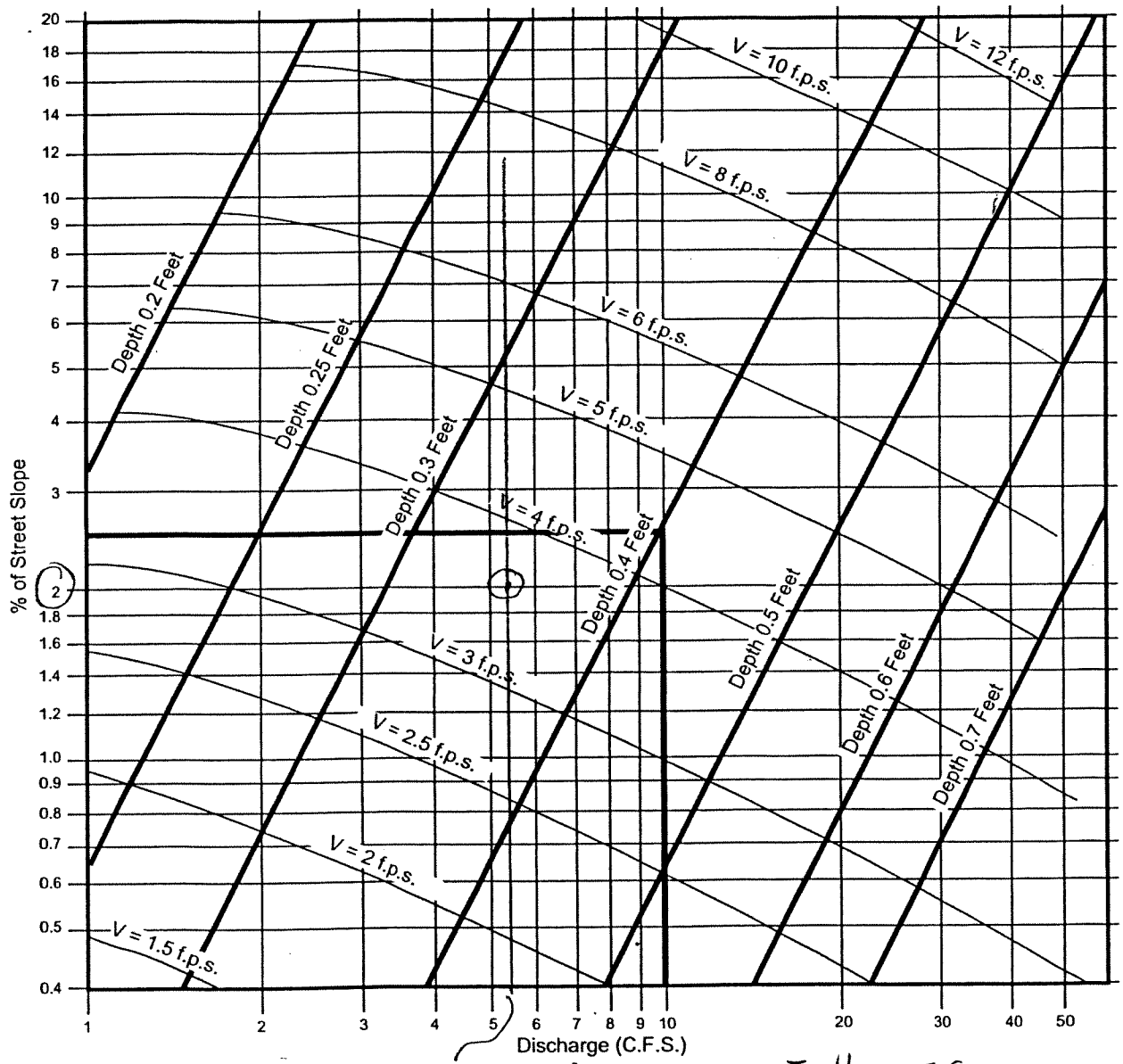
FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

Basin H ~ Type G Curb & Gutter ~ 950 LF @ 2% avg.





5.4 Qgutter = 5.4 CFS
Vgutter = 3.6 FPS
Tt = 4.4 min

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

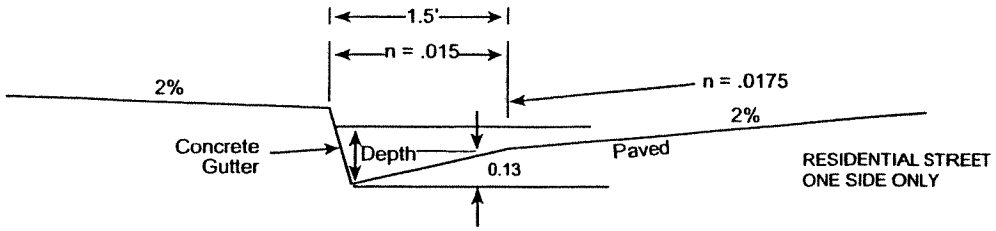
SOURCE: San Diego County Department of Special District Services Design Manual

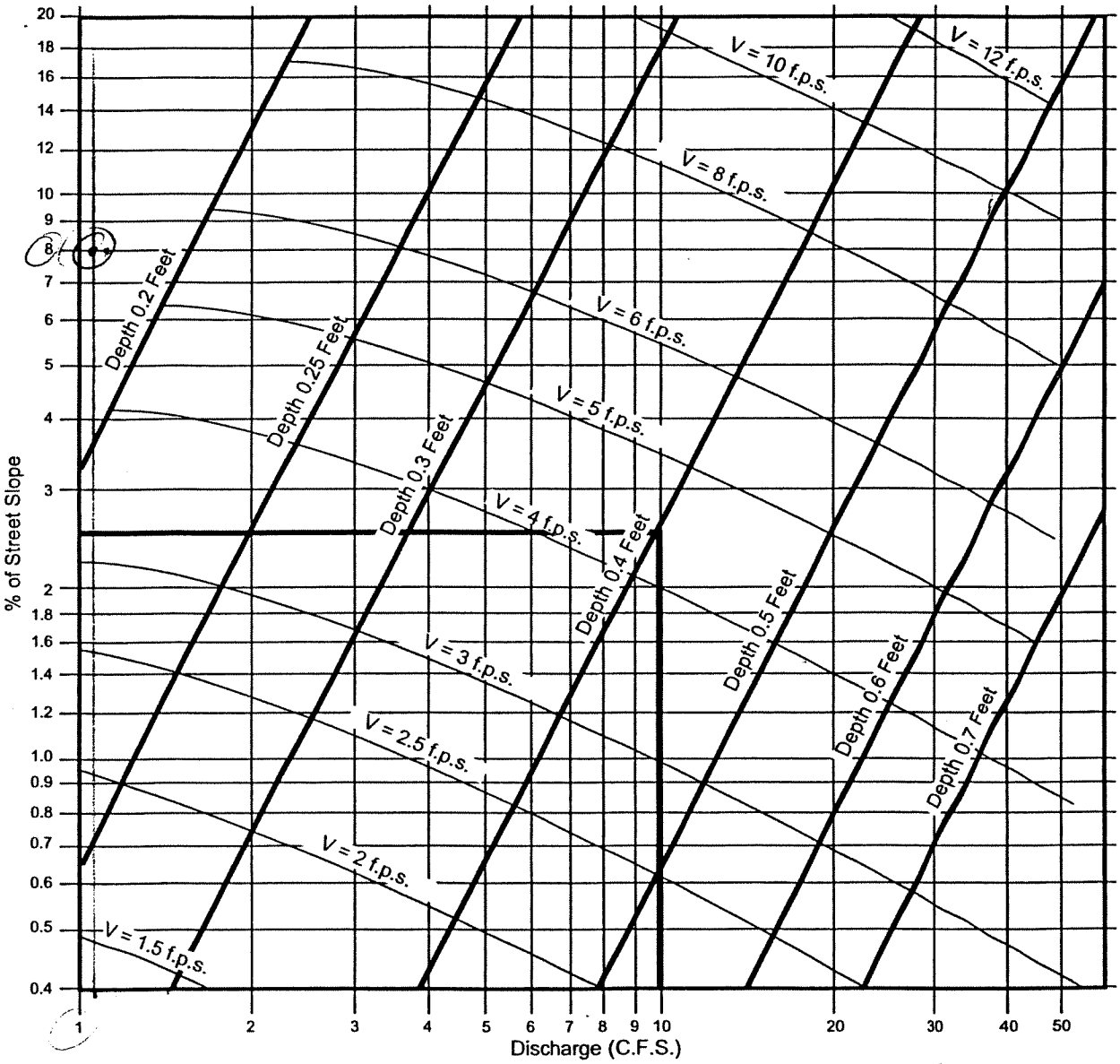
FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

Basin O ~ Type G Curb & Gutter ~ 350 LF @ 8% avg





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

Q gutter = 10.1 CFS use
V gutter = 5.5 FPS
T_t = 1.0 min

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

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

OFFSITE HYDROLOGY

CALC'S - EXISTING

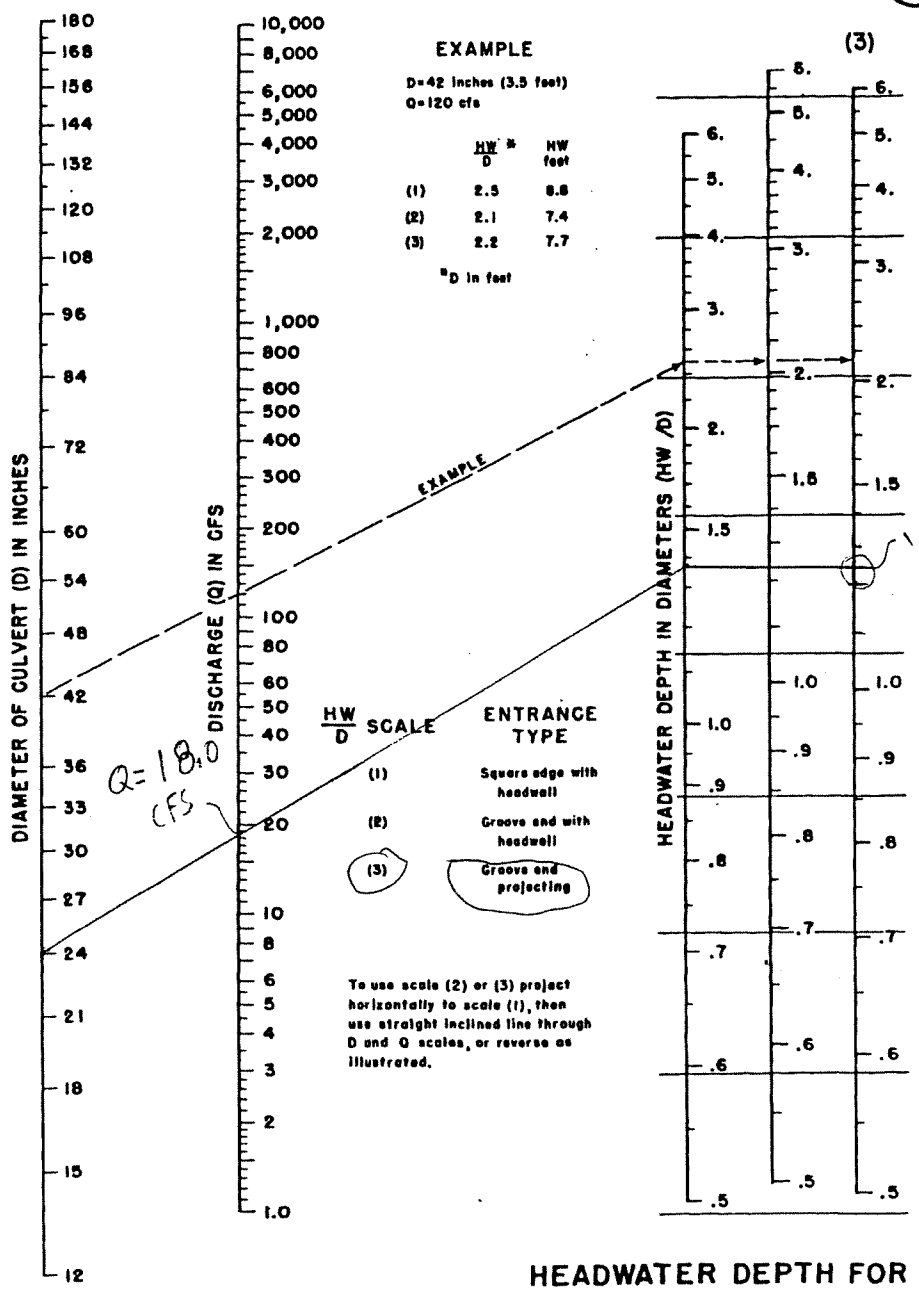
CONDITIONS

SEE BASIN MAP 3

24" RCP SD. - Basin OS1

NODE [14]

CHART 1B



HEADWATER SCALES 283
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

Q = 18 CFS
Max

628 - 625.5 = 2.5 = HW

D = 2.0' HW/D = 1.25

BASIN OS1 TRAVEL TIME - ITERATIVE SOLUTION

FIRST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 57.4+(2.5 CFS/ACRE*2.91 ACRE)/2= 61.0 CFS

Lt =	300	FT	C=	0.41	
$S_{(AVG)}$=	0.047	FT/FT	A=	2.91	Acres
$V_{(AVG)}$=	12.7	FPS	P6=	3.1	in.

T_t = 300'*(1/12.7FPS)*(1min./60sec) = 0.4 min.

Tc = To+Tc = 5.8 + 0.4 = 6.2 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.12 in./hr

Q_B = [ΣC*A]I_{100} = 59.7 CFS

CHECK: $Q_{(AVG)}$ = 57.4+(59.7-57.4)/2 = 58.56 not equal 61.04

SECOND ITERATION: ASSUME q_i= 0.8 CFS/ACRE

$Q_{(AVG)}$= 18.6+(3.7 CFS/ACRE*2.57 ACRE)/2= 58.56 CFS

Lt =	300	FT	C=	0.41	
$S_{(AVG)}$=	0.047	FT/FT	A=	2.91	Acres
$V_{(AVG)}$=	12.5	FPS	P6=	3.1	in.

T_t = 300'*(1/~~12.7~~ 12.5FPS)*(1min./60sec) = 0.4 min.

Tc = ~~To+Tc = 5.2 + 0.2~~ 5.8+0.4 = 6.2 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.12 in./hr

$Q_{\cancel{19}}$ B = [ΣC*A]I_{100} = 59.7 CFS

CHECK: $Q_{(AVG)}$ = 9.3+(18.0-9.3)/2 = 58.54 approx. 58.56 ok

JUNCTION CALC'S

NODE C (ADD BASINS 052, 053, 054

$T_1 = 5.0$ min
$Q_1 = 30.6$ CFS } 052
$I_1 = 8.17$

$T_2 = 5.4$ min
$Q_2 = 28.2$ CFS } 053 + 054
$I_2 = 7.81$

$$Q_{J1} = Q_1 + \frac{T_1}{T_2} Q_2 = 30.6 + \frac{5}{5.4}(28.2) = 56.7 \text{ CFS}$$

$$Q_{J2} = Q_2 + \frac{I_2}{I_1} Q_1 = 28.2 + \frac{7.81}{8.17}(30.6) = 57.4$$

$$\boxed{Q_C = 57.4 \text{ CFS}}$$

Earthen Channel - Basin OS1

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	58.5600 cfs
Slope	0.0470 ft/ft
Manning's n	0.0200
Height	30.0000 in
Bottom width	12.0000 in
Left slope	0.5000 ft/ft (V/H)
Right slope	0.5000 ft/ft (V/H)

Computed Results:

Depth	15.5856 in
Velocity	12.5327 fps
Full Flowrate	277.5984 cfs
Flow area	4.6726 ft2
Flow perimeter	81.7011 in
Hydraulic radius	8.2355 in
Top width	74.3425 in
Area	15.0000 ft2
Perimeter	146.1641 in
Percent full	51.9521 %

Critical Information

Critical depth	23.7797 in
Critical slope	0.0064 ft/ft
Critical velocity	5.9540 fps
Critical area	9.8354 ft2
Critical perimeter	118.3460 in
Critical hydraulic radius	11.9675 in
Critical top width	107.1187 in
Specific energy	3.7397 ft
Minimum energy	2.9725 ft
Froude number	2.5441
Flow condition	Supercritical

Earth swale - Basin 052

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	30.6000 cfs
Slope	0.0700 ft/ft
Manning's n	0.0200
Height	60.0000 in
Bottom width	12.0000 in
Left slope	0.2500 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	8.7202 in
Velocity	10.7786 fps
Full Flowrate	3788.1925 cfs
Flow area	2.8390 ft2
Flow perimeter	83.9088 in
Hydraulic radius	4.8721 in
Top width	81.7617 in
Area	105.0000 ft2
Perimeter	506.7727 in
Percent full	14.5337 %

Critical Information

Critical depth	14.1230 in
Critical slope	0.0070 ft/ft
Critical velocity	4.5553 fps
Critical area	6.7174 ft2
Critical perimeter	128.4611 in
Critical hydraulic radius	7.5300 in
Critical top width	124.9839 in
Specific energy	2.5321 ft
Minimum energy	1.7654 ft
Froude number	2.9438
Flow condition	Supercritical

$$T_t = \frac{650'}{10.8\,FPS} \cdot \frac{1\,min}{60\,sec} = 1.0\,min$$

BASIN OS3 TRAVEL TIME - ITERATIVE SOLUTION

IRST ITERATION: ASSUME q_i= 2.5 CFS/ACRE

$Q_{(AVG)}$= 18.6+(2.5 CFS/ACRE*2.57 ACRE)/2= 21.8 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	2.57	Acres
$V_{(AVG)}$=	15.9	FPS	P6=	3.1	in.

T_t = 200'*(1/15.9FPS)*(1min./60sec) = 0.2 min.

Tc = To+Tc = 5.2 + 0.2 = 5.4 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.81 in./hr

$Q_{\cancel{19}}$ D = [ΣC*A]I_{100} = 28.2 CFS

CHECK: $Q_{(AVG)}$ = 18.6+(28.2-18.6)/2 = 23.42 not equal 21.81

SECOND ITERATION: ASSUME q_i= 3.7 CFS/ACRE

$Q_{(AVG)}$= 18.6+(3.7 CFS/ACRE*2.57 ACRE)/2= 23.42 CFS

Lt =	200	FT	C=	0.41	
$S_{(AVG)}$=	0.06	FT/FT	A=	2.57	Acres
$V_{(AVG)}$=	16.2	FPS	P6=	3.1	in.

T_t = 200'*(1/16.2 FPS)*(1min./60sec) = 0.2 min.

Tc = To+Tc = 5.2 + 0.2 = 5.4 min.

