PRELIMINARY DRAINAGE STUDY

FOR

PFISTER RESIDENCE

APN: 357-182-06 & 07

PREPARED BY:

SOWARDS AND BROWN ENGINEERING, INC.
CONSULTING ENGINEERS
2187 NEWCASTLE AVENUE, SUITE 103, CARDIFF, CA 92007
(760) 436-8500

20-021
3/19/21

PFISTER RESIDENCE

DRAINAGE STUDY FOR:

LOTS 15 AND 16 IN LBODK 34 OF LA JOLLA HERMOSA UNIT NO. 2, IN THE CITY OF SAN DIEGO, COUNTY OF SAN DIEGO, STATE OF CALIFORNIA ACCORDING TO MAP THEREOF NO. 2055, FILED IN THE OFFICE OF THE COUNTY RECORDER OF SAN DIEGO COUNTY SEPTEMBER 15, 1927.

APN: 357-182-06 & 07

CRITERIA:

1. USE THE CURRENT COUNTY OF SAN DIEGO HYDROLOGY MANUAL "RATIONAL METHOD".

2. DESIGN FOR A 100-YEAR FREQUENCY STORM USING THE COUNTY OF SAN DIEGO 6 HOUR AND 24 HOUR PRECIPITATION ISOPLUVIALS, AND THE INTENSITY-DURATION FORMULA. SEE ATTACHED MAPS.

3. RUNOFF COEFFICIENT FACTORS HAVE BEEN WEIGHTED BASED ON THE INDIVIDUAL "C" FACTORS FOR DIFFERENT SURFACES (I.E. CONCRETE=0.90), AND THE AREAS OF THE INDIVIDUAL SURFACES. OFFSITE RUNOFF COEFFICIENTS ARE BASED ON HIGH DENSITY RESIDENTIAL (24.0 DU/AC OR LESS) COEFFICIENTS PER TABLE 3-1.

4. RUNOFF COEFFICIENT FOR PERVIOUS SURFACES (LANDSCAPING AND PERVIOUS PAVERS) ARE BASED ON SOIL TYPE "D" BASED ON SITE LOCATION AND THE USDA WEB SOIL SURVEY WEBSITE AND TABLE 3-1. SEE ATTACHED USDA REPORT.

5. TIMES OF CONCENTRATION (TC) ARE DETERMINED FROM THE URBAN OVERLAND NATURAL WATERSHED FLOW FORMULAS.

6. REFER TO THE ATTACHED DRAINAGE MAPS FOR BASIN AREAS AND LOCATIONS.

SITE SPECIFIC:

1. THE PROJECT PROPOSES TO MERGE THE TWO LOTS, REMOVE THE EXISTING RESIDENCE ON LOT 16 AND BUILD A NEW RESIDENCE ON THE MERGED LOT.

2. CURRENTLY THE SITE DRAINS SOUTHERLY DOWN STEEP SLOPES TO FOLSOM DRIVE. LOT 15 IS EMPTY AND LOT 16 HAS A SINGLE FAMILY RESIDENCE. ACCESS IS FROM FOLSOM DRIVE. THERE ARE SINGLE FAMILY RESIDENCES TO THE SOUTH, EAST AND WEST OF THE LOTS, AND A NATURAL STEEP SLOPE TO THE NORTH.

3. THE PROPOSED DEVELOPMENT WILL INCORPORATE BIOFILTRATION PLANTERS TO TREAT PROPOSED IMPERVIOUS SURFACES AND PROVIDE HYDROMODIFICATION AND PEAK STORM RUNOFF MITIGATION. DRAINAGE PATTERNS WILL BE MAINTAINED AND RUNOFF FROM A MAJORITY OF THE SITE WILL BE PIPED TO A CURB OUTLET ON FOLSOM DRIVE.

PRE-DEVELOPMENT HYDROLOGY

BASIN A: (OFFSITE) AREA = 62,578 SF = 1.437 AC 0 SF IMPERVIOUS

BASED ON TABLE 3-1 C=0.35 FOR SOIL TYPE 'D'
C=0.90 FOR IMPERVIOUS SURFACES

$C_A = 0.35$

THE BASIN SLOPE IS SUFFICIENTLY CONSISTENT TO NOT REQUIRE A SLOPE PROFILE.

T_i FOR THE FIRST 100', USE OVERLAND FLOW (S = 30%)

$T_i = 1.8(1.1\text{-}C)D^{1/2}/S^{1/3} = 1.8(1.1\text{-}0.35)(100)^{1/2}/30^{1/3} = 4.3$ MIN

T_t FOR 357', USE NATURAL WATERSHED FORMULA

L = 357' = 0.067 MILE $\Delta E = 118.5'$

$T_t = (11.9L^3/\ \Delta E)^{0.385} \text{ x } 60 = (11.9(0.067)^3/118.5)^{0.385} \text{ x } 60 = 1.1$ MIN

$T_C = 4.3 + 1.1 = 5.4$ MIN

$I_{100} = 7.44P_6T_C^{-.645} = 7.44(2.0)5.4^{-.645} = \underline{5.01\text{ IN/HR}}$

$Q_{100} = CIA = 0.35(5.01)1.437 =$ **2.52 CFS**

FLOW IS OVER NATURAL SLOPE TO A BROW DITCH IN LOT 15.

BASIN B: (OFFSITE) AREA = 33,667 SF = 0.773 AC   0 SF IMPERVIOUS

BASED ON TABLE 3-1   C=0.35 FOR SOIL TYPE 'D'
C=0.90 FOR IMPERVIOUS SURFACES

$C_B = 0.35$

THE BASIN SLOPE IS SUFFICIENTLY CONSISTENT TO NOT REQUIRE A SLOPE PROFILE.

T_i FOR THE FIRST 100', USE OVERLAND FLOW (S = 32.5%)

$T_i = 1.8(1.1\text{-}C)D^{1/2}/S^{1/3} = 1.8(1.1\text{-}0.35)(100)^{1/2}/32.5^{1/3} = 4.2$ MIN

T_t FOR 374', USE NATURAL WATERSHED FORMULA

L = 357' = 0.071 MILE $\Delta E = 128.5'$

$T_t = (11.9L^3/\ \Delta E)^{0.385} \text{ x } 60 = (11.9(0.071)^3/128.5)^{0.385} \text{ x } 60 = 1.1$ MIN

$T_C = 4.2 + 1.1 = 5.3$ MIN

$I_{100} = 7.44P_6T_C^{-.645} = 7.44(2.0)5.3^{-.645} = \underline{5.08 \text{ IN/HR}}$

$Q_{100} = CIA = 0.35(5.08)0.773 =$ **1.37 CFS**

FLOW IS OVER NATURAL SLOPE TO LOT 16.

BASIN C: AREA = 11,296 SF = 0.259 AC   7,955 SF IMPERVIOUS

$C_C = [7,955(0.90) + 3,341(0.35)] / 11,296 = \underline{0.74}$

BY INSPECTION, $T_C < 5$ MIN THEREFORE $T_C = 5.0$ MIN

$I_{100} = 7.44P_6T_C^{-.645} = 7.44(2.0)5.0^{-.645} = \underline{5.27 \text{ IN/HR}}$

$Q_{100} = CIA = 0.74(5.27)0.259 =$ **1.01 CFS**

FLOW IS OVER ROOF, HARDSCAPE AND LANDSCAPING TO FOLSOM DRIVE.

<u>BASIN D:</u> AREA = 6,741 SF = <u>0.155 AC</u> 0 SF IMPERVIOUS

C_D = <u>0.35</u>

BY INSPECTION, $T_C < 5$ MIN THEREFORE $T_C = 5.0$ MIN

$I_{100} = 7.44P_6T_C^{-.645} = 7.44(2.0)5.0^{-.645} = \underline{5.27\text{ IN/HR}}$

Q_{100} = CIA = 0.35(5.27)0.155 = **<u>0.29 CFS</u>**

FLOW IS OVER STEEP PLANTED SLOPE TO FOLSOM DRIVE.

