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Client: City of Arlington Project: Stormwater Comprehensive Plan

Location: Arlington, WA Subject: Portage Creek 4th Tier Basin

Project No: 33757537 Calculation No: HM-4 Revision No. 0 Sheet 1 of 90

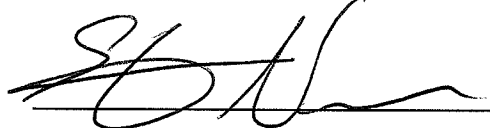
Kruger Creek, Prairie Creek, and Upper Portage Creek Subbasins Analysis

(Title of Calculations/Document)

STEP 1

	Signature	Date
Methodology & Assumptions Developed		<u>6/9/08</u>
Methodology & Assumptions Approved	<u>Carla Jelicich</u>	<u>6/10/08</u>

STEP 2

Calculations Completed		<u>6/12/08</u>
Calculations Checked	<u>Carla Jelicich</u>	<u>6/20/08</u>

STEP 3

Task Manager Approved n/a

Project Manager Approved _____

COMMENTS

Purpose: Evaluate the existing stormwater conveyance system that routes flows from within the Kruger Creek Subbasin, Prairie Creek Subbasin, and Upper Portage Creek Subbasin 5th tier basins to Upper Portage Creek and Prairie Creek within the City of Arlington (City).

Background: The focus of this evaluation was to locate potential problems within the existing Kruger Creek Subbasin, Prairie Creek Subbasin, and Upper Portage Creek Subbasin stormwater systems.

Stormwater hydraulic problems previously identified in 1995, 1999, and 2003 assessment memos include:

1. Prairie Creek Subbasin
 - a. Sweetwater culvert, north of Cemetery Rd (no existing problem no. -- Project No. 214);
 - b. 67th Ave NE culvert crossing, near Cemetery Rd (Problem No. 24 -- Project No. 211);
 - c. Railroad culvert crossing, near the intersection of 204th St NE and 69th Ave NE (Problem No. 25 -- Project No. 213);
 - d. McKinley Ave culvert (no existing problem no. -- Project No. 212); and
 - e. 71st Ave culvert crossing, south of 204th St NE (Problem No. 28 -- Project No. 210).
2. Upper Portage Creek Subbasin
 - a. Railroad culvert crossing, near the intersection of 69th Ave NE and 204th St NE (Problem No. 18 -- Project No. 4).
3. Lower Portage Creek Subbasin
 - a. Local flooding near the intersection of 59th Ave and 192nd St NE (Problem No. 15 -- No proposed project);
 - b. Local flooding on 188th St, near 66th Ave NE (Problem No. 16 -- Project No. 215); and
 - c. Local flooding of agricultural lands, near 43rd Ave (Problem No. 17 -- Project No. 106).
4. Kruger Creek Subbasin
 - a. Burn Rd culvert crossing, near 207th St NE (no existing problem no. -- Project No. 206).

Approach: The Kruger Creek, Prairie Creek, and Upper Portage Creek subbasins were evaluated to determine the capacity of the existing storm drainage network under fully developed conditions. The storm drainage network within these subbasins includes a network of pipes with varying diameters, open-channel ditches, and ponds.

The Lower Portage Creek Subbasin conveyance concerns are not addressed within this calculation package. The two known conveyance issues within Lower Portage Creek Subbasin have caused local flooding near the intersections of 59th Ave and 192nd St; and 188th St near 66th Ave. More information on these two conveyance issues is needed prior to a formal resolution recommendation. Additional modeling and evaluation of these areas shall be pursued if requested by the City. Inadequate conveyance capacity is not responsible for the local flooding of agricultural lands near 43rd Ave and the City has already identified a wetland project to mitigate the issue.

The location of Kruger Creek, Prairie Creek, and Upper Portage Creek subbasins within the City are shown in Figure 1. The location of known problem areas is shown in Figures 2, 3, and 4.

The hydrology was developed based on the 24-hour frequency design storm (See Attachment 1). This evaluation used the rainfall data from the 2-year, 10-year, 25-year, and 100-year 24-hour storms and identified culverts that may be undersized. A summary of the rainfall data is presented in Table 1.

The culverts within each subbasin, where flooding has been reported by City staff, are all located at the downstream end of each basin. It was assumed that the entire subbasin would act as the contributing basin area to each culvert. Due to the close proximity of the culvert(s) within each basin, the same design parameters (i.e. flow) were applied globally, therefore only one culvert in each subbasin needed to have the diameter estimated. This diameter was then assumed to be the same for other culverts within the subbasin. The flow rate entering each culvert was estimated using the Santa Barbara Urban Hydrograph (SBUH) method, for the 2-, 10-, 25-, and 100-yr, 24-hr storms.

The runoff curve number inputs required for the SBUH method were estimated from the values suggested by the Natural Resources Conservation Service's (NRCS) TR-55 manual. The NRCS suggested runoff curve numbers vary depending on the hydrologic soil group and land-use zoning type. A weighted average for the recommended curve number was used to determine one RCN for the entire basin. The calculations for the runoff curve number can be found in Attachment 2.

Results: A XPSWMM model was previously created to estimate stormwater runoff. The XPSWMM results are included in Attachment 3. To verify the flow rates, the contributing basin areas and impervious area percentages from the model were used with the SBUH method. The results from the Time of Concentration estimates and SBUH method results for each subbasin analysis are included in Attachment 4.

The flow rates obtained from using the SBUH method were more conservative than the XPSWMM values, therefore they were used as design flows. Haestad's FlowMaster software was used to solve for the full flow diameter. The proposed diameter of the culverts was based on the 10-year, 24-hour storm with an additional 0.5-ft for freeboard. This design diameter was also compared with the estimated required diameter to adequately convey the 25-year, 24-hour storm also. The FlowMaster results are included in Attachment 5.

Because the creeks may be fish bearing, oversized culverts with no headwater conditions were also evaluated. This is summarized in Attachment 5. See Table 2 for a summary of the recommended culvert upgrades within the Kruger Creek, Prairie Creek, and Upper Portage Creek subbasins.

The stormwater issues addressed in this report already have existing, proposed projects to resolve them. The completion of the City of Arlington's stormwater Project Nos. 4, 206, 210, 211, 212, 213, and 214 should resolve the stormwater issues referenced in this report. See Attachment 6 for a brief description of these projects.

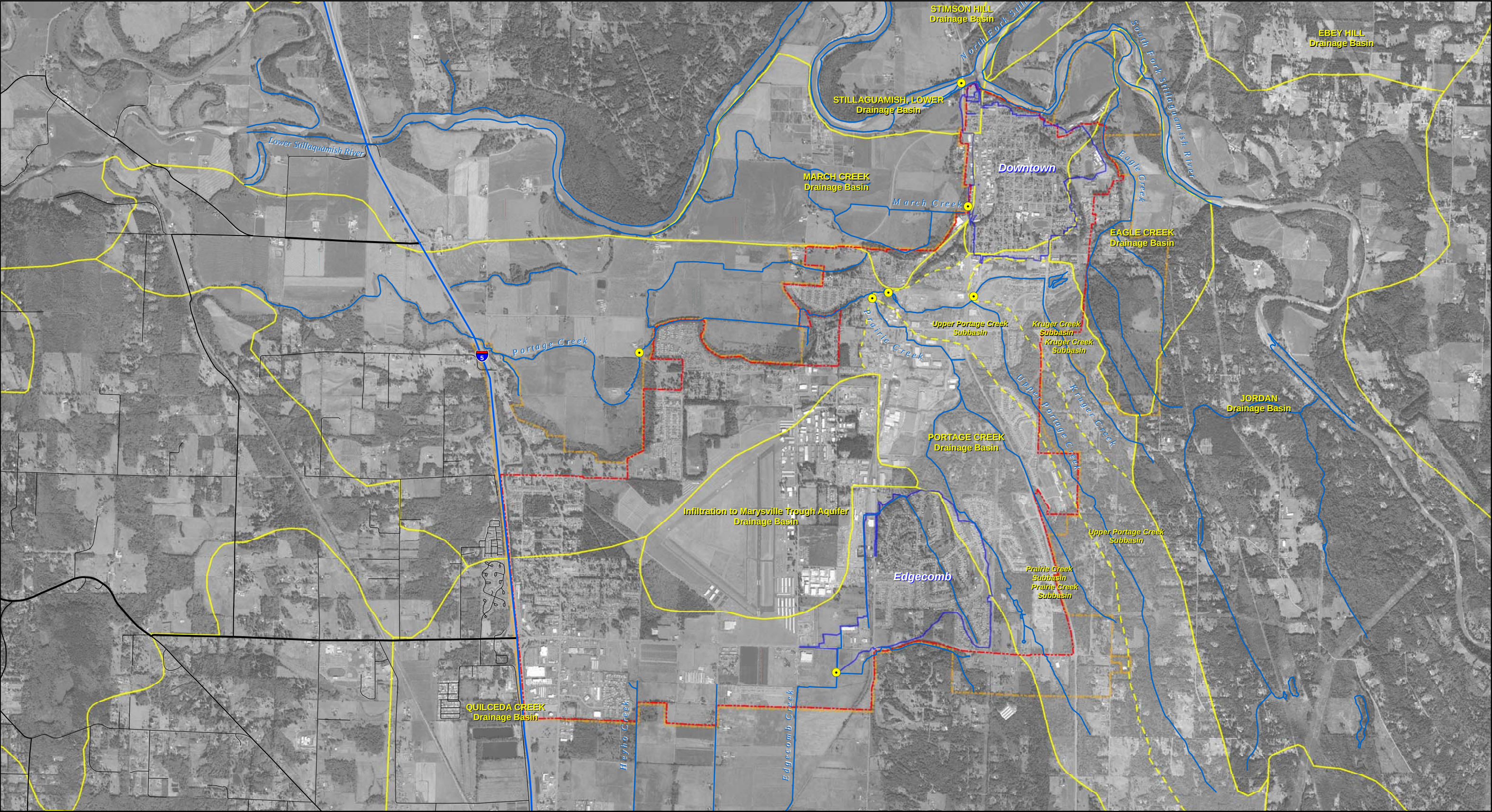
<i>Table 1 – 24-Hour Design Rainfall</i>			
Return Period (years)	Rainfall Depth (inches)	Return Period (years)	Rainfall Depth (inches)
2-year	1.80	25-year	3.20
10-year	2.75	100-year	3.75

**Table 2 - Hydraulic Analysis Results
Recommended Culvert Diameters**

Subbasin	Culvert Location	Contributing Basin Area (Acres)	10-Yr, 24-Hr Storm (cfs)	25-Yr, 24-Hr Storm (cfs)	100-Yr, 24-Hr Storm (cfs)	Minimum Diameter (in.)	Recommended Diameter (in.)
Kruger Creek	Burn Rd, near 207 th St	355.5	53.7	72.1	96.1	60	96
Prairie Creek	Sweetwater	1,099.3	146.3	183.6	231.3	84	96
Prairie Creek	McKinley Ave	1,099.3	146.3	183.6	231.3	84	96
Prairie Creek	67 th Ave, north of Cemetery Rd	1,099.3	146.3	183.6	231.3	84	96
Prairie Creek	R/R X-ing, near 69 th Ave & 204 th St	1,099.3	146.3	183.6	231.3	84	96
Prairie Creek	71 st Ave, south of 204 th St	1,099.3	146.3	183.6	231.3	84	96
Upper Portage Creek	R/R X-ing, near 69 th Ave & 206 th St	1,340.8	138.7	183.5	242.6	84	96

* The proposed diameter is based on designing the culverts with no headwater condition.

** All culverts were evaluated assuming smooth interior, concrete material construction.



- Legend**
- Drainage Basin Outfalls
 - State Highway
 - Arterial
 - Street
 - ▬ Arlington City Limits
 - ▬ UGA Zones
 - ▬ Drainage Basins
 - ▬ Subbasins

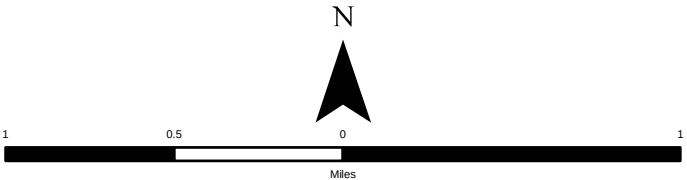


Figure 1
Arlington Drainage Basins and Subbasins



- Arlington City Limits
- UGA Zones
- Drainage Basins
- Roads



Not all features in the legend are in the map

\\sa\projects\project\Environmental\6 - WATER RESOURCES GROUP\6 - PROJECT\CITY of Arlington Stormwater\6 - GIS\Stormwater\Inventory\Maps\Figure 7 - Kruger Creek Subbasin.mxd Sept. 6, 2007

\\sa\mied\h\mied\Arlington\GIS\maps\Figure 6 - 7.mxd and 11\sa 2006 Kruger Creek Drainage Basin.mxd

Figure 2
Kruger Creek Subbasin
Arlington

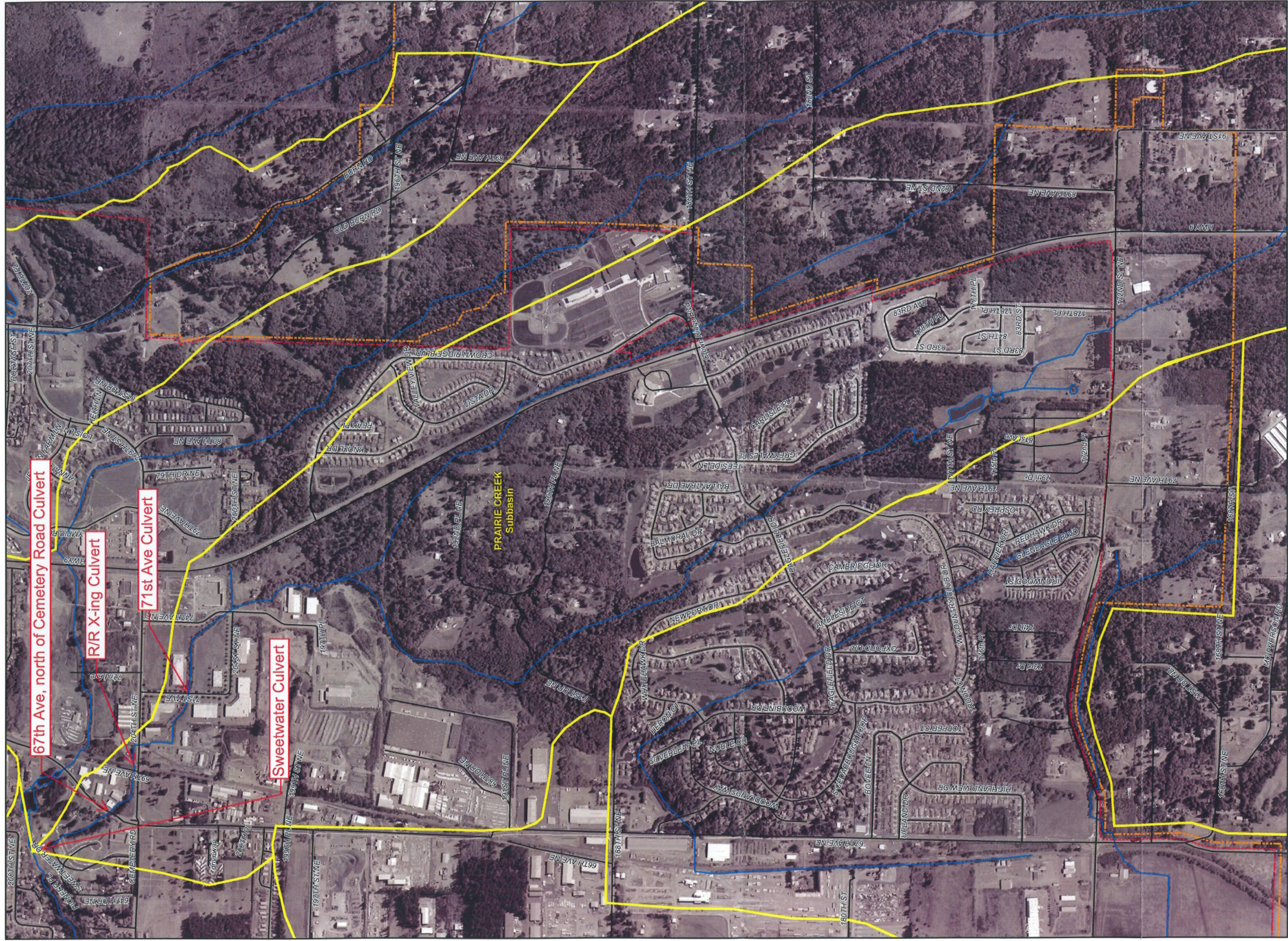


Figure 3
Prairie Creek Subbasin
Arlington



Not all features in the legend are in the map



- Arlington City Limits
- UGA Zones
- Drainage Basins
- Roads

Figure 4
Upper Portage Creek Subbasin
Arlington



Not all features in the legend are in the map

ATTACHMENT 1
Isopluvials of 24-Hour Precipitation

Site Location, ~1.80"