I_{100} = 7.44 * P6 * Tc^(-0.645) = 7.81 in./hr

$Q_{\cancel{19}}$ D = [ΣC*A]I_{100} = 28.2 CFS

HECK: $Q_{(AVG)}$ = 9.3+(18.0-9.3)/2 = 23.42 approx. 23.42 ok

Conc. Browdith Basin 053

tmp#28.txt

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	23.4200 cfs
Slope	0.0600 ft/ft
Manning's n	0.0130
Height	24.0000 in
Bottom width	12.0000 in
Left slope	1.0000 ft/ft (V/H)
Right slope	1.0000 ft/ft (V/H)

Q average

Computed Results:

Depth	9.6101 in
Velocity	16.2392 fps
Full Flowrate	156.7559 cfs
Flow area	1.4422 ft2
Flow perimeter	39.1814 in
Hydraulic radius	5.3003 in
Top width	31.2202 in
Area	6.0000 ft2
Perimeter	79.8823 in
Percent full	40.0420 %

Critical Information

Critical depth	19.1744 in
Critical slope	0.0036 ft/ft
Critical velocity	5.6419 fps
Critical area	4.1511 ft2
Critical perimeter	66.2335 in
Critical hydraulic radius	9.0249 in
Critical top width	50.3489 in
Specific energy	4.8991 ft
Minimum energy	2.3968 ft
Froude number	3.8453
Flow condition	Supercritical

$$T_t = \frac{200'}{16.2\ FPS} \cdot \frac{1\ min}{60\ sec} = 0.2\ min$$

Earth swale - Basin 054

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	18.6000 cfs
Slope	0.0320 ft/ft
Manning's n	0.0200
Height	24.0000 in
Bottom width	6.0000 in
Left slope	0.2500 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	8.9787 in
Velocity	7.1169 fps
Full Flowrate	226.0174 cfs
Flow area	2.6135 ft2
Flow perimeter	80.0405 in
Hydraulic radius	4.7019 in
Top width	77.8298 in
Area	17.0000 ft2
Perimeter	203.9091 in
Percent full	37.4114 %

Critical Information

Critical depth	12.0076 in
Critical slope	0.0075 ft/ft
Critical velocity	4.1284 fps
Critical area	4.5054 ft2
Critical perimeter	105.0173 in
Critical hydraulic radius	6.1778 in
Critical top width	102.0609 in
Specific energy	1.5354 ft
Minimum energy	1.5010 ft
Froude number	1.9766
Flow condition	Supercritical

$$T_J = \frac{250'}{7.1\,FPS} \cdot \frac{1\,min}{60\,sec} = \underline{0.6\,min}$$

$$Q_{12} = Q_{15} + Q_{13} + Q_{E4} = 48.0 + 30.1 + 1.8 = 79.9 \text{ cfs}$$

$$Q_{10} = Q_{12} + Q_{E2} + Q_{E5} + Q_{E3} + Q_{G}$$

$$= 79.9 + 28.8 + 0.4 + 18.4 + 3.8 = \underline{131.3}$$

100' WIDE CHANNEL ~ 300' DOWNSTREAM
see section A-A' BASIN MAP 2

Channel Calculator

Given Input Data:

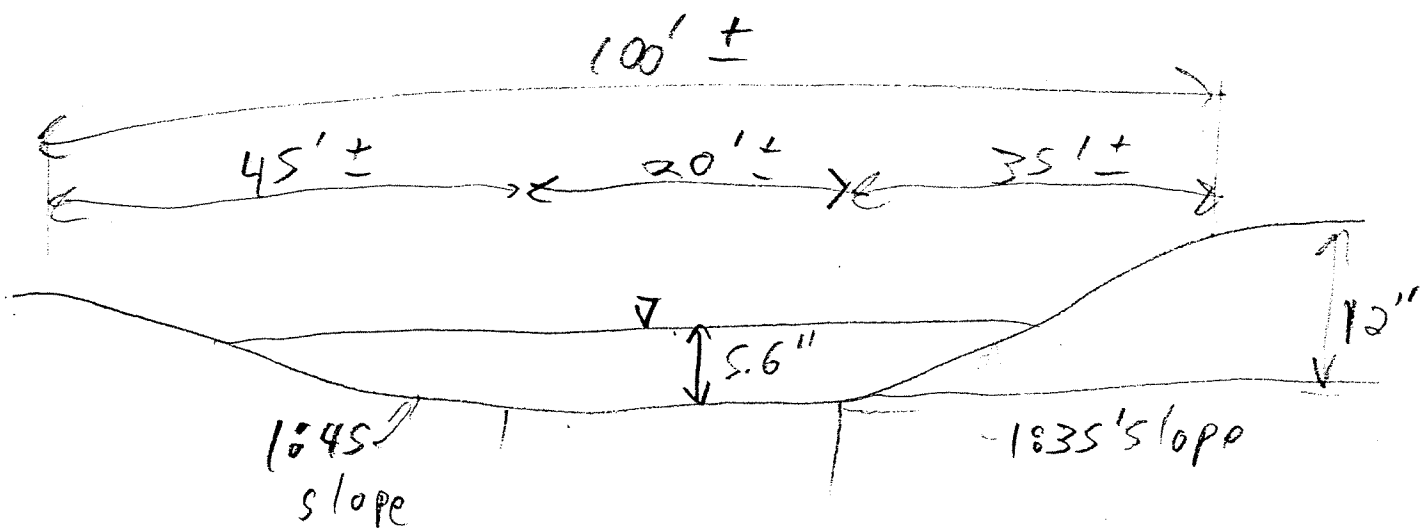
Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	131.3000 cfs — Q1
Slope	0.0500 ft/ft
Manning's n	0.0200
Height	12.0000 in
Bottom width	240.0000 in
Left slope	0.0286 ft/ft (V/H)
Right slope	0.0333 ft/ft (V/H)

Computed Results:

Depth	5.6471 in — Tail water
Velocity	7.9055 fps
Full Flowrate	632.4178 cfs
Flow area	16.6088 ft2
Flow perimeter	607.2109 in
Hydraulic radius	3.9388 in
Top width	607.0361 in
Area	52.4975 ft2
Perimeter	1020.3121 in
Percent full	47.0595 %

Critical Information

Critical depth	8.9986 in
Critical slope	0.0074 ft/ft
Critical velocity	3.9463 fps
Critical area	33.2717 ft2
Critical perimeter	825.1414 in
Critical hydraulic radius	5.8064 in
Critical top width	824.8630 in
Specific energy	1.4418 ft
Minimum energy	1.1248 ft
Froude number	2.4323
Flow condition	Supercritical



L-TYPE H.W. & 180' BROADCRESTED WEIR ELEV. 603.0 W/4-24" CULVERTS

Culvert Calculator

Entered Data:

Shape	Circular
Number of Barrels	4
Solving for	Headwater
Chart Number	1
Scale Number	1
Chart Description	CONCRETE PIPE CULVERT; NO BEVELED RING
ENTRANCE	
Scale Decsription	SQUARE EDGE ENTRANCE WITH HEADWALL
Overtopping	On
Flowrate	131.3000 cfs
Manning's n	0.0130
Roadway Elevation	601.8100 ft
Inlet Elevation	598.7600 ft
Outlet Elevation	598.3100 ft
Diameter	24.0000 in
Length	39.0000 ft
Entrance Loss	0.0000
Tailwater	0.4700 ft

Computed Results:

Headwater	601.8253 ft Overtopping Occurred
Slope	0.0115 ft/ft
Velocity	NA

Messages:

Overtopping Occurred

DIS-CHARGE Flow cfs	HEAD-WATER ELEV. ft	INLET CONTROL DEPTH ft	OUTLET CONTROL DEPTH ft	FLOW TYPE	NORMAL DEPTH in	CRITICAL DEPTH in	OUTLET VEL. fps	OUTLET DEPTH ft	TAILWATER VEL. fps	TAILWATER DEPTH ft
3.80	599.70	0.94	0.66	NA	6.42	8.20	5.63	0.53	0.00	0.47
7.60	600.17	1.41	1.10	NA	9.22	11.76	6.83	0.77	0.00	0.47
11.40	600.60	1.84	1.48	NA	11.57	14.54	7.61	0.96	0.00	0.47
15.20	601.03	2.27	1.85	NA	13.76	16.87	8.16	1.15	0.00	0.47
19.00	601.54	2.78	2.22	NA	15.98	18.82	8.55	1.33	0.00	0.47
22.80	601.38	0.00	2.62	NA	18.48	18.82	8.01	1.54	0.00	0.47

Overtopping Results

22.80	601.81
26.60	601.82
30.40	601.82
34.20	601.83
38.00	601.83
41.80	601.84
45.60	601.84
49.40	601.85
53.20	601.86
57.00	601.86
60.80	601.87
64.60	601.87
68.40	601.88

CFS	WS Elev.
72.20	601.88
76.00	601.89
79.80	601.89
83.60	601.90
87.40	601.91
91.20	601.91
95.00	601.92
98.80	601.92
102.60	601.93
106.40	601.93
110.20	601.94
114.00	601.94
117.80	601.95
121.60	601.96
125.40	601.96
129.20	601.97
133.00	601.97
136.80	601.98
140.60	601.98
144.40	601.99
148.20	602.00
152.00	602.00
155.80	602.01
159.60	602.01
163.40	602.02
167.20	602.02
171.00	602.03
174.80	602.03
178.60	602.04
182.40	602.05
186.20	602.05
190.00	602.06
193.80	602.06
197.60	602.07
201.40	602.07
205.20	602.08
209.00	602.09
212.80	602.09
216.60	602.10
220.40	602.10
224.20	602.11
228.00	602.11
231.80	602.12
235.60	602.12
239.40	602.13
243.20	602.14
247.00	602.14
250.80	602.15
254.60	602.15
258.40	602.16
262.20	602.16
266.00	602.17
269.80	602.17
273.60	602.18
277.40	602.19
281.20	602.19
285.00	602.20
288.80	602.20
292.60	602.21
296.40	602.21
300.20	602.22
304.00	602.23
307.80	602.23

D-36 CONC. CHANNEL

NODES 12-10

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	133.1000 cfs
Slope	0.0050 ft/ft
Manning's n	0.0130
Height	48.0000 in
Bottom width	24.0000 in
Left slope	0.5000 ft/ft (V/H)
Right slope	0.5000 ft/ft (V/H)

Computed Results:

Depth	26.8834 in
Velocity	9.1677 fps
Full Flowrate	515.1398 cfs
Flow area	14.5183 ft2
Flow perimeter	144.2262 in
Hydraulic radius	14.4955 in
Top width	131.5336 in
Area	40.0000 ft2
Perimeter	238.6625 in
Percent full	56.0071 %

Critical Information

Critical depth	31.4893 in
Critical slope	0.0024 ft/ft
Critical velocity	6.9979 fps
Critical area	19.0201 ft2
Critical perimeter	164.8243 in
Critical hydraulic radius	16.6170 in
Critical top width	149.9571 in
Specific energy	3.5464 ft
Minimum energy	3.9362 ft
Froude number	1.4044
Flow condition	Supercritical

W.S. elev = 603.3 @ NODE 12

W.S. elev = 601.97 @ NODE 10

30" RCP S.D @ 0.85%

NODES 15-12

tmp#30.txt

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Diameter Full
Diameter	32.8064 in
Depth	32.8064 in
Flowrate	48.0000 cfs
Slope	0.0085 ft/ft
Manning's n	0.0130

Computed Results:

Area	5.8701 ft2
Wetted Area	5.8701 ft2
Wetted Perimeter	103.0644 in
Perimeter	103.0644 in
Velocity	8.1770 fps
Hydraulic Radius	8.2016 in
Percent Full	100.0000 %
Full flow Flowrate	48.0000 cfs
Full flow velocity	8.1770 fps

Critical Information

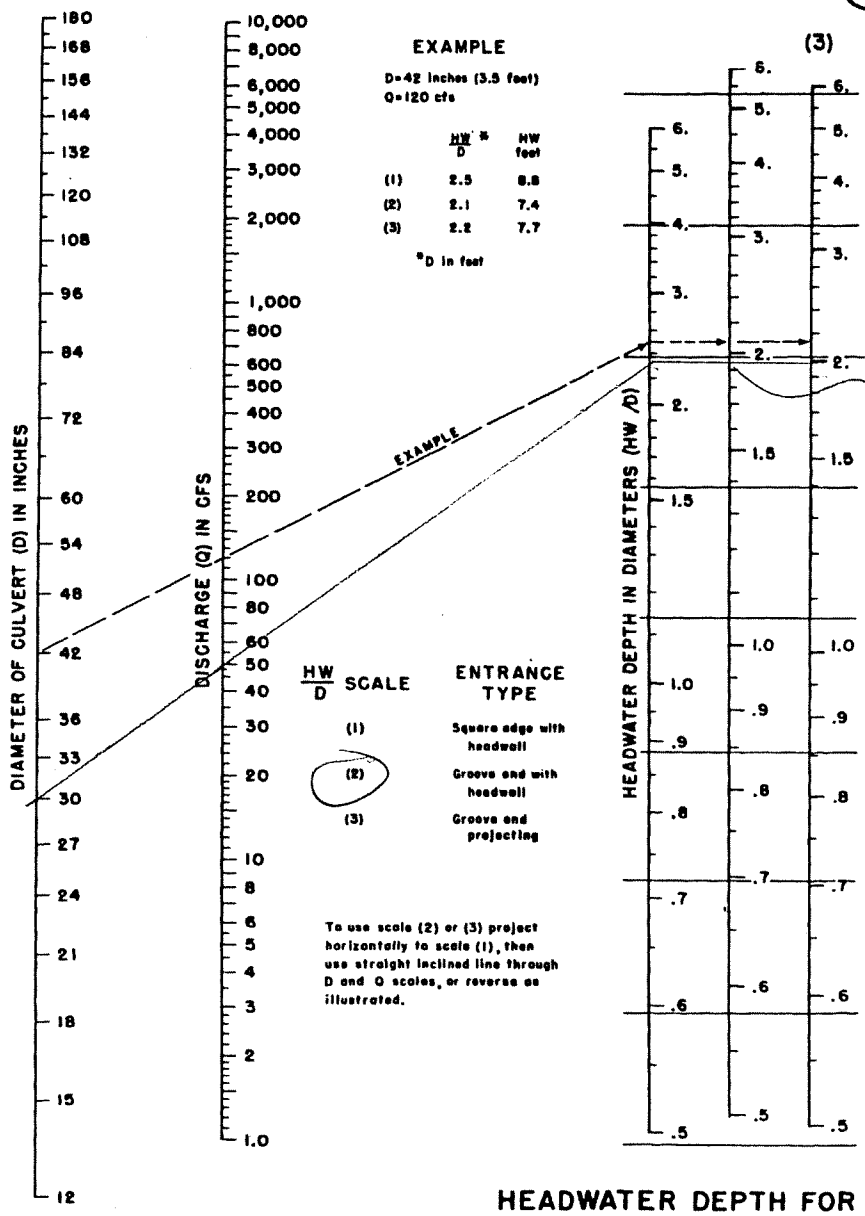
Critical depth	29.0074 in
Critical slope	0.0059 ft/ft
Critical velocity	8.2665 fps
Critical area	5.8066 ft2
Critical perimeter	76.7405 in
Critical hydraulic radius	10.8957 in
Critical top width	32.8064 in
Specific energy	3.5382 ft
Minimum energy	3.6259 ft
Froude number	0.8119
Flow condition	Subcritical

PIPE UNDER PRESSURE

Type A-4 C.O.

NODE 15

CHART 1B



$\frac{HW}{D} = 1.91$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$Q_{15} = 48.0$ CFS

$D = 2.5'$

$HW = 4.78$

FL = 604.05

W.S. elev = 608.83

18" RCP S.D. @ 7.0%

NODES 16 - 15

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	18.0000 in
Flowrate	10.2000 cfs
Slope	0.0700 ft/ft
Manning's n	0.0130

Computed Results:

Depth	7.5462 in
Area	1.7671 ft2
Wetted Area	0.7026 ft2
Wetted Perimeter	25.3539 in
Perimeter	56.5487 in
Velocity	14.5168 fps
Hydraulic Radius	3.9907 in
Percent Full	41.9231 %
Full flow Flowrate	27.7919 cfs
Full flow velocity	15.7270 fps

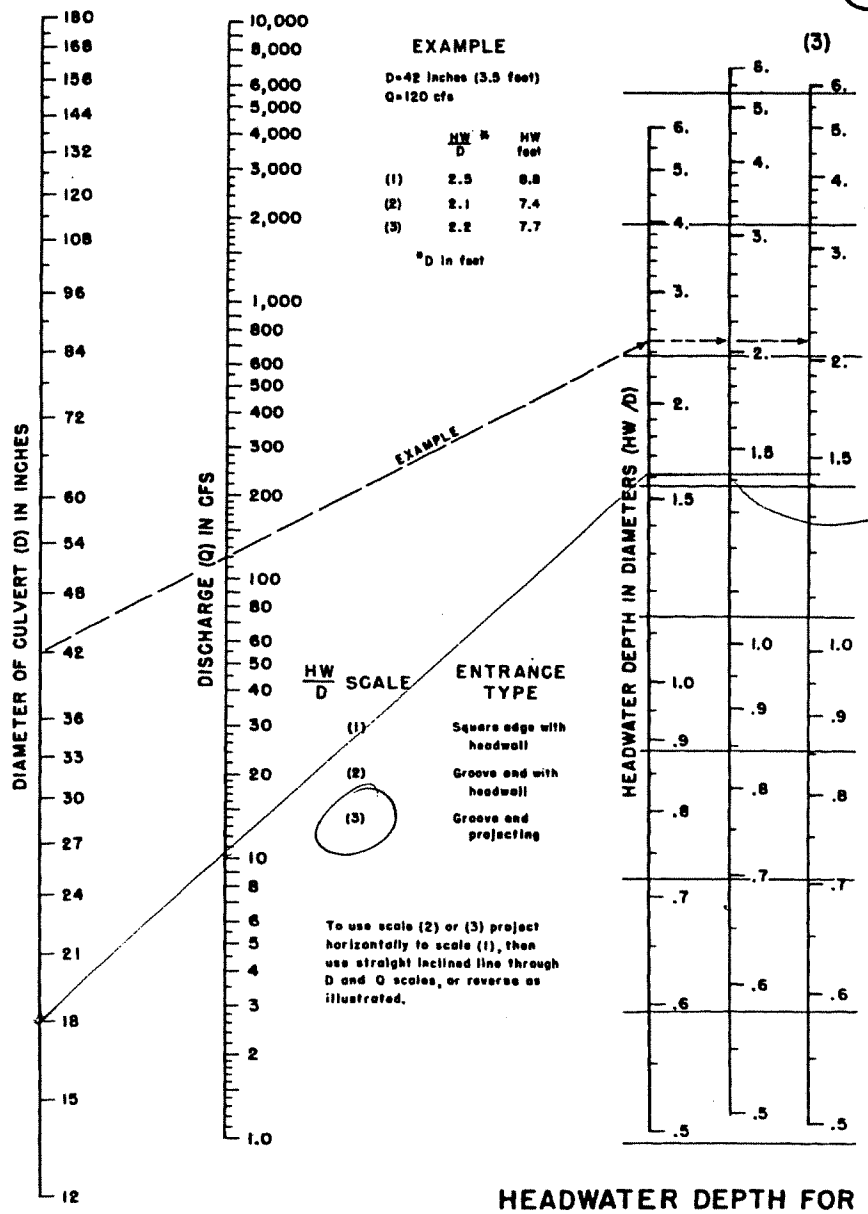
Critical Information

Critical depth	15.4735 in
Critical slope	0.0071 ft/ft
Critical velocity	6.0257 fps
Critical area	1.6928 ft2
Critical perimeter	41.2213 in
Critical hydraulic radius	5.9134 in
Critical top width	18.0000 in
Specific energy	3.9038 ft
Minimum energy	1.9342 ft
Froude number	3.7147
Flow condition	Supercritical

15' Type B-1 Inlet

NODE 116

CHART 1B



$\frac{HW}{D} = 1.42$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

D = 1.5'

HW = 2.13

Q_{16} = 10.2 CFS

FL = 608.39

wselev = 610.52

30" RCP S.P @ 3.14%

NODES 17 - 15

tmp#32.txt

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	30.0000 in
Flowrate	37.8000 cfs
Slope	0.0314 ft/ft
Manning's n	0.0130

Computed Results:

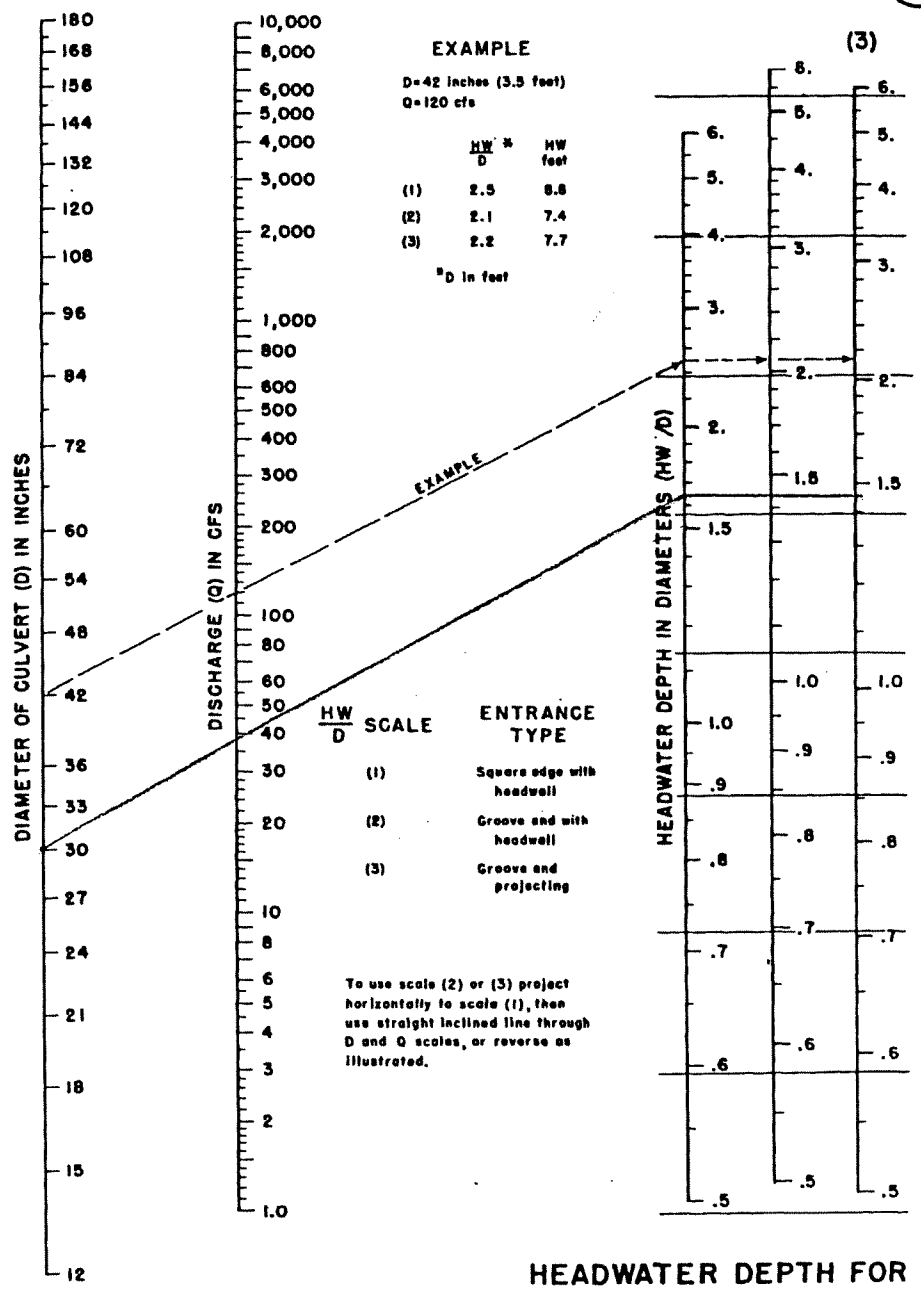
Depth	15.3536 in
Area	4.9087 ft2
Wetted Area	2.5280 ft2
Wetted Perimeter	47.8312 in
Perimeter	94.2478 in
Velocity	14.9523 fps
Hydraulic Radius	7.6109 in
Percent Full	51.1787 %
Full flow Flowrate	72.6826 cfs
Full flow velocity	14.8068 fps

Critical Information

Critical depth	26.2890 in
Critical slope	0.0061 ft/ft
Critical velocity	7.8648 fps
Critical area	4.8062 ft2
Critical perimeter	69.7019 in
Critical hydraulic radius	9.9294 in
Critical top width	30.0000 in
Specific energy	4.7539 ft
Minimum energy	3.2861 ft
Froude number	2.6214
Flow condition	Supercritical

Type A-4 C.O.
Node 17

CHART 1B



$\frac{Hw}{D} = 1.45$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$\frac{Hw}{D} = 1.45$ $Hw = 3.62'$ $FL = 613.47$ $Wselev = 617.09$

$Q_{17} = 37.8$ CFS

30" RCP S.D. @ 8.8%

NODE 18-17

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	30.0000 in
Flowrate	37.8000 cfs
Slope	0.0880 ft/ft
Manning's n	0.0130

Computed Results:

Depth	11.4808 in
Area	~~4.9087 ft2~~
Wetted Area	1.7280 ft2
Wetted Perimeter	40.0193 in
Perimeter	94.2478 in
Velocity	21.8752 fps
Hydraulic Radius	6.2178 in
Percent Full	38.2693 %
Full flow Flowrate	121.6765 cfs
Full flow velocity	24.7877 fps

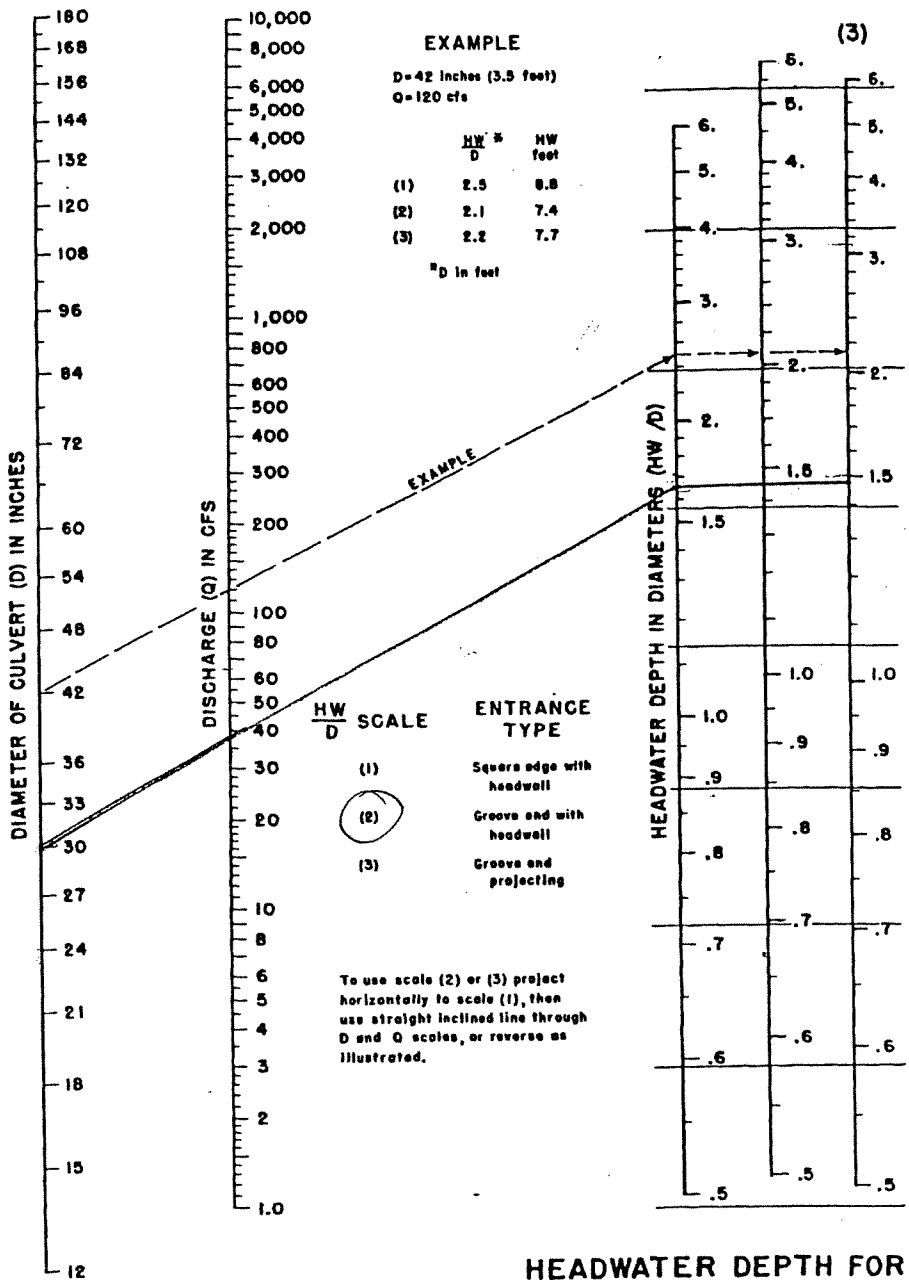
Critical Information

Critical depth	26.2890 in
Critical slope	0.0061 ft/ft
Critical velocity	7.8648 fps
Critical area	4.8062 ft2
Critical perimeter	69.7019 in
Critical hydraulic radius	9.9294 in
Critical top width	30.0000 in
Specific energy	8.3932 ft
Minimum energy	3.2861 ft
Froude number	4.5735
Flow condition	Supercritical

30" RCP SD - Basin L

Model [18]

CHART 1B



$\frac{HW}{D} = 1.45$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$\frac{HW}{D} = 1.45$, $HW = 3.62'$

$FL = 615.37$

$Q_{18} = 37.8$ CFS

W.S. elev. $= 619.0'$

100' WIDE CHANNEL ~300' DOWNSTREAM

SEE SECTION A-A' Basin MAP 1

Channel Calculator

Given Input Data:

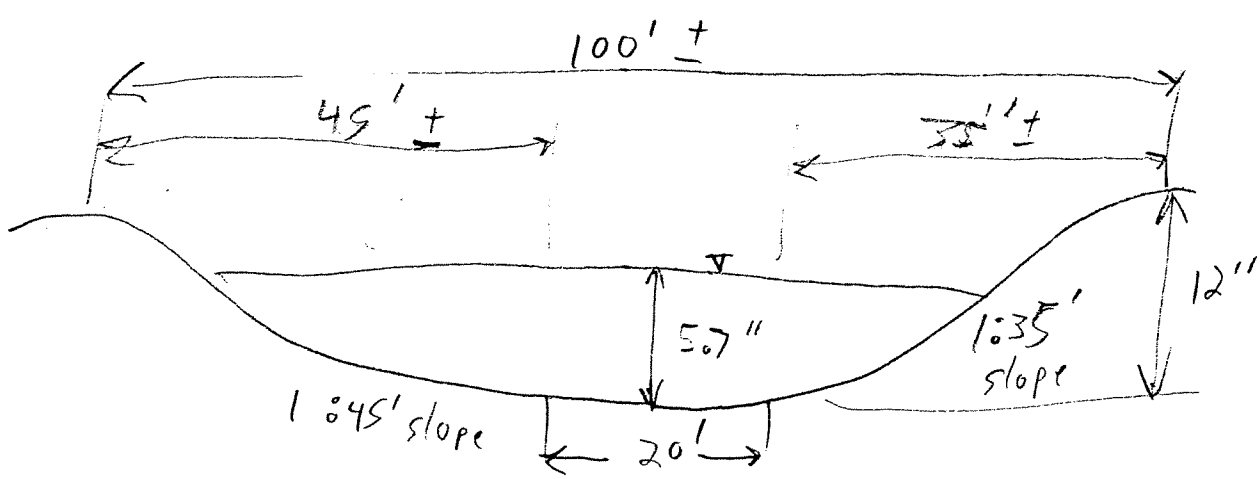
Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	133.3000 cfs — Q_1
Slope	0.0500 ft/ft
Manning's n	0.0200
Height	12.0000 in
Bottom width	240.0000 in
Left slope	0.0286 ft/ft (V/H)
Right slope	0.0333 ft/ft (V/H)

Computed Results:

Depth	5.6903 in — Tailwater
Velocity	7.9388 fps
Full Flowrate	632.4178 cfs
Flow area	16.7910 ft2
Flow perimeter	610.0158 in
Hydraulic radius	3.9637 in
Top width	609.8397 in
Area	52.4975 ft2
Perimeter	1020.3121 in
Percent full	47.4190 %

Critical Information

Critical depth	9.0679 in
Critical slope	0.0074 ft/ft
Critical velocity	3.9590 fps
Critical area	33.6698 ft2
Critical perimeter	829.6481 in
Critical hydraulic radius	5.8440 in
Critical top width	829.3675 in
Specific energy	1.4536 ft
Minimum energy	1.1335 ft
Froude number	2.4349
Flow condition	Supercritical



MOD. 16' B-2 INLET w/ 7-24" RCP CULVERTS

HOPE [2]

tmp#19.txt

Culvert Calculator

Entered Data:

Shape	Circular
Number of Barrels	7
Solving for	Headwater
Chart Number	1
Scale Number	1
Chart Description	CONCRETE PIPE CULVERT; NO BEVELED RING ENTRANCE
Scale Decsription	SQUARE EDGE ENTRANCE WITH HEADWALL
Overtopping	Off
Flowrate	133.0000 cfs = Q_2
Manning's n	0.0130
Roadway Elevation	601.8100 ft
Inlet Elevation	598.7600 ft
Outlet Elevation	598.3100 ft
Diameter	24.0000 in
Length	39.0000 ft
Entrance Loss	0.0000
Tailwater	0.4750 ft = 5.7"

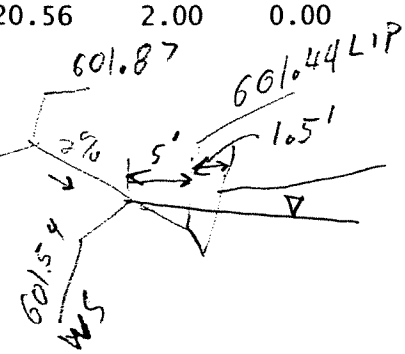
Computed Results:

Headwater	601.5443 ft Inlet Control
Slope	0.0115 ft/ft
Velocity	8.5505 fps

Messages:

Inlet head > Outlet head.
Computing Inlet Control headwater.
Solving Inlet Equation 26.
Solving Inlet Equation 28.
Headwater: 601.5443 ft

DIS-CHARGE Flow cfs	HEAD-WATER ELEV. ft	INLET CONTROL DEPTH ft	OUTLET CONTROL DEPTH ft	FLOW TYPE	NORMAL DEPTH in	CRITICAL DEPTH in	OUTLET VEL. fps	OUTLET DEPTH ft	TAILWATER VEL. fps	TAILWATER DEPTH ft
3.80	599.42	0.00	0.66	NA	6.42	18.82	4.01	0.53	0.00	0.47
7.60	599.86	0.00	1.10	NA	9.22	18.82	4.96	0.77	0.00	0.47
11.40	600.24	0.00	1.48	NA	11.57	18.82	5.73	0.96	0.00	0.47
15.20	600.61	0.00	1.85	NA	13.76	18.82	6.44	1.15	0.00	0.47
19.00	600.98	0.00	2.22	NA	15.98	18.82	7.19	1.33	0.00	0.47
22.80	601.38	0.00	2.62	NA	18.48	18.82	8.01	1.54	0.00	0.47
60.80	599.65	0.89	0.00	NA	24.00	24.00	19.35	2.00	0.00	0.47
64.60	601.58	2.82	0.00	NA	24.00	24.00	20.56	2.00	0.00	0.47

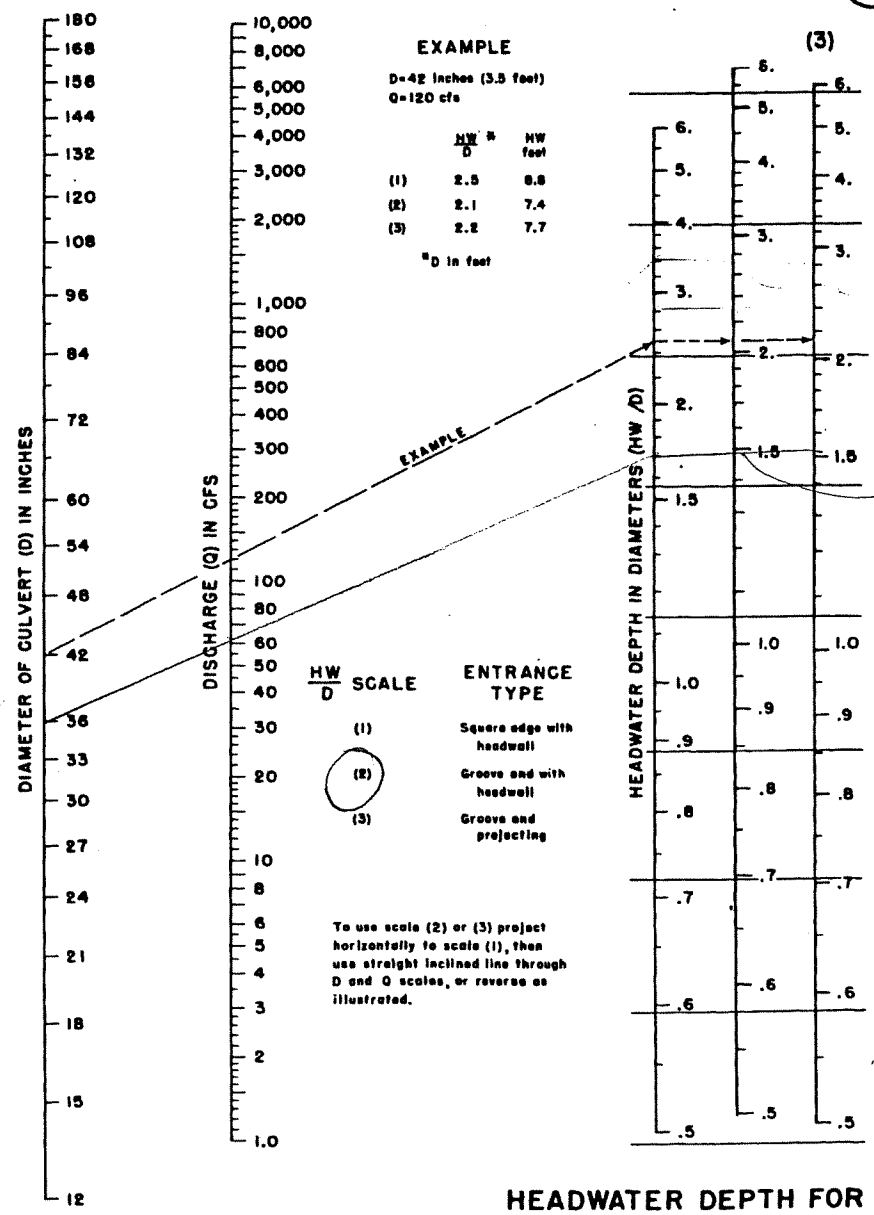


6.5' From Curb Line to be Flooded

Type A-4 C.O.,

NODE [9]

CHART 1B



$\frac{HW}{D} = 1.5$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

Q-9 = 63.0 CFS

D = 3.0'

HW = 4.5'

FL = 599.28

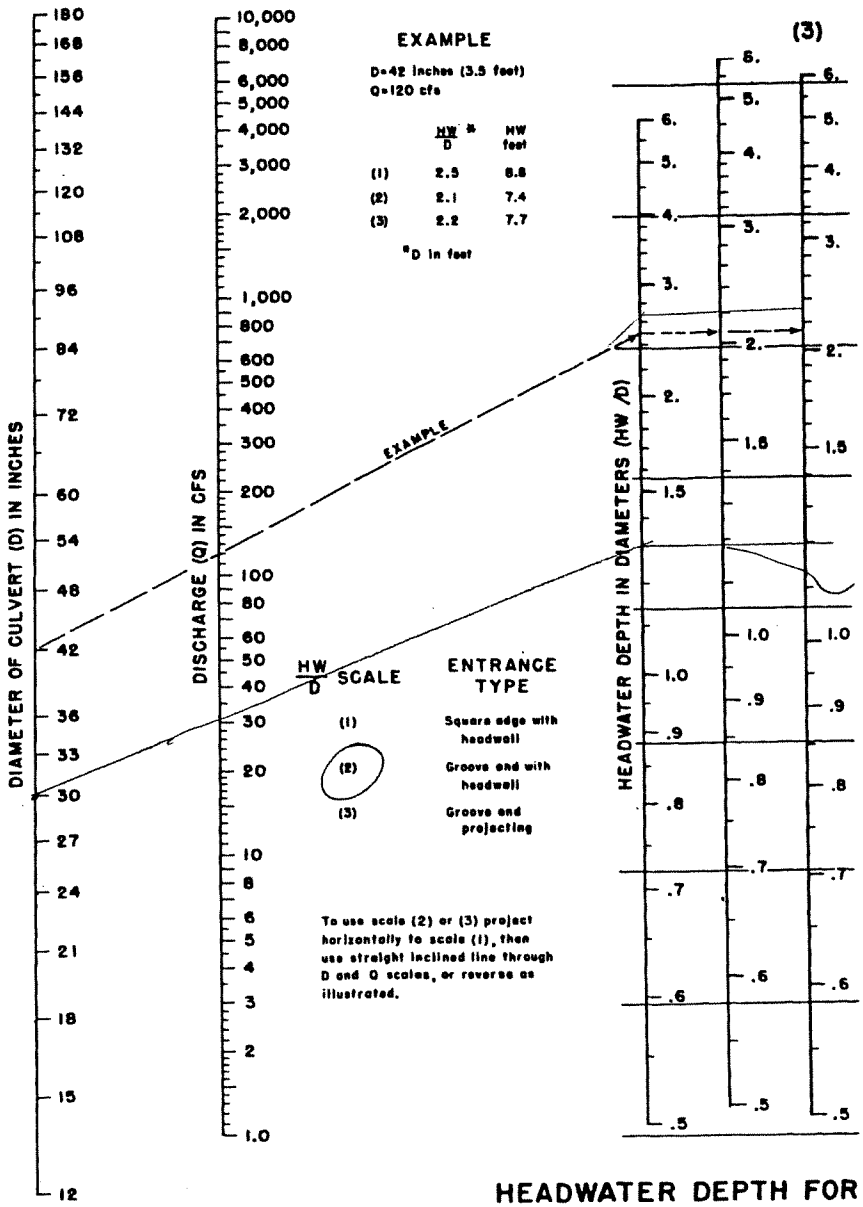
US Elev = 603.78

RIM = 605.0

MOD. TYPEF C.B.