<u>BASIN E:</u> AREA = 5,356 SF = <u>0.123 AC</u> 0 SF IMPERVIOUS

C_E = <u>0.35</u>

BY INSPECTION, $T_C < 5$ MIN THEREFORE $T_C = 5.0$ MIN

$I_{100} = 7.44P_6T_C^{-.645} = 7.44(2.0)5.0^{-.645} = \underline{5.27\text{ IN/HR}}$

Q_{100} = CIA = 0.35(5.27)0.123 = **<u>0.23 CFS</u>**

FLOW IS OVER STEEP PLANTED SLOPE AND BROW DITCH TO ADJACENT PROPERTY TO THE WEST.

<u>PRE-DEVELOPMENT BASIN SUMMARY</u>

BASIN	AREA (AC)	'C'	T_C (MIN)	I_{100} (IN/HR)	Q_{100} (CFS)
A	1.437	0.35	5.4	5.01	2.52
B	0.773	0.35	5.3	5.08	1.37
C	0.259	0.74	5.0	5.27	1.01
D	0.155	0.35	5.0	5.27	0.29
E	0.123	0.35	5.0	5.27	0.23

PRE-DEVELOPMENT FLOOD ROUTING

JUNCTION A: BASINS A+E $T_E < T_A$

TRANSIT TIME FOR BASIN A IS NEGLIGIBLE AND WILL BE INGNORED

$Q_E = 0.23 + (5.0/5.4)2.52 = 2.56$ CFS

$Q_A = (5.01/5.27).23 + 2.52 = 2.74$ CFS *

$Q_{JA} = \underline{2.74\text{ CFS}}$ $T_{JA} = \underline{5.4\text{ MIN}}$ $I_{JA} = \underline{5.01\text{ IN/HR}}$

JUNCTION B: BASINS B+C $T_C < T_B$

BASIN B T_C USE NATURAL WATERSHED FORMULA

$L = 113' = 0.021$ MILE $\Delta E = 19'$

$T_t = (11.9L^3/\Delta E)^{0.385} \times 60 = (11.9(0.021)^3/19)^{0.385} \times 60 = 0.6$ MIN

$T_C = 5.3 + 0.6 = \underline{5.9\text{ MIN}}$

$I_{100} = 7.44P_6T_C^{-.645} = 7.44(2.0)5.9^{-.645} = \underline{4.74\text{ IN/HR}}$

$Q_C = 1.01 + (5.0/5.9)1.37 = 2.17$ CFS

$Q_B = (4.74/5.27)1.01 + 1.37 = 2.28$ CFS *

$Q_{JB} = \underline{2.28\text{ CFS}}$ $T_{JA} = \underline{5.9\text{ MIN}}$ $I_{JA} = \underline{4.74\text{ IN/HR}}$

JUNCTION C: JUNCTIONS A+B + BASIN D $T_D < T_{JA} < T_{JB}$

TRANSIT TIME IN GUTTER IS NEGLIGIBLE AND WILL BE INGNORED

$Q_D = 0.29 + (5.0/5.4)2.74 + (5.0/5.9)2.28 = 4.76$ CFS

$Q_{JA} = (5.01/5.27)0.29 + 2.74 + (5.4/5.9)2.28 = 5.10$ CFS

$Q_{JB} = (4.74/5.27)0.29 + (4.74/5.01)2.74 + 2.28 = 5.13$ CFS *

$Q_{JA} = \underline{5.13\text{ CFS}}$ $T_{JA} = \underline{5.9\text{ MIN}}$ $I_{JA} = \underline{4.74\text{ IN/HR}}$

POST-DEVELOPMENT HYDROLOGY

BASIN 1: (OFFSITE) AREA = 62,578 SF = 1.437 AC 0 SF IMPERVIOUS

(SAME AS BASIN A)

$C_1 = 0.35$

$I_{100} = 7.44P_6T_C^{-.645} = 7.44(2.0)5.4^{-.645} = \underline{5.01\text{ IN/HR}}$

$Q_{100} = CIA = 0.35(5.01)1.437 =$ **2.52 CFS**

FLOW IS OVER NATURAL SLOPE TO A BROW DITCH IN LOT 15.

BASIN 2: (OFFSITE) AREA = 33,667 SF = 0.773 AC 0 SF IMPERVIOUS

(SAME AS BASIN B)

$C_2 = 0.35$

$I_{100} = 7.44P_6T_C^{-.645} = 7.44(2.0)5.3^{-.645} = \underline{5.08\text{ IN/HR}}$

$Q_{100} = CIA = 0.35(5.08)0.773 =$ **1.37 CFS**

FLOW IS OVER NATURAL SLOPE TO LOT 16.

BASIN 3: AREA = 4,854 SF = 0.111 AC 36 SF IMPERVIOUS

$C_3 = [36(0.90) + 4{,}818(0.35)] / 4{,}854 = \underline{0.35}$

BY INSPECTION, $T_i < 5$ MIN THEREFORE $T_C = 5.0$ MIN, $I_{100} = \underline{5.27\text{ IN/HR}}$

$Q_{100} = CIA = 0.35(5.27)0.111 =$ **0.20 CFS**

FLOW IS COLLECTED IN INLETS AND PIPED TO A PROPOSED CURB OUTLET IN FOLSOM DRIVE.

BASIN 4: AREA = 1,071 SF = 0.025 AC 510 SF IMPERVIOUS

C_4 = [510(0.90) + 561(0.35)] / 1,071 = 0.61

BY INSPECTION, T_i < 5 MIN THEREFORE T_C = 5.0 MIN, I_{100} = 5.27 IN/HR

Q_{100} = CIA = 0.61(5.27)0.025 = **0.08 CFS**

FLOW IS ROUTED TO A BIOFILTRATION BASIN FOR TREATMENT, THEN PIPED TO A PROPOSED CURB OUTLET IN FOLSOM DRIVE.

BASIN 5: AREA = 1,407 SF = 0.032 AC 115 SF IMPERVIOUS

C_5 = [115(0.90) + 1,392(0.35)] / 1,071 = 0.42

BY INSPECTION, T_i < 5 MIN THEREFORE T_C = 5.0 MIN, I_{100} = 5.27 IN/HR

Q_{100} = CIA = 0.42(5.27)0.032 = **0.07 CFS**

FLOW IS COLLECTED IN INLETS AND PIPED TO A PROPOSED CURB OUTLET IN FOLSOM DRIVE.

BASIN 6: AREA = 3,150 SF = 0.072 AC 0 SF IMPERVIOUS

C_6 = 0.35

BY INSPECTION, T_i < 5 MIN THEREFORE T_C = 5.0 MIN, I_{100} = 5.27 IN/HR

Q_{100} = CIA = 0.35(5.27)0.072 = **0.13 CFS**

FLOW IS OVER STEEP PLANTED SLOPE TO ADJACENT PROPERTY TO THE WEST.

BASIN 7: AREA = 5,542 SF = <u>0.127 AC</u> 114 SF IMPERVIOUS

C_7 = [114(0.90) + 5,428(0.35)] / 5.542 = <u>0.36</u>

BY INSPECTION, $T_i < 5$ MIN THEREFORE $T_C = 5.0$ MIN, I_{100} = <u>5.27 IN/HR</u>

Q_{100} = CIA = 0.36(5.27)0.127 = **<u>0.23 CFS</u>**

FLOW IS COLLECTED IN INLETS AND PIPED TO A PROPOSED CURB OUTLET IN FOLSOM DRIVE.

BASIN 8: AREA = 6,004 SF = <u>0.138 AC</u> 5,662 SF IMPERVIOUS

C_8 = [5,662(0.90) + 342(0.35)] / 6,004 = <u>0.87</u>

BY INSPECTION, $T_i < 5$ MIN THEREFORE $T_C = 5.0$ MIN, I_{100} = <u>5.27 IN/HR</u>

Q_{100} = CIA = 0.87(5.27)0.138 = **<u>0.63 CFS</u>**

ROOF FLOW IS ROUTED TO A BIOFILTRATION BASIN FOR TREATMENT, THEN PIPED TO A PROPOSED CURB OUTLET IN FOLSOM DRIVE.