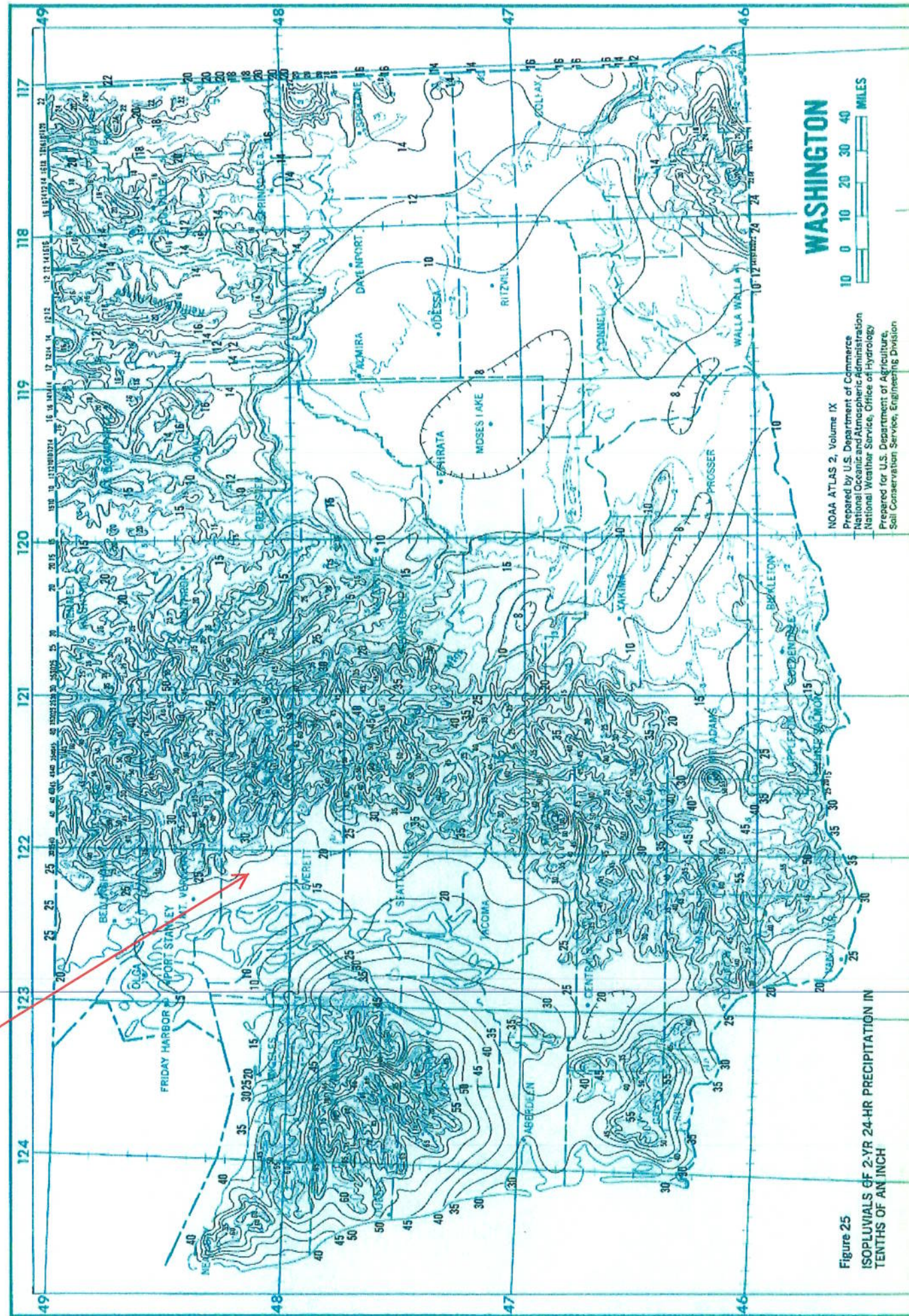


Figure 25
ISOPHYETS OF 2-YR 24-HR PRECIPITATION IN
TENTHS OF AN INCH

NOAA ATLAS 2, Volume IX
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

Site Location, ~2.75"

11/90

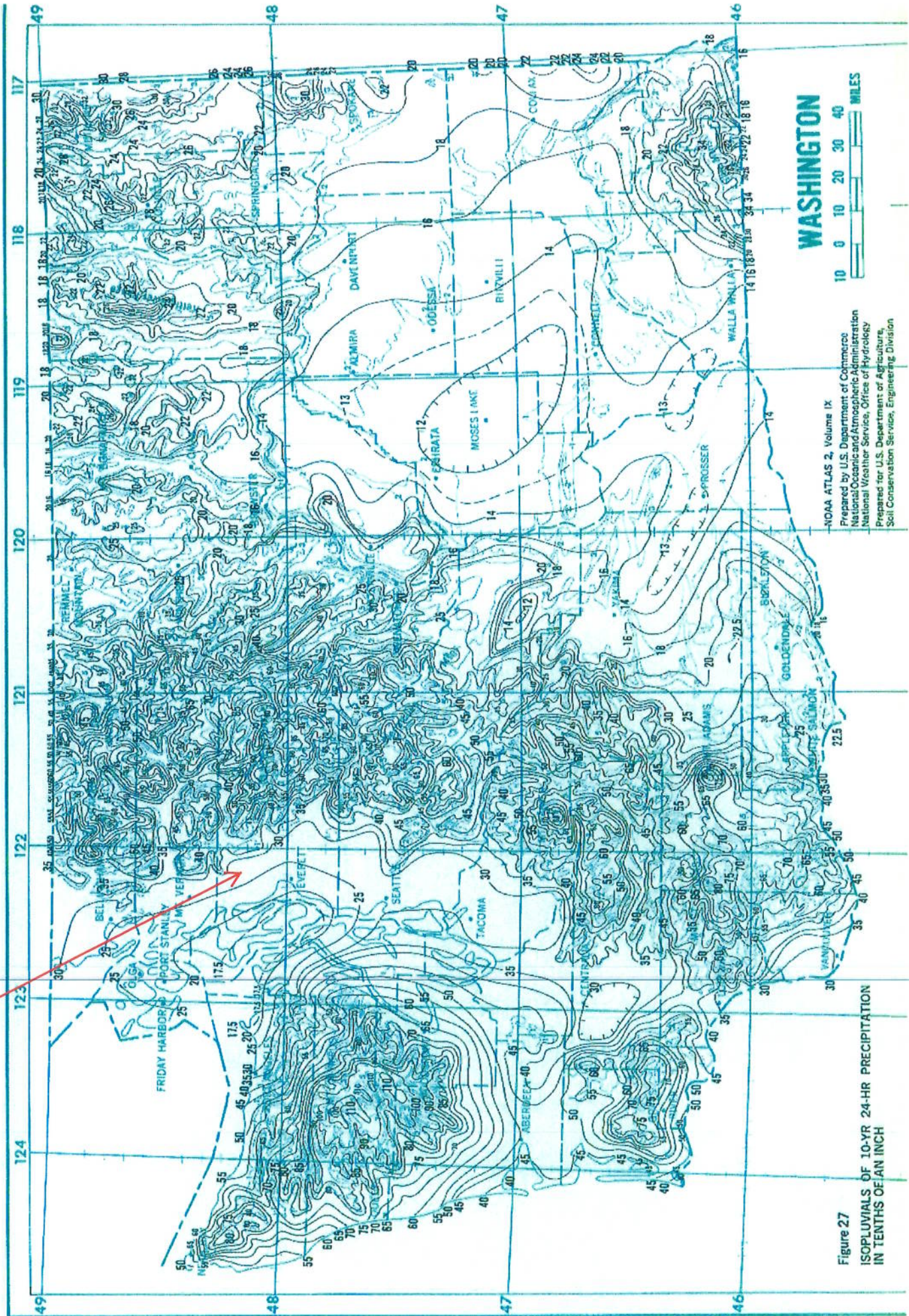
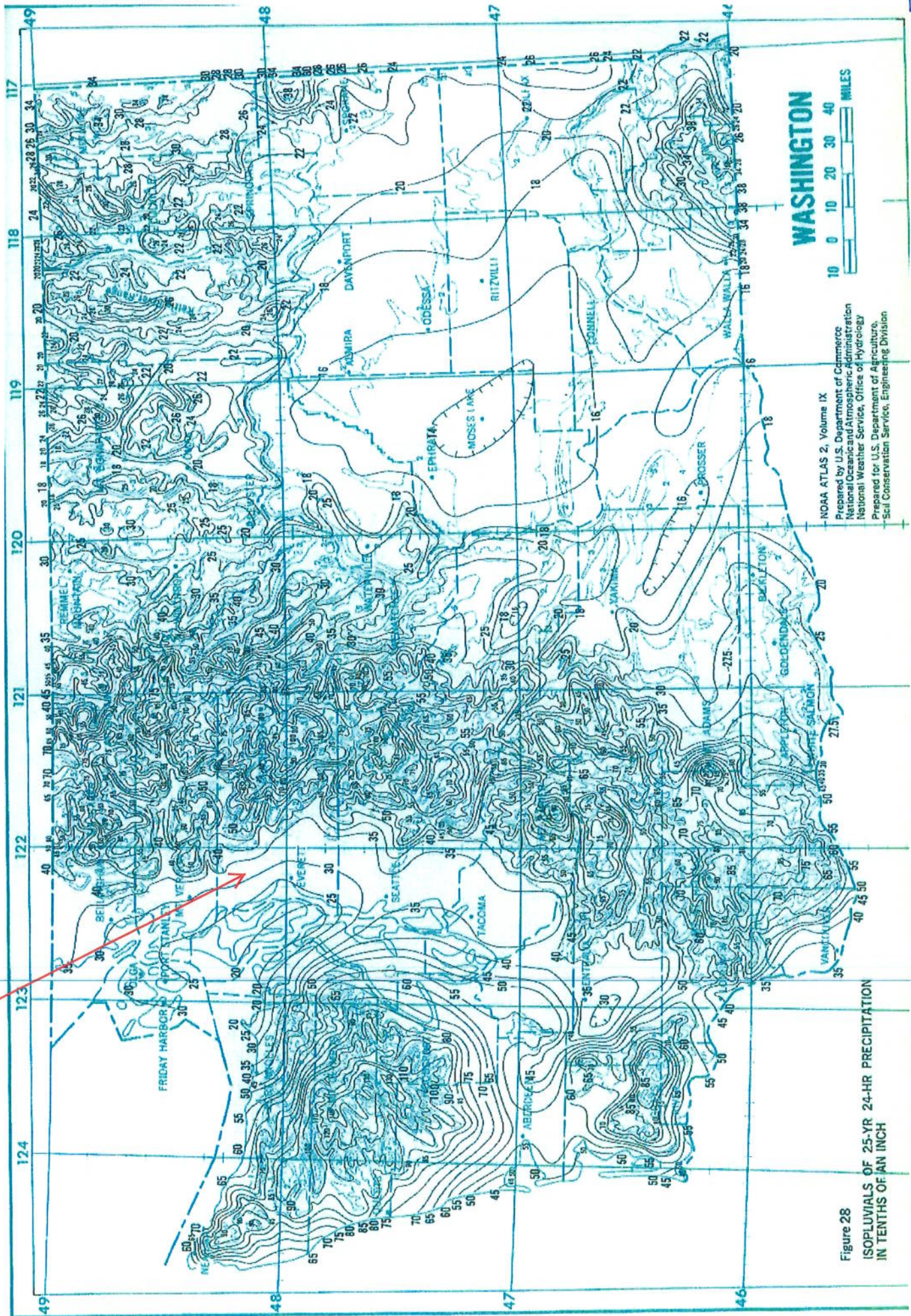


Figure 27
ISOPLUVIALS OF 10-YR 24-HR PRECIPITATION
IN TENTHS OF AN INCH

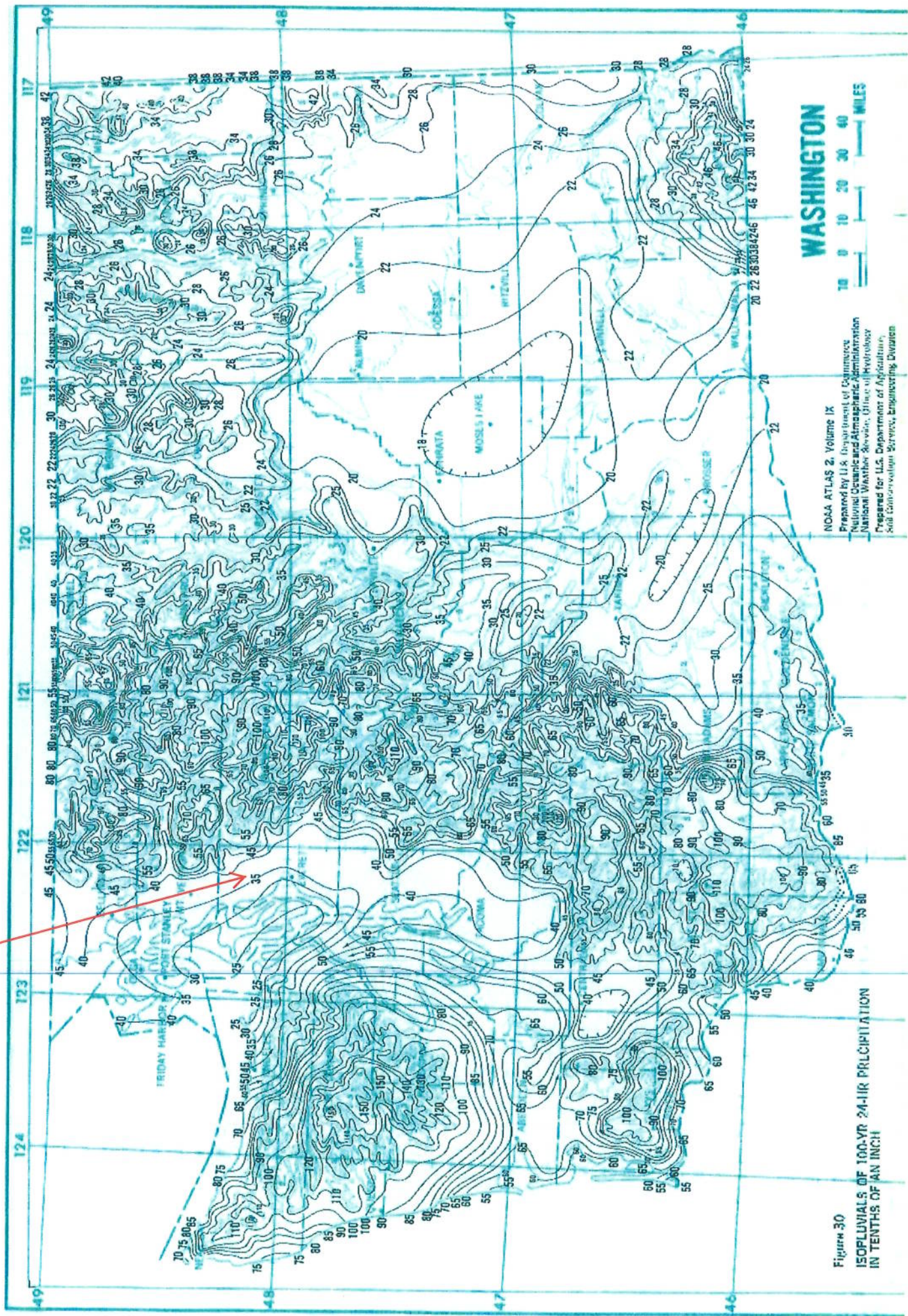
NOAA ATLAS 2, Volume IX
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

12/90

Site Location, ~3.20"

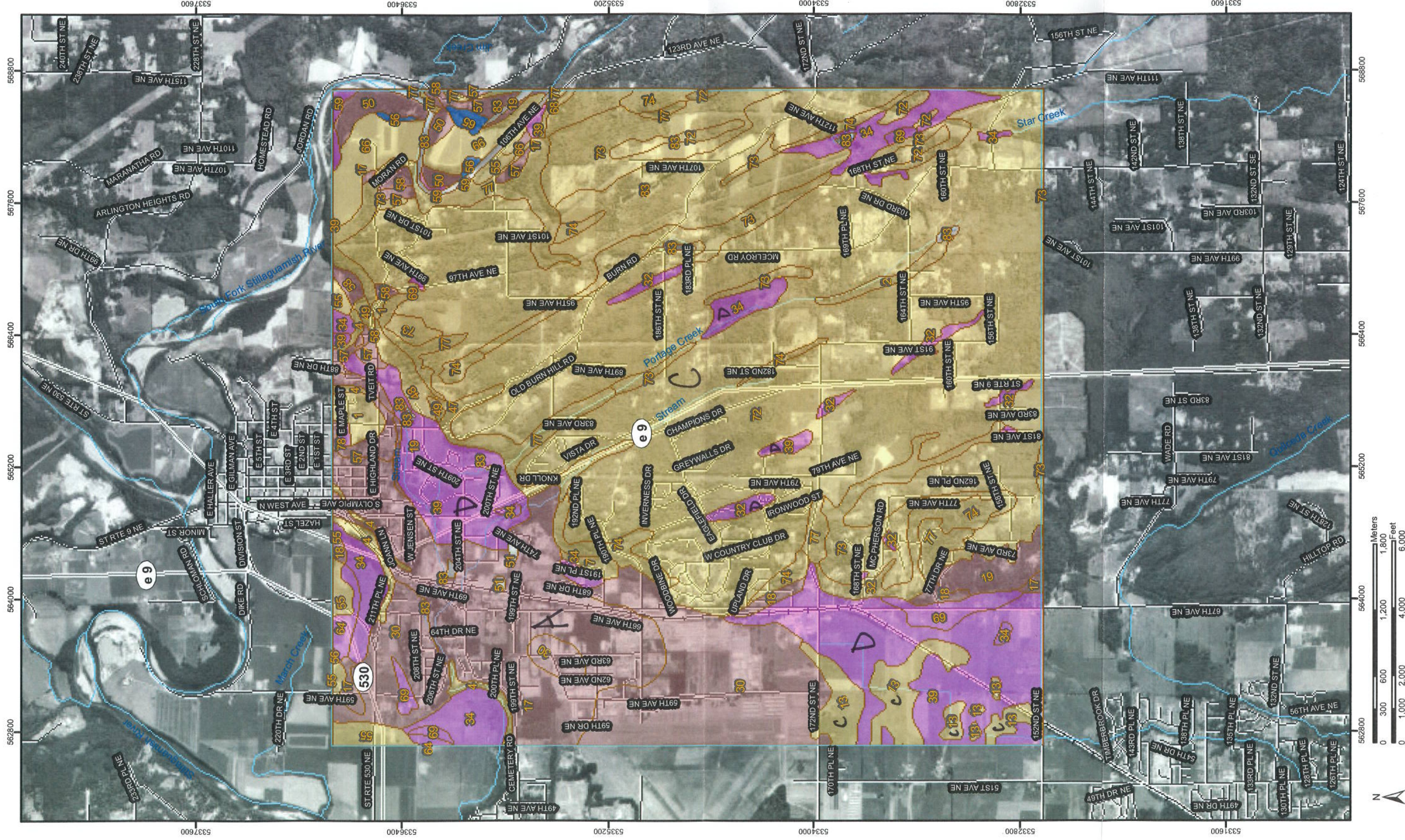


Site Location, ~3.75"



13/90

ATTACHMENT 2
Runoff Curve Number Evaluation & Hydrologic Soil Group Information



16/90

MAP LEGEND

- Area of Interest (AOI)

Area of Interest (AOI)
- Soils

Soil Map Units

A

A/D

B

B/D

C

C/D

D
- Soil Ratings

A

A/D

B

B/D

C

C/D

D
- Local Roads

Other Roads
- Political Features

Municipalities

Cities

Urban Areas
- Water Features

Oceans

Streams and Canals
- Transportation

Rails

Roads

Interstate Highways

US Routes

State Highways

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: UTM Zone 10N

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

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 4, Dec 12, 2006

Date(s) aerial images were photographed: 7/10/1990; 7/18/1990; 8/4/1990

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.