NODE 3

CHART 1B



$\frac{HW}{D} = 1.2$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$Q_3 = 31.6$ CFS

$D = 2.5$

$HW = 3.0$

FL = 599.65

RIM 605.1

Wselev = 602.65

NODE 3 → 4

~~tmp#2.txt~~

Manning Pipe Calculator

Given Input Data:

Shape	Circular	
Solving for	Depth of Flow	
Diameter	24.0000 in	← pipe size
Flowrate	20.5000 cfs	← Q_{100}
Slope	0.0650 ft/ft	← slope
Manning's n	0.0150	

Computed Results:

Depth	10.7057 in	*
Area	~~3.1416 ft2~~	
Wetted Area	1.3555 ft2	
Wetted Perimeter	35.1055 in	
Perimeter	75.3982 in	
Velocity	15.1236 fps	
Hydraulic Radius	5.5602 in	
Percent Full	44.6071 %	
Full flow Flowrate	49.9859 cfs	
Full flow velocity	15.9110 fps	

* Depth = 11" ±

∴ 24" pipe sufficient

NODE 4 → 5

~~tmp#1.txt~~

Manning Pipe Calculator

Given Input Data:

Shape	Circular	
Solving for	Depth of Flow	
Diameter	24.0000 in	← pipe size
Flowrate	20.5000 cfs	← Q100
Slope	0.1100 ft/ft	← slope
Manning's n	0.0150	

Computed Results:

Depth	9.2580 in	*
Area	~~3.1416 ft2~~	
Wetted Area	1.1178 ft2	
Wetted Perimeter	32.1662 in	
Perimeter	75.3982 in	
Velocity	18.3395 fps	
Hydraulic Radius	5.0041 in	
Percent Full	38.5750 %	
Full flow Flowrate	65.0260 cfs	
Full flow velocity	20.6984 fps	

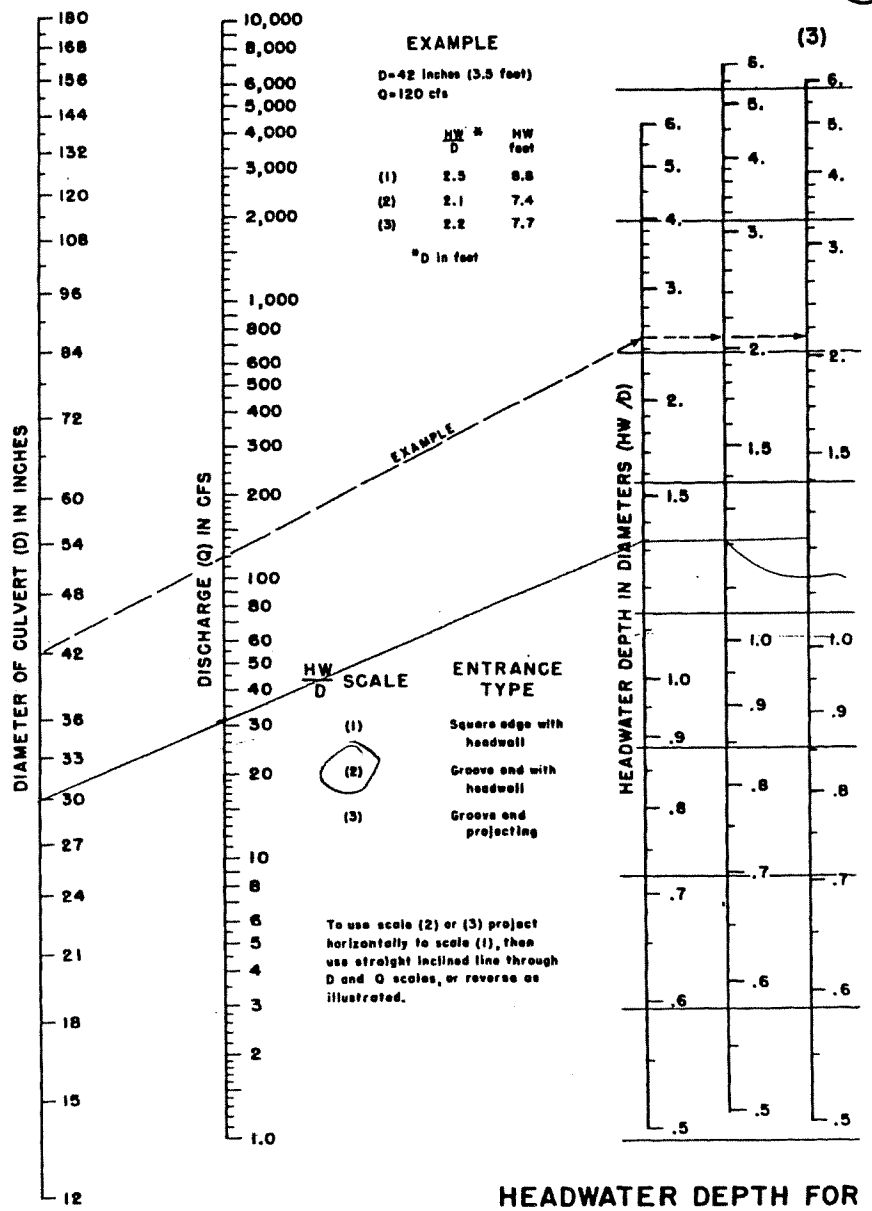
* Depth = 9" ±

∴ 24" pipe sufficient.

A-4 C.O.

MODE [6]

CHART 1B



$\frac{HW}{D} = 1.2$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$Q_6 = 31.4$

$D = 2.5'$

$HW = 3.0'$

FL = 600.73

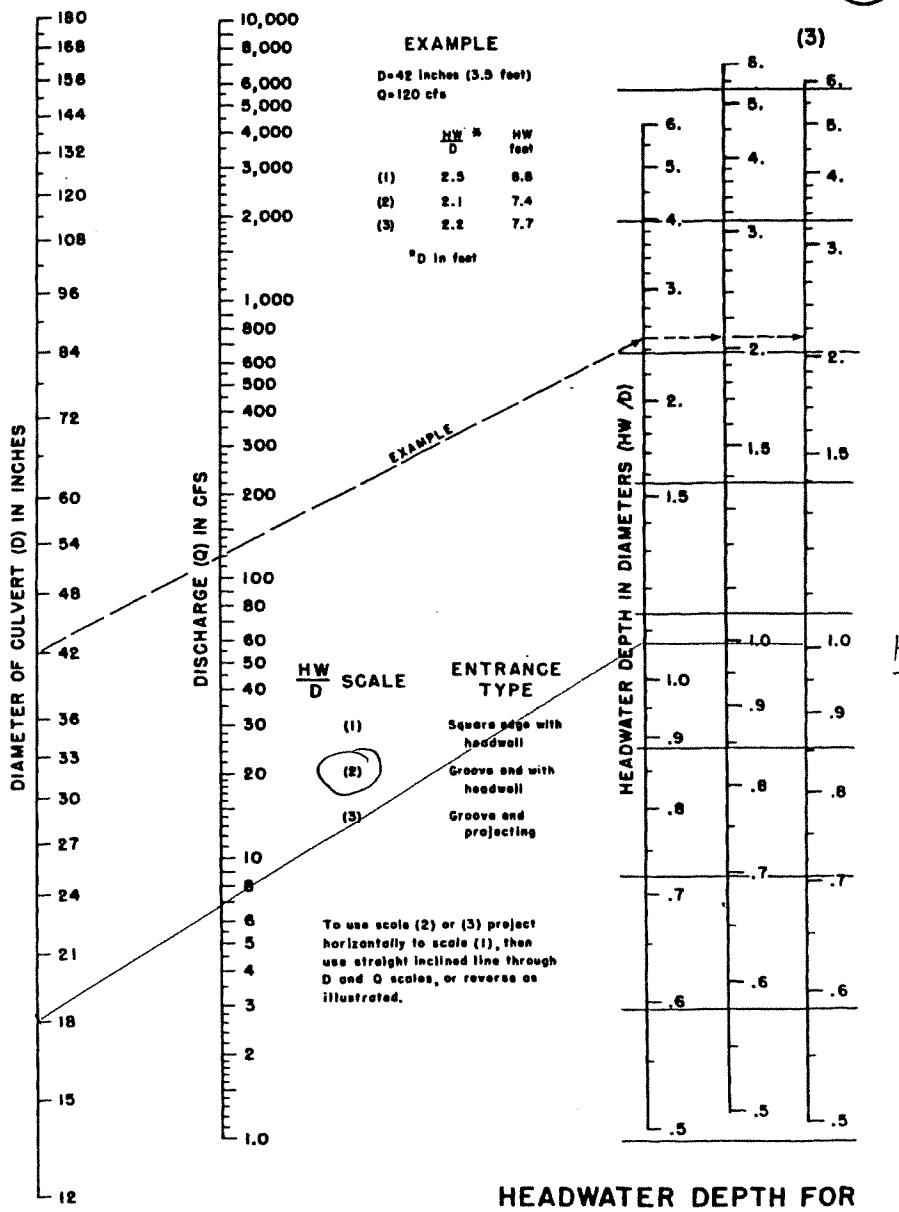
wselev = 603.73

RIM = 604.8

STORMWATER INTERCEPTOR

NODE 7

CHART 1B



$\frac{HW}{D} = 1.0$

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

$Q_7 = 6.8$ CFS

FL = 601.8

D = 1.5'

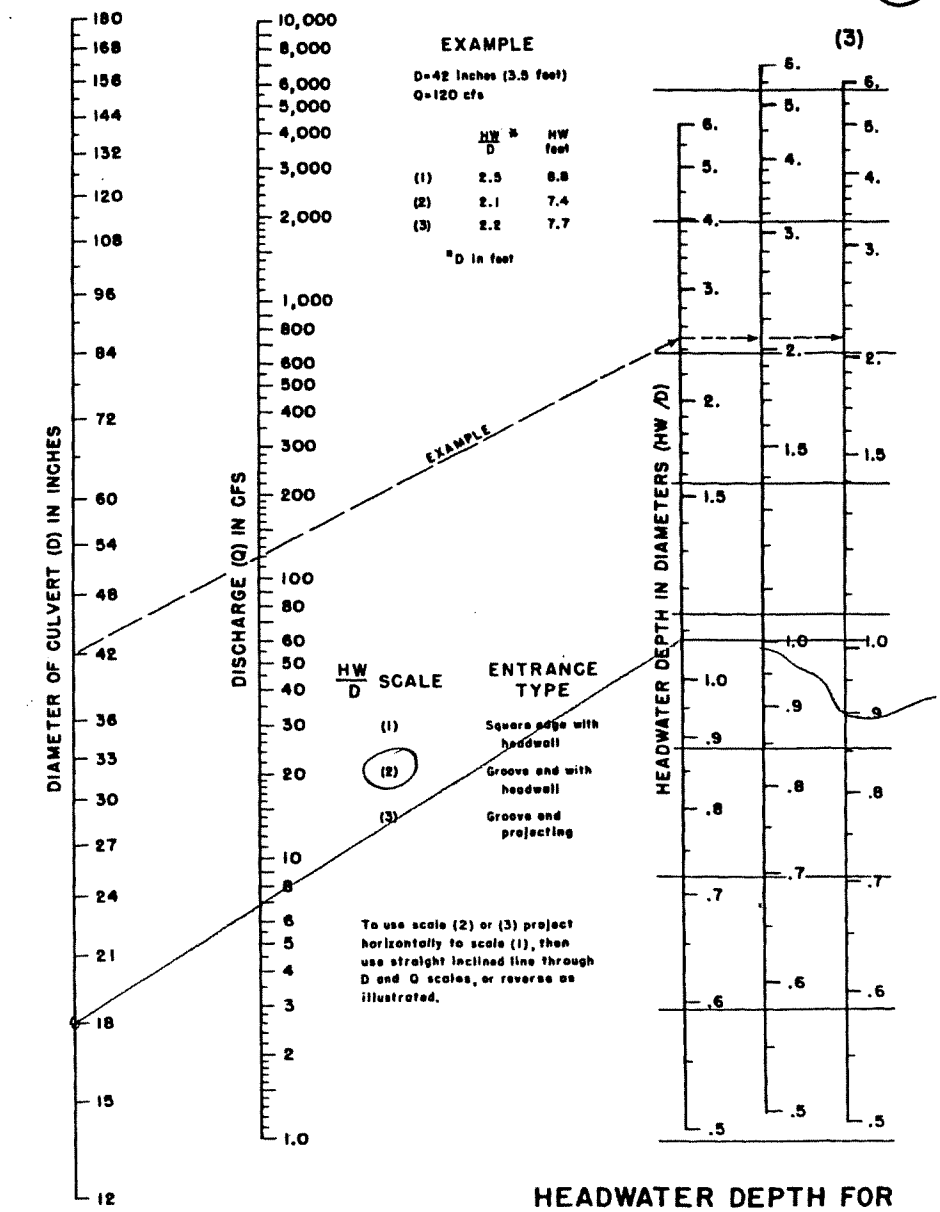
HW = 1.5'

W.S. Elev = 603.3

8' Type B-1 Curb Inlet

NODE 8

CHART 1B



$\frac{HW}{D} = 1.00$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$Q_8 = 6.8$ CFS

$D = 1.5'$

$HW = 1.50'$

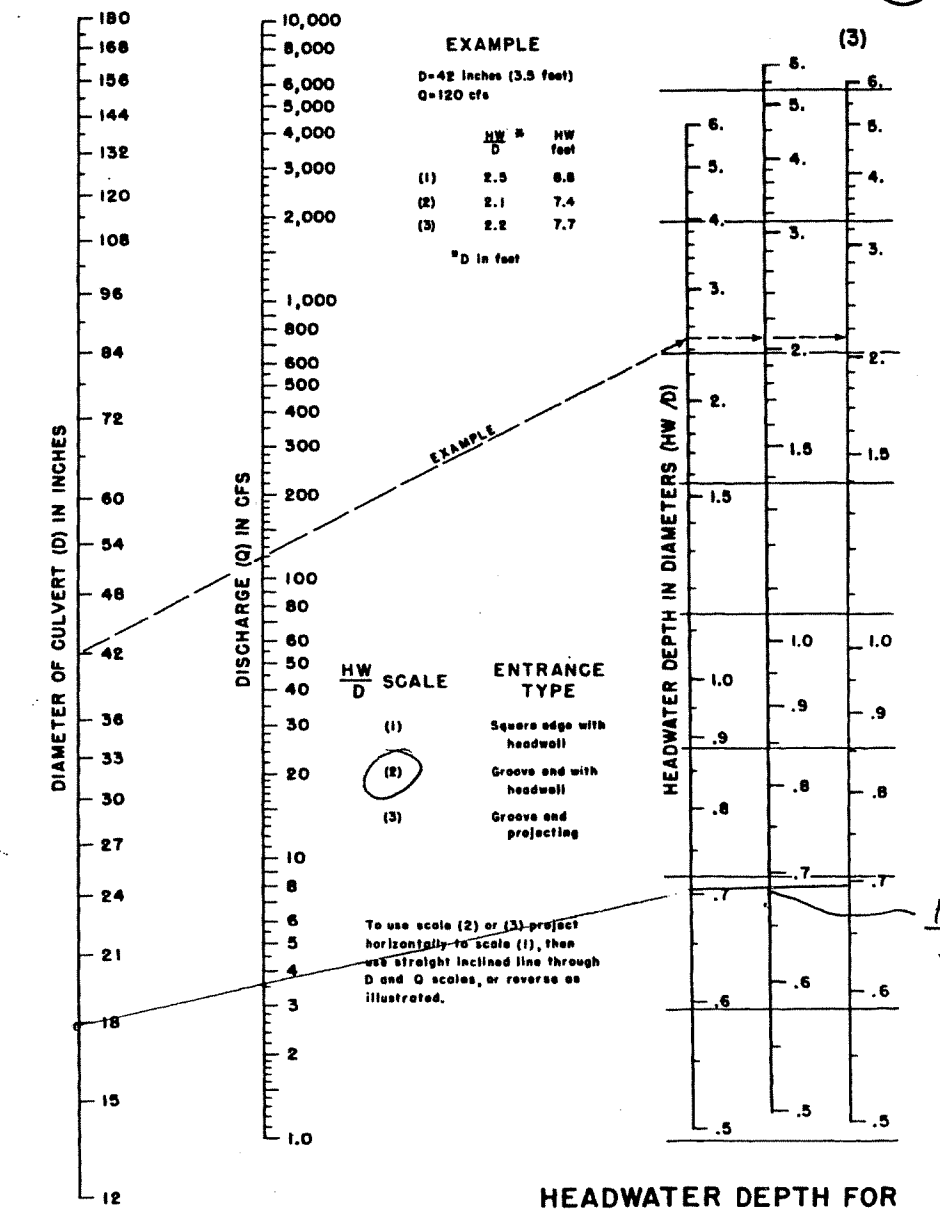
FL = 601.89

W.S. Elev. = 603.39

9' Type B-1 Curb Inlet

NODE 11

CHART 1B



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$Q_9 = 3.6$ CFS

$D = 1.5'$

$HW = 1.01'$

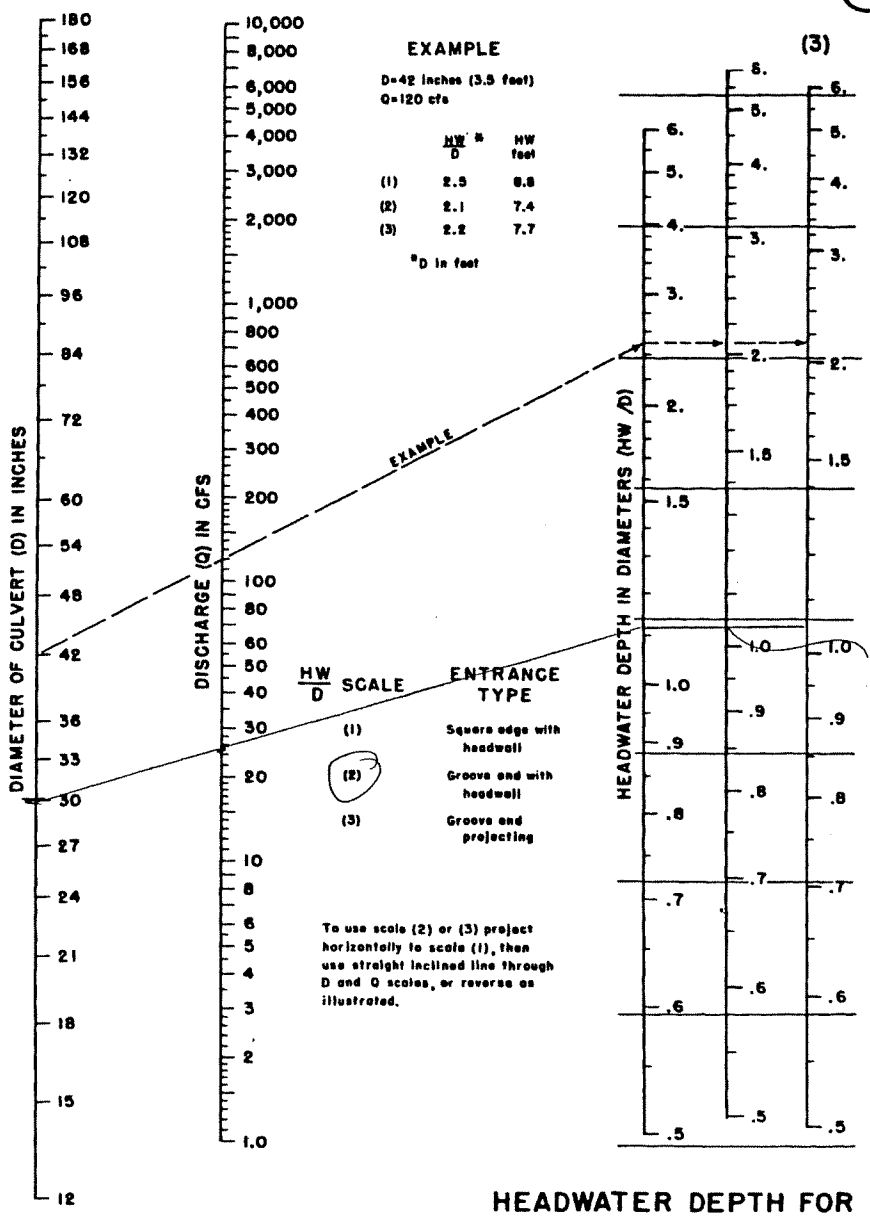
FL = 602.41

W.S. ELEV = 603.42

MOD. TYPE F C.B

NODE 13

CHART 1B



$\frac{Hw}{D} = 1.03$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$Q_{13} = 24.6$ CFS