BASIN 9: AREA = 568 SF = <u>0.13 AC</u> SELF RETAINING POOL

C_9 = 0.00

Q_{100} = **<u>0.00 CFS</u>**

BASIN 10: AREA = 1,364 SF = <u>0.031 AC</u> 292 SF IMPERVIOUS

C_{10} = [292(0.90) + 1,072(0.35)] / 6,004 = <u>0.47</u>

BY INSPECTION, $T_i < 5$ MIN THEREFORE $T_C = 5.0$ MIN, I_{100} = <u>5.27 IN/HR</u>

Q_{100} = CIA = 0.47(5.27)0.031 = **<u>0.08 CFS</u>**

FLOW IS OVER SLOPE TO FOLSOM DRIVE.

POST-DEVELOPMENT BASIN SUMMARY

BASIN	AREA (AC)	'C'	T_C (MIN)	I_{100} (IN/HR)	Q_{100} (CFS)
1	1.437	0.35	5.4	5.01	2.52
2	0.773	0.35	5.3	5.08	1.37
3	0.111	0.35	5.0	5.27	0.20
4	0.025	0.61	5.0	5.27	0.08
5	0.032	0.42	5.0	5.27	0.07
6	0.072	0.35	5.0	5.27	0.13
7	0.127	0.36	5.0	5.27	0.24
8	0.138	0.87	5.0	5.27	0.63
9	0.013	0.00	5.0	5.27	0.00
10	0.031	0.47	5.0	5.27	0.08

<u>POST-DEVELOPMENT FLOOD ROUTING</u>

<u>JUNCTION 1:</u> BASINS 1+6 $T_6 < T_1$

TRANSIT TIME FOR BASIN 1 IS NEGLIGIBLE AND WILL BE INGNORED

$Q_6 = 0.13 + (5.0/5.4)2.52 = 2.46$ CFS

$Q_1 = (5.01/5.27).13 + 2.52 = 2.64$ CFS *

$Q_{J1} = \underline{2.64 \text{ CFS}}$ $T_{J1} = \underline{5.4 \text{ MIN}}$ $I_{J1} = \underline{5.01 \text{ IN/HR}}$

<u>JUNCTION 2:</u> BASINS 2+3+4+5+7+8 $T_3=T_4=T_5=T_7=T_8= < T_2$

<u>BASIN 2 T_C</u> USE PARTIALLY FULL PIPE FLOW

L = 258' SLOPE = 41.13' / 258 = 16%

$T_t = (258' / 11.67) / 60 = 0.4$ MIN (SEE SHEET 13 FOR FLOW CALCULATION)

$T_C = 5.3 + 0.4 = \underline{5.7 \text{ MIN}}$

$I_{100} = 7.44P_6T_C^{-.645} = 7.44(2.0)5.7^{-.645} = \underline{4.84 \text{ IN/HR}}$

$Q_3 = 0.20+0.08+0.07+0.24+0.63+ (5.0/5.7)1.37 = 2.42$ CFS

$Q_2 = (4.84/5.27)(0.20+0.08+0.07+0.24+0.63) + 1.37 = 2.49$ CFS *

$Q_{J2} = \underline{2.49 \text{ CFS}}$ $T_{J2} = \underline{5.7 \text{ MIN}}$ $I_{J2} = \underline{4.84 \text{ IN/HR}}$

<u>JUNCTION 3:</u> JUNCTIONS J1+J2+BASIN 10 $T_{10}< T_{J1}<T_{J2}$

TRANSIT TIME IN GUTTER IS NEGLIGIBLE AND WILL BE INGNORED

$Q_{10} = 0.08+ (5.0/5.4)2.64+ (5.0/5.7)2.49 = 4.71$ CFS

$Q_{J1} = (5.01/5.27)0.08+ 2.64+ (5.4/5.7)2.49 = 5.08$ CFS

$Q_{J2} = (4.84/5.27)0.08+ (4.84/5.08)2.64+ 2.49 = 5.08$ CFS *

$Q_{J3} = \underline{5.08 \text{ CFS}}$ $T_{J3} = \underline{5.7 \text{ MIN}}$ $I_{J3} = \underline{4.84 \text{ IN/HR}}$

Partially Full Pipe Flow Calculations - U.S. Units

Calculation of Discharge, Q, and average velocity, V

Instructions: *Enter values in blue boxes. Spreadsheet calculates values in yellow boxes*

Inputs

Pipe Diameter, **D** =	6	in
Depth of flow, **y** =	3.45	in
Manning roughness, $\mathbf{n_{full}}$ =	0.011	
Pipe Slope, **S** =	0.1600	ft/ft

Calculations

y/D =	0.575	
$\mathbf{n/n_{full}}$ =	1.23	
n =	0.013	

Calculations

Pipe Diameter, **D** =	0.5	ft
Pipe Radius, **r** =	0.25	ft
Circ. Segment Height, **h** =	0.2125	ft
Central Angle, θ =	2.84	radians
Cross-Sect. Area, **A** =	0.117	ft^2
Wetted Perimeter, **P** =	0.86	ft
Hydraulic Radius, **R** =	0.14	ft
Discharge, **Q** =	**1.36**	**cfs**
Ave. Velocity, **V** =	**11.67**	**ft/sec**
pipe % full [(A/A_{full})*100%] =	59.51%	

PRE vs POST-DEVELOPMENT IMPERVIOUS AREA

PRE DEVELOPMENT:

BASIN	AREA (SF)
A	0
B	0
C	7,955
D	0
E	0
	7,955SF IMPERVIOUS

POST DEVELOPMENT:

BASIN	AREA (SF)
1	0
2	0
3	36
4	510
5	115
6	0
7	114
8	5,662
9	0
10	292
	6,578 SF IMPERVIOUS

THERE IS AN DECREASE IN IMPERVIOUS AREA.

PRE vs POST-DEVELOPMENT HYDROLOGY

PRE DEVELOPMENT:

BASIN	FLOW (CFS)	T_C (MIN)	I_{100}
A	2.52	5.4	5.01
B	1.37	5.3	5.08
C	1.01	5.0	5.27
D	0.29	5.0	5.27
E	0.23	5.0	5.27
JUNCTION A	2.74 CFS	5.4	5.01
JUNCTION B	2.28 CFS	5.9	4.74
JUNCTION C	5.13 CFS	5.9	4.74

POST DEVELOPMENT:

BASIN	FLOW (CFS)	T_C (MIN)	I_{100}
1	2.52	5.4	5.01
2	1.37	5.3	4.84
3	0.20	5.0	5.27
4	0.08	5.0	5.27
5	0.07	5.0	5.27
6	0.13	5.0	5.27
7	0.24	5.0	5.27
8	0.63	5.0	5.27
9	0.00	5.0	5.27
10	0.08	5.0	5.27
JUNCTION 1	2.64 CFS	5.4	5.01
JUNCTION 2	2.49 CFS	5.7	4.84
JUNCTION 3	5.08 CFS	5.7	4.84

THERE IS AN 1% DECREASE IN TOTAL FLOW AFTER DEVELOPMENT. FLOW ONTO THE PROPERTY TO THE WEST WAS REDUCED (JUNCTION A VS 1).

POST-DEVELOPMENT HYDRAULICS

JUNCTION 1: Q_{100} = 2.64 CFS

ASSUME 6” PVC @ 16% MIN: Q_{MAX} = 2.66 CFS > Q_{100}
(SEE SHEET 17 FOR Q_{MAX} CALCULATIONS)

ASSUME 24” BROW DITCH @ 1% MIN : Q_{MAX} = 9.06 CFS > Q_{100}
(SEE SHEET 18 FOR Q_{MAX} CALCULATIONS)

JUNCTION 2: Q_{100} = 2.48 CFS

ASSUME 6” PVC @ 14% MIN: Q_{MAX} = 2.49 CFS > Q_{100}
(SEE SHEET 19 FOR Q_{MAX} CALCULATIONS)

NOTE: PGP AS SUBMITTED WILL REQUIRE ADJUSTMENT TO PIPE PROFILE

BASINS 3 4 5 7 & 8: MAX Q_{100} = 0.63 CFS

ASSUME 6” PVC @ 1% MIN : Q_{MAX} = 0.66 CFS > Q_{100}
(SEE SHEET 20 FOR Q_{MAX} CALCULATIONS)

Partially Full Pipe Flow Calculations - U.S. Units

Calculation of Discharge, Q, and average velocity, V

Instructions: *Enter values in blue boxes. Spreadsheet calculates values in yellow boxes*