17/90

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Snohomish County Area, Washington				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Alderwood gravelly sandy loam, 2 to 8 percent slopes	C	42.6	0.4%
2	Alderwood gravelly sandy loam, 8 to 15 percent slopes	C	29.7	0.3%
4	Alderwood-Everett gravelly sandy loams, 25 to 70 percent slopes	C	59.5	0.6%
7	Bellingham silty clay loam	C	16.0	0.2%
13	Custer fine sandy loam	C	197.8	2.1%
17	Everett gravelly sandy loam, 0 to 8 percent slopes	A	811.3	8.5%
18	Everett gravelly sandy loam, 8 to 15 percent slopes	A	36.5	0.4%
19	Everett gravelly sandy loam, 15 to 25 percent slopes	A	88.2	0.9%
30	Lynnwood loamy sand, 0 to 3 percent slopes	A	748.7	7.9%
32	McKenna gravelly silt loam, 0 to 8 percent slopes	D	71.6	0.8%
34	Mukilteo muck	D	309.7	3.3%
39	Norma loam	D	754.3	7.9%
47	Pastik silt loam, 0 to 8 percent slopes	C	1.8	0.0%
48	Pastik silt loam, 8 to 25 percent slopes	C	38.5	0.4%
49	Pastik silt loam, 25 to 50 percent slopes	C	13.1	0.1%
50	Pilchuck loamy sand	A	68.5	0.7%
51	Pits		6.1	0.1%
55	Puget silty clay loam	C	81.0	0.9%
56	Puyallup fine sandy loam	B	9.9	0.1%
57	Ragnar fine sandy loam, 0 to 8 percent slopes	A	91.9	1.0%
58	Ragnar fine sandy loam, 8 to 15 percent slopes	A	37.6	0.4%

18/90

Hydrologic Soil Group— Summary by Map Unit — Snohomish County Area, Washington				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
59	Riverwash	D	18.4	0.2%
64	Snohomish silt loam	D	31.5	0.3%
65	Sulsavar gravelly loam, 0 to 8 percent slopes	B	14.3	0.2%
66	Sultan silt loam	C	169.5	1.8%
68	Sumas silt loam	C	7.8	0.1%
69	Terric Medisaprists, nearly level	D	80.1	0.8%
72	Tokul gravelly loam, 0 to 8 percent slopes	C	4,304.1	45.3%
73	Tokul gravelly loam, 8 to 15 percent slopes	C	637.9	6.7%
74	Tokul gravelly loam, 15 to 25 percent slopes	C	246.6	2.6%
77	Tokul-Winston gravelly loams, 25 to 65 percent slopes	C	408.9	4.3%
78	Urban land	D	4.9	0.1%
83	Water		53.2	0.6%
Totals for Area of Interest (AOI)			9,491.4	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: Lower

20/90

Table 2-2a Runoff curve numbers for urban areas ^{1/}

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area ^{2/}	A	B	C	D
<i>Fully developed urban areas (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) ^{3/} :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ^{4/}		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
<i>Developing urban areas</i>					
Newly graded areas					
(pervious areas only, no vegetation) ^{5/}		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

¹ Average runoff condition, and $I_a = 0.2S$.

² The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

³ CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

⁴ Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

⁵ Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Job City of Arlington

Project No. _____

Page _____ of _____

Description Prairie Creek SubbasinComputed by SMNSheet 1 of _____Date 6/12/08

Checked by _____

Date _____

Reference

Prairie:

Note: *Data used in the following calculations was obtained from existing XP-SWMM model

Total Area = 1,099.3 Acres*
Contributing

Impervious Area = 38.6%* x 1,099.3 Acres = 424.3 Acres

Pervious Area = (100% - 38.6%) x 1,099.3 Acres = 675.0 Acres

RCN for impervious area = 98, as recommended by NRCS in the TR-55 manual, Table 2-22, see attachment

RCN for pervious area $\Rightarrow$

~90% type C HSG
~5% type D HSG
~5% type A HSG } from NRCS soil survey map, see attached

Zoning breakdown $\rightarrow$ 49% residential

~~4% high density residential~~

19% commercial & industrial

5% public school

27% rural residential / mostly pasture & forest

from Comprehensive
Stormwater Plan

pg. 71

5/4/08 version

To simplify analysis, assume type C HSG only.

From TR-55 manual the following RCN's correspond to ^{each} zone type for type C HSG
Residential $\rightarrow$ 81, Commercial & Industrial $\rightarrow \frac{94+91}{2} \approx 93$, Schools $\rightarrow$ 80 (assume same as 1/2 Acre residential),
Pasture/forest $\rightarrow$ 74 for open space, grass cover > 75%.

$$\text{Weighted Avg} = \frac{(49 \times 81) + (19 \times 93) + (5 \times 80) + (27 \times 74)}{100} = 81$$

Job City of Arlington

Project No. _____

Page _____ of _____

Description Kruger Creek SubbasinComputed by SMNSheet 1 of _____Date 6/12/08

Checked by _____

Date _____

Reference

Note: * Data obtained from XP-SWMM model

Total Contributing Area = 355.50* Acres

Impervious Area = $(18\% \times 355.50) = 64.0$ Acres

Pervious Area = $(100\% - 18\%) \times 355.50 = 291.5$ Acres

RCN for impervious area = 98, as recommended by NRCS in the TR-55 manual, Table 2-22, see attachment.

RCN for pervious area $\Rightarrow$

HSB: Significant portion is type C, estimated from attached NRSC soil map.

Land zoning use summary: (For RCN, use same assumptions as Prairie Creek)

18% high density residential $\rightarrow$ RCN = 83

15% moderate density residential $\rightarrow$ RCN = 81

2% commercial $\rightarrow$ RCN = 94

less than 1% public school $\rightarrow$ RCN = 80

10% unknown $\rightarrow$ RCN = 80 (assume similar to school, open space w/ some bldgs)

55% forest $\rightarrow$ RCN = 74

Weighted Avg = $\frac{(18 \times 83) + (15 \times 81) + (2 \times 94) + (1 \times 80) + (10 \times 80) + (55 \times 74)}{101}$

= 78

Job City of Arlington

Project No. _____

Page _____ of _____

Description Upper / Lower Portage Creek SubbasinComputed by SMNSheet 1 of _____Upper Portage Creek ONLY

Checked by _____

Date 6/12/08

Date _____

Reference

Note: * Data obtained from XP-SWMM model

Total contributing area = 1,340.8* Acres (total basin area, according to
 Impervious Area = $(21.8\% \times 1,340.8)$ is 1,080 Acres so I chose value in
 = 292.3 Acres XP-SWMM model that was closest.)

Pervious Area = $(100\% - 21.8\%) \times (1,340.8) = 1,048.5$ Acres

RCN for impervious area = 98, as recommended by NRCS in the TR-55 manual, Table 2-2a, see Attachment.

RCN for pervious area $\Rightarrow$

HSB = primarily type C, estimated from attached NRCS soil map.

The following data is from pg 70 of the SCP.

Land Zoning Use Summary: (For RCN, use same assumptions as Prairie Creek)

15% residential $\rightarrow$ RCN = 81

9% commercial & industrial $\rightarrow$ RCN = 93

3% open space $\rightarrow$ RCN = 74

73% forest $\rightarrow$ RCN = 74

Weighted Avg = $\frac{(15 \times 81) + (9 \times 93) + (3 \times 74) + (73 \times 74)}{100} = 77$

ATTACHMENT 3
XPSWMM Model Results

XP-SWMM Input

25/90

```
#####
#       Data Group F1       #
# Evaporation Rate (in/day) #
#####
```

```
JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV DEC.
-----
0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
```

```
#####
# Table R1. S U B C A T C H M E N T D A T A #
#       Physical Hydrology Data       #
#####
```

Subcatchment Number	Name	Channel or inlet	Width (ft)	Area (ac)	Per- cent Imperv	Slope ft/ft	"n" Imprv	"n" Perv	Deprs Imprv	Deprs Perv	Prct Storge Strge Deten
1	Port-1#1	Port-1	47160.	4072.7	28.60	0.020	0.012	0.450	0.010	0.100	0.00
2	Port-2#1	Port-2	31560.	2525.4	30.90	0.020	0.012	0.450	0.010	0.100	0.00
3	Port-3#1	Port-3	12680.	1340.8	21.80	0.020	0.012	0.450	0.010	0.100	0.00
4	Port-4#1	Port-4	4350.0	528.00	3.40	0.020	0.012	0.450	0.010	0.100	0.00
5	Prairie-3#1	Prairie-3	17860.	1099.3	38.60	0.020	0.012	0.450	0.010	0.100	0.00
6	Prairie-2#1	Prairie-2	5570.0	348.60	38.10	0.020	0.012	0.450	0.010	0.100	0.00
7	Prairie-1#1	Prairie-1	8520.0	658.60	32.00	0.020	0.012	0.450	0.010	0.100	0.00
8	Kruger#1	Kruger	3080.0	355.50	18.00	0.020	0.012	0.450	0.010	0.100	0.00

```
Total Number of Subcatchments...      8
Total Tributary Area (acres)....    10928.90
Impervious Area (acres).....    3087.28
Pervious Area (acres).....    7841.62
Total Width (feet).....    130780.00
Percent Imperviousness.....    28.25
```


26/90

Portage Creek 4th Tier Basin
2-Yr, 24-Hr Storm

Rainfall input summary from Runoff #
#####

Total rainfall for gage # 1 is 1.8000 inches

Rainfall input summary from Runoff Continuity Check #
#####

Total rainfall read for gage # 1 is 1.8000 in
Total rainfall read for gage # 1 is 1440.00 minutes

* Table R5. CONTINUITY CHECK FOR SURFACE WATER *
* Any continuity error can be fixed by lowering the *
* wet and transition time step. The transition time *
* should not be much greater than the wet time step. *

	cubic feet	Inches over Total Basin
Total Precipitation (Rain plus Snow)	7.140943E+07	1.800
Total Infiltration	7.114620E+05	0.018
Total Evaporation	0.000000E+00	0.000
Surface Runoff from Watersheds	5.040898E+07	1.271
Total Water remaining in Surface Storage	2.030395E+07	0.512
Infiltration over the Pervious Area...	7.114620E+05	0.025

Infiltration + Evaporation +		
Surface Runoff + Snow removal +		
Water remaining in Surface Storage +		
Water remaining in Snow Cover.....	7.142439E+07	1.800
Total Precipitation + Initial Storage.	7.140943E+07	1.800

* Table R6. Continuity Check for Channel/Pipes *
* You should have zero continuity error *
* if you are not using runoff hydraulics *

	cubic feet	Inches over Total Basin
Initial Channel/Pipe Storage.....	0.000000E+00	0.000
Final Channel/Pipe Storage.....	0.000000E+00	0.000
Surface Runoff from Watersheds.....	5.040898E+07	1.271
Groundwater Subsurface Inflow or Diversion..	0.000000E+00	0.000
Evaporation Loss from Channels.....	0.000000E+00	0.000
Groundwater Flow Diverted Out of Network....	0.000000E+00	0.000
Channel/Pipe/Inlet Outflow.....	5.040898E+07	1.271
Initial Storage + Inflow.....	5.040898E+07	1.271
Final Storage + Outflow + Diverted GW.....	5.040898E+07	1.271

* Final Storage + Outflow + Evaporation - *
* Watershed Runoff - Groundwater Inflow - *
* Initial Channel/Pipe Storage *
* ----- *
* Final Storage + Outflow + Evaporation *

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Portage Creek 4th Tier Basin
2-Yr, 24-Hr Storm

Table R9. Summary Statistics for Subcatchments #
#####

Note: Total Runoff Depth includes pervious & impervious area
Pervious and Impervious Runoff Depth is only the runoff from those two areas.

Subcatchment.....	Port-1#1	Port-2#1	Port-3#1	Port-4#1	Prairie-3#1	Prairie-2#1
Area (acres).....	4072.70000	2525.40000	1340.80000	528.00000	1099.30000	348.60000
Percent Impervious.....	28.60000	30.90000	21.80000	3.40000	38.60000	38.10000
Total Rainfall (in)....	1.80000	1.80000	1.80000	1.80000	1.80000	1.80000
Max Intensity (in/hr)...	0.43380	0.43380	0.43380	0.43380	0.43380	0.43380
Pervious Area						
Total Runoff Depth (in)	1.08631	1.12553	0.97312	0.82915	1.24780	1.24058
Total Losses (in).....	0.02458	0.02459	0.02458	0.02460	0.02460	0.02460
Remaining Depth (in)...	0.68911	0.64988	0.80229	0.94625	0.52760	0.53482
Peak Runoff Rate (cfs)...	215.98839	137.33240	66.67345	27.51832	65.16328	20.55676
Total Impervious Area						
Total Runoff Depth (in)	1.75872	1.75869	1.76003	1.77967	1.75946	1.75939
Peak Runoff Rate (cfs)...	451.92914	302.72928	114.29661	7.73920	165.37305	51.74113
Impervious Area with depression storage						
Total Runoff Depth (in)	1.75872	1.75869	1.76003	1.77967	1.75946	1.75939
Peak Runoff Rate (cfs)...	451.92914	302.72928	114.29661	7.73920	165.37305	51.74113
Impervious Area without depression storage						
Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs)...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Total Area						
Total Runoff Depth (in)	1.27862	1.32118	1.14467	0.86147	1.44530	1.43825
Peak Runoff Rate (cfs)...	667.91753	440.06168	180.97006	35.25753	230.53634	72.29789
Unit Runoff (in/hr)....	0.16400	0.17425	0.13497	0.06678	0.20971	0.20739
Rational Formula						
Pervious Tc. (mins)....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Perv. Intensity (in/hr)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Pervious C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious Tc. (mins)...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Imp. Intensity (in/hr)...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area (Ha).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Tc.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Intensity.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Subcatchment.....	Prairie-1#1	Kruger#1
Area (acres).....	658.60000	355.50000
Percent Impervious.....	32.00000	18.00000
Total Rainfall (in)....	1.80000	1.80000
Max Intensity (in/hr)...	0.43380	0.43380
Pervious Area		
Total Runoff Depth (in)	1.14315	0.91821
Total Losses (in).....	0.02459	0.02459
Remaining Depth (in)...	0.63227	0.85720
Peak Runoff Rate (cfs)...	36.19755	17.34807
Total Impervious Area		
Total Runoff Depth (in)	1.75869	1.76189
Peak Runoff Rate (cfs)...	81.75536	25.28919
Impervious Area with depression storage		
Total Runoff Depth (in)	1.75869	1.76189
Peak Runoff Rate (cfs)...	81.75536	25.28919
Impervious Area without depression storage		
Total Runoff Depth (in)	0.00000	0.00000
Peak Runoff Rate (cfs)...	0.00000	0.00000
Total Area		
Total Runoff Depth (in)	1.34012	1.07007
Peak Runoff Rate (cfs)...	117.95291	42.63726
Unit Runoff (in/hr)....	0.17910	0.11994
Rational Formula		
Pervious Tc. (mins)....	0.00000	0.00000
Perv. Intensity (in/hr)	0.00000	0.00000
Pervious C	0.00000	0.00000
Impervious Tc. (mins)...	0.00000	0.00000
Imp. Intensity (in/hr)...	0.00000	0.00000
Impervious C	0.00000	0.00000
Partial Area (Ha).....	0.00000	0.00000
Partial Area Tc.....	0.00000	0.00000
Partial Area Intensity.	0.00000	0.00000

Portage Creek 4th Tier Basin
10-Yr, 24-Hr Storm

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Rainfall input summary from Runoff #
#####

Total rainfall for gage # 1 is 2.7500 inches

Rainfall input summary from Runoff Continuity Check #
#####

Total rainfall read for gage # 1 is 2.7500 in
Total rainfall read for gage # 1 is 1440.00 minutes

* Table R5. CONTINUITY CHECK FOR SURFACE WATER *
* Any continuity error can be fixed by lowering the *
* wet and transition time step. The transition time *
* should not be much greater than the wet time step. *

	cubic feet	Inches over Total Basin
Total Precipitation (Rain plus Snow)	1.090977E+08	2.750
Total Infiltration	7.203274E+05	0.018
Total Evaporation	0.000000E+00	0.000
Surface Runoff from Watersheds	8.311477E+07	2.095
Total Water remaining in Surface Storage	2.528539E+07	0.637
Infiltration over the Pervious Area...	7.203274E+05	0.025

Infiltration + Evaporation +		
Surface Runoff + Snow removal +		
Water remaining in Surface Storage +		
Water remaining in Snow Cover.....	1.091205E+08	2.751
Total Precipitation + Initial Storage.	1.090977E+08	2.750

* Table R6. Continuity Check for Channel/Pipes *
* You should have zero continuity error *
* if you are not using runoff hydraulics *

	cubic feet	Inches over Total Basin
Initial Channel/Pipe Storage.....	0.000000E+00	0.000
Final Channel/Pipe Storage.....	0.000000E+00	0.000
Surface Runoff from Watersheds.....	8.311477E+07	2.095
Groundwater Subsurface Inflow or Diversion..	0.000000E+00	0.000
Evaporation Loss from Channels.....	0.000000E+00	0.000
Groundwater Flow Diverted Out of Network....	0.000000E+00	0.000
Channel/Pipe/Inlet Outflow.....	8.311477E+07	2.095
Initial Storage + Inflow.....	8.311477E+07	2.095
Final Storage + Outflow + Diverted GW.....	8.311477E+07	2.095

* Final Storage + Outflow + Evaporation - *
* Watershed Runoff - Groundwater Inflow - *
* Initial Channel/Pipe Storage *
* ----- *
* Final Storage + Outflow + Evaporation *

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Portage Creek 4th Tier Basin
10-Yr, 24-Hr Storm

Table R9. Summary Statistics for Subcatchments #
#####

Note: Total Runoff Depth includes pervious & impervious area
Pervious and Impervious Runoff Depth is only the runoff from those two areas.