D = 2.5'

Hw = 2.58

FL = 601.43

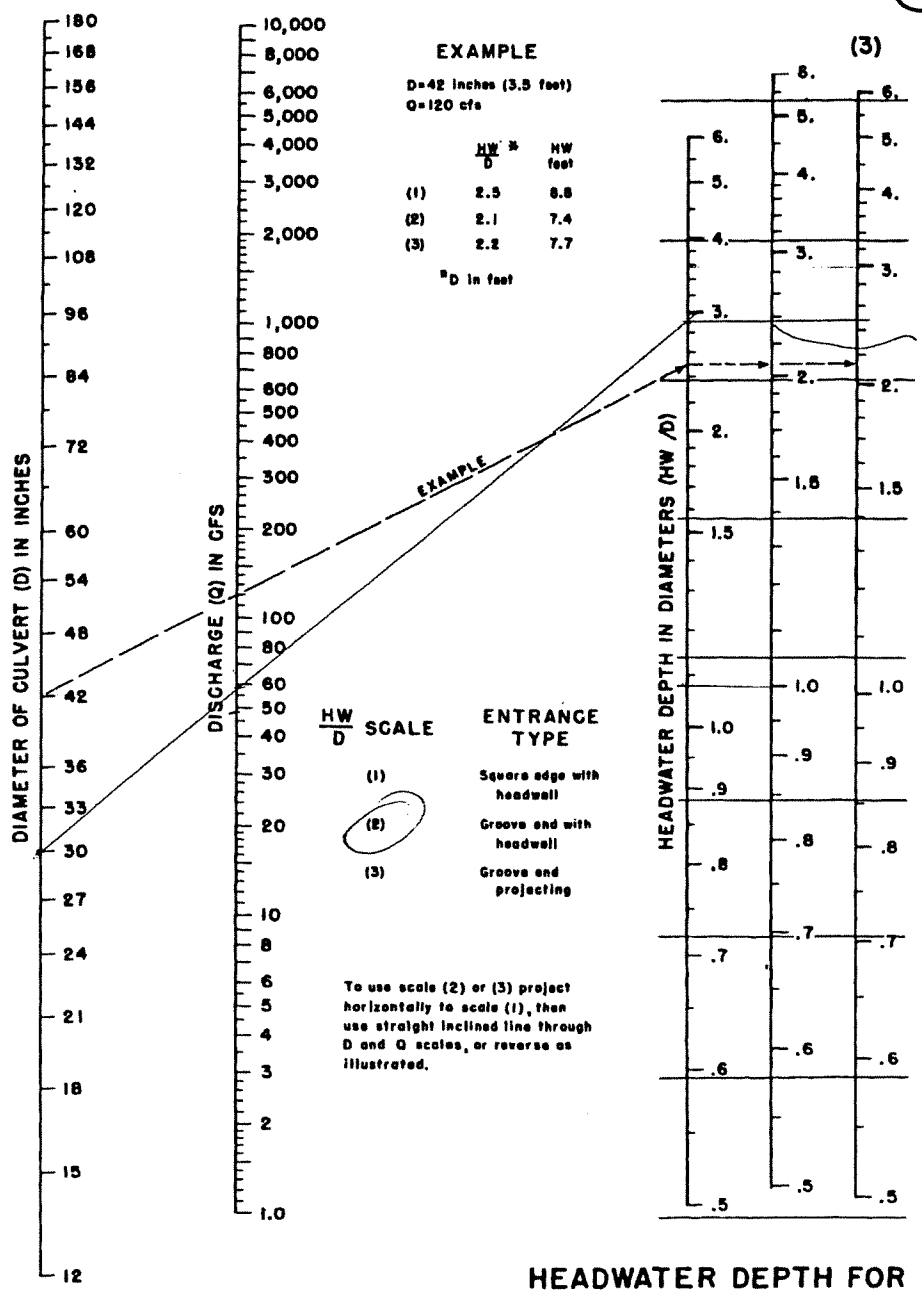
RIM = 605.4

wselev = 604.01

Type A-4 C.O.

Node 112

CHART 1B



$\frac{HW}{D} = 2.35$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

D = 2.5

HW = 5.9'

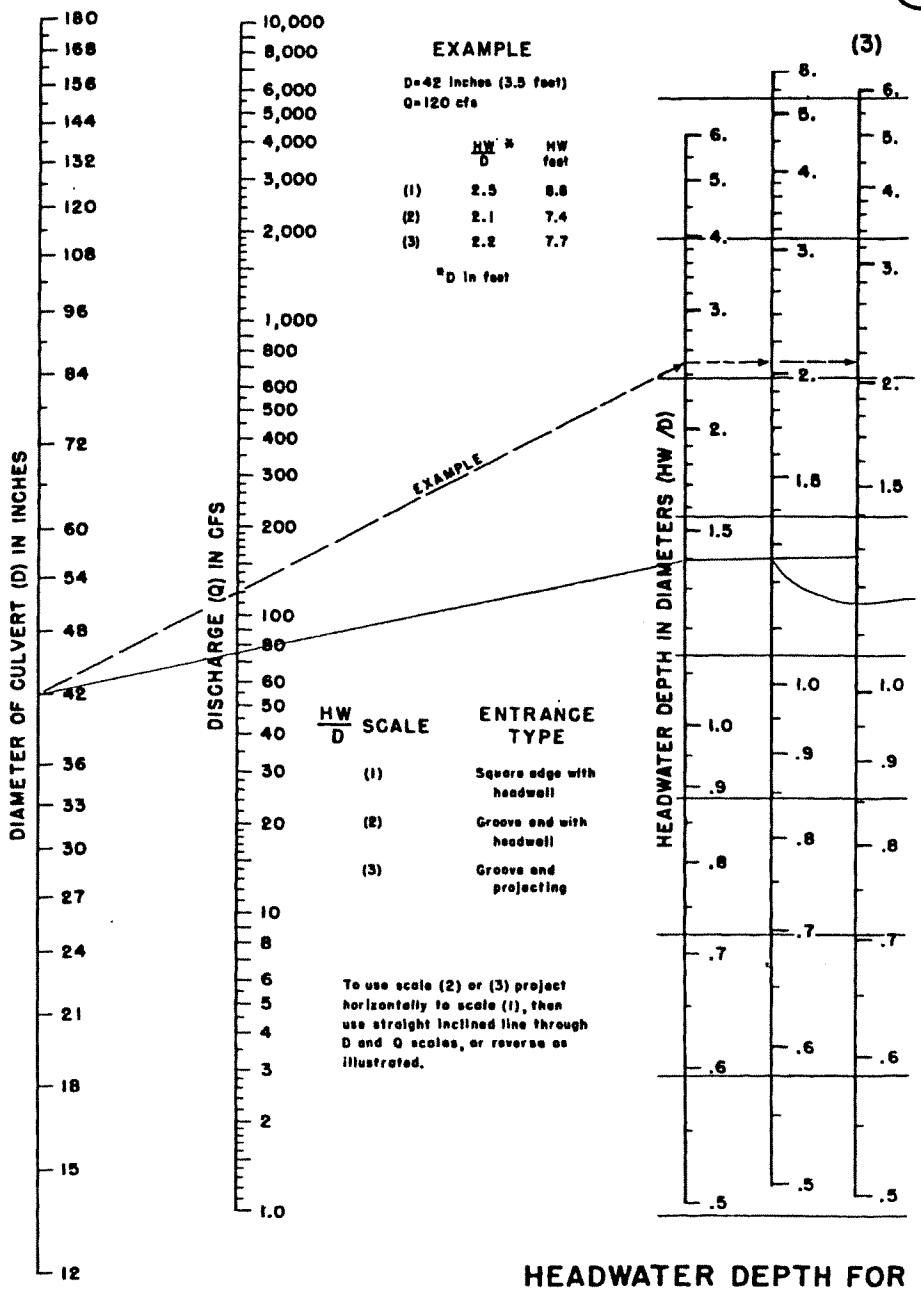
Q_{12} = 48.0 CFS

FL = 600.77

WS elev. = 606.67

Type A-4 C.O.
MODE [6]

CHART 1B



$1.26 = \frac{HW}{D}$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

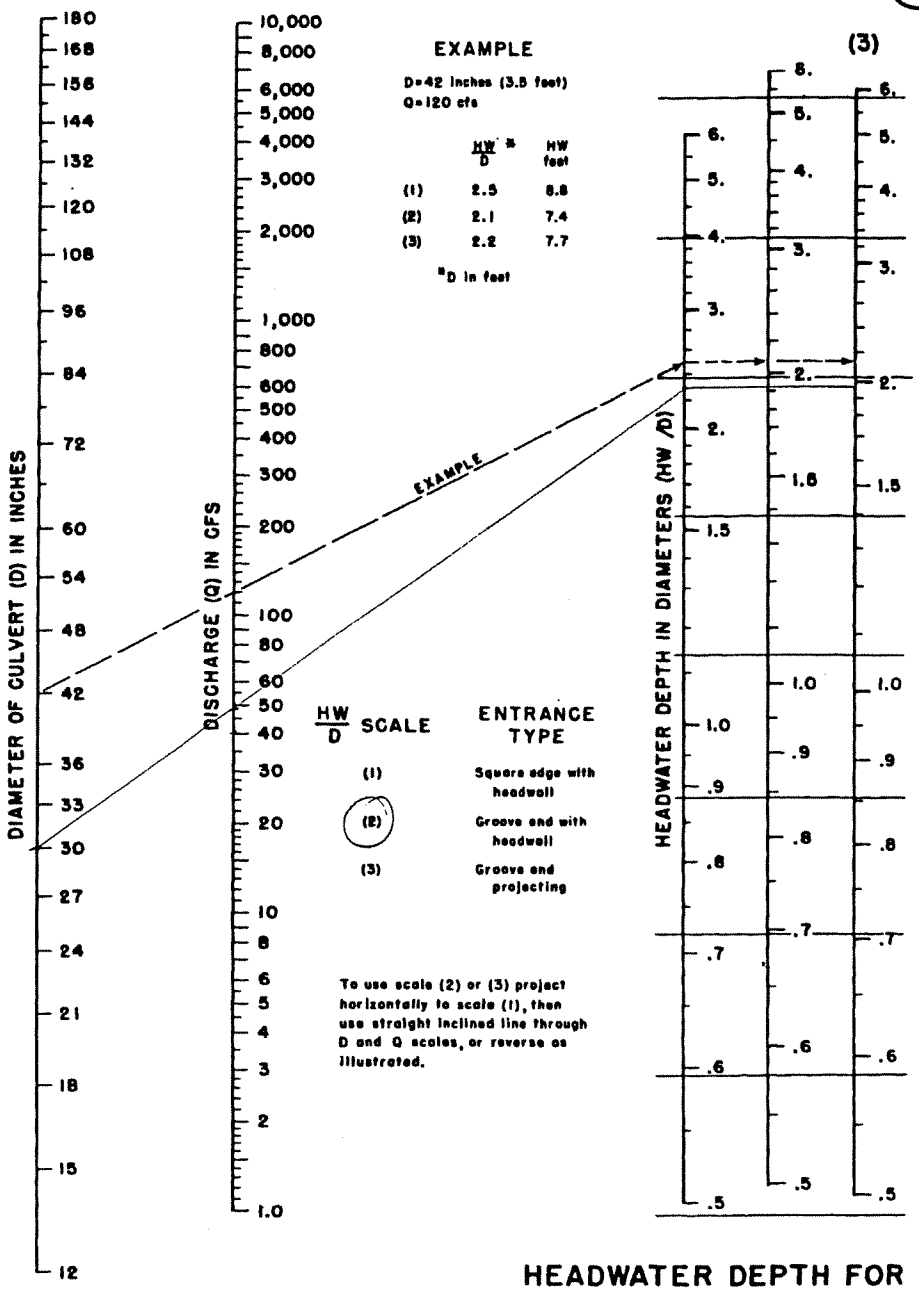
$Q_6 = 73.1$ CFS
$D = 3.5'$
$HW = 4.4'$

FL =
WSelev =

TYPE A-4 C.O.

Node 15

CHART 1B



HW/D = 1.91

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$\frac{HW}{D} = 1.91$ HW = 4.78' FL = 604.05

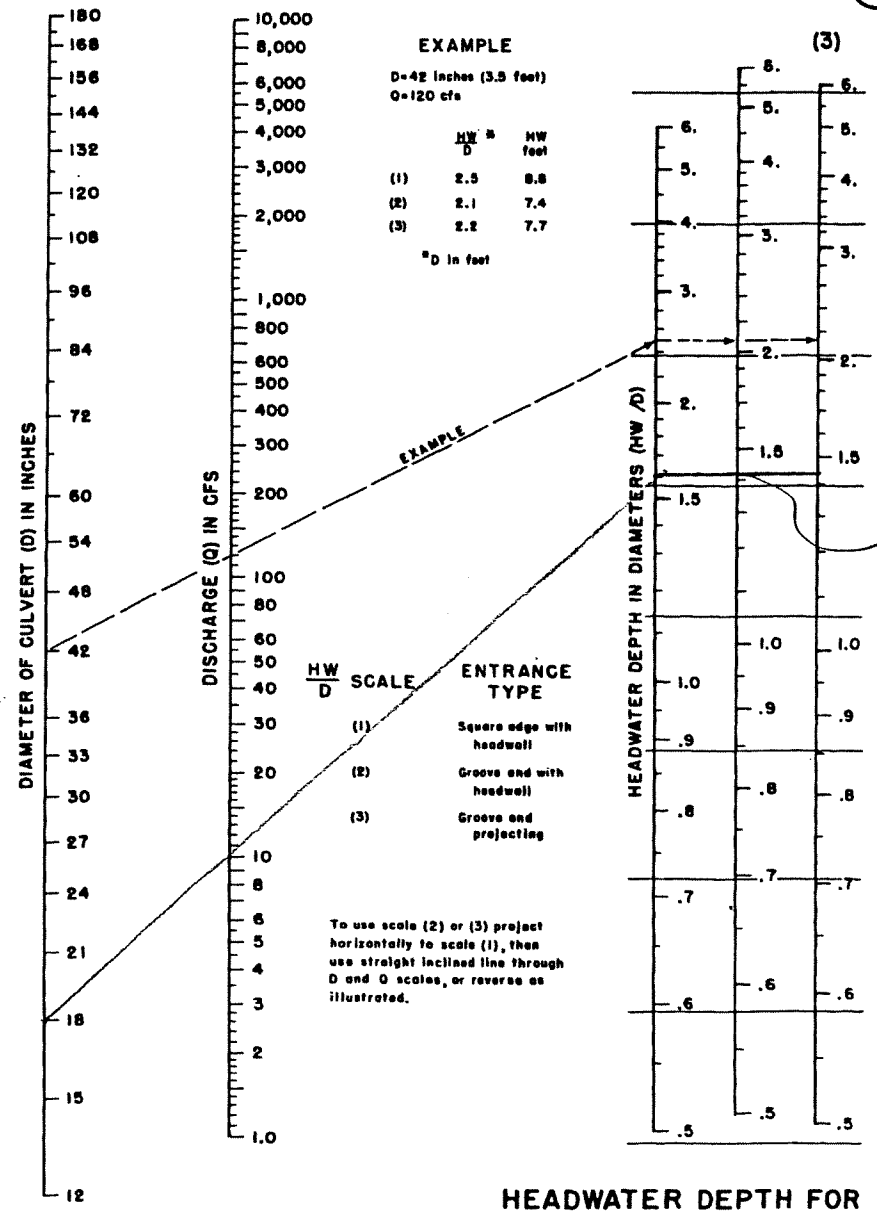
$WS_{elev} = 608.83$

$Q_{15} = 48.0$ CFS

15' Type B-1 Inlet

NODE 16

CHART 1B



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

D = 1.5'

HW = 2.13

Q_{16} = 10.2 CFS

FL = 608.39

WSelev = 610.52

18" RCP S.D. @ 7.0 %

NODES - 16 - 15

tmp#33.txt

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	18.0000 in
Flowrate	10.2000 cfs
Slope	0.0700 ft/ft
Manning's n	0.0130

Computed Results:

Depth	7.5462 in
Area	1.7671 ft2
Wetted Area	0.7026 ft2
Wetted Perimeter	25.3539 in
Perimeter	56.5487 in
Velocity	14.5168 fps
Hydraulic Radius	3.9907 in
Percent Full	41.9231 %
Full flow Flowrate	27.7919 cfs
Full flow velocity	15.7270 fps

Critical Information

Critical depth	15.4735 in
Critical slope	0.0071 ft/ft
Critical velocity	6.0257 fps
Critical area	1.6928 ft2
Critical perimeter	41.2213 in
Critical hydraulic radius	5.9134 in
Critical top width	18.0000 in
Specific energy	3.9038 ft
Minimum energy	1.9342 ft
Froude number	3.7147
Flow condition	Supercritical

Nodes 17-15 30" RCP S.D.

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	30.0000 in
Flowrate	37.8000 cfs
Slope	0.0314 ft/ft
Manning's n	0.0130

Computed Results:

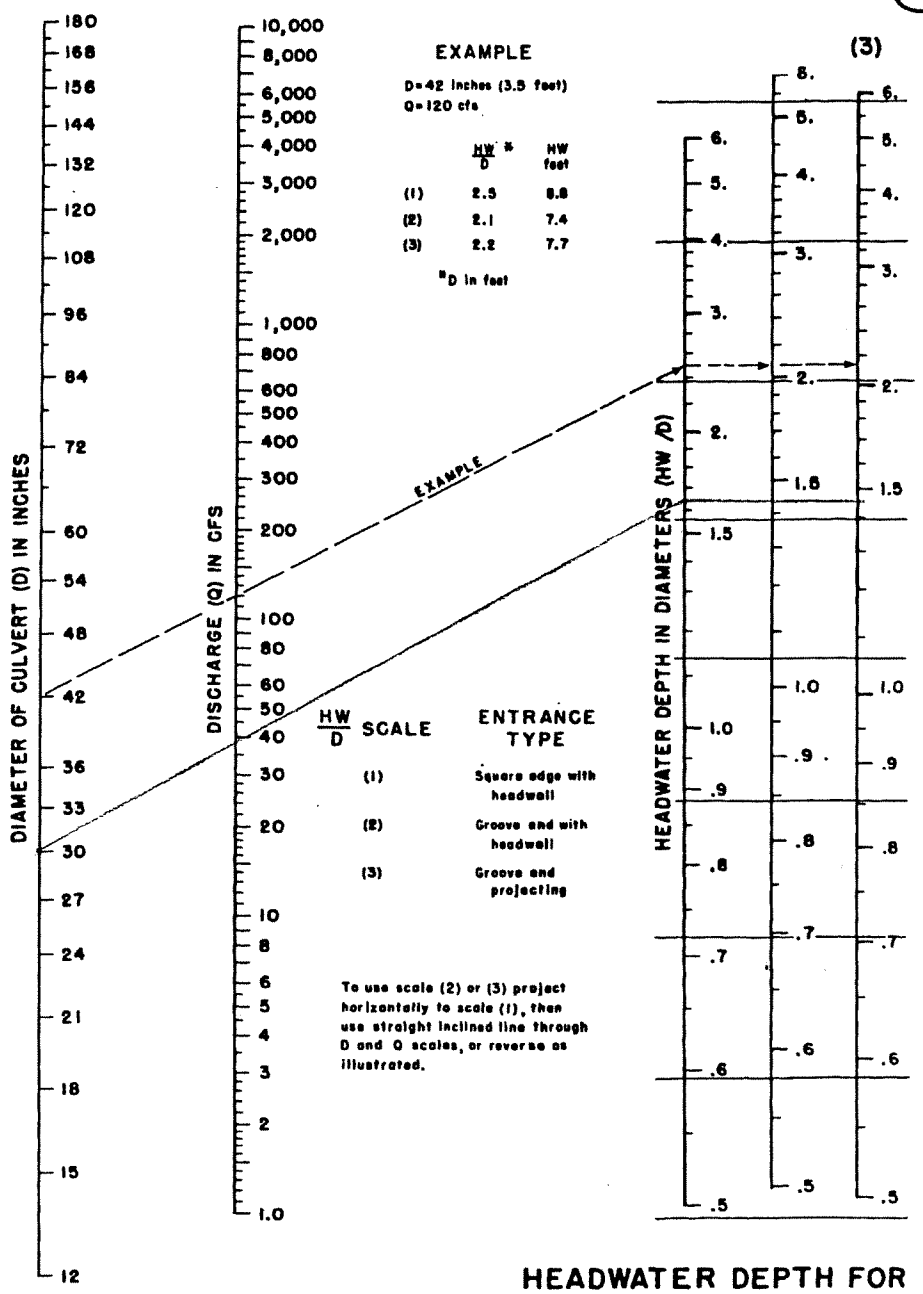
Depth	15.3536 in
Area	4.9087 ft2
Wetted Area	2.5280 ft2
Wetted Perimeter	47.8312 in
Perimeter	94.2478 in
Velocity	14.9523 fps
Hydraulic Radius	7.6109 in
Percent Full	51.1787 %
Full flow Flowrate	72.6826 cfs
Full flow velocity	14.8068 fps