Inputs

Pipe Diameter, **D** =	6	in
Depth of flow, **y** =	6	in
Manning roughness, $\mathbf{n_{full}}$ =	0.011	
Pipe Slope, **S** =	0.1600	ft/ft

Calculations

y/D =	1.000	
$\mathbf{n/n_{full}}$ =	1.00	
n =	0.011	

Calculations

Pipe Diameter, **D** =	0.5	ft
Pipe Radius, **r** =	0.25	ft
Circ. Segment Height, **h** =	0	ft
Central Angle, θ =	0.00	radians
Cross-Sect. Area, **A** =	0.196	ft^2
Wetted Perimeter, **P** =	1.57	ft
Hydraulic Radius, **R** =	0.13	ft
Discharge, **Q** =	**2.66**	**cfs**
Ave. Velocity, **V** =	**13.55**	**ft/sec**
pipe % full [(A/A_{full})*100%] =	100.00%	

Partially Full Pipe Flow Calculations - U.S. Units

Calculation of Discharge, Q, and average velocity, V

Instructions: *Enter values in blue boxes. Spreadsheet calculates values in yellow boxes*

Inputs

Pipe Diameter, **D** =	24	in
Depth of flow, **y** =	12	in
Manning roughness, n_{full} =	0.013	
Pipe Slope, **S** =	0.0100	ft/ft

Calculations

y/D =	0.500	
n/n_{full} =	1.25	
n =	0.016	

Calculations

Pipe Diameter, **D** =	2	ft
Pipe Radius, **r** =	1	ft
Circ. Segment Height, **h** =	1	ft
Central Angle, θ =	3.14	radians
Cross-Sect. Area, **A** =	1.571	ft^2
Wetted Perimeter, **P** =	3.14	ft
Hydraulic Radius, **R** =	0.50	ft
Discharge, **Q** =	**9.06**	**cfs**
Ave. Velocity, **V** =	**5.76**	**ft/sec**
pipe % full $[(A/A_{full})*100\%]$ =	50.00%	

Partially Full Pipe Flow Calculations - U.S. Units

Calculation of Discharge, Q, and average velocity, V

Instructions: *Enter values in blue boxes. Spreadsheet calculates values in yellow boxes*

Inputs

Pipe Diameter, **D** =	6	in
Depth of flow, **y** =	6	in
Manning roughness, $\mathbf{n_{full}}$ =	0.011	
Pipe Slope, **S** =	0.1400	ft/ft

Calculations

y/D =	1.000	
$\mathbf{n/n_{full}}$ =	1.00	
n =	0.011	

Calculations

Pipe Diameter, **D** =	0.5	ft
Pipe Radius, **r** =	0.25	ft
Circ. Segment Height, **h** =	0	ft
Central Angle, θ =	0.00	radians
Cross-Sect. Area, **A** =	0.196	ft^2
Wetted Perimeter, **P** =	1.57	ft
Hydraulic Radius, **R** =	0.13	ft
Discharge, **Q** =	**2.49**	**cfs**
Ave. Velocity, **V** =	**12.67**	**ft/sec**
pipe % full [(A/A_{full})*100%] =	100.00%	

Partially Full Pipe Flow Calculations - U.S. Units

Calculation of Discharge, Q, and average velocity, V

Instructions: *Enter values in blue boxes. Spreadsheet calculates values in yellow boxes*

Inputs

Pipe Diameter, **D** =	6	in
Depth of flow, **y** =	6	in
Manning roughness, $\mathbf{n_{full}}$ =	0.011	
Pipe Slope, **S** =	0.0100	ft/ft

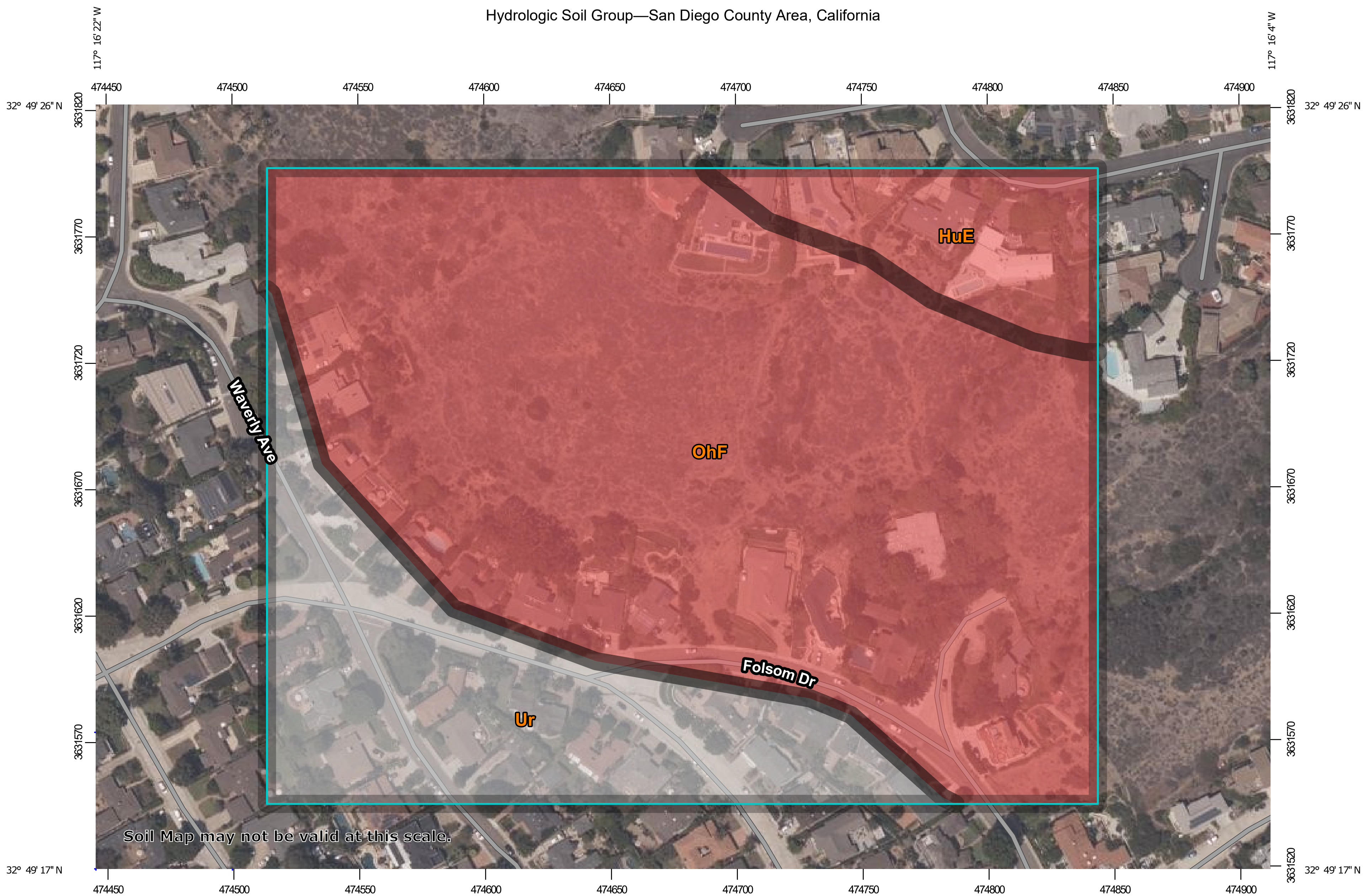
Calculations

y/D =	1.000	
$\mathbf{n/n_{full}}$ =	1.00	
n =	0.011	

Calculations

Pipe Diameter, **D** =	0.5	ft
Pipe Radius, **r** =	0.25	ft
Circ. Segment Height, **h** =	0	ft
Central Angle, θ =	0.00	radians
Cross-Sect. Area, **A** =	0.196	ft^2
Wetted Perimeter, **P** =	1.57	ft
Hydraulic Radius, **R** =	0.13	ft
Discharge, **Q** =	**0.66**	**cfs**
Ave. Velocity, **V** =	**3.39**	**ft/sec**
pipe % full [(A/A_{full})*100%] =	100.00%	

Hydrologic Soil Group—San Diego County Area, California



Map Scale: 1:2,130 if printed on A landscape (11" x 8.5") sheet.