Subcatchment.....	Port-1#1	Port-2#1	Port-3#1	Port-4#1	Prairie-3#1	Prairie-2#1
Area (acres).....	4072.70000	2525.40000	1340.80000	528.00000	1099.30000	348.60000
Percent Impervious.....	28.60000	30.90000	21.80000	3.40000	38.60000	38.10000
Total Rainfall (in).....	2.75000	2.75000	2.75000	2.75000	2.75000	2.75000
Max Intensity (in/hr).....	0.66275	0.66275	0.66275	0.66275	0.66275	0.66275
Pervious Area						
Total Runoff Depth (in).....	1.87047	1.92352	1.71264	1.50097	2.08411	2.07480
Total Losses (in).....	0.02468	0.02469	0.02467	0.02467	0.02472	0.02472
Remaining Depth (in).....	0.85485	0.80178	1.01269	1.22436	0.64117	0.65048
Peak Runoff Rate (cfs).....	397.38243	252.94675	122.53288	49.52158	120.22971	37.93788
Total Impervious Area						
Total Runoff Depth (in).....	2.69988	2.69985	2.70156	2.72677	2.70083	2.70074
Peak Runoff Rate (cfs).....	710.17156	475.73399	179.17652	11.84864	259.51769	81.20691
Impervious Area with depression storage						
Total Runoff Depth (in).....	2.69988	2.69985	2.70156	2.72677	2.70083	2.70074
Peak Runoff Rate (cfs).....	710.17156	475.73399	179.17652	11.84864	259.51769	81.20691
Impervious Area without depression storage						
Total Runoff Depth (in).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Total Area						
Total Runoff Depth (in).....	2.10768	2.16341	1.92822	1.54264	2.32216	2.31329
Peak Runoff Rate (cfs).....	1107.55399	728.68074	301.70940	61.37022	379.74740	119.14480
Unit Runoff (in/hr).....	0.27195	0.28854	0.22502	0.11623	0.34544	0.34178
Rational Formula						
Pervious Tc. (mins).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Perv. Intensity (in/hr).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Pervious C.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious Tc. (mins).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Imp. Intensity (in/hr).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious C.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area (Ha).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Tc.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Intensity.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Subcatchment.....	Prairie-1#1	Kruger#1				
Area (acres).....	658.60000	355.50000				
Percent Impervious.....	32.00000	18.00000				
Total Rainfall (in).....	2.75000	2.75000				
Max Intensity (in/hr).....	0.66275	0.66275				
Pervious Area						
Total Runoff Depth (in).....	1.94709	1.63340				
Total Losses (in).....	0.02470	0.02467				
Remaining Depth (in).....	0.77821	1.09193				
Peak Runoff Rate (cfs).....	66.70151	31.67177				
Total Impervious Area						
Total Runoff Depth (in).....	2.69984	2.70395				
Peak Runoff Rate (cfs).....	128.47906	39.50579				
Impervious Area with depression storage						
Total Runoff Depth (in).....	2.69984	2.70395				
Peak Runoff Rate (cfs).....	128.47906	39.50579				
Impervious Area without depression storage						
Total Runoff Depth (in).....	0.00000	0.00000				
Peak Runoff Rate (cfs).....	0.00000	0.00000				
Total Area						
Total Runoff Depth (in).....	2.18797	1.82610				
Peak Runoff Rate (cfs).....	195.18057	71.17756				
Unit Runoff (in/hr).....	0.29636	0.20022				
Rational Formula						
Pervious Tc. (mins).....	0.00000	0.00000				
Perv. Intensity (in/hr).....	0.00000	0.00000				
Pervious C.....	0.00000	0.00000				
Impervious Tc. (mins).....	0.00000	0.00000				
Imp. Intensity (in/hr).....	0.00000	0.00000				
Impervious C.....	0.00000	0.00000				
Partial Area (Ha).....	0.00000	0.00000				
Partial Area Tc.....	0.00000	0.00000				
Partial Area Intensity.....	0.00000	0.00000				

Portage Creek 4th Tier Basin
25-Yr, 24-Hr Storm

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Rainfall input summary from Runoff #
#####

Total rainfall for gage # 1 is 3.2000 inches

Rainfall input summary from Runoff Continuity Check #
#####

Total rainfall read for gage # 1 is 3.2000 in
Total rainfall read for gage # 1 is 1440.00 minutes

* Table R5. CONTINUITY CHECK FOR SURFACE WATER *
* Any continuity error can be fixed by lowering the *
* wet and transition time step. The transition time *
* should not be much greater than the wet time step. *

	cubic feet	Inches over Total Basin
Total Precipitation (Rain plus Snow)	1.269501E+08	3.200
Total Infiltration	7.246430E+05	0.018
Total Evaporation	0.000000E+00	0.000
Surface Runoff from Watersheds	9.893804E+07	2.494
Total Water remaining in Surface Storage	2.731373E+07	0.688
Infiltration over the Pervious Area...	7.246430E+05	0.025

Infiltration + Evaporation +		
Surface Runoff + Snow removal +		
Water remaining in Surface Storage +		
Water remaining in Snow Cover.....	1.269764E+08	3.201
Total Precipitation + Initial Storage.....	1.269501E+08	3.200

* Table R6. Continuity Check for Channel/Pipes *
* You should have zero continuity error *
* if you are not using runoff hydraulics *

	cubic feet	Inches over Total Basin
Initial Channel/Pipe Storage.....	0.000000E+00	0.000
Final Channel/Pipe Storage.....	0.000000E+00	0.000
Surface Runoff from Watersheds.....	9.893804E+07	2.494
Groundwater Subsurface Inflow or Diversion..	0.000000E+00	0.000
Evaporation Loss from Channels.....	0.000000E+00	0.000
Groundwater Flow Diverted Out of Network....	0.000000E+00	0.000
Channel/Pipe/Inlet Outflow.....	9.893804E+07	2.494
Initial Storage + Inflow.....	9.893804E+07	2.494
Final Storage + Outflow + Diverted GW.....	9.893804E+07	2.494

* Final Storage + Outflow + Evaporation - *
* Watershed Runoff - Groundwater Inflow - *
* Initial Channel/Pipe Storage *
* ----- *
* Final Storage + Outflow + Evaporation *

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Portage Creek 4th Tier Basin
25-Yr, 24-Hr Storm

Table R9. Summary Statistics for Subcatchments #
#####

Note: Total Runoff Depth includes pervious & impervious area
Pervious and Impervious Runoff Depth is only the runoff from those two areas.

Subcatchment.....	Port-1#1	Port-2#1	Port-3#1	Port-4#1	Prairie-3#1	Prairie-2#1
Area (acres).....	4072.70000	2525.40000	1340.80000	528.00000	1099.30000	348.60000
Percent Impervious.....	28.60000	30.90000	21.80000	3.40000	38.60000	38.10000
Total Rainfall (in).....	3.20000	3.20000	3.20000	3.20000	3.20000	3.20000
Max Intensity (in/hr).....	0.77120	0.77120	0.77120	0.77120	0.77120	0.77120
Pervious Area						
Total Runoff Depth (in).....	2.25305	2.31154	2.07749	1.83796	2.48708	2.47696
Total Losses (in).....	0.02474	0.02475	0.02472	0.02471	0.02479	0.02479
Remaining Depth (in).....	0.92221	0.86371	1.09780	1.33733	0.68813	0.69825
Peak Runoff Rate (cfs).....	492.83581	313.64127	151.76881	61.17563	148.57742	46.90716
Total Impervious Area						
Total Runoff Depth (in).....	3.14614	3.14611	3.14798	3.17555	3.14718	3.14709
Peak Runoff Rate (cfs).....	832.78619	557.87898	209.94580	13.81854	304.18802	95.18888
Impervious Area with depression storage						
Total Runoff Depth (in).....	3.14614	3.14611	3.14798	3.17555	3.14718	3.14709
Peak Runoff Rate (cfs).....	832.78619	557.87898	209.94580	13.81854	304.18802	95.18888
Impervious Area without depression storage						
Total Runoff Depth (in).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Total Area						
Total Runoff Depth (in).....	2.50848	2.56942	2.31085	1.88343	2.74188	2.73228
Peak Runoff Rate (cfs).....	1325.62200	871.52026	361.71461	74.99417	452.76544	142.09603
Unit Runoff (in/hr).....	0.32549	0.34510	0.26978	0.14203	0.41187	0.40762
Rational Formula						
Pervious Tc. (mins).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Perv. Intensity (in/hr).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Pervious C.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious Tc. (mins).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Imp. Intensity (in/hr).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious C.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area (Ha).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Tc.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Intensity.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Subcatchment.....	Prairie-1#1	Kruger#1				
Area (acres).....	658.60000	355.50000				
Percent Impervious.....	32.00000	18.00000				
Total Rainfall (in).....	3.20000	3.20000				
Max Intensity (in/hr).....	0.77120	0.77120				
Pervious Area						
Total Runoff Depth (in).....	2.33743	1.98838				
Total Losses (in).....	0.02475	0.02471				
Remaining Depth (in).....	0.83782	1.18691				
Peak Runoff Rate (cfs).....	82.78944	39.27609				
Total Impervious Area						
Total Runoff Depth (in).....	3.14610	3.15059				
Peak Runoff Rate (cfs).....	150.66427	46.23754				
Impervious Area with depression storage						
Total Runoff Depth (in).....	3.14610	3.15059				
Peak Runoff Rate (cfs).....	150.66427	46.23754				
Impervious Area without depression storage						
Total Runoff Depth (in).....	0.00000	0.00000				
Peak Runoff Rate (cfs).....	0.00000	0.00000				
Total Area						
Total Runoff Depth (in).....	2.59620	2.19758				
Peak Runoff Rate (cfs).....	233.45371	85.51363				
Unit Runoff (in/hr).....	0.35447	0.24054				
Rational Formula						
Pervious Tc. (mins).....	0.00000	0.00000				
Perv. Intensity (in/hr).....	0.00000	0.00000				
Pervious C.....	0.00000	0.00000				
Impervious Tc. (mins).....	0.00000	0.00000				
Imp. Intensity (in/hr).....	0.00000	0.00000				
Impervious C.....	0.00000	0.00000				
Partial Area (Ha).....	0.00000	0.00000				
Partial Area Tc.....	0.00000	0.00000				
Partial Area Intensity.....	0.00000	0.00000				

Portage Creek 4th Tier Basin
100-Yr, 24-Hr Storm

32/90

Rainfall input summary from Runoff #
#####

Total rainfall for gage # 1 is 3.7500 inches

Rainfall input summary from Runoff Continuity Check #
#####

Total rainfall read for gage # 1 is 3.7500 in
Total rainfall read for gage # 1 is 1440.00 minutes

* Table R5. CONTINUITY CHECK FOR SURFACE WATER *
* Any continuity error can be fixed by lowering the *
* wet and transition time step. The transition time *
* should not be much greater than the wet time step. *

	cubic feet	Inches over Total Basin
Total Precipitation (Rain plus Snow)	1.487697E+08	3.750
Total Infiltration	7.011597E+05	0.018
Total Evaporation	0.000000E+00	0.000
Surface Runoff from Watersheds	1.184997E+08	2.987
Total Water remaining in Surface Storage	2.959940E+07	0.746
Infiltration over the Pervious Area...	7.011597E+05	0.025

Infiltration + Evaporation +		
Surface Runoff + Snow removal +		
Water remaining in Surface Storage +		
Water remaining in Snow Cover.....	1.488003E+08	3.751
Total Precipitation + Initial Storage.	1.487697E+08	3.750

* Table R6. Continuity Check for Channel/Pipes *
* You should have zero continuity error *
* if you are not using runoff hydraulics *

	cubic feet	Inches over Total Basin
Initial Channel/Pipe Storage.....	0.000000E+00	0.000
Final Channel/Pipe Storage.....	0.000000E+00	0.000
Surface Runoff from Watersheds.....	1.184997E+08	2.987
Groundwater Subsurface Inflow or Diversion...	0.000000E+00	0.000
Evaporation Loss from Channels.....	0.000000E+00	0.000
Groundwater Flow Diverted Out of Network...	0.000000E+00	0.000
Channel/Pipe/Inlet Outflow.....	1.184997E+08	2.987
Initial Storage + Inflow.....	1.184997E+08	2.987
Final Storage + Outflow + Diverted GW.....	1.184997E+08	2.987

* Final Storage + Outflow + Evaporation - *
* Watershed Runoff - Groundwater Inflow - *
* Initial Channel/Pipe Storage *
* ----- *
* Final Storage + Outflow + Evaporation *

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Portage Creek 4th Tier Basin 100-Yr, 24-Hr Storm

Table R9. Summary Statistics for Subcatchments #
#####

Note: Total Runoff Depth includes pervious & impervious area
Pervious and Impervious Runoff Depth is only the runoff from those two areas.

Subcatchment.....	Port-1#1	Port-2#1	Port-3#1	Port-4#1	Prairie-3#1	Prairie-2#1
Area (acres).....	4072.70000	2525.40000	1340.80000	528.00000	1099.30000	348.60000
Percent Impervious.....	28.60000	30.90000	21.80000	3.40000	38.60000	38.10000
Total Rainfall (in)....	3.75000	3.75000	3.75000	3.75000	3.75000	3.75000
Max Intensity (in/hr)...	0.90375	0.90375	0.90375	0.90375	0.90375	0.90375
Pervious Area						
Total Runoff Depth (in)	2.72812	2.79256	2.53296	2.26221	2.98461	2.97358
Total Losses (in).....	0.02380	0.02381	0.02377	0.02375	0.02386	0.02386
Remaining Depth (in)...	0.99808	0.93363	1.19327	1.46403	0.74153	0.75256
Peak Runoff Rate (cfs)...	616.60535	392.82432	189.64526	76.61584	184.74024	58.35463
Total Impervious Area						
Total Runoff Depth (in)	3.69186	3.69183	3.69387	3.72415	3.69300	3.69290
Peak Runoff Rate (cfs)...	982.62925	658.26639	247.52842	16.22507	358.76177	112.27111
Impervious Area with depression storage						
Total Runoff Depth (in)	3.69186	3.69183	3.69387	3.72415	3.69300	3.69290
Peak Runoff Rate (cfs)...	982.62925	658.26639	247.52842	16.22507	358.76177	112.27111
Impervious Area without depression storage						
Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs)...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Total Area						
Total Runoff Depth (in)	3.00375	3.07043	2.78604	2.31192	3.25805	3.24764
Peak Runoff Rate (cfs)...	1599.23461	1051.09071	437.17368	92.84091	543.50200	170.62573
Unit Runoff (in/hr)....	0.39267	0.41621	0.32605	0.17584	0.49441	0.48946
Rational Formula						
Pervious Tc. (mins)....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Perv. Intensity (in/hr)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Pervious C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious Tc. (mins)...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Imp. Intensity (in/hr)...	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area (Ha).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Tc.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Intensity.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Subcatchment.....	Prairie-1#1	Kruger#1				
Area (acres).....	658.60000	355.50000				
Percent Impervious.....	32.00000	18.00000				
Total Rainfall (in)....	3.75000	3.75000				
Max Intensity (in/hr)...	0.90375	0.90375				
Pervious Area						
Total Runoff Depth (in)	2.82101	2.43286				
Total Losses (in).....	0.02382	0.02376				
Remaining Depth (in)...	0.90517	1.29338				
Peak Runoff Rate (cfs)...	103.60532	49.10166				
Total Impervious Area						
Total Runoff Depth (in)	3.69182	3.69674				
Peak Runoff Rate (cfs)...	177.77638	54.73191				
Impervious Area with depression storage						
Total Runoff Depth (in)	3.69182	3.69674				
Peak Runoff Rate (cfs)...	177.77638	54.73191				
Impervious Area without depression storage						
Total Runoff Depth (in)	0.00000	0.00000				
Peak Runoff Rate (cfs)...	0.00000	0.00000				
Total Area						
Total Runoff Depth (in)	3.09967	2.66036				
Peak Runoff Rate (cfs)...	281.38170	103.83357				
Unit Runoff (in/hr)....	0.42724	0.29208				
Rational Formula						
Pervious Tc. (mins)....	0.00000	0.00000				
Perv. Intensity (in/hr)	0.00000	0.00000				
Pervious C	0.00000	0.00000				
Impervious Tc. (mins)...	0.00000	0.00000				
Imp. Intensity (in/hr)...	0.00000	0.00000				
Impervious C	0.00000	0.00000				
Partial Area (Ha).....	0.00000	0.00000				
Partial Area Tc.....	0.00000	0.00000				
Partial Area Intensity.	0.00000	0.00000				

ATTACHMENT 4
Time of Concentration
And
SBUH results for East section of Edgecomb Basin

City of Arlington
Time of Concentration
Kruger Creek Subbasin

Calculate Time of Concentration (Tc)

$$T_c = \text{Sum}(T_t)$$

Where:

$$T_t = \text{travel time (min)} = \frac{L}{(60 \times V)} \quad (\text{for shallow concentrated flow or channel flow})$$

$$T_t = \text{travel time (min)} = \frac{0.42(n_s L)^{0.8}}{(P_2)^{0.5}(s_o)^{0.4}} \quad (\text{for sheet flow})$$

Where:

$$V = \text{avg. velocity (ft/s)} = V = k(s_o)^{0.5}$$

k = time of concentration velocity factor (ft/s)

L = flow length (ft)

n_s = sheet flow Manning's effective roughness coefficient

P_2 = 2-year, 24-hour rainfall (in)

s_o = slope of hydraulic grade line (land slope, ft/ft)

	L (ft)	$k_{s/c}$	V (fps)	n_s	P_2	s_o (ft/ft)	Tt (min)
a - sheet (surface flow)	100	NA	NA	0.15	1.8	0.020	13.1
b - culvert (pipe)	100	42	5.9	NA	NA	0.020	0.3
c - channel (stream/ditch)	5,000	17	2.4	NA	NA	0.020	34.7
Total (Tc)							48.0

* All lengths are rough estimates.