Critical Information

Critical depth	26.2890 in
Critical slope	0.0061 ft/ft
Critical velocity	7.8648 fps
Critical area	4.8062 ft2
Critical perimeter	69.7019 in
Critical hydraulic radius	9.9294 in
Critical top width	30.0000 in
Specific energy	4.7539 ft
Minimum energy	3.2861 ft
Froude number	2.6214
Flow condition	Supercritical

Type A-4 C.O.
Node 17

CHART 1B



$\frac{Hw}{D} = 1.45$

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

$\frac{Hw}{D} = 1.45$ $Hw = 3.62'$ $FL = 613.47$ $Wselev = 617.09$

$Q_{17} = 37.8$ CFS

30" RCP S.D @ 8.8%

NODE 18-17

tmp#34.txt

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	30.0000 in
Flowrate	37.8000 cfs
Slope	0.0880 ft/ft
Manning's n	0.0130

Computed Results:

Depth	11.4808 in
Area	4.9087 ft2
Wetted Area	1.7280 ft2
Wetted Perimeter	40.0193 in
Perimeter	94.2478 in
Velocity	21.8752 fps
Hydraulic Radius	6.2178 in
Percent Full	38.2693 %
Full flow Flowrate	121.6765 cfs
Full flow velocity	24.7877 fps

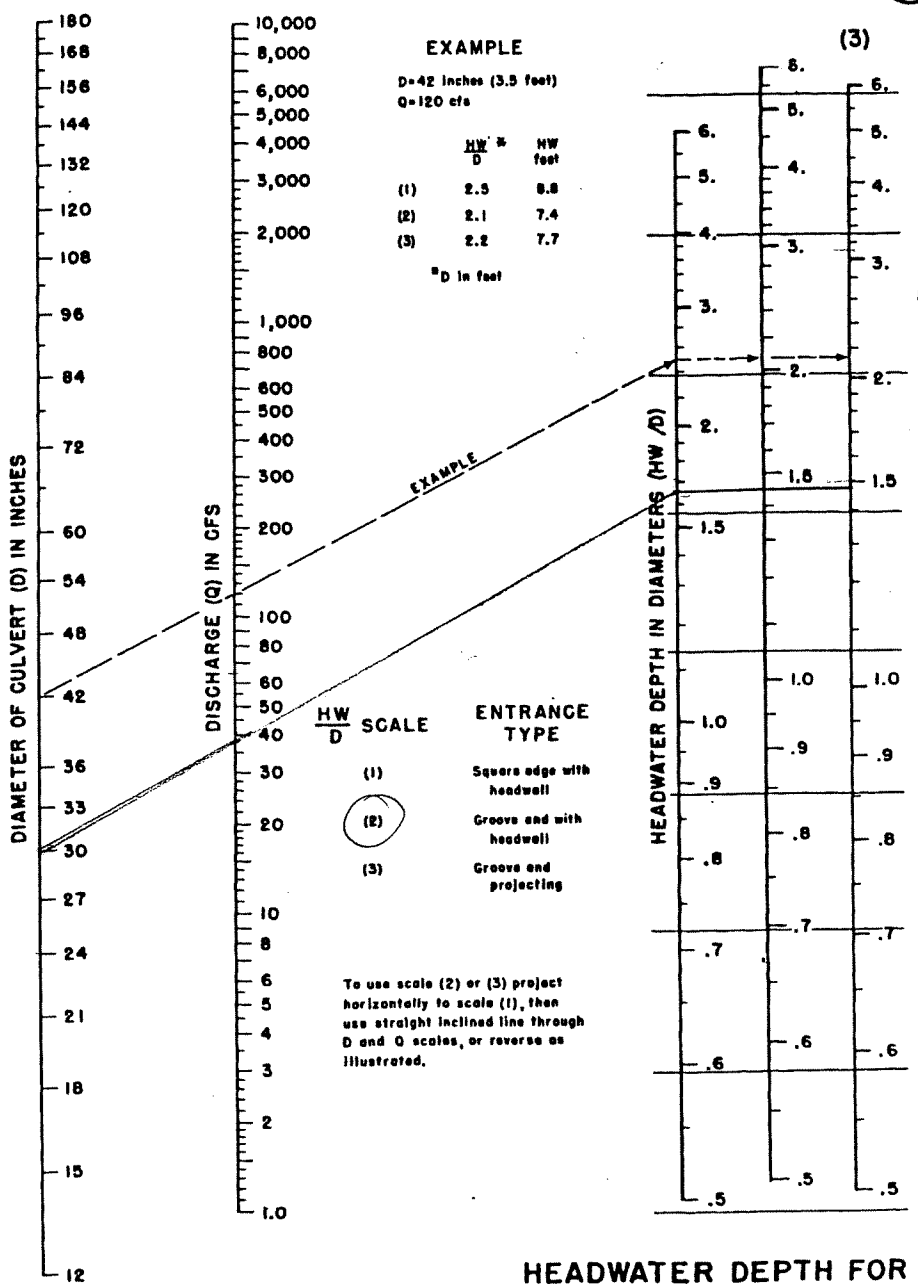
Critical Information

Critical depth	26.2890 in
Critical slope	0.0061 ft/ft
Critical velocity	7.8648 fps
Critical area	4.8062 ft2
Critical perimeter	69.7019 in
Critical hydraulic radius	9.9294 in
Critical top width	30.0000 in
Specific energy	8.3932 ft
Minimum energy	3.2861 ft
Froude number	4.5735
Flow condition	Supercritical

30" RCP SD - Basin L

Node [18]

CHART 1B



$\frac{HW}{D} = 1.45$

HEADWATER SCALES 283
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

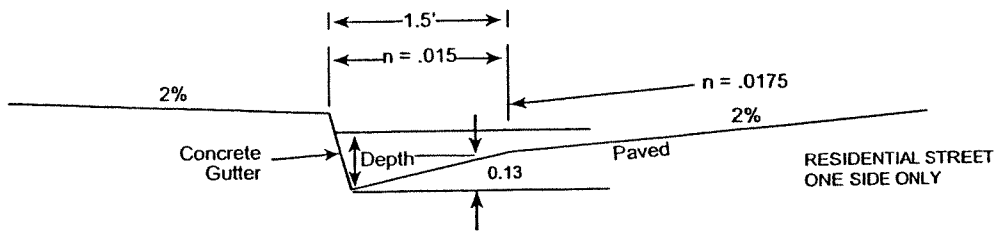
$\frac{HW}{D} = 1.45$, $HW = 3.62'$

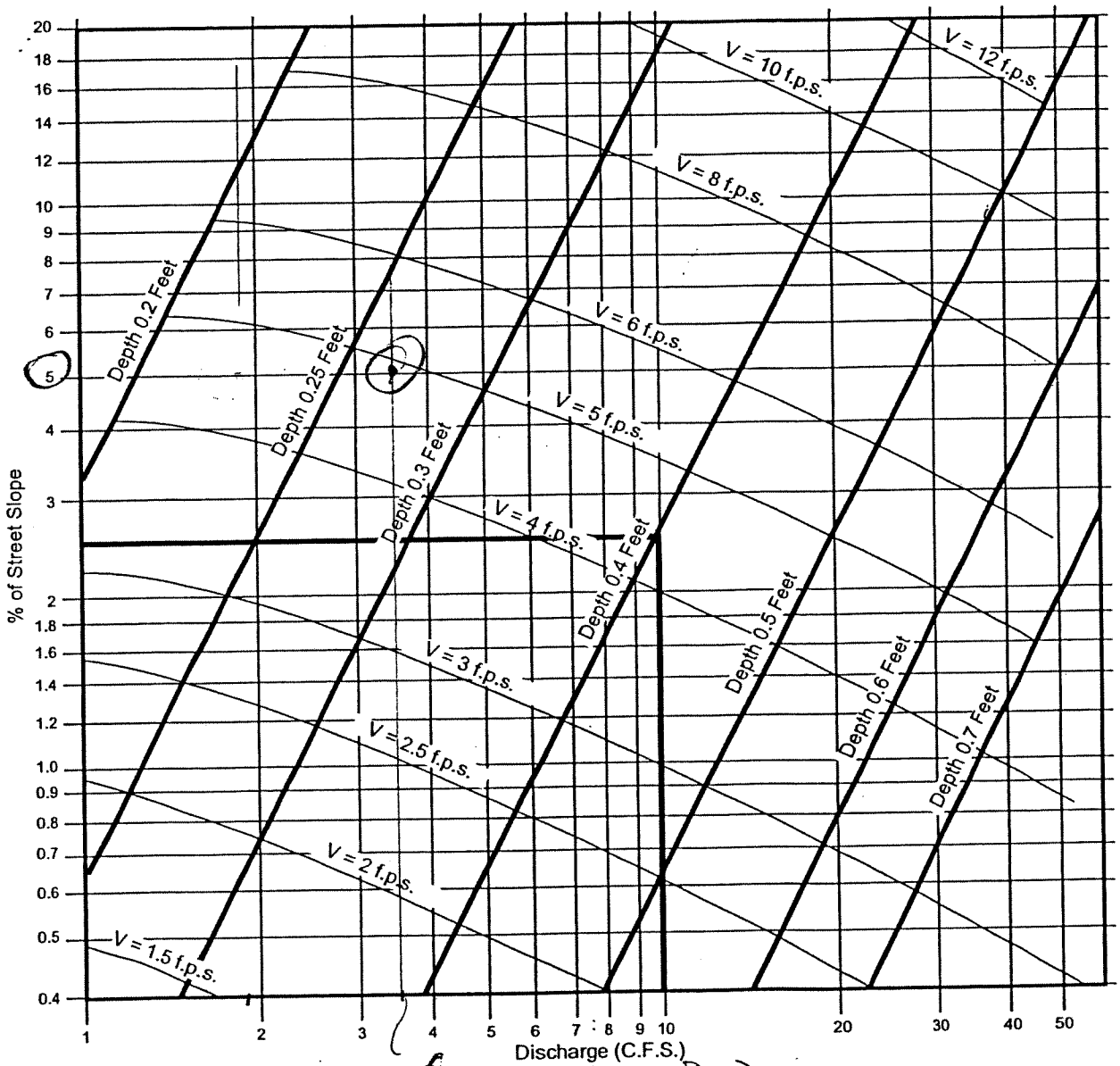
$FL = 615.37$

$Q_{18} = 37.8$ CFS

W.S. elev. $= 619.0'$

Basin D - Type G Curb & Gutter @ 5% ~650LF





$T_T = 2.2$

$V_{gutter} = 4.9$

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

$Q_{gutter} = 3.6$ CFS

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

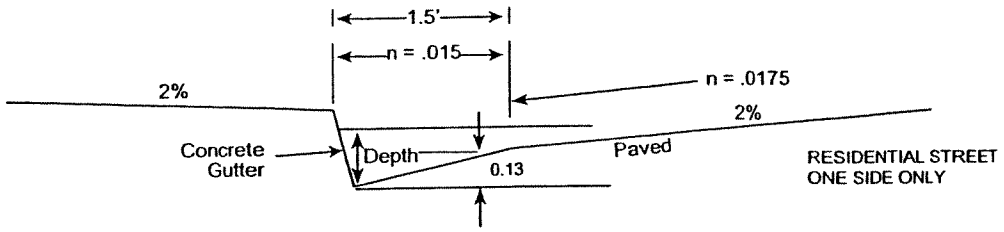
FIGURE

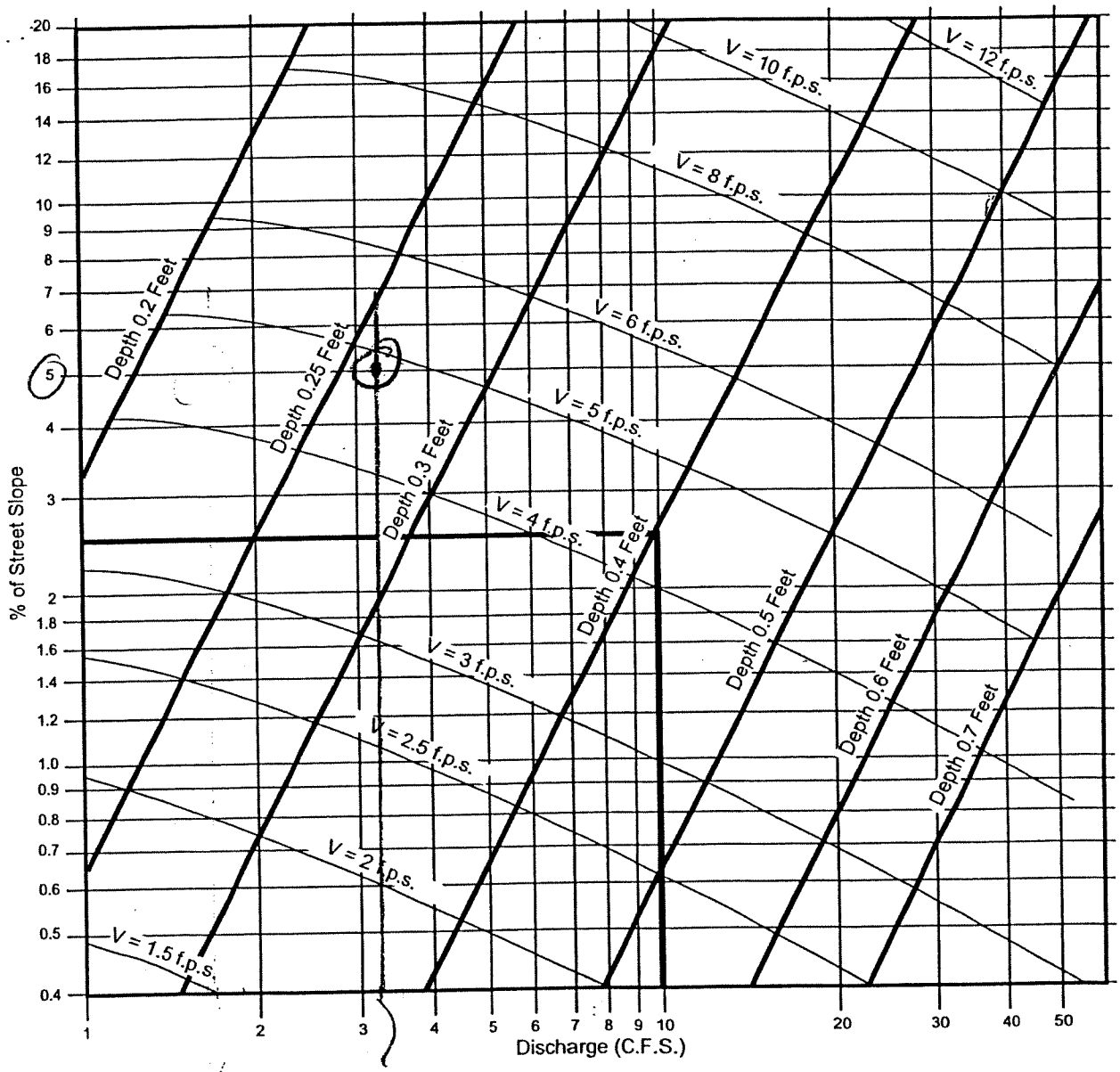
Gutter and Roadway Discharge - Velocity Chart

3-6

D = 0.26' ok

Basin E - Type G Curb & Gutter ~ 650 LF @ 5%





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

V = 4.8 FPS
Tt = 2.3 min
Qgutter = 3.2 CFS

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

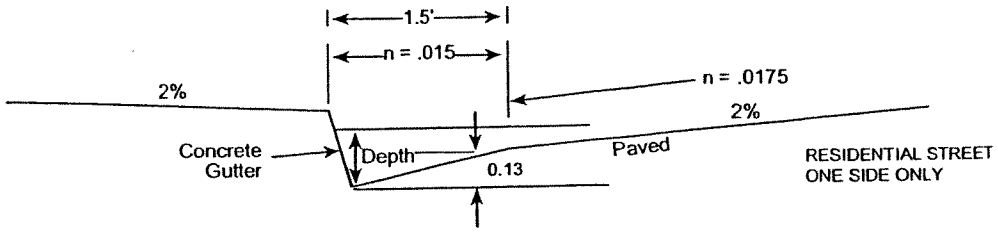
FIGURE

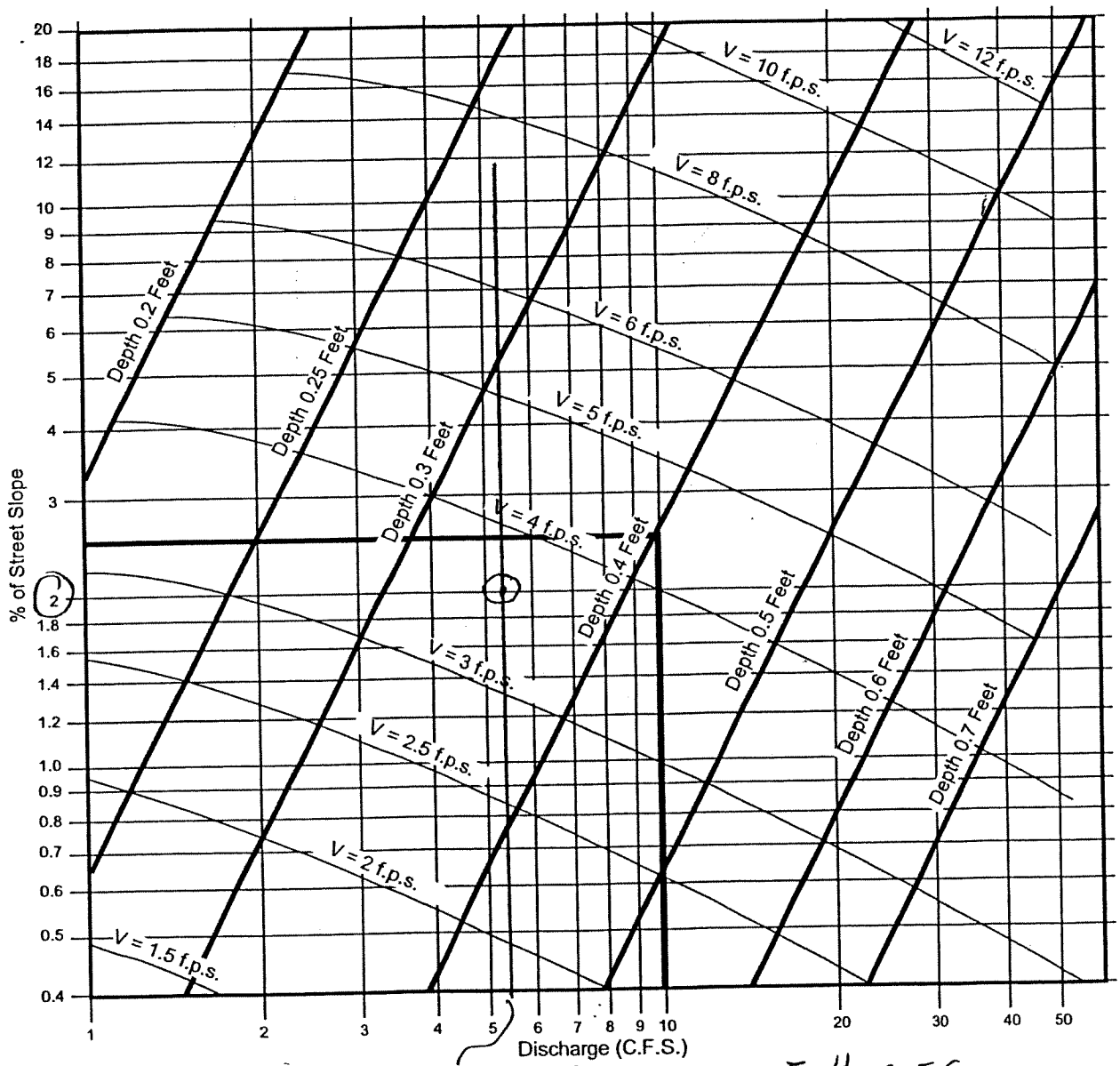
Gutter and Roadway Discharge - Velocity Chart

3-6

D = 0.26' OK

Basin H ~ Type G Curb & Gutter ~ 950 LF @ 2% avg.