N

0 30 60 120 180 Meters

0 100 200 400 600 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 15, May 27, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 22, 2018—Aug 31, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
HuE	Huerhuero-Urban land complex, 9 to 30 percent slopes	D	1.7	8.1%
OhF	Olivenhain cobbly loam, 30 to 50 percent slopes	D	14.3	69.5%
Ur	Urban land		4.6	22.4%
Totals for Area of Interest			**20.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

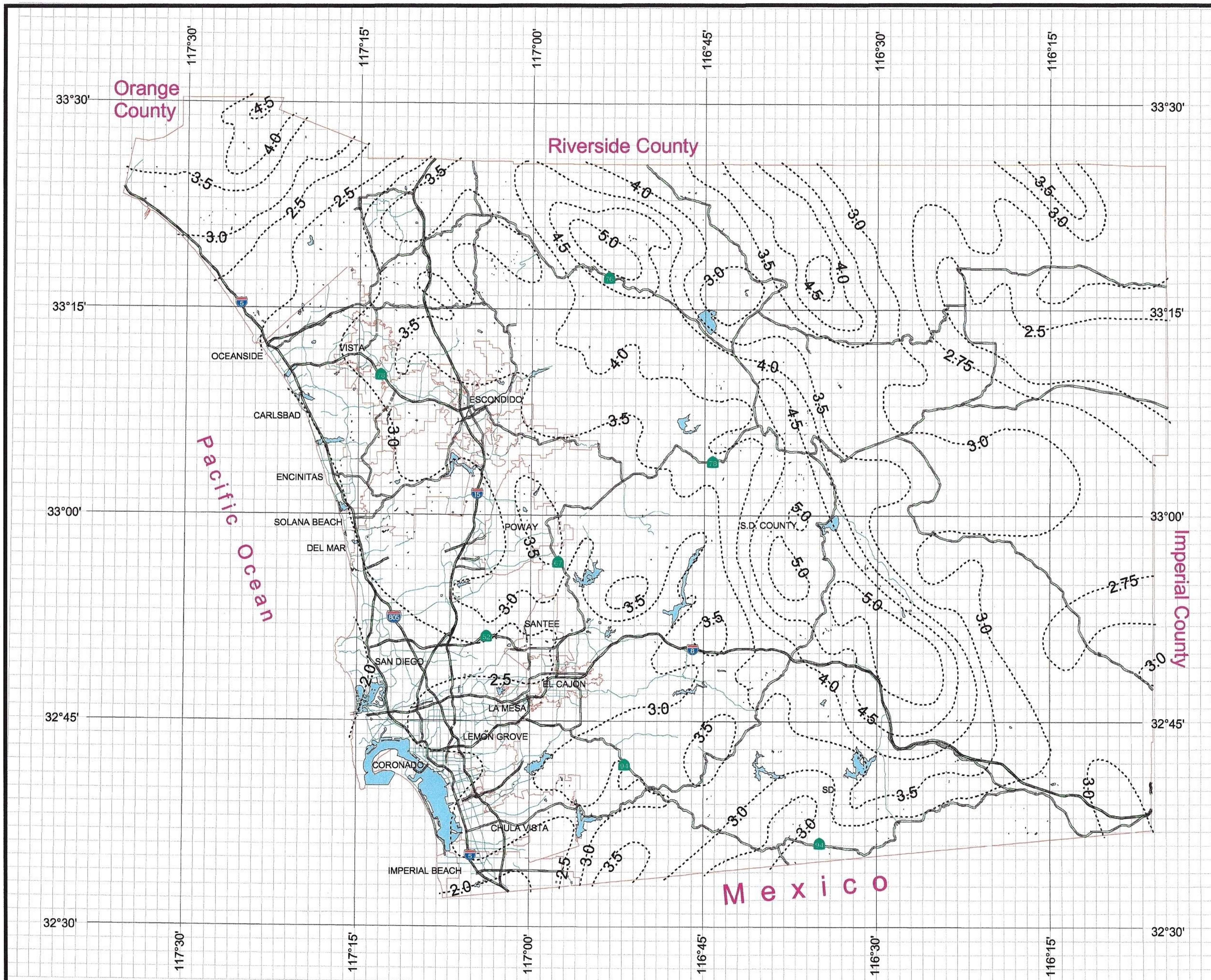
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

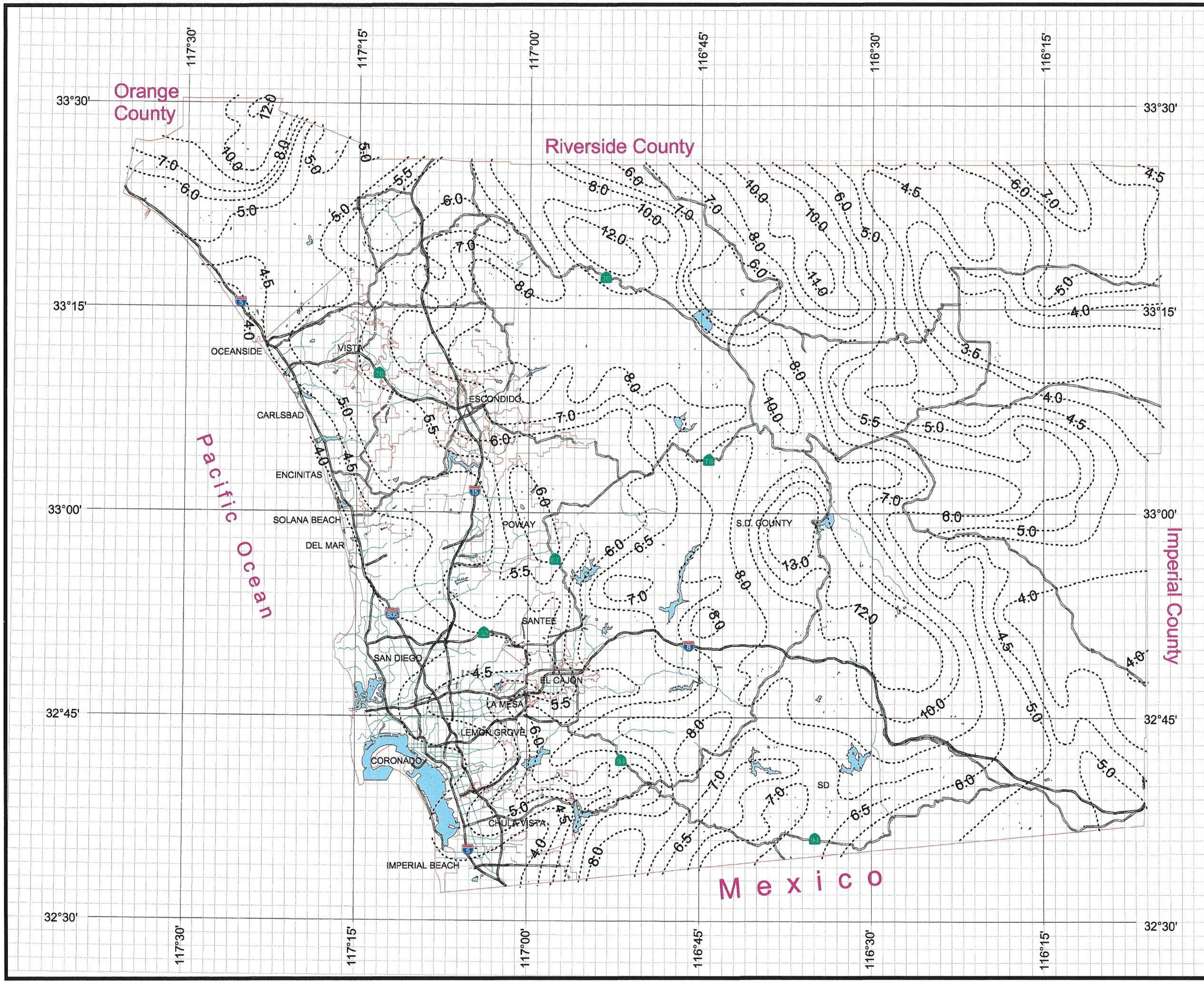
.... Isopluvial (inches)

DPW GIS
Department of Public Works
Geographic Information Services

SanGIS
We Have San Diego Covered!