36/90

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Kruger Creek Subbasin
Storm Event: 2-YEAR, 24-HOUR
Given:

Area = 355.50 acres
P_t = 1.80 inches
dt = 10 min.
T_c = 48 min.

PERVIOUS AREA
(Interim Final Cover Area)

Area = 291.50 acres

CN = 78

S = 2.82

0.2S = 0.56

IMPERVIOUS AREA
(Roads)

Area = 64.00 acres

CN = 98

S = 0.20

0.2S = 0.04

SUMMARY	
T _{pk} (hrs) =	7.83
T _c (min) =	48
Q _{pk} (cfs) =	21.28
Vol (cf) =	738,135

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution

Column (4) = Col. (3) x P_t

Column (5) = Accumulated Sum of Col. (4)

Column (6) = [If P ≤ 0.2S] = 0; Note, use PERVIOUS Area "S" value.

[If P > 0.2S] = (Col.(5) - 0.2S) / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.

Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step

Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.

Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.

Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))

Column (11) = (60.5 x Col.(10) x Total Area) / 10 (dt = 10 minutes)

Routing Constant, w = dt / (2T_c + dt) = 0.0943

Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step

+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)]

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of P _t	(4) Rainfall in.	(5) Accumulated Rainfall in.	(6) Accumulated Runoff in.	(7) Incremental Runoff in.	(8) Accumulated Runoff in.	(9) Incremental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0072	0.0072	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0072	0.0144	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0072	0.0216	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
4	40	0.0040	0.0072	0.0288	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
5	50	0.0040	0.0072	0.0360	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
6	60	0.0040	0.0072	0.0432	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
7	70	0.0040	0.0072	0.0504	0.0000	0.0000	0.0004	0.0004	0.0004	0.2	0.02
8	80	0.0040	0.0072	0.0576	0.0000	0.0000	0.0013	0.0008	0.0008	0.3	0.06
9	90	0.0040	0.0072	0.0648	0.0000	0.0000	0.0025	0.0012	0.0012	0.5	0.12
10	100	0.0040	0.0072	0.0720	0.0000	0.0000	0.0041	0.0016	0.0016	0.6	0.21
11	110	0.0050	0.0090	0.0810	0.0000	0.0000	0.0066	0.0025	0.0025	1.0	0.32
12	120	0.0050	0.0090	0.0900	0.0000	0.0000	0.0096	0.0029	0.0029	1.1	0.45
13	130	0.0050	0.0090	0.0990	0.0000	0.0000	0.0129	0.0034	0.0034	1.3	0.60
14	140	0.0050	0.0090	0.1080	0.0000	0.0000	0.0166	0.0037	0.0037	1.4	0.74
15	150	0.0050	0.0090	0.1170	0.0000	0.0000	0.0207	0.0041	0.0041	1.6	0.89
16	160	0.0050	0.0090	0.1260	0.0000	0.0000	0.0251	0.0044	0.0044	1.7	1.03
17	170	0.0060	0.0108	0.1368	0.0000	0.0000	0.0307	0.0056	0.0056	2.2	1.20
18	180	0.0060	0.0108	0.1476	0.0000	0.0000	0.0367	0.0060	0.0060	2.3	1.40
19	190	0.0060	0.0108	0.1584	0.0000	0.0000	0.0430	0.0063	0.0063	2.4	1.58
20	200	0.0060	0.0108	0.1692	0.0000	0.0000	0.0496	0.0066	0.0066	2.6	1.75
21	210	0.0060	0.0108	0.1800	0.0000	0.0000	0.0564	0.0069	0.0069	2.7	1.92
22	220	0.0060	0.0108	0.1908	0.0000	0.0000	0.0635	0.0071	0.0071	2.7	2.06
23	230	0.0070	0.0126	0.2034	0.0000	0.0000	0.0721	0.0086	0.0086	3.3	2.25
24	240	0.0070	0.0126	0.2160	0.0000	0.0000	0.0809	0.0088	0.0088	3.4	2.46
25	250	0.0070	0.0126	0.2286	0.0000	0.0000	0.0900	0.0091	0.0091	3.5	2.65
26	260	0.0070	0.0126	0.2412	0.0000	0.0000	0.0993	0.0093	0.0093	3.6	2.82
27	270	0.0070	0.0126	0.2538	0.0000	0.0000	0.1088	0.0095	0.0095	3.7	2.97
28	280	0.0070	0.0126	0.2664	0.0000	0.0000	0.1184	0.0097	0.0097	3.7	3.11
29	290	0.0082	0.0148	0.2812	0.0000	0.0000	0.1300	0.0115	0.0021	4.5	3.30
30	300	0.0082	0.0148	0.2959	0.0000	0.0000	0.1417	0.0117	0.0021	4.5	3.53
31	310	0.0082	0.0148	0.3107	0.0000	0.0000	0.1537	0.0119	0.0021	4.6	3.73
32	320	0.0082	0.0148	0.3254	0.0000	0.0000	0.1658	0.0121	0.0022	4.7	3.90
33	330	0.0082	0.0148	0.3402	0.0000	0.0000	0.1780	0.0123	0.0022	4.7	4.06
34	340	0.0082	0.0148	0.3550	0.0000	0.0000	0.1904	0.0124	0.0022	4.8	4.19
35	350	0.0095	0.0171	0.3721	0.0000	0.0000	0.2050	0.0145	0.0026	5.6	4.38
36	360	0.0095	0.0171	0.3892	0.0000	0.0000	0.2197	0.0147	0.0026	5.7	4.62
37	370	0.0095	0.0171	0.4063	0.0000	0.0000	0.2345	0.0148	0.0027	5.7	4.83
38	380	0.0095	0.0171	0.4234	0.0000	0.0000	0.2495	0.0150	0.0027	5.8	5.01
39	390	0.0095	0.0171	0.4405	0.0000	0.0000	0.2645	0.0151	0.0027	5.8	5.16
40	400	0.0095	0.0171	0.4576	0.0000	0.0000	0.2797	0.0152	0.0027	5.9	5.29
41	410	0.0134	0.0241	0.4817	0.0000	0.0000	0.3014	0.0216	0.0039	8.4	5.64
42	420	0.0134	0.0241	0.5058	0.0000	0.0000	0.3232	0.0218	0.0039	8.4	6.16
43	430	0.0134	0.0241	0.5299	0.0000	0.0000	0.3451	0.0220	0.0040	8.5	6.60
44	440	0.0180	0.0324	0.5623	0.0000	0.0000	0.3748	0.0297	0.0053	11.5	7.24
45	450	0.0180	0.0324	0.5947	0.0003	0.0003	0.4048	0.0299	0.0057	12.2	8.11
46	460	0.0340	0.0612	0.6559	0.0029	0.0026	0.4619	0.0571	0.0124	26.6	10.24
47	470	0.0540	0.0972	0.7531	0.0119	0.0090	0.5537	0.0918	0.0239	51.4	15.67
48	480	0.0270	0.0486	0.8017	0.0185	0.0066	0.6000	0.0463	0.0137	29.6	20.35 Q peak
49	490	0.0180	0.0324	0.8341	0.0236	0.0051	0.6310	0.0310	0.0088	21.0	21.28
50	500	0.0134	0.0241	0.8582	0.0278	0.0042	0.6541	0.0231	0.0076	16.3	20.79
51	510	0.0134	0.0241	0.8824	0.0323	0.0045	0.6773	0.0232	0.0079	16.9	20.01
52	520	0.0134	0.0241	0.9065	0.0371	0.0048	0.7005	0.0232	0.0081	17.4	19.47
53	530	0.0088	0.0158	0.9223	0.0404	0.0039	0.7158	0.0153	0.0055	11.7	18.55
54	540	0.0088	0.0158	0.9382	0.0438	0.0034	0.7311	0.0153	0.0056	12.0	17.29
55	550	0.0088	0.0158	0.9540	0.0474	0.0036	0.7464	0.0153	0.0057	12.2	16.31
56	560	0.0088	0.0158	0.9698	0.0510	0.0037	0.7617	0.0153	0.0058	12.4	15.55
57	570	0.0088	0.0158	0.9857	0.0548	0.0038	0.7770	0.0153	0.0059	12.6	14.98
58	580	0.0088	0.0158	1.0015	0.0587	0.0039	0.7924	0.0153	0.0060	12.8	14.55
59	590	0.0088	0.0158	1.0174	0.0628	0.0040	0.8077	0.0154	0.0061	13.0	14.25
60	600	0.0088	0.0158	1.0332	0.0669	0.0041	0.8231	0.0154	0.0062	13.3	14.04
61	610	0.0088	0.0158	1.0490	0.0711	0.0043	0.8385	0.0154	0.0063	13.5	13.91
62	620	0.0088	0.0158	1.0649	0.0755	0.0044	0.8539	0.0154	0.0063	13.7	13.84
63	630	0.0088	0.0158	1.0807	0.0800	0.0045	0.8693	0.0154	0.0064	13.9	13.83
64	640	0.0088	0.0158	1.0966	0.0846	0.0046	0.8847	0.0154	0.0065	14.0	13.85
65	650	0.0072	0.0130	1.1095	0.0884	0.0038	0.8973	0.0126	0.0054	11.6	13.66
66	660	0.0072	0.0130	1.1225	0.0923	0.0039	0.9100	0.0126	0.0055	11.8	13.29
67	670	0.0072	0.0130	1.1354	0.0962	0.0040	0.9226	0.0126	0.0055	11.9	13.01

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of Pt	(4) Incre- mental Rainfall in.	(5) Accum- lated Rainfall in.	Pervious Area (6) Accum- lated Runoff in.	(7) Incre- mental Runoff in.	Impervious Area (8) Accum- lated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
68	680	0.0072	0.0130	1.1484	0.1003	0.0040	0.9353	0.0126	0.0056	12.0	12.81
69	690	0.0072	0.0130	1.1614	0.1044	0.0041	0.9479	0.0126	0.0056	12.1	12.67
70	700	0.0072	0.0130	1.1743	0.1085	0.0042	0.9606	0.0127	0.0057	12.2	12.58
71	710	0.0072	0.0130	1.1873	0.1128	0.0042	0.9732	0.0127	0.0058	12.4	12.53
72	720	0.0072	0.0130	1.2002	0.1171	0.0043	0.9859	0.0127	0.0058	12.5	12.51
73	730	0.0072	0.0130	1.2132	0.1214	0.0044	0.9986	0.0127	0.0059	12.6	12.52
74	740	0.0072	0.0130	1.2262	0.1259	0.0044	1.0112	0.0127	0.0059	12.7	12.54
75	750	0.0072	0.0130	1.2391	0.1304	0.0045	1.0239	0.0127	0.0060	12.8	12.59
76	760	0.0072	0.0130	1.2521	0.1349	0.0046	1.0366	0.0127	0.0060	12.9	12.64
77	770	0.0057	0.0103	1.2623	0.1386	0.0036	1.0467	0.0100	0.0048	10.3	12.45
78	780	0.0057	0.0103	1.2726	0.1422	0.0037	1.0567	0.0101	0.0048	10.4	12.06
79	790	0.0057	0.0103	1.2829	0.1460	0.0037	1.0668	0.0101	0.0049	10.5	11.75
80	800	0.0057	0.0103	1.2931	0.1497	0.0038	1.0768	0.0101	0.0049	10.5	11.51
81	810	0.0057	0.0103	1.3034	0.1535	0.0038	1.0869	0.0101	0.0049	10.6	11.33
82	820	0.0057	0.0103	1.3136	0.1574	0.0038	1.0969	0.0101	0.0050	10.7	11.20
83	830	0.0057	0.0103	1.3239	0.1612	0.0039	1.1070	0.0101	0.0050	10.7	11.11
84	840	0.0057	0.0103	1.3342	0.1652	0.0039	1.1171	0.0101	0.0050	10.8	11.04
85	850	0.0057	0.0103	1.3444	0.1691	0.0039	1.1271	0.0101	0.0050	10.9	11.00
86	860	0.0057	0.0103	1.3547	0.1731	0.0040	1.1372	0.0101	0.0051	10.9	10.98
87	870	0.0057	0.0103	1.3649	0.1771	0.0040	1.1473	0.0101	0.0051	11.0	10.98
88	880	0.0057	0.0103	1.3752	0.1812	0.0041	1.1574	0.0101	0.0051	11.1	10.98
89	890	0.0050	0.0090	1.3842	0.1847	0.0036	1.1662	0.0088	0.0045	9.7	10.87
90	900	0.0050	0.0090	1.3932	0.1883	0.0036	1.1751	0.0088	0.0046	9.8	10.67
91	910	0.0050	0.0090	1.4022	0.1920	0.0036	1.1839	0.0088	0.0046	9.8	10.51
92	920	0.0050	0.0090	1.4112	0.1957	0.0037	1.1928	0.0088	0.0046	9.9	10.38
93	930	0.0050	0.0090	1.4202	0.1993	0.0037	1.2016	0.0088	0.0046	9.9	10.30
94	940	0.0050	0.0090	1.4292	0.2031	0.0037	1.2105	0.0089	0.0046	10.0	10.23
95	950	0.0050	0.0090	1.4382	0.2068	0.0037	1.2193	0.0089	0.0047	10.0	10.19
96	960	0.0050	0.0090	1.4472	0.2106	0.0038	1.2282	0.0089	0.0047	10.1	10.16
97	970	0.0050	0.0090	1.4562	0.2144	0.0038	1.2370	0.0089	0.0047	10.1	10.15
98	980	0.0050	0.0090	1.4652	0.2182	0.0038	1.2459	0.0089	0.0047	10.2	10.15
99	990	0.0050	0.0090	1.4742	0.2220	0.0038	1.2547	0.0089	0.0047	10.2	10.16
100	1000	0.0050	0.0090	1.4832	0.2259	0.0039	1.2636	0.0089	0.0048	10.3	10.17
101	1010	0.0040	0.0072	1.4904	0.2290	0.0031	1.2707	0.0071	0.0038	8.2	9.99
102	1020	0.0040	0.0072	1.4976	0.2321	0.0031	1.2778	0.0071	0.0038	8.3	9.66
103	1030	0.0040	0.0072	1.5048	0.2353	0.0031	1.2849	0.0071	0.0039	8.3	9.40
104	1040	0.0040	0.0072	1.5120	0.2384	0.0032	1.2920	0.0071	0.0039	8.3	9.20
105	1050	0.0040	0.0072	1.5192	0.2416	0.0032	1.2991	0.0071	0.0039	8.3	9.03
106	1060	0.0040	0.0072	1.5264	0.2448	0.0032	1.3062	0.0071	0.0039	8.4	8.91
107	1070	0.0040	0.0072	1.5336	0.2480	0.0032	1.3132	0.0071	0.0039	8.4	8.81
108	1080	0.0040	0.0072	1.5408	0.2512	0.0032	1.3203	0.0071	0.0039	8.4	8.73
109	1090	0.0040	0.0072	1.5480	0.2545	0.0032	1.3274	0.0071	0.0039	8.5	8.68
110	1100	0.0040	0.0072	1.5552	0.2577	0.0033	1.3345	0.0071	0.0039	8.5	8.64
111	1110	0.0040	0.0072	1.5624	0.2610	0.0033	1.3416	0.0071	0.0040	8.5	8.61
112	1120	0.0040	0.0072	1.5696	0.2643	0.0033	1.3487	0.0071	0.0040	8.5	8.59
113	1130	0.0040	0.0072	1.5768	0.2675	0.0033	1.3558	0.0071	0.0040	8.6	8.58
114	1140	0.0040	0.0072	1.5840	0.2709	0.0033	1.3629	0.0071	0.0040	8.6	8.58
115	1150	0.0040	0.0072	1.5912	0.2742	0.0033	1.3700	0.0071	0.0040	8.6	8.59
116	1160	0.0040	0.0072	1.5984	0.2775	0.0033	1.3771	0.0071	0.0040	8.6	8.59
117	1170	0.0040	0.0072	1.6056	0.2809	0.0034	1.3842	0.0071	0.0040	8.7	8.60
118	1180	0.0040	0.0072	1.6128	0.2842	0.0034	1.3914	0.0071	0.0040	8.7	8.62
119	1190	0.0040	0.0072	1.6200	0.2876	0.0034	1.3985	0.0071	0.0041	8.7	8.63
120	1200	0.0040	0.0072	1.6272	0.2910	0.0034	1.4056	0.0071	0.0041	8.7	8.65
121	1210	0.0040	0.0072	1.6344	0.2944	0.0034	1.4127	0.0071	0.0041	8.8	8.67
122	1220	0.0040	0.0072	1.6416	0.2978	0.0034	1.4198	0.0071	0.0041	8.8	8.69
123	1230	0.0040	0.0072	1.6488	0.3013	0.0034	1.4269	0.0071	0.0041	8.8	8.71
124	1240	0.0040	0.0072	1.6560	0.3047	0.0035	1.4340	0.0071	0.0041	8.8	8.73
125	1250	0.0040	0.0072	1.6632	0.3082	0.0035	1.4411	0.0071	0.0041	8.9	8.76
126	1260	0.0040	0.0072	1.6704	0.3117	0.0035	1.4482	0.0071	0.0041	8.9	8.78
127	1270	0.0040	0.0072	1.6776	0.3152	0.0035	1.4553	0.0071	0.0041	8.9	8.80
128	1280	0.0040	0.0072	1.6848	0.3187	0.0035	1.4624	0.0071	0.0042	8.9	8.82
129	1290	0.0040	0.0072	1.6920	0.3222	0.0035	1.4696	0.0071	0.0042	9.0	8.85
130	1300	0.0040	0.0072	1.6992	0.3257	0.0035	1.4767	0.0071	0.0042	9.0	8.87
131	1310	0.0040	0.0072	1.7064	0.3293	0.0035	1.4838	0.0071	0.0042	9.0	8.89
132	1320	0.0040	0.0072	1.7136	0.3328	0.0036	1.4909	0.0071	0.0042	9.0	8.92
133	1330	0.0040	0.0072	1.7208	0.3364	0.0036	1.4980	0.0071	0.0042	9.1	8.94
134	1340	0.0040	0.0072	1.7280	0.3400	0.0036	1.5051	0.0071	0.0042	9.1	8.97
135	1350	0.0040	0.0072	1.7352	0.3436	0.0036	1.5122	0.0071	0.0042	9.1	8.99
136	1360	0.0040	0.0072	1.7424	0.3472	0.0036	1.5194	0.0071	0.0042	9.1	9.01
137	1370	0.0040	0.0072	1.7496	0.3508	0.0036	1.5265	0.0071	0.0043	9.1	9.04
138	1380	0.0040	0.0072	1.7568	0.3545	0.0036	1.5336	0.0071	0.0043	9.2	9.06
139	1390	0.0040	0.0072	1.7640	0.3581	0.0037	1.5407	0.0071	0.0043	9.2	9.08
140	1400	0.0040	0.0072	1.7712	0.3618	0.0037	1.5478	0.0071	0.0043	9.2	9.11
141	1410	0.0040	0.0072	1.7784	0.3654	0.0037	1.5550	0.0071	0.0043	9.2	9.13
142	1420	0.0040	0.0072	1.7856	0.3691	0.0037	1.5621	0.0071	0.0043	9.3	9.15
143	1430	0.0040	0.0072	1.7928	0.3728	0.0037	1.5692	0.0071	0.0043	9.3	9.17
144	1440	0.0040	0.0072	1.8000	0.3766	0.0037	1.5763	0.0071	0.0043	9.3	9.20