5.4 Q_{gutter} = 5.4 CFS

V_{gutter} = 3.6 FPS

T_t = 4.4 min

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

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

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

D = 0.35'
ok

13 INLET CAPACITY

R.E.C. CONSULTANTS
2442 SECOND AVENUE
SAN DIEGO, CA 92101
619-232-9200

COUNTY OF SAN DIEGO
100 YEAR STORM - COUNTY OF SAN DIEGO
HYDROLOGY - HOMELAND ESTATES - INLETS

THE SITE HAS ONE MOD. TYPE B CURB INLET - AT A SAG

Q_{100}= 23.40 cfs BASINS ADDED: F,G,O,N

(Curb Inlet)
from chart 1-103.6C (City of San Diego Drainage Design Manual)

Q/L = 1.5 cfs/ft of clear opening (typ.)

L= 15.6 ft **Use 16' std. Type B inlet.**

THE SITE HAS TWO TYPE B CURB INLETS ON GRADE

(Curb Inlet 1 - NODE 11)
Q_{100}= 3.60 cfs BASINS ADDED: D

from chart 1-103.6A (City of San Diego Drainage Design Manual)

Q/L = 0.7*(0.77)^(3/2) cfs/ft of clear opening (typ.)

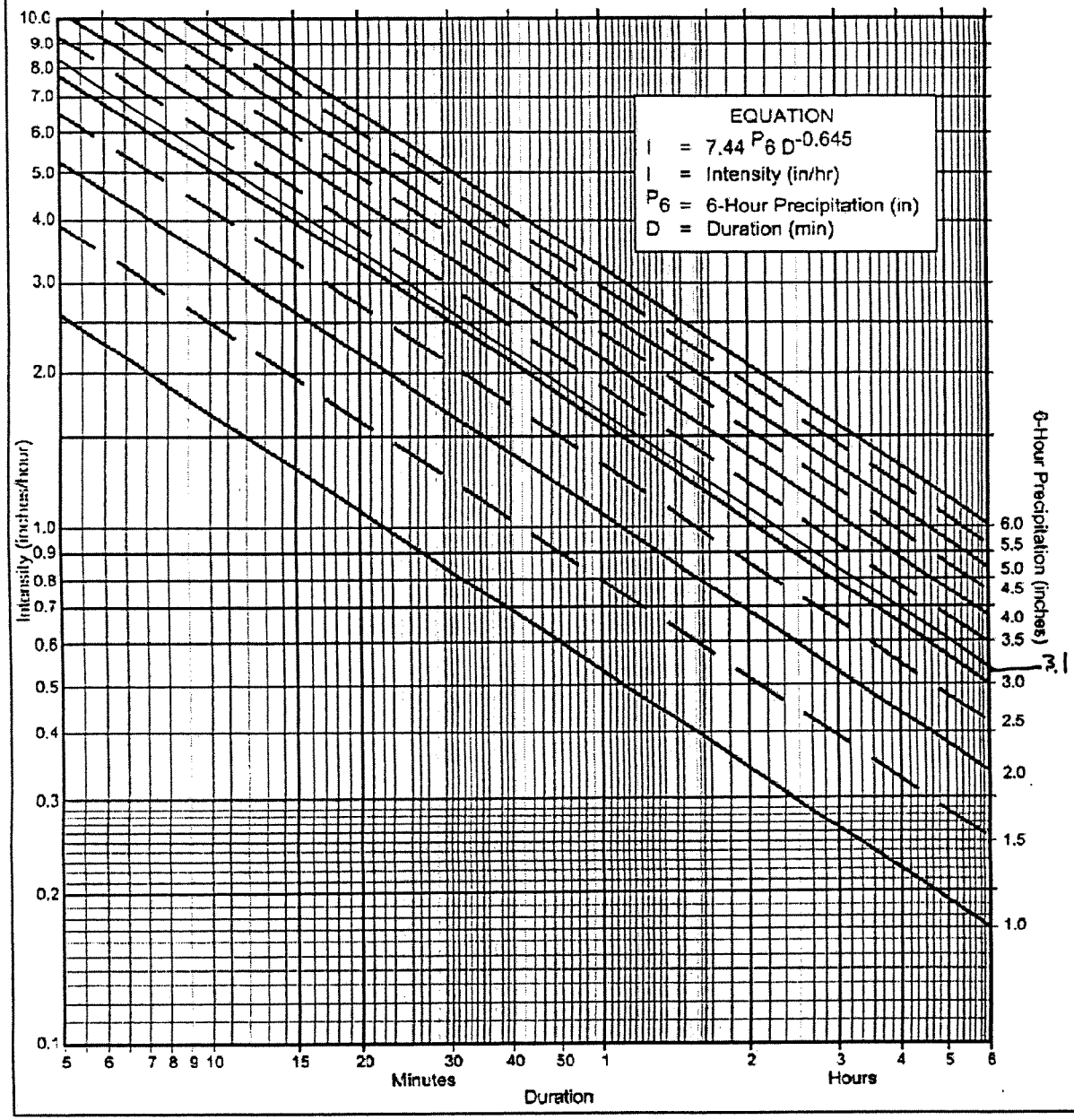
L= 7.6 ft **Use 8.0' Opening (Std. 8' Type B-1 inlet)**

(Curb Inlet 2 - NODE 8)
Q_{100}= 3.20 cfs BASINS ADDED: G,H,O

from chart 1-103.6C (City of San Diego Drainage Design Manual)

Q/L = 0.7*(0.77)^(3/2) cfs/ft of clear opening (typ.)

L= 6.8 ft **Use 7.0' Opening (Std. 8' Type B-1 inlet)**



Directions for Application:

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

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

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

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

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

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 3.1 in., P_{24} = 5.6, $\frac{P_6}{P_{24}}$ = 55 %(2)

(c) Adjusted P_6(2) = 3.1 in.

(d) I_x = _____ min.

(e) I = _____ in./hr.

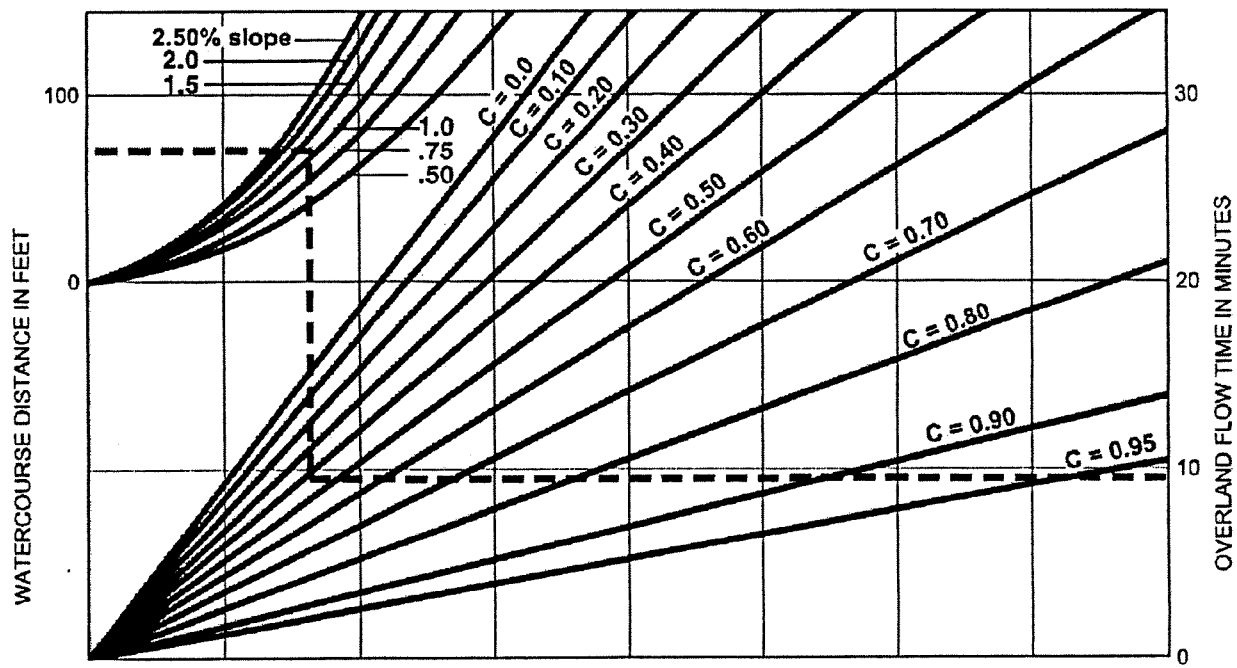
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6 / Duration	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
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



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

3-3

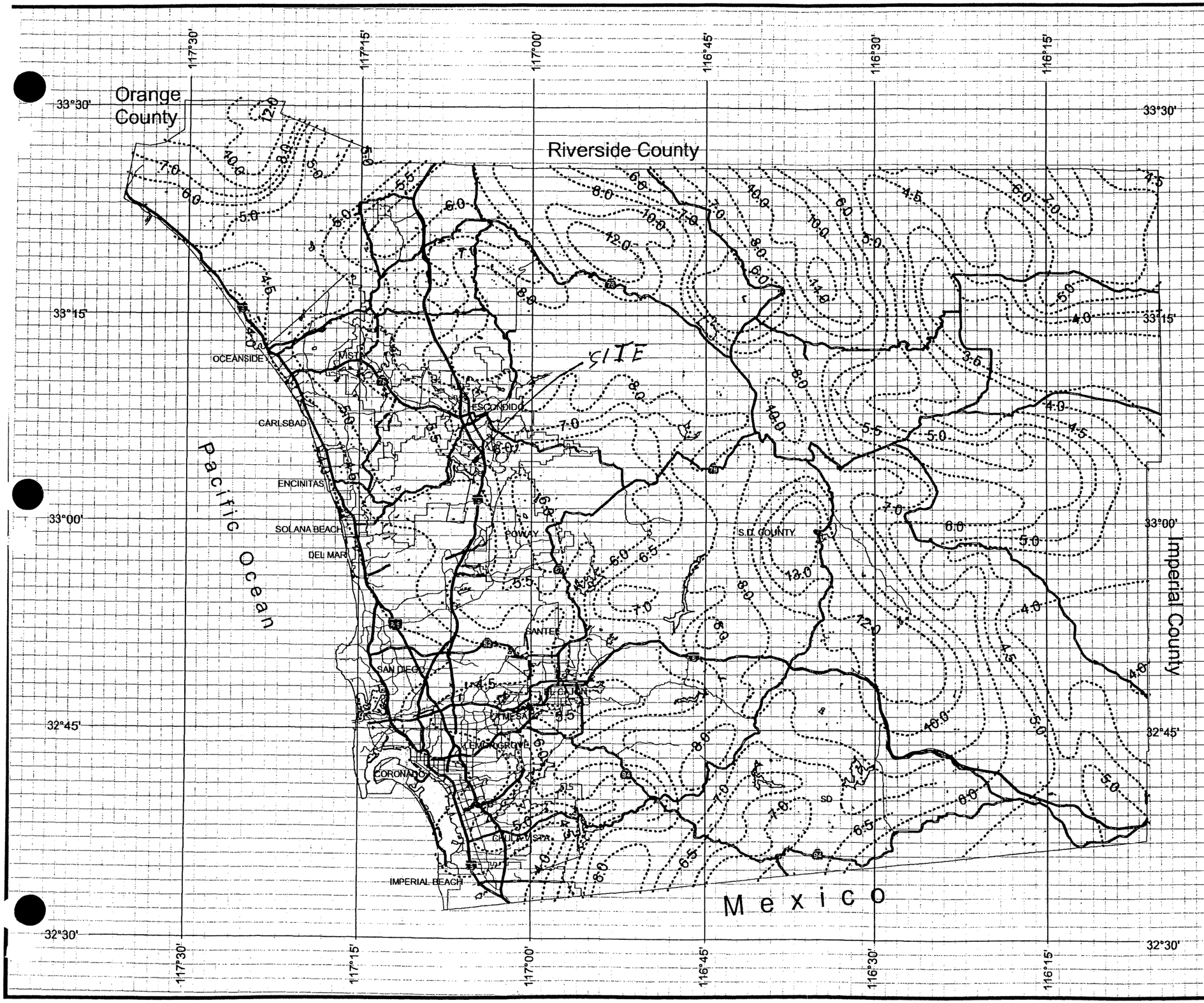
Rational Formula - Overland Time of Flow Nomograph

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)



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N
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S

3 0 3 Miles

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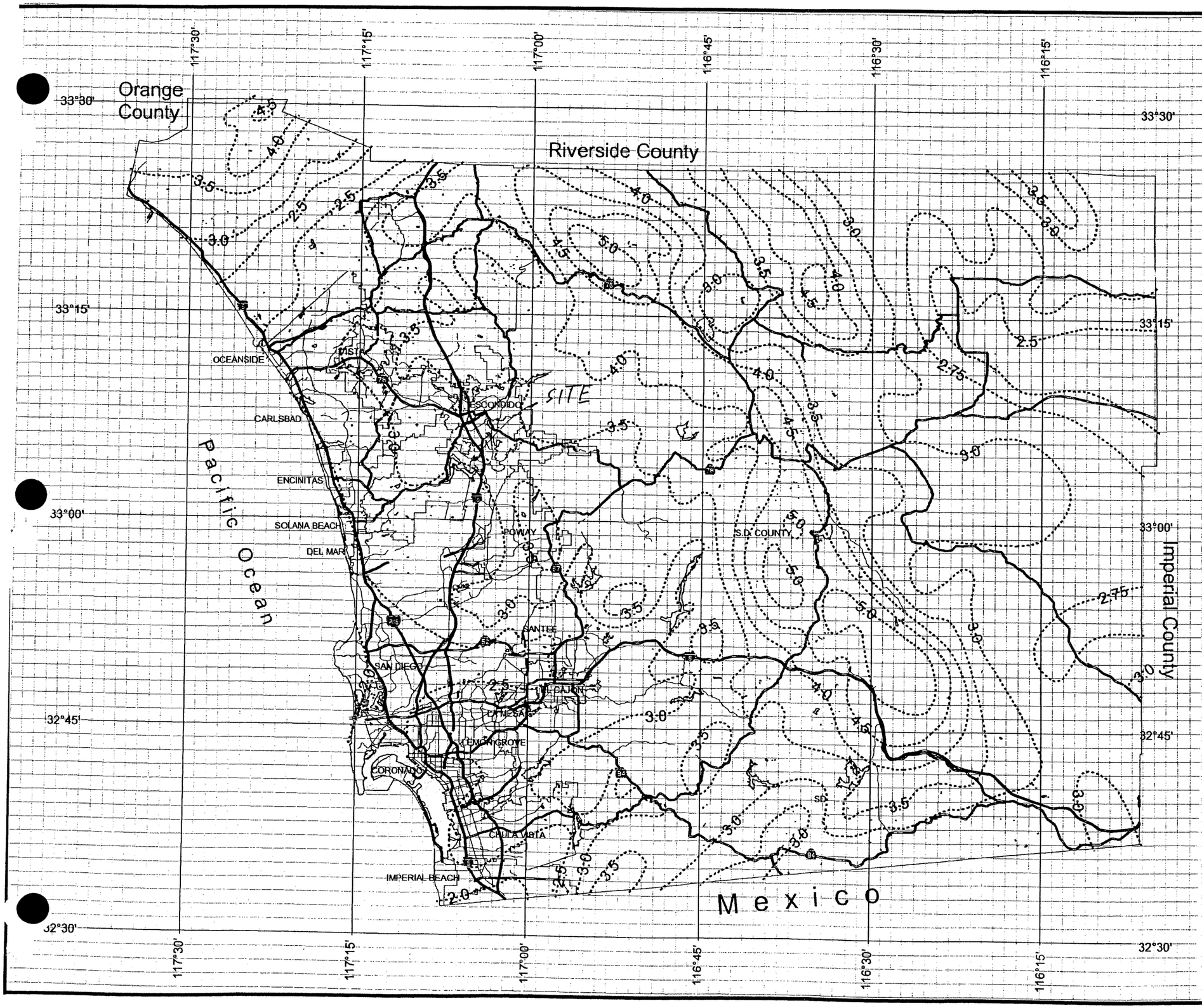
County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)



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3 0 3 Miles

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

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

values will be used for the MRM calculations. After the independent drainage systems have been combined, RM calculations are continued to the next point of interest.

3.4.2 Procedure for Combining Independent Drainage Systems at a Junction

Calculate the peak Q, T_c, and I for each of the independent drainage systems at the point of the junction. These values will be used for the MRM calculations.

At the junction of two or more independent drainage systems, the respective peak flows are combined to obtain the maximum flow out of the junction at T_c. Based on the approximation that total runoff increases directly in proportion to time, a general equation may be written to determine the maximum Q and its corresponding T_c using the peak Q, T_c, and I for each of the independent drainage systems at the point immediately before the junction. The general equation requires that contributing Q's be numbered in order of increasing T_c.

Let Q_1, T_1, and I_1 correspond to the tributary area with the shortest T_c. Likewise, let Q_2, T_2, and I_2 correspond to the tributary area with the next longer T_c; Q_3, T_3, and I_3 correspond to the tributary area with the next longer T_c; and so on. When only two independent drainage systems are combined, leave Q_3, T_3, and I_3 out of the equation. Combine the independent drainage systems using the junction equation below:

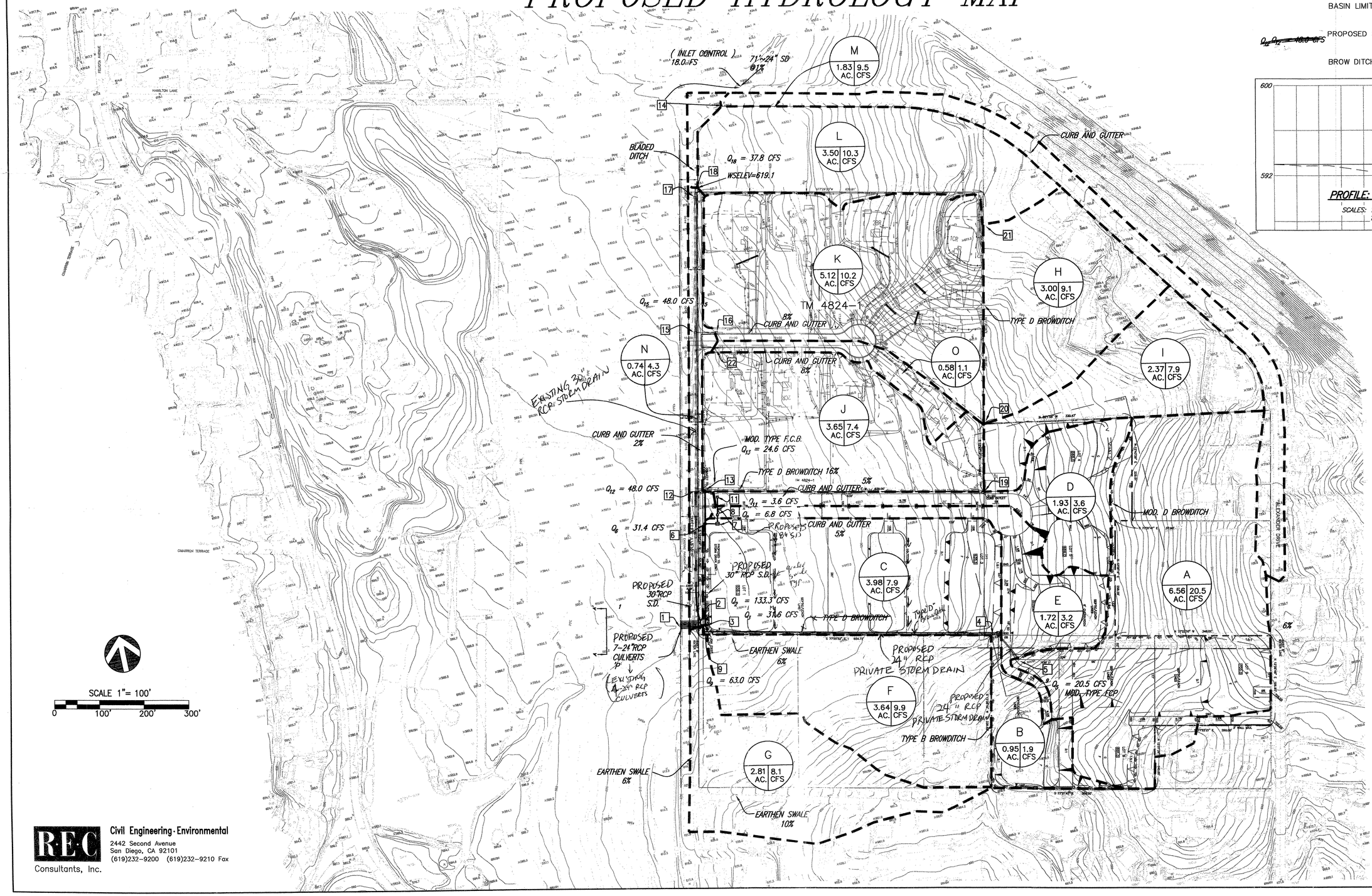
Junction Equation: $T_1 < T_2 < T_3$

$$Q_{T1} = Q_1 + \frac{T_1}{T_2} Q_2 + \frac{T_1}{T_3} Q_3$$

$$Q_{T2} = Q_2 + \frac{I_2}{I_1} Q_1 + \frac{T_2}{T_3} Q_3$$

$$Q_{T3} = Q_3 + \frac{I_3}{I_1} Q_1 + \frac{I_3}{I_2} Q_2$$

COUNTY OF SAN DIEGO TRACT 5362
HOMELAND ESTATES
PROPOSED HYDROLOGY MAP



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SHEET 1 OF 1

COUNTY TRACT 5362, HYDROLOGY MAP

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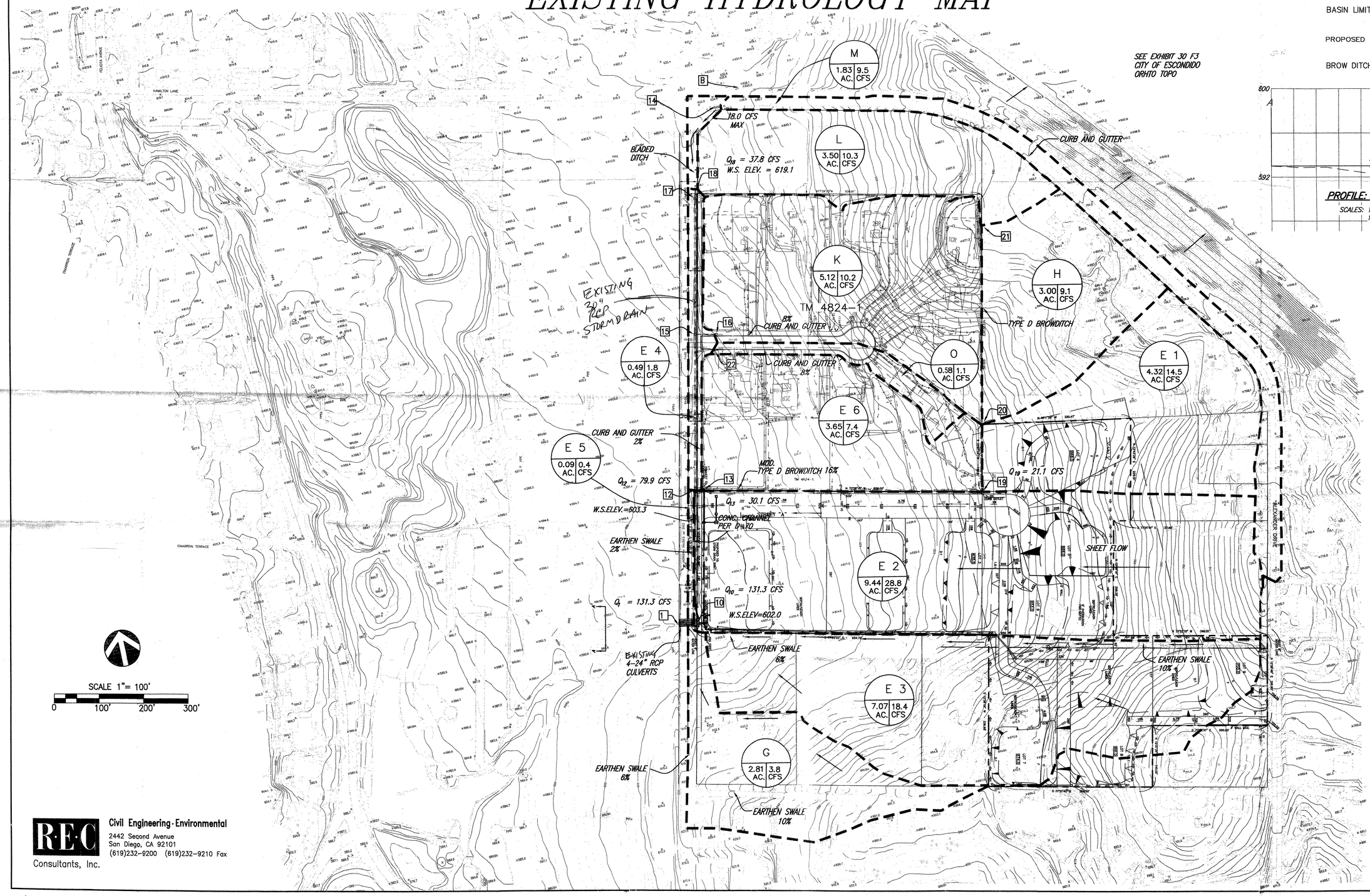
COUNTY OF SAN DIEGO TRACT 5362
HOMELAND ESTATES
EXISTING HYDROLOGY MAP



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COUNTY TRACT 5362, HYDROLOGY MAP

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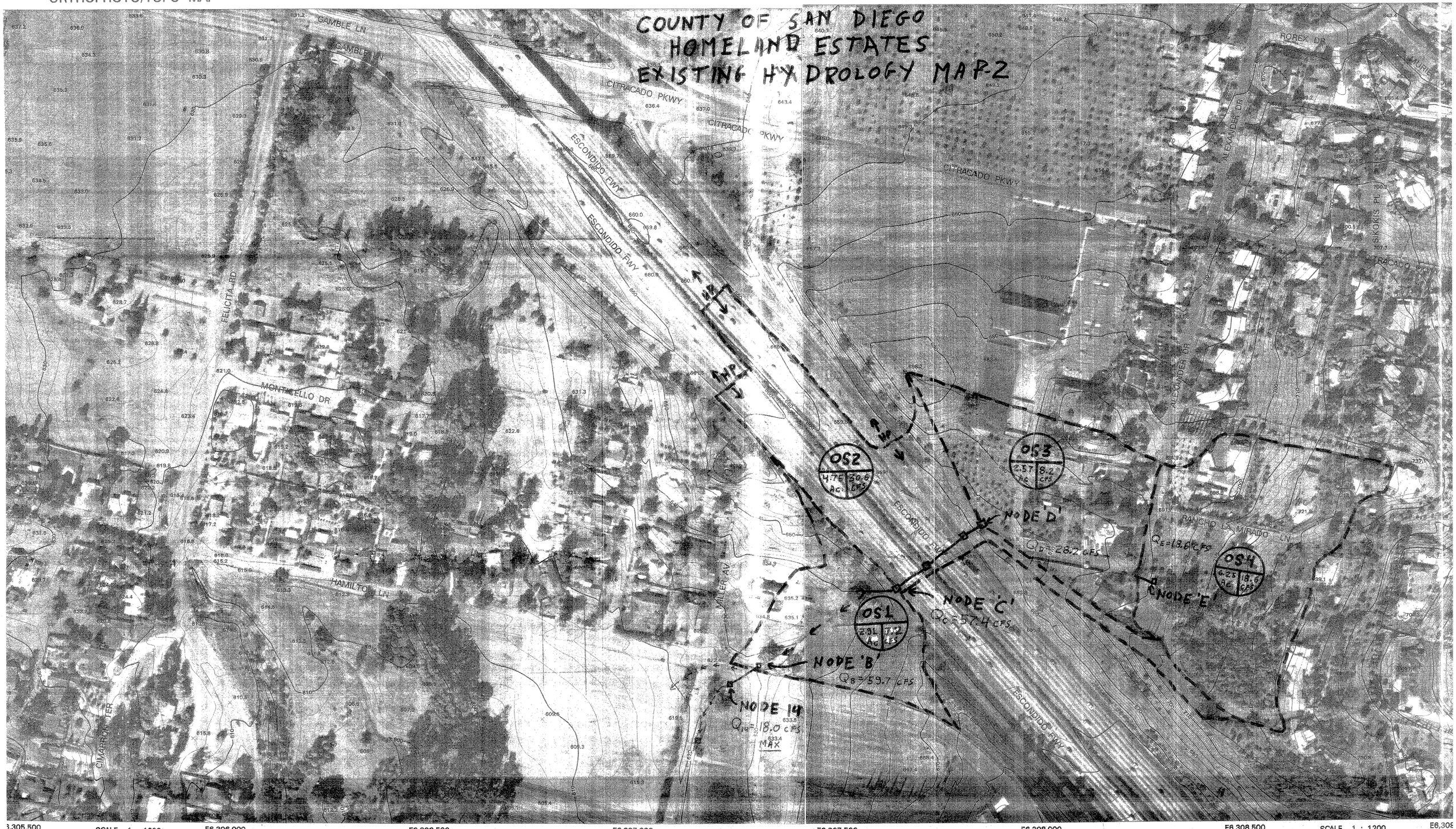
CITY OF ESCONDIDO
ORTHOPHOTO/TOPO MAP

COUNTY OF SAN DIEGO
HOMELAND ESTATES
EXISTING HYDROLOGY MAP-2



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SCALE 1 : 1200

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CONTOUR INTERVAL 2 FEET
SOUTH AND WEST SHEET MARGIN COORDINATES
ON CALIFORNIA STATE PLANE COORDINATE SYSTEM
NAD 1983

INDEX TO ADJOINING SHEETS

1978-6301	1978-6304	1978-6307
1976-6301	1976-6304	1976-6307
1974-6301	1974-6304	1974-6307

CITY OF ESCONDIDO
STATE OF CALIFORNIA

SHEET 2 OF 2

SCALE 1 : 1200

100 50 0 100 200

CONTOUR INTERVAL 2 FEET
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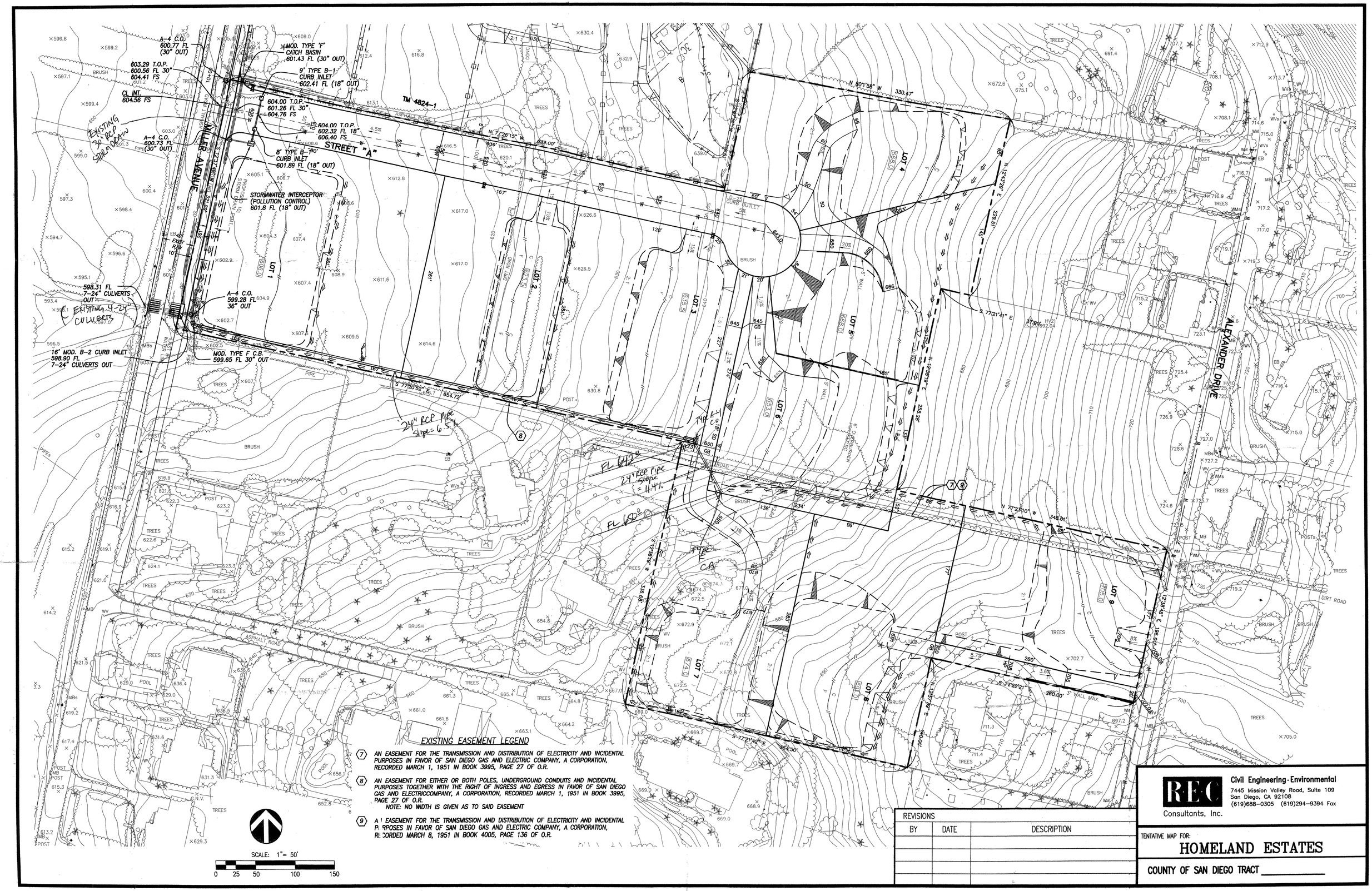
ON CALIFORNIA STATE PLANE COORDINATE S
NAD 1983

16 HYDRAULICS EXHIBIT/ SOILS MAP:(POCKET)



EXISTING EASEMENT LEGEND

(7) AN EASEMENT FOR THE TRANSMISSION AND DISTRIBUTION OF ELECTRICITY AND INCIDENTAL PURPOSES IN FAVOR OF SAN DIEGO GAS AND ELECTRIC COMPANY, A CORPORATION, RECORDED MARCH 1, 1951 IN BOOK 3995, PAGE 27 OF O.R.

(8) AN EASEMENT FOR EITHER OR BOTH POLES, UNDERGROUND CONDUITS AND INCIDENTAL PURPOSES TOGETHER WITH THE RIGHT OF INGRESS AND EGRESS IN FAVOR OF SAN DIEGO GAS AND ELECTRICCOMPANY, A CORPORATION, RECORDED MARCH 1, 1951 IN BOOK 3995, PAGE 27 OF O.R.
NOTE: NO WIDTH IS GIVEN AS TO SAID EASEMENT

(9) AN EASEMENT FOR THE TRANSMISSION AND DISTRIBUTION OF ELECTRICITY AND INCIDENTAL PURPOSES IN FAVOR OF SAN DIEGO GAS AND ELECTRIC COMPANY, A CORPORATION, RECORDED MARCH 8, 1951 IN BOOK 4005, PAGE 136 OF O.R.

REVISIONS		
BY	DATE	DESCRIPTION

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San Diego, CA 92108
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TENTATIVE MAP FOR:

HOMELAND ESTATES

COUNTY OF SAN DIEGO TRACT _____

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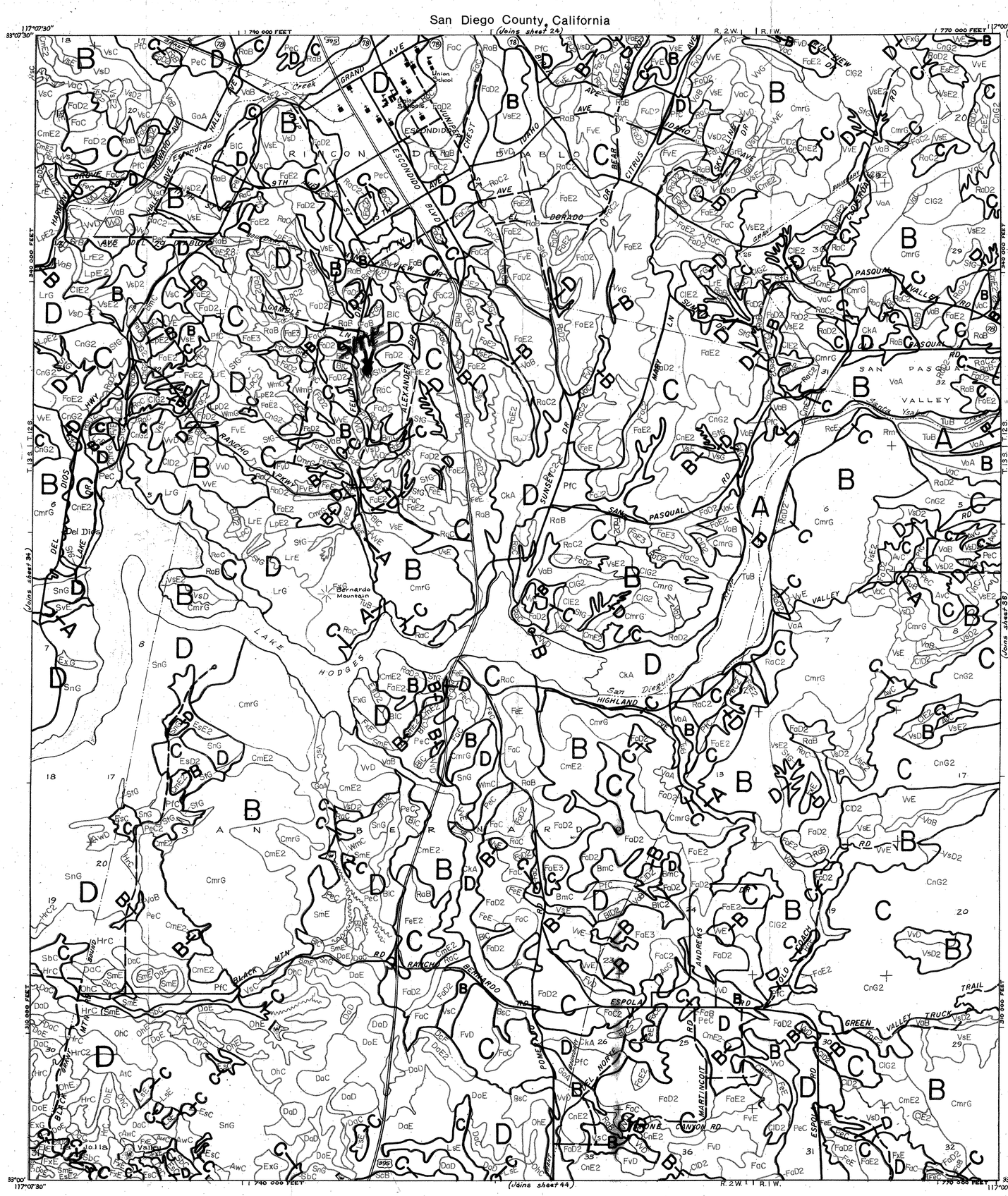
Escondido

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

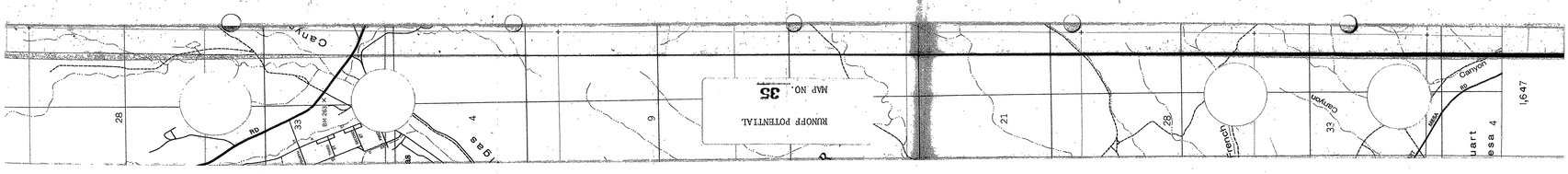
North

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.

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