N S E W

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

.... Isopluvial (inches)

DPW GIS
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SanGIS
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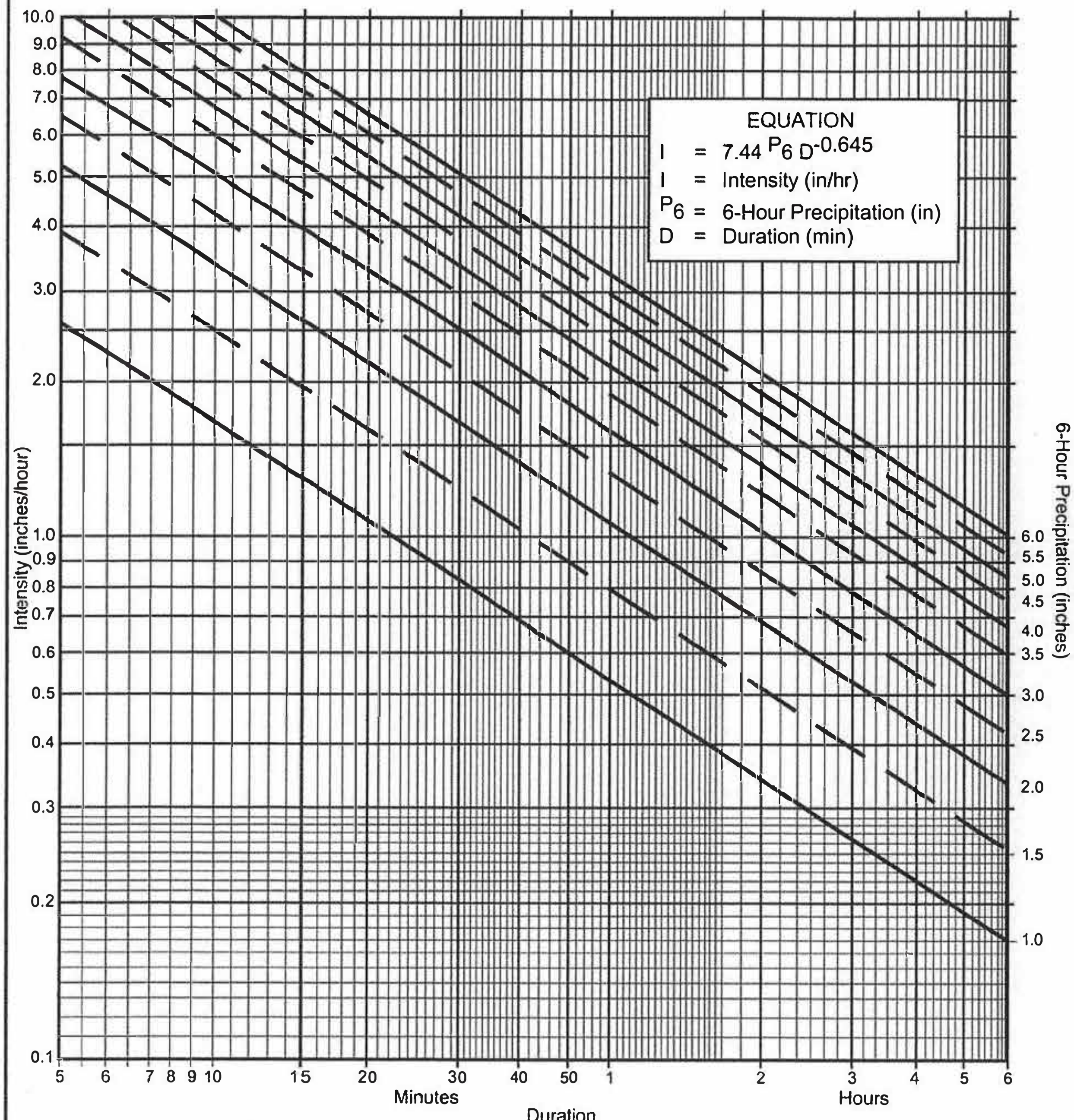
N S E W

3 0 3 Miles



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 = 2.0 in., P_{24} = 3.5, $\frac{P_6}{P_{24}}$ = 57 %(2)

(c) Adjusted $P_6^{(2)}$ = 2.0 in.

(d) t_x = 5 min.

(e) I = 5.27 in./hr.

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

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

Intensity-Duration Design Chart - Template

FIGURE

3-1

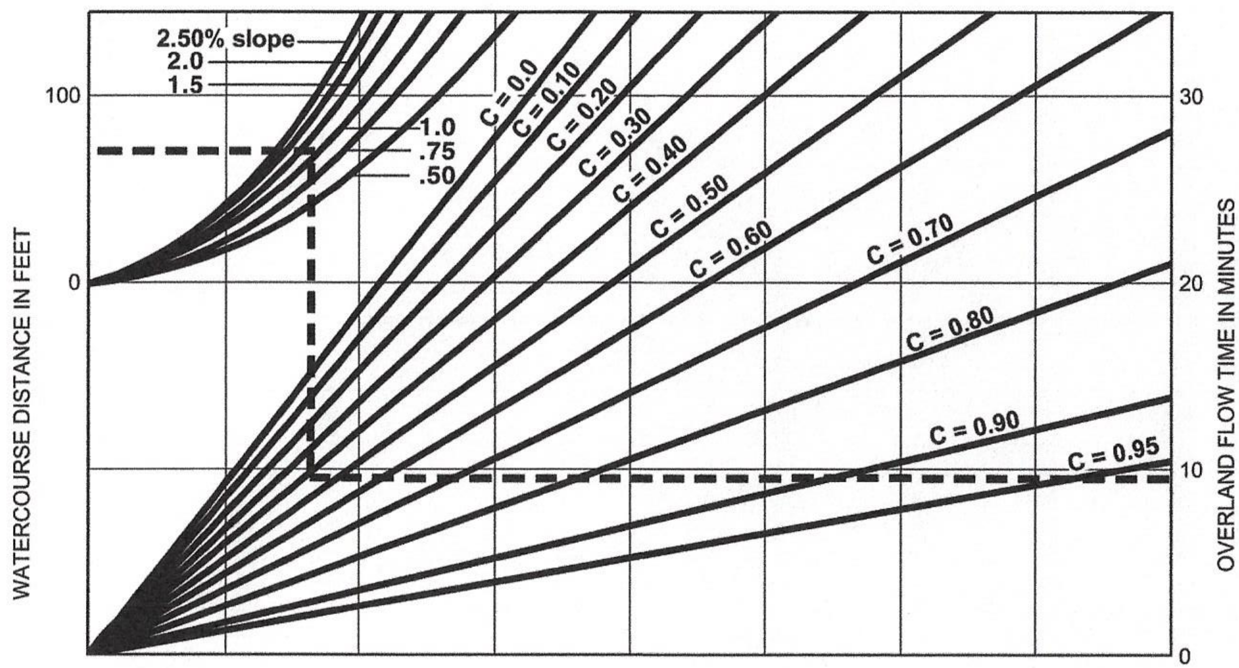
Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

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

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

DU/A = dwelling units per acre

NRCS = National Resources Conservation Service



EXAMPLE:

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

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

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE **3-3**

Rational Formula - Overland Time of Flow Nomograph

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.