Total Volume of Runoff¹ =

738,135 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \text{Sum} Q \times dt$$

$$V(\text{cu.ft.}) = \text{Sum} Q(\text{cu.ft/s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

38/90

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Kruger Creek Subbasin
Storm Event: 10-YEAR, 24-HOUR
Given:

Area = 355.50 acres
P_t = 2.75 inches
d_t = 10 min.
T_c = 48 min.

PERVIOUS AREA
(Interim Final Cover Area)

Area = 291.50 acres

CN = 78

S = 2.82

0.2S = 0.56

IMPERVIOUS AREA
(Roads)

Area = 64.00 acres

CN = 98

S = 0.20

0.2S = 0.04

SUMMARY	
T _{pk} (hrs) =	7.83
T _c (min) =	48
Q _{pk} (cfs) =	53.72
Vol (cf) =	1,545,251

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution

Column (4) = Col. (3) x P_t

Column (5) = Accumulated Sum of Col. (4)

Column (6) = [If P ≤ 0.2S = 0; Note, use PERVIOUS Area "S" value.

[If P > 0.2S] = (Col.(5) - 0.2S)/2 / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.

Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step

Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.

Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.

Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))

Column (11) = (60.5 x Col.(10) x Total Area) / 10 (dt = 10 minutes)

Routing Constant, w = dt / (2T_c + dt) = 0.0943

Column (12) = Col.(12) of Previous Time Step + (w x Col.(11) of Previous Time Step

+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step))

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of P _t	(4) Incremental Rainfall in.	(5) Accumulated Rainfall in.	(6) Pervious Area Accumulated Runoff in.	(7) Incremental Runoff in.	(8) ImperVIOUS Area Accumulated Runoff in.	(9) Incremental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0110	0.0110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0110	0.0220	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0110	0.0330	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
4	40	0.0040	0.0110	0.0440	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
5	50	0.0040	0.0110	0.0550	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
6	60	0.0040	0.0110	0.0660	0.0000	0.0000	0.0000	0.0000	0.0000	0.3	0.04
7	70	0.0040	0.0110	0.0770	0.0000	0.0000	0.0000	0.0000	0.0000	0.7	0.13
8	80	0.0040	0.0110	0.0880	0.0000	0.0000	0.0000	0.0000	0.0000	1.0	0.27
9	90	0.0040	0.0110	0.0990	0.0000	0.0000	0.0000	0.0000	0.0000	1.3	0.44
10	100	0.0040	0.0110	0.1100	0.0000	0.0000	0.0000	0.0000	0.0000	1.6	0.63
11	110	0.0050	0.0138	0.1238	0.0000	0.0000	0.0000	0.0000	0.0000	1.8	0.83
12	120	0.0050	0.0138	0.1376	0.0000	0.0000	0.0000	0.0000	0.0000	2.5	1.08
13	130	0.0050	0.0138	0.1514	0.0000	0.0000	0.0000	0.0000	0.0000	2.8	1.37
14	140	0.0050	0.0138	0.1652	0.0000	0.0000	0.0000	0.0000	0.0000	3.0	1.65
15	150	0.0050	0.0138	0.1790	0.0000	0.0000	0.0000	0.0000	0.0000	3.2	1.92
16	160	0.0050	0.0138	0.1928	0.0000	0.0000	0.0000	0.0000	0.0000	3.3	2.17
17	170	0.0060	0.0165	0.2093	0.0000	0.0000	0.0000	0.0000	0.0000	3.5	2.41
18	180	0.0060	0.0165	0.2258	0.0000	0.0000	0.0000	0.0000	0.0000	4.4	2.70
19	190	0.0060	0.0165	0.2423	0.0000	0.0000	0.0000	0.0000	0.0000	4.6	3.03
20	200	0.0060	0.0165	0.2588	0.0000	0.0000	0.0000	0.0000	0.0000	4.7	3.33
21	210	0.0060	0.0165	0.2753	0.0000	0.0000	0.0000	0.0000	0.0000	4.8	3.60
22	220	0.0060	0.0165	0.2918	0.0000	0.0000	0.0000	0.0000	0.0000	4.9	3.85
23	230	0.0070	0.0193	0.3108	0.0000	0.0000	0.0000	0.0000	0.0000	5.1	4.06
24	240	0.0070	0.0193	0.3300	0.0000	0.0000	0.0000	0.0000	0.0000	6.0	4.34
25	250	0.0070	0.0193	0.3493	0.0000	0.0000	0.0000	0.0000	0.0000	6.1	4.67
26	260	0.0070	0.0193	0.3685	0.0000	0.0000	0.0000	0.0000	0.0000	6.2	4.95
27	270	0.0070	0.0193	0.3878	0.0000	0.0000	0.0000	0.0000	0.0000	6.3	5.20
28	280	0.0070	0.0193	0.4070	0.0000	0.0000	0.0000	0.0000	0.0000	6.4	5.42
29	290	0.0082	0.0226	0.4296	0.0000	0.0000	0.0000	0.0000	0.0000	6.5	5.61
30	300	0.0082	0.0226	0.4521	0.0000	0.0000	0.0000	0.0000	0.0000	7.7	5.88
31	310	0.0082	0.0226	0.4747	0.0000	0.0000	0.0000	0.0000	0.0000	7.7	6.22
32	320	0.0082	0.0226	0.4972	0.0000	0.0000	0.0000	0.0000	0.0000	7.8	6.52
33	330	0.0082	0.0226	0.5198	0.0000	0.0000	0.0000	0.0000	0.0000	7.9	6.77
34	340	0.0082	0.0226	0.5423	0.0000	0.0000	0.0000	0.0000	0.0000	7.9	6.98
35	350	0.0095	0.0261	0.5684	0.0000	0.0000	0.0000	0.0000	0.0000	8.0	7.16
36	360	0.0095	0.0261	0.5946	0.0000	0.0000	0.0000	0.0000	0.0000	9.3	7.44
37	370	0.0095	0.0261	0.6207	0.0011	0.0008	0.0000	0.0000	0.0000	9.9	7.85
38	380	0.0095	0.0261	0.6468	0.0024	0.0012	0.0000	0.0000	0.0000	10.8	8.32
39	390	0.0095	0.0261	0.6729	0.0040	0.0017	0.0000	0.0000	0.0000	11.6	8.87
40	400	0.0095	0.0261	0.6991	0.0062	0.0021	0.0000	0.0000	0.0000	12.5	9.47
41	410	0.0134	0.0369	0.7359	0.0089	0.0037	0.0000	0.0000	0.0000	13.3	10.11
42	420	0.0134	0.0369	0.7728	0.0144	0.0045	0.0000	0.0000	0.0000	20.0	11.35
43	430	0.0134	0.0369	0.8096	0.0197	0.0053	0.0000	0.0000	0.0000	21.5	13.12
44	440	0.0180	0.0495	0.8591	0.0279	0.0083	0.0000	0.0000	0.0000	22.9	14.84
45	450	0.0180	0.0495	0.9086	0.0375	0.0096	0.0000	0.0000	0.0000	33.0	17.31
46	460	0.0340	0.0935	1.0021	0.0589	0.0214	0.0000	0.0000	0.0000	35.3	20.49
47	470	0.0540	0.1485	1.1506	0.1010	0.0421	0.0000	0.0000	0.0000	72.7	26.81
48	480	0.0270	0.0743	1.2249	0.1254	0.0244	0.0000	0.0000	0.0000	130.2	40.89
49	490	0.0180	0.0495	1.2744	0.1429	0.0175	0.0000	0.0000	0.0000	144.5	48.89
50	500	0.0134	0.0369	1.3112	0.1565	0.0136	0.0000	0.0000	0.0000	159.4	53.72
51	510	0.0134	0.0369	1.3481	0.1705	0.0141	0.0000	0.0000	0.0000	174.3	58.61
52	520	0.0134	0.0369	1.3849	0.1850	0.0145	0.0000	0.0000	0.0000	189.2	63.50
53	530	0.0088	0.0242	1.4091	0.1948	0.0098	0.0000	0.0000	0.0000	199.1	67.39
54	540	0.0088	0.0242	1.4333	0.2048	0.0100	0.0000	0.0000	0.0000	209.0	71.28
55	550	0.0088	0.0242	1.4575	0.2149	0.0102	0.0000	0.0000	0.0000	218.9	75.17
56	560	0.0088	0.0242	1.4817	0.2252	0.0103	0.0000	0.0000	0.0000	228.8	79.06
57	570	0.0088	0.0242	1.5059	0.2358	0.0105	0.0000	0.0000	0.0000	238.7	82.95
58	580	0.0088	0.0242	1.5301	0.2464	0.0107	0.0000	0.0000	0.0000	248.6	86.84
59	590	0.0088	0.0242	1.5543	0.2573	0.0109	0.0000	0.0000	0.0000	258.5	90.73
60	600	0.0088	0.0242	1.5785	0.2683	0.0110	0.0000	0.0000	0.0000	268.4	94.62
61	610	0.0088	0.0242	1.6027	0.2795	0.0112	0.0000	0.0000	0.0000	278.3	98.51
62	620	0.0088	0.0242	1.6269	0.2909	0.0114	0.0000	0.0000	0.0000	288.2	102.40
63	630	0.0088	0.0242	1.6511	0.3024	0.0115	0.0000	0.0000	0.0000	298.1	106.29
64	640	0.0088	0.0242	1.6753	0.3141	0.0117	0.0000	0.0000	0.0000	308.0	110.18
65	650	0.0072	0.0198	1.6951	0.3237	0.0097	0.0000	0.0000	0.0000	317.9	114.07
66	660	0.0072	0.0198	1.7149	0.3335	0.0098	0.0000	0.0000	0.0000	327.8	117.96
67	670	0.0072	0.0198	1.7347	0.3433	0.0099	0.0000	0.0000	0.0000	337.7	121.85

Q peak

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of Pt	(4) Incremental Rainfall in.	(5) Accumulated Rainfall in.	Pervious Area (6) Accumulated Runoff in.	(7) Incremental Runoff in.	Impervious Area (8) Accumulated Runoff in.	(9) Incremental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
68	680	0.0072	0.0198	1.7545	0.3533	0.0100	1.5313	0.0196	0.0117	25.1	27.51
69	690	0.0072	0.0198	1.7743	0.3634	0.0101	1.5509	0.0196	0.0118	25.3	27.08
70	700	0.0072	0.0198	1.7941	0.3735	0.0102	1.5705	0.0196	0.0118	25.5	26.76
71	710	0.0072	0.0198	1.8139	0.3838	0.0102	1.5901	0.0196	0.0119	25.7	26.54
72	720	0.0072	0.0198	1.8337	0.3941	0.0103	1.6097	0.0196	0.0120	25.8	26.39
73	730	0.0072	0.0198	1.8535	0.4045	0.0104	1.6293	0.0196	0.0121	26.0	26.30
74	740	0.0072	0.0198	1.8733	0.4150	0.0105	1.6489	0.0196	0.0122	26.1	26.25
75	750	0.0072	0.0198	1.8931	0.4256	0.0106	1.6685	0.0196	0.0122	26.3	26.25
76	760	0.0072	0.0198	1.9129	0.4363	0.0107	1.6881	0.0196	0.0123	26.5	26.27
77	770	0.0057	0.0157	1.9286	0.4449	0.0085	1.7036	0.0155	0.0098	21.1	25.79
78	780	0.0057	0.0157	1.9443	0.4535	0.0086	1.7191	0.0155	0.0098	21.1	24.91
79	790	0.0057	0.0157	1.9599	0.4621	0.0086	1.7346	0.0155	0.0099	21.2	24.21
80	800	0.0057	0.0157	1.9756	0.4708	0.0087	1.7502	0.0155	0.0099	21.3	23.66
81	810	0.0057	0.0157	1.9913	0.4795	0.0087	1.7657	0.0155	0.0100	21.4	23.23
82	820	0.0057	0.0157	2.0070	0.4883	0.0088	1.7812	0.0155	0.0100	21.5	22.90
83	830	0.0057	0.0157	2.0226	0.4971	0.0088	1.7968	0.0155	0.0100	21.6	22.64
84	840	0.0057	0.0157	2.0383	0.5060	0.0089	1.8123	0.0155	0.0101	21.7	22.46
85	850	0.0057	0.0157	2.0540	0.5150	0.0089	1.8279	0.0155	0.0101	21.8	22.32
86	860	0.0057	0.0157	2.0697	0.5240	0.0090	1.8434	0.0155	0.0102	21.9	22.23
87	870	0.0057	0.0157	2.0853	0.5330	0.0090	1.8589	0.0155	0.0102	22.0	22.17
88	880	0.0057	0.0157	2.1010	0.5421	0.0091	1.8745	0.0155	0.0102	22.0	22.14
89	890	0.0050	0.0138	2.1148	0.5501	0.0080	1.8881	0.0136	0.0090	19.4	21.87
90	900	0.0050	0.0138	2.1285	0.5581	0.0080	1.9018	0.0136	0.0091	19.5	21.41
91	910	0.0050	0.0138	2.1423	0.5662	0.0081	1.9154	0.0136	0.0091	19.5	21.05
92	920	0.0050	0.0138	2.1560	0.5743	0.0081	1.9291	0.0136	0.0091	19.6	20.77
93	930	0.0050	0.0138	2.1698	0.5825	0.0081	1.9427	0.0136	0.0091	19.7	20.55
94	940	0.0050	0.0138	2.1835	0.5907	0.0082	1.9563	0.0136	0.0092	19.7	20.39
95	950	0.0050	0.0138	2.1973	0.5989	0.0082	1.9700	0.0136	0.0092	19.8	20.27
96	960	0.0050	0.0138	2.2110	0.6071	0.0083	1.9836	0.0136	0.0092	19.8	20.18
97	970	0.0050	0.0138	2.2248	0.6154	0.0083	1.9973	0.0136	0.0093	19.9	20.12
98	980	0.0050	0.0138	2.2385	0.6237	0.0083	2.0109	0.0137	0.0093	20.0	20.09
99	990	0.0050	0.0138	2.2523	0.6321	0.0084	2.0246	0.0137	0.0093	20.0	20.07
100	1000	0.0050	0.0138	2.2660	0.6405	0.0084	2.0382	0.0137	0.0093	20.1	20.06
101	1010	0.0040	0.0110	2.2770	0.6472	0.0067	2.0492	0.0109	0.0075	16.1	19.69
102	1020	0.0040	0.0110	2.2880	0.6540	0.0068	2.0601	0.0109	0.0075	16.1	19.02
103	1030	0.0040	0.0110	2.2990	0.6607	0.0068	2.0710	0.0109	0.0075	16.2	18.48
104	1040	0.0040	0.0110	2.3100	0.6675	0.0068	2.0819	0.0109	0.0075	16.2	18.05
105	1050	0.0040	0.0110	2.3210	0.6743	0.0068	2.0929	0.0109	0.0076	16.2	17.70
106	1060	0.0040	0.0110	2.3320	0.6812	0.0068	2.1038	0.0109	0.0076	16.3	17.43
107	1070	0.0040	0.0110	2.3430	0.6880	0.0069	2.1147	0.0109	0.0076	16.3	17.22
108	1080	0.0040	0.0110	2.3540	0.6949	0.0069	2.1256	0.0109	0.0076	16.4	17.05
109	1090	0.0040	0.0110	2.3650	0.7018	0.0069	2.1366	0.0109	0.0076	16.4	16.92
110	1100	0.0040	0.0110	2.3760	0.7087	0.0069	2.1475	0.0109	0.0076	16.4	16.82
111	1110	0.0040	0.0110	2.3870	0.7156	0.0069	2.1584	0.0109	0.0077	16.5	16.75
112	1120	0.0040	0.0110	2.3980	0.7226	0.0070	2.1694	0.0109	0.0077	16.5	16.70
113	1130	0.0040	0.0110	2.4090	0.7295	0.0070	2.1803	0.0109	0.0077	16.5	16.66
114	1140	0.0040	0.0110	2.4200	0.7365	0.0070	2.1912	0.0109	0.0077	16.6	16.64
115	1150	0.0040	0.0110	2.4310	0.7435	0.0070	2.2022	0.0109	0.0077	16.6	16.63
116	1160	0.0040	0.0110	2.4420	0.7506	0.0070	2.2131	0.0109	0.0077	16.6	16.62
117	1170	0.0040	0.0110	2.4530	0.7576	0.0070	2.2240	0.0109	0.0077	16.7	16.63
118	1180	0.0040	0.0110	2.4640	0.7647	0.0071	2.2350	0.0109	0.0078	16.7	16.64
119	1190	0.0040	0.0110	2.4750	0.7718	0.0071	2.2459	0.0109	0.0078	16.7	16.65
120	1200	0.0040	0.0110	2.4860	0.7789	0.0071	2.2568	0.0109	0.0078	16.8	16.67
121	1210	0.0040	0.0110	2.4970	0.7860	0.0071	2.2678	0.0109	0.0078	16.8	16.69
122	1220	0.0040	0.0110	2.5080	0.7931	0.0071	2.2787	0.0109	0.0078	16.8	16.71
123	1230	0.0040	0.0110	2.5190	0.8003	0.0072	2.2896	0.0109	0.0078	16.9	16.73
124	1240	0.0040	0.0110	2.5300	0.8074	0.0072	2.3006	0.0109	0.0078	16.9	16.76
125	1250	0.0040	0.0110	2.5410	0.8146	0.0072	2.3115	0.0109	0.0079	16.9	16.78
126	1260	0.0040	0.0110	2.5520	0.8218	0.0072	2.3224	0.0109	0.0079	16.9	16.81
127	1270	0.0040	0.0110	2.5630	0.8291	0.0072	2.3334	0.0109	0.0079	17.0	16.84
128	1280	0.0040	0.0110	2.5740	0.8363	0.0072	2.3443	0.0109	0.0079	17.0	16.87
129	1290	0.0040	0.0110	2.5850	0.8436	0.0073	2.3553	0.0109	0.0079	17.0	16.90
130	1300	0.0040	0.0110	2.5960	0.8508	0.0073	2.3662	0.0109	0.0079	17.1	16.93
131	1310	0.0040	0.0110	2.6070	0.8581	0.0073	2.3771	0.0109	0.0079	17.1	16.95
132	1320	0.0040	0.0110	2.6180	0.8654	0.0073	2.3881	0.0109	0.0080	17.1	16.98
133	1330	0.0040	0.0110	2.6290	0.8728	0.0073	2.3990	0.0109	0.0080	17.2	17.01
134	1340	0.0040	0.0110	2.6400	0.8801	0.0073	2.4100	0.0109	0.0080	17.2	17.04
135	1350	0.0040	0.0110	2.6510	0.8875	0.0074	2.4209	0.0109	0.0080	17.2	17.07
136	1360	0.0040	0.0110	2.6620	0.8948	0.0074	2.4318	0.0109	0.0080	17.2	17.10
137	1370	0.0040	0.0110	2.6730	0.9022	0.0074	2.4428	0.0109	0.0080	17.3	17.13
138	1380	0.0040	0.0110	2.6840	0.9096	0.0074	2.4537	0.0109	0.0080	17.3	17.16
139	1390	0.0040	0.0110	2.6950	0.9171	0.0074	2.4647	0.0109	0.0081	17.3	17.19
140	1400	0.0040	0.0110	2.7060	0.9245	0.0074	2.4756	0.0109	0.0081	17.4	17.22
141	1410	0.0040	0.0110	2.7170	0.9319	0.0075	2.4866	0.0109	0.0081	17.4	17.25
142	1420	0.0040	0.0110	2.7280	0.9394	0.0075	2.4975	0.0109	0.0081	17.4	17.28
143	1430	0.0040	0.0110	2.7390	0.9469	0.0075	2.5085	0.0109	0.0081	17.4	17.30
144	1440	0.0040	0.0110	2.7500	0.9544	0.0075	2.5194	0.0109	0.0081	17.5	17.33