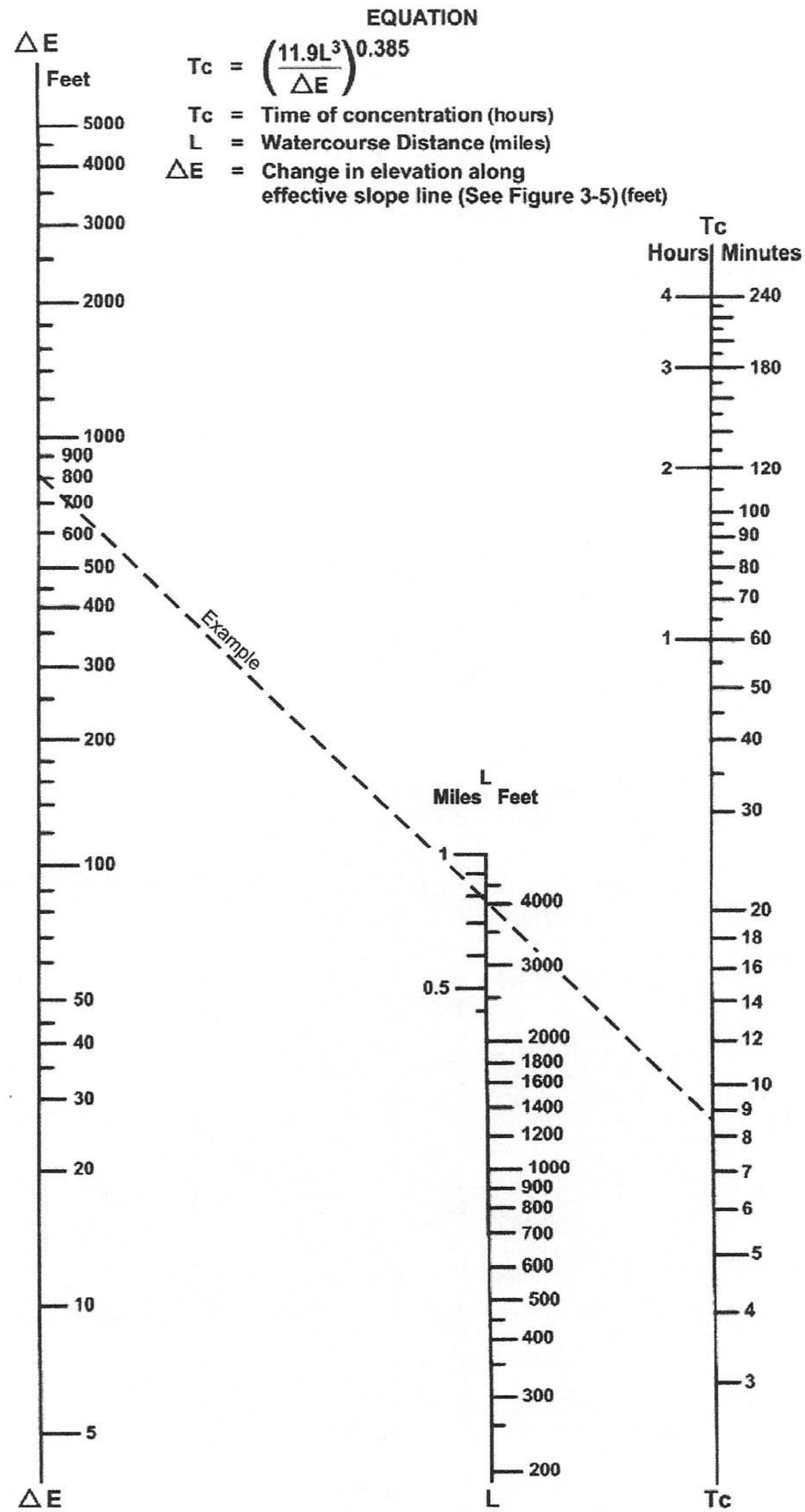
Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved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