Total Volume of Runoff = 1,545,251 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \sum Q \times dt$$

$$V(\text{cu.ft.}) = \sum Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Kruger Creek Subbasin
Storm Event: 25-YEAR, 24-HOUR
Given:

Area = 355.50 acres
P_t = 3.20 inches
d_t = 10 min.
T_c = 48 min.

PERVIOUS AREA

(Interim Final Cover Area)

Area = 291.50 acres
CN = 78
S = 2.82
0.2S = 0.56

IMPERVIOUS AREA

(Roads)

Area = 64.00 acres
CN = 98
S = 0.20
0.2S = 0.04

SUMMARY	
T _{pk} (hrs) =	7.83
T _c (min) =	48
Q _{pk} (cfs) =	72.05
Vol (cf) =	1,975,346

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution
Column (4) = Col. (3) x P_t
Column (5) = Accumulated Sum of Col. (4)
Column (6) = [If P <= 0.2S] = 0; Note, use PERVIOUS Area "S" value.
[If P > 0.2S] = (Col.(5) - 0.2S) * 2 / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.
Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step
Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.
Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.
Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))
Column (11) = (80.5 x Col.(10) x Total area) / 10 (dt = 10 minutes)
Routing Constant, w = dt / (2T_c + dt) = 0.0943
Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step + Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of P _t	(4) Incremental Rainfall in.	(5) Accumulated Rainfall in.	(6) Pervious Area Accumulated Runoff in.	(7) Incremental Runoff in.	(8) ImperVIOUS Area Accumulated Runoff in.	(9) Incremental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0128	0.0128	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0128	0.0256	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0128	0.0384	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
4	40	0.0040	0.0128	0.0512	0.0000	0.0000	0.0000	0.0000	0.0000	0.2	0.02
5	50	0.0040	0.0128	0.0640	0.0000	0.0000	0.0024	0.0019	0.0003	0.7	0.10
6	60	0.0040	0.0128	0.0768	0.0000	0.0000	0.0054	0.0030	0.0005	1.2	0.26
7	70	0.0040	0.0128	0.0896	0.0000	0.0000	0.0094	0.0040	0.0007	1.6	0.47
8	80	0.0040	0.0128	0.1024	0.0000	0.0000	0.0143	0.0049	0.0009	1.9	0.70
9	90	0.0040	0.0128	0.1152	0.0000	0.0000	0.0199	0.0056	0.0010	2.2	0.95
10	100	0.0040	0.0128	0.1280	0.0000	0.0000	0.0261	0.0062	0.0011	2.4	1.21
11	110	0.0050	0.0160	0.1440	0.0000	0.0000	0.0347	0.0086	0.0015	3.3	1.52
12	120	0.0050	0.0160	0.1600	0.0000	0.0000	0.0439	0.0093	0.0017	3.6	1.88
13	130	0.0050	0.0160	0.1760	0.0000	0.0000	0.0539	0.0099	0.0018	3.8	2.23
14	140	0.0050	0.0160	0.1920	0.0000	0.0000	0.0643	0.0105	0.0019	4.1	2.55
15	150	0.0050	0.0160	0.2080	0.0000	0.0000	0.0753	0.0109	0.0020	4.2	2.85
16	160	0.0050	0.0160	0.2240	0.0000	0.0000	0.0866	0.0114	0.0020	4.4	3.13
17	170	0.0060	0.0192	0.2432	0.0000	0.0000	0.1008	0.0141	0.0025	5.5	3.47
18	180	0.0060	0.0192	0.2624	0.0000	0.0000	0.1153	0.0146	0.0026	5.6	3.86
19	190	0.0060	0.0192	0.2816	0.0000	0.0000	0.1303	0.0150	0.0027	5.8	4.22
20	200	0.0060	0.0192	0.3008	0.0000	0.0000	0.1457	0.0153	0.0028	5.9	4.53
21	210	0.0060	0.0192	0.3200	0.0000	0.0000	0.1613	0.0156	0.0028	6.1	4.80
22	220	0.0060	0.0192	0.3392	0.0000	0.0000	0.1772	0.0159	0.0029	6.2	5.05
23	230	0.0070	0.0224	0.3616	0.0000	0.0000	0.1961	0.0189	0.0034	7.3	5.37
24	240	0.0070	0.0224	0.3840	0.0000	0.0000	0.2152	0.0192	0.0034	7.4	5.74
25	250	0.0070	0.0224	0.4064	0.0000	0.0000	0.2346	0.0194	0.0035	7.5	6.07
26	260	0.0070	0.0224	0.4288	0.0000	0.0000	0.2542	0.0196	0.0035	7.6	6.35
27	270	0.0070	0.0224	0.4512	0.0000	0.0000	0.2741	0.0198	0.0036	7.7	6.59
28	280	0.0070	0.0224	0.4736	0.0000	0.0000	0.2941	0.0200	0.0036	7.8	6.80
29	290	0.0082	0.0262	0.4998	0.0000	0.0000	0.3178	0.0237	0.0043	9.2	7.12
30	300	0.0082	0.0262	0.5261	0.0000	0.0000	0.3416	0.0238	0.0043	9.2	7.51
31	310	0.0082	0.0262	0.5523	0.0000	0.0000	0.3656	0.0240	0.0043	9.3	7.84
32	320	0.0082	0.0262	0.5786	0.0001	0.0001	0.3898	0.0242	0.0044	9.5	8.13
33	330	0.0082	0.0262	0.6048	0.0006	0.0005	0.4141	0.0243	0.0048	10.3	8.47
34	340	0.0082	0.0262	0.6310	0.0016	0.0010	0.4386	0.0244	0.0052	11.2	8.90
35	350	0.0095	0.0304	0.6614	0.0032	0.0017	0.4670	0.0285	0.0065	14.0	9.60
36	360	0.0095	0.0304	0.6918	0.0055	0.0023	0.4956	0.0286	0.0070	15.1	10.53
37	370	0.0095	0.0304	0.7222	0.0084	0.0029	0.5244	0.0287	0.0075	16.2	11.50
38	380	0.0095	0.0304	0.7526	0.0118	0.0034	0.5532	0.0288	0.0080	17.2	12.47
39	390	0.0095	0.0304	0.7830	0.0158	0.0040	0.5822	0.0289	0.0085	18.2	13.46
40	400	0.0095	0.0304	0.8134	0.0203	0.0045	0.6112	0.0290	0.0089	19.1	14.44
41	410	0.0134	0.0429	0.8563	0.0274	0.0072	0.6523	0.0411	0.0133	28.6	16.22
42	420	0.0134	0.0429	0.8992	0.0356	0.0082	0.6935	0.0412	0.0141	30.3	18.72
43	430	0.0134	0.0429	0.9421	0.0447	0.0091	0.7349	0.0414	0.0149	32.0	21.07
44	440	0.0180	0.0576	0.9997	0.0583	0.0136	0.7906	0.0557	0.0212	45.6	24.41
45	450	0.0180	0.0576	1.0573	0.0734	0.0151	0.8465	0.0559	0.0225	48.3	26.67
46	460	0.0340	0.1088	1.1661	0.1059	0.0325	0.9525	0.1060	0.0457	98.3	37.09
47	470	0.0540	0.1728	1.3389	0.1670	0.0611	1.1217	0.1692	0.0805	173.2	55.71
48	480	0.0270	0.0864	1.4253	0.2014	0.0345	1.2066	0.0849	0.0436	93.7	70.38 Q peak
49	490	0.0180	0.0576	1.4829	0.2258	0.0243	1.2633	0.0567	0.0301	64.8	72.05
50	500	0.0134	0.0429	1.5258	0.2445	0.0188	1.3055	0.0422	0.0230	49.4	69.24
51	510	0.0134	0.0429	1.5686	0.2638	0.0193	1.3478	0.0423	0.0234	50.4	65.59
52	520	0.0134	0.0429	1.6115	0.2836	0.0198	1.3901	0.0423	0.0239	51.3	62.82
53	530	0.0088	0.0282	1.6397	0.2969	0.0133	1.4179	0.0278	0.0159	34.2	59.03
54	540	0.0088	0.0282	1.6678	0.3104	0.0135	1.4457	0.0278	0.0161	34.6	54.39
55	550	0.0088	0.0282	1.6960	0.3242	0.0137	1.4735	0.0278	0.0163	35.0	50.69
56	560	0.0088	0.0282	1.7242	0.3381	0.0139	1.5013	0.0278	0.0164	35.3	47.75
57	570	0.0088	0.0282	1.7523	0.3522	0.0141	1.5292	0.0278	0.0166	35.7	45.44
58	580	0.0088	0.0282	1.7805	0.3665	0.0143	1.5570	0.0278	0.0168	36.0	43.63
59	590	0.0088	0.0282	1.8086	0.3810	0.0145	1.5849	0.0279	0.0169	36.4	42.23
60	600	0.0088	0.0282	1.8368	0.3957	0.0147	1.6127	0.0279	0.0171	36.7	41.16
61	610	0.0088	0.0282	1.8650	0.4106	0.0149	1.6406	0.0279	0.0172	37.0	40.35
62	620	0.0088	0.0282	1.8931	0.4257	0.0151	1.6685	0.0279	0.0174	37.4	39.75
63	630	0.0088	0.0282	1.9213	0.4409	0.0152	1.6964	0.0279	0.0175	37.7	39.33
64	640	0.0088	0.0282	1.9494	0.4563	0.0154	1.7243	0.0279	0.0177	38.0	39.05
65	650	0.0072	0.0230	1.9725	0.4690	0.0127	1.7471	0.0228	0.0146	31.3	38.21
66	660	0.0072	0.0230	1.9955	0.4819	0.0128	1.7699	0.0228	0.0146	31.5	36.93
67	670	0.0072	0.0230	2.0186	0.4948	0.0130	1.7928	0.0228	0.0147	31.7	35.92