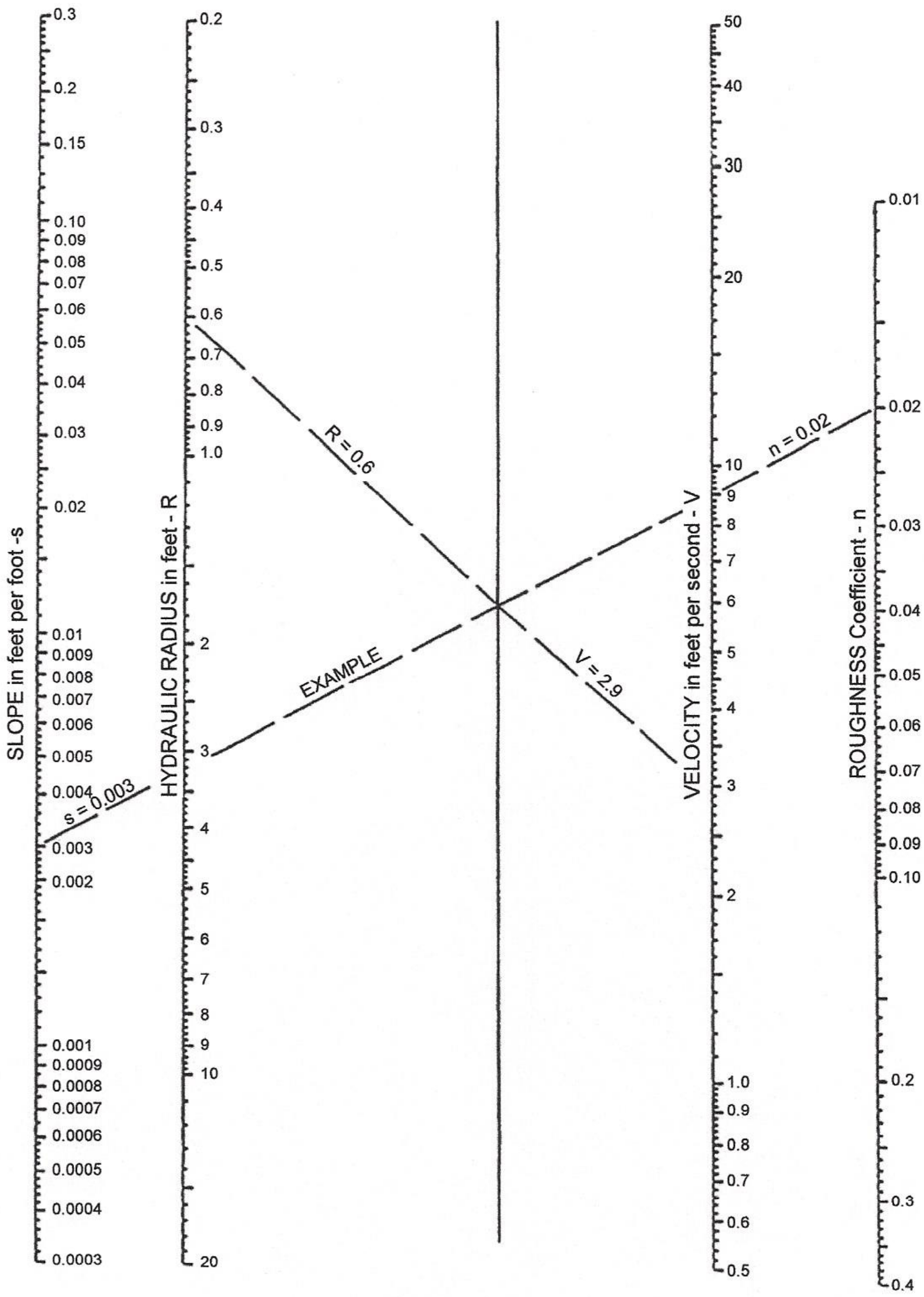


SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE **3-4**

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

EQUATION: $V = \frac{1.49}{n} R^{2/3} s^{1/2}$



GENERAL SOLUTION

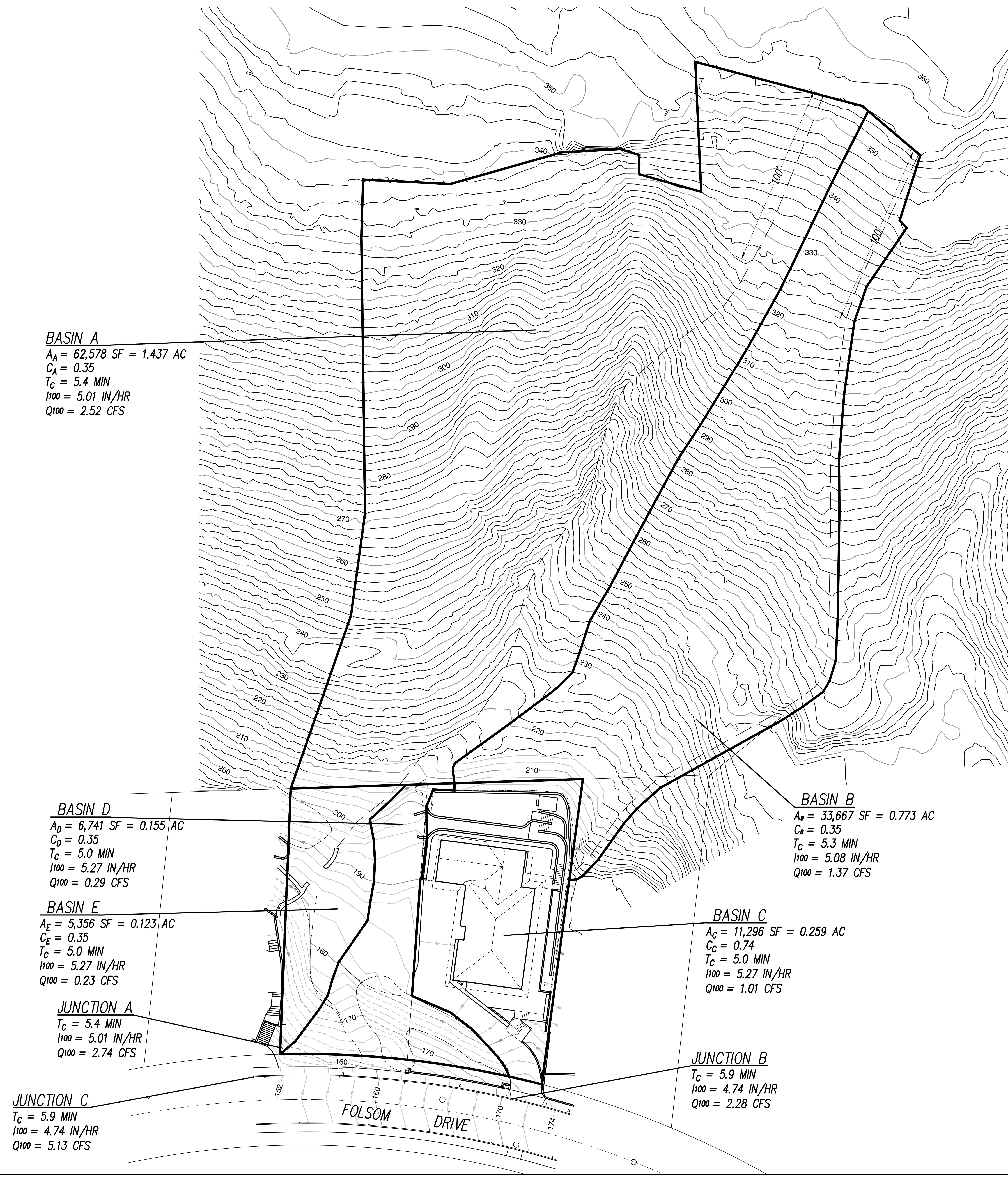
SOURCE: USDOT, FHWA, HDS-3 (1961)

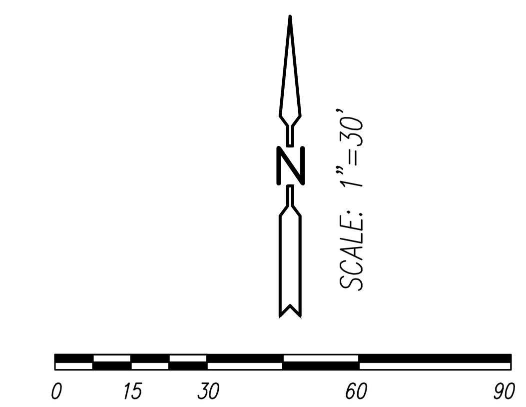
FIGURE

3-7

Manning's Equation Nomograph

PRE-DEVELOPMENT DRAINAGE MAP





REGISTERED PROFESSIONAL ENGINEER
No. 36190
Exp. 6/30/22
CIVIL
STATE OF CALIFORNIA

PRE-DEVELOPMENT DRAINAGE MAP

JOB NO. 20-029 3-19-21

SOWARDS & BROWN ENGINEERING
CONSULTING ENGINEERS
2187 NEWCASTLE AVENUE SUITE 103
CARDIFF BY THE SEA, CA., 92007
TEL. 760/436-8500 FAX 760/436-8603

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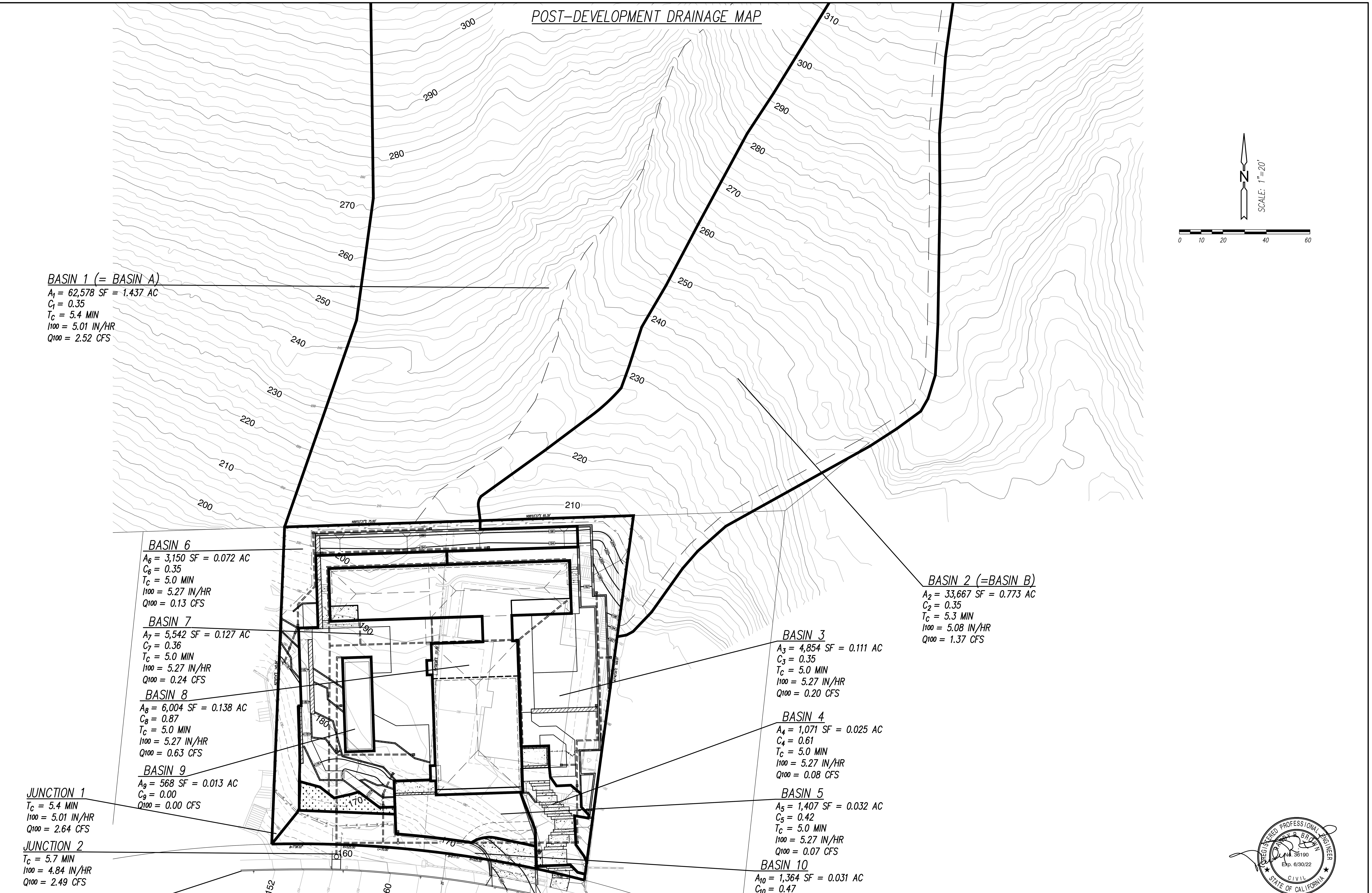

POST-DEVELOPMENT DRAINAGE MAP

JOB NO. 20-029 3-19-21

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CONSULTING ENGINEERS
2187 NEWCASTLE AVENUE SUITE 103
CARDIFF BY THE SEA, CA., 92007

TEL. 760/436-8500 FAX 760/436-8603