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of Pt	(4) Incremental Rainfall in.	(5) Accumulated Rainfall in.	Pervious Area (6) Accumulated Runoff in.	(7) Incremental Runoff in.	Impervious Area (8) Accumulated Runoff in.	(9) Incremental Runoff in.	(10) Total Runoff in.	(11) Instant hydrograph cfs	(12) design hydrograph cfs
68	680	0.0072	0.0230	2.0416	0.5079	0.0131	1.8156	0.0228	0.0148	31.9	35.14
69	690	0.0072	0.0230	2.0646	0.5211	0.0132	1.8384	0.0228	0.0149	32.1	34.54
70	700	0.0072	0.0230	2.0877	0.5344	0.0133	1.8613	0.0228	0.0150	32.3	34.10
71	710	0.0072	0.0230	2.1107	0.5477	0.0134	1.8841	0.0229	0.0151	32.4	33.77
72	720	0.0072	0.0230	2.1338	0.5612	0.0135	1.9070	0.0229	0.0152	32.6	33.53
73	730	0.0072	0.0230	2.1568	0.5748	0.0136	1.9299	0.0229	0.0153	32.8	33.38
74	740	0.0072	0.0230	2.1798	0.5885	0.0137	1.9527	0.0229	0.0153	33.0	33.29
75	750	0.0072	0.0230	2.2029	0.6022	0.0138	1.9756	0.0229	0.0154	33.1	33.24
76	760	0.0072	0.0230	2.2259	0.6161	0.0139	1.9985	0.0229	0.0155	33.3	33.24
77	770	0.0057	0.0182	2.2442	0.6272	0.0110	2.0166	0.0181	0.0123	26.5	32.61
78	780	0.0057	0.0182	2.2624	0.6383	0.0111	2.0347	0.0181	0.0124	26.6	31.47
79	790	0.0057	0.0182	2.2806	0.6494	0.0112	2.0528	0.0181	0.0124	26.7	30.56
80	800	0.0057	0.0182	2.2989	0.6607	0.0112	2.0709	0.0181	0.0125	26.8	29.84
81	810	0.0057	0.0182	2.3171	0.6719	0.0113	2.0890	0.0181	0.0125	26.9	29.28
82	820	0.0057	0.0182	2.3354	0.6833	0.0113	2.1071	0.0181	0.0126	27.0	28.84
83	830	0.0057	0.0182	2.3536	0.6946	0.0114	2.1253	0.0181	0.0126	27.1	28.50
84	840	0.0057	0.0182	2.3718	0.7061	0.0114	2.1434	0.0181	0.0126	27.2	28.24
85	850	0.0057	0.0182	2.3901	0.7176	0.0115	2.1615	0.0181	0.0127	27.3	28.05
86	860	0.0057	0.0182	2.4083	0.7291	0.0115	2.1796	0.0181	0.0127	27.4	27.92
87	870	0.0057	0.0182	2.4266	0.7407	0.0116	2.1977	0.0181	0.0128	27.5	27.82
88	880	0.0057	0.0182	2.4448	0.7524	0.0116	2.2159	0.0181	0.0128	27.6	27.77
89	890	0.0050	0.0160	2.4608	0.7626	0.0103	2.2318	0.0159	0.0113	24.3	27.42
90	900	0.0050	0.0160	2.4768	0.7729	0.0103	2.2477	0.0159	0.0113	24.3	26.83
91	910	0.0050	0.0160	2.4928	0.7833	0.0103	2.2636	0.0159	0.0113	24.4	26.36
92	920	0.0050	0.0160	2.5088	0.7936	0.0104	2.2795	0.0159	0.0114	24.5	25.99
93	930	0.0050	0.0160	2.5248	0.8041	0.0104	2.2954	0.0159	0.0114	24.5	25.71
94	940	0.0050	0.0160	2.5408	0.8145	0.0105	2.3113	0.0159	0.0114	24.6	25.49
95	950	0.0050	0.0160	2.5568	0.8250	0.0105	2.3272	0.0159	0.0115	24.7	25.33
96	960	0.0050	0.0160	2.5728	0.8355	0.0105	2.3431	0.0159	0.0115	24.7	25.21
97	970	0.0050	0.0160	2.5888	0.8461	0.0106	2.3590	0.0159	0.0115	24.8	25.12
98	980	0.0050	0.0160	2.6048	0.8567	0.0106	2.3749	0.0159	0.0116	24.8	25.06
99	990	0.0050	0.0160	2.6208	0.8673	0.0106	2.3909	0.0159	0.0116	24.9	25.03
100	1000	0.0050	0.0160	2.6368	0.8780	0.0107	2.4068	0.0159	0.0116	25.0	25.01
101	1010	0.0040	0.0128	2.6496	0.8865	0.0086	2.4195	0.0127	0.0093	20.0	24.54
102	1020	0.0040	0.0128	2.6624	0.8951	0.0086	2.4322	0.0127	0.0093	20.1	23.69
103	1030	0.0040	0.0128	2.6752	0.9037	0.0086	2.4450	0.0127	0.0093	20.1	23.01
104	1040	0.0040	0.0128	2.6880	0.9123	0.0086	2.4577	0.0127	0.0094	20.1	22.46
105	1050	0.0040	0.0128	2.7008	0.9210	0.0086	2.4704	0.0127	0.0094	20.2	22.03
106	1060	0.0040	0.0128	2.7136	0.9296	0.0087	2.4832	0.0127	0.0094	20.2	21.68
107	1070	0.0040	0.0128	2.7264	0.9383	0.0087	2.4959	0.0127	0.0094	20.3	21.41
108	1080	0.0040	0.0128	2.7392	0.9470	0.0087	2.5087	0.0127	0.0094	20.3	21.20
109	1090	0.0040	0.0128	2.7520	0.9558	0.0087	2.5214	0.0127	0.0095	20.3	21.03
110	1100	0.0040	0.0128	2.7648	0.9645	0.0088	2.5341	0.0127	0.0095	20.4	20.90
111	1110	0.0040	0.0128	2.7776	0.9733	0.0088	2.5469	0.0127	0.0095	20.4	20.80
112	1120	0.0040	0.0128	2.7904	0.9821	0.0088	2.5596	0.0127	0.0095	20.4	20.73
113	1130	0.0040	0.0128	2.8032	0.9909	0.0088	2.5723	0.0127	0.0095	20.5	20.68
114	1140	0.0040	0.0128	2.8160	0.9997	0.0088	2.5851	0.0127	0.0095	20.5	20.64
115	1150	0.0040	0.0128	2.8288	1.0086	0.0089	2.5978	0.0127	0.0096	20.5	20.62
116	1160	0.0040	0.0128	2.8416	1.0175	0.0089	2.6106	0.0127	0.0096	20.6	20.61
117	1170	0.0040	0.0128	2.8544	1.0263	0.0089	2.6233	0.0127	0.0096	20.6	20.61
118	1180	0.0040	0.0128	2.8672	1.0353	0.0089	2.6360	0.0127	0.0096	20.6	20.61
119	1190	0.0040	0.0128	2.8800	1.0442	0.0089	2.6488	0.0127	0.0096	20.7	20.62
120	1200	0.0040	0.0128	2.8928	1.0531	0.0089	2.6615	0.0127	0.0096	20.7	20.64
121	1210	0.0040	0.0128	2.9056	1.0621	0.0090	2.6743	0.0127	0.0096	20.8	20.66
122	1220	0.0040	0.0128	2.9184	1.0711	0.0090	2.6870	0.0127	0.0097	20.8	20.68
123	1230	0.0040	0.0128	2.9312	1.0801	0.0090	2.6998	0.0127	0.0097	20.8	20.70
124	1240	0.0040	0.0128	2.9440	1.0891	0.0090	2.7125	0.0127	0.0097	20.9	20.73
125	1250	0.0040	0.0128	2.9568	1.0982	0.0090	2.7253	0.0127	0.0097	20.9	20.75
126	1260	0.0040	0.0128	2.9696	1.1072	0.0091	2.7380	0.0127	0.0097	20.9	20.78
127	1270	0.0040	0.0128	2.9824	1.1163	0.0091	2.7507	0.0127	0.0097	20.9	20.81
128	1280	0.0040	0.0128	2.9952	1.1254	0.0091	2.7635	0.0127	0.0098	21.0	20.84
129	1290	0.0040	0.0128	3.0080	1.1345	0.0091	2.7762	0.0127	0.0098	21.0	20.87
130	1300	0.0040	0.0128	3.0208	1.1437	0.0091	2.7890	0.0127	0.0098	21.0	20.90
131	1310	0.0040	0.0128	3.0336	1.1528	0.0092	2.8017	0.0127	0.0098	21.1	20.93
132	1320	0.0040	0.0128	3.0464	1.1620	0.0092	2.8145	0.0127	0.0098	21.1	20.96
133	1330	0.0040	0.0128	3.0592	1.1712	0.0092	2.8272	0.0127	0.0098	21.1	20.99
134	1340	0.0040	0.0128	3.0720	1.1804	0.0092	2.8400	0.0127	0.0098	21.2	21.02
135	1350	0.0040	0.0128	3.0848	1.1896	0.0092	2.8527	0.0127	0.0099	21.2	21.05
136	1360	0.0040	0.0128	3.0976	1.1988	0.0092	2.8655	0.0127	0.0099	21.2	21.08
137	1370	0.0040	0.0128	3.1104	1.2081	0.0093	2.8782	0.0128	0.0099	21.3	21.11
138	1380	0.0040	0.0128	3.1232	1.2174	0.0093	2.8910	0.0128	0.0099	21.3	21.14
139	1390	0.0040	0.0128	3.1360	1.2267	0.0093	2.9037	0.0128	0.0099	21.3	21.17
140	1400	0.0040	0.0128	3.1488	1.2360	0.0093	2.9165	0.0128	0.0099	21.3	21.21
141	1410	0.0040	0.0128	3.1616	1.2453	0.0093	2.9292	0.0128	0.0099	21.4	21.24
142	1420	0.0040	0.0128	3.1744	1.2546	0.0093	2.9420	0.0128	0.0100	21.4	21.27
143	1430	0.0040	0.0128	3.1872	1.2640	0.0094	2.9547	0.0128	0.0100	21.4	21.29
144	1440	0.0040	0.0128	3.2000	1.2734	0.0094	2.9675	0.0128	0.0100	21.5	21.32

Total Volume of Runoff = 1,975,346 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \sum Q \times dt$$

$$V(\text{cu.ft.}) = \sum Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Kruger Creek Subbasin
Storm Event: 100-YEAR, 24-HOUR
Given:

Area = 355.50 acres
P_t = 3.75 inches
d_t = 10 min.
T_c = 48 min.

PERVIOUS AREA

(Interim Final Cover Area)

Area = 291.50 acres

CN = 78

S = 2.82

0.2S = 0.56

IMPERVIOUS AREA

(Roads)

Area = 64.00 acres

CN = 98

S = 0.20

0.2S = 0.04

SUMMARY

T_{pk} (hrs) = 7.83

T_c (min) = 48

Q_{pk} (cfs) = 96.11

Vol (cf) = 2,529,236

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution

Column (4) = Col. (3) x P_t

Column (5) = Accumulated Sum of Col. (4)

Column (6) = [If P ≤ 0.2S] = 0; Note, use PERVIOUS Area "S" value.

[If P > 0.2S] = (Col.(5) - 0.2S)² / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.

Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step

Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.

Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.

Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))

Column (11) = (60.5 x Col.(10) x Total Area) / 10 (dt = 10 minutes)

Routing Constant, w = dt / (2T_c + dt) = 0.0943

Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step

+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)]

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of P _t	(4) Incre- mental Rainfall in.	(5) Accum- ulated Rainfall in.	(6) Pervious Area Accumulated Runoff in.	(7) Incre- mental Runoff in.	(8) Impervious Area Accumulated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0150	0.0150	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0150	0.0300	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0150	0.0450	0.0000	0.0000	0.0001	0.0001	0.0001	0.0	0.00
4	40	0.0040	0.0150	0.0600	0.0000	0.0000	0.0016	0.0016	0.0016	0.6	0.06
5	50	0.0040	0.0150	0.0750	0.0000	0.0000	0.0049	0.0033	0.0033	1.3	0.23
6	60	0.0040	0.0150	0.0900	0.0000	0.0000	0.0096	0.0046	0.0046	1.8	0.47
7	70	0.0040	0.0150	0.1050	0.0000	0.0000	0.0154	0.0058	0.0058	2.2	0.77
8	80	0.0040	0.0150	0.1200	0.0000	0.0000	0.0221	0.0068	0.0068	2.6	1.08
9	90	0.0040	0.0150	0.1350	0.0000	0.0000	0.0297	0.0076	0.0076	2.9	1.40
10	100	0.0040	0.0150	0.1500	0.0000	0.0000	0.0381	0.0083	0.0083	3.2	1.72
11	110	0.0050	0.0188	0.1688	0.0000	0.0000	0.0493	0.0112	0.0112	4.4	2.11
12	120	0.0050	0.0188	0.1875	0.0000	0.0000	0.0613	0.0120	0.0120	4.7	2.56
13	130	0.0050	0.0188	0.2063	0.0000	0.0000	0.0741	0.0127	0.0127	4.9	2.98
14	140	0.0050	0.0188	0.2250	0.0000	0.0000	0.0874	0.0133	0.0133	5.2	3.37
15	150	0.0050	0.0188	0.2438	0.0000	0.0000	0.1012	0.0138	0.0138	5.3	3.73
16	160	0.0050	0.0188	0.2625	0.0000	0.0000	0.1154	0.0142	0.0142	5.5	4.05
17	170	0.0060	0.0225	0.2850	0.0000	0.0000	0.1330	0.0176	0.0176	6.8	4.45
18	180	0.0060	0.0225	0.3075	0.0000	0.0000	0.1511	0.0181	0.0181	7.0	4.91
19	190	0.0060	0.0225	0.3300	0.0000	0.0000	0.1695	0.0185	0.0185	7.1	5.32
20	200	0.0060	0.0225	0.3525	0.0000	0.0000	0.1884	0.0188	0.0188	7.3	5.68
21	210	0.0060	0.0225	0.3750	0.0000	0.0000	0.2075	0.0191	0.0191	7.4	5.99
22	220	0.0060	0.0225	0.3975	0.0000	0.0000	0.2269	0.0194	0.0194	7.5	6.27
23	230	0.0070	0.0263	0.4238	0.0000	0.0000	0.2498	0.0229	0.0229	8.9	6.63
24	240	0.0070	0.0263	0.4500	0.0000	0.0000	0.2730	0.0232	0.0232	9.0	7.07
25	250	0.0070	0.0263	0.4763	0.0000	0.0000	0.2965	0.0235	0.0235	9.1	7.44
26	260	0.0070	0.0263	0.5025	0.0000	0.0000	0.3202	0.0237	0.0237	9.2	7.76
27	270	0.0070	0.0263	0.5288	0.0000	0.0000	0.3440	0.0239	0.0239	9.2	8.03
28	280	0.0070	0.0263	0.5550	0.0000	0.0000	0.3681	0.0241	0.0241	9.3	8.27
29	290	0.0082	0.0308	0.5858	0.0002	0.0002	0.3965	0.0284	0.0052	11.3	8.65
30	300	0.0082	0.0308	0.6165	0.0010	0.0008	0.4250	0.0286	0.0058	12.5	9.25
31	310	0.0082	0.0308	0.6473	0.0024	0.0014	0.4537	0.0287	0.0063	13.6	9.97
32	320	0.0082	0.0308	0.6780	0.0044	0.0020	0.4826	0.0289	0.0069	14.8	10.77
33	330	0.0082	0.0308	0.7088	0.0071	0.0026	0.5116	0.0290	0.0074	15.9	11.63
34	340	0.0082	0.0308	0.7395	0.0103	0.0032	0.5407	0.0291	0.0079	16.9	12.53
35	350	0.0095	0.0356	0.7751	0.0147	0.0044	0.5746	0.0339	0.0097	20.9	13.74
36	360	0.0095	0.0356	0.8108	0.0198	0.0051	0.6086	0.0340	0.0103	22.2	15.22
37	370	0.0095	0.0356	0.8464	0.0257	0.0058	0.6427	0.0341	0.0109	23.5	16.66
38	380	0.0095	0.0356	0.8820	0.0322	0.0065	0.6769	0.0342	0.0115	24.8	18.07
39	390	0.0095	0.0356	0.9176	0.0394	0.0072	0.7113	0.0343	0.0121	25.9	19.44
40	400	0.0095	0.0356	0.9533	0.0472	0.0078	0.7457	0.0344	0.0126	27.1	20.78
41	410	0.0134	0.0503	1.0035	0.0592	0.0120	0.7943	0.0486	0.0186	40.1	23.19
42	420	0.0134	0.0503	1.0538	0.0724	0.0132	0.8431	0.0488	0.0196	42.2	26.58
43	430	0.0134	0.0503	1.1040	0.0867	0.0143	0.8920	0.0489	0.0205	44.2	29.71
44	440	0.0180	0.0675	1.1715	0.1076	0.0209	0.9578	0.0658	0.0290	62.3	34.15
45	450	0.0180	0.0675	1.2390	0.1303	0.0227	1.0238	0.0660	0.0305	65.6	39.77
46	460	0.0340	0.1275	1.3665	0.1777	0.0474	1.1488	0.1250	0.0614	132.0	50.91
47	470	0.0540	0.2025	1.5690	0.2640	0.0863	1.3481	0.1993	0.1066	229.3	75.39
48	480	0.0270	0.1013	1.6703	0.3116	0.0476	1.4481	0.0999	0.0570	122.7	94.37 Q peak
49	490	0.0180	0.0675	1.7378	0.3449	0.0333	1.5148	0.0667	0.0393	84.5	96.11
50	500	0.0134	0.0503	1.7880	0.3704	0.0255	1.5644	0.0497	0.0299	64.2	92.00
51	510	0.0134	0.0503	1.8383	0.3965	0.0261	1.6142	0.0497	0.0304	65.3	86.86
52	520	0.0134	0.0503	1.8885	0.4232	0.0267	1.6639	0.0497	0.0308	66.3	82.89
53	530	0.0088	0.0330	1.9215	0.4410	0.0178	1.6966	0.0327	0.0205	44.1	77.67
54	540	0.0088	0.0330	1.9545	0.4591	0.0181	1.7293	0.0327	0.0207	44.5	71.38
55	550	0.0088	0.0330	1.9875	0.4774	0.0183	1.7620	0.0327	0.0209	45.0	66.35
56	560	0.0088	0.0330	2.0205	0.4959	0.0185	1.7947	0.0327	0.0211	45.4	62.35
57	570	0.0088	0.0330	2.0535	0.5147	0.0188	1.8274	0.0327	0.0213	45.7	59.18
58	580	0.0088	0.0330	2.0865	0.5337	0.0190	1.8601	0.0327	0.0214	46.1	56.69
59	590	0.0088	0.0330	2.1195	0.5529	0.0192	1.8928	0.0327	0.0216	46.5	54.73
60	600	0.0088	0.0330	2.1525	0.5723	0.0194	1.9256	0.0327	0.0218	46.9	53.21
61	610	0.0088	0.0330	2.1855	0.5918	0.0196	1.9583	0.0327	0.0220	47.2	52.05
62	620	0.0088	0.0330	2.2185	0.6116	0.0198	1.9911	0.0328	0.0221	47.6	51.18
63	630	0.0088	0.0330	2.2515	0.6316	0.0200	2.0238	0.0328	0.0223	47.9	50.53
64	640	0.0088	0.0330	2.2845	0.6518	0.0202	2.0566	0.0328	0.0224	48.3	50.07
65	650	0.0072	0.0270	2.3115	0.6684	0.0166	2.0834	0.0268	0.0185	39.7	48.93
66	660	0.0072	0.0270	2.3385	0.6852	0.0168	2.1103	0.0268	0.0186	40.0	47.21
67	670	0.0072	0.0270	2.3655	0.7021	0.0169	2.1371	0.0268	0.0187	40.2	45.86

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distri- bution % of Pt	(4) Incre- mental Rainfall in.	(5) Accum- ulated Rainfall in.	Pervious Area		Impervious Area		(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
					(6) Accum- ulated Runoff in.	(7) Incre- mental Runoff in.	(8) Accum- ulated Runoff in.	(9) Incre- mental Runoff in.			
68	680	0.0072	0.0270	2.3925	0.7191	0.0170	2.1639	0.0268	0.0188	40.4	44.81
69	690	0.0072	0.0270	2.4195	0.7362	0.0171	2.1907	0.0268	0.0189	40.6	43.99
70	700	0.0072	0.0270	2.4465	0.7535	0.0172	2.2176	0.0268	0.0190	40.8	43.37
71	710	0.0072	0.0270	2.4735	0.7708	0.0173	2.2444	0.0268	0.0191	41.0	42.90
72	720	0.0072	0.0270	2.5005	0.7883	0.0175	2.2712	0.0268	0.0191	41.2	42.55
73	730	0.0072	0.0270	2.5275	0.8058	0.0176	2.2981	0.0268	0.0192	41.4	42.31
74	740	0.0072	0.0270	2.5545	0.8235	0.0177	2.3249	0.0268	0.0193	41.6	42.15
75	750	0.0072	0.0270	2.5815	0.8413	0.0178	2.3518	0.0268	0.0194	41.7	42.05
76	760	0.0072	0.0270	2.6085	0.8591	0.0179	2.3786	0.0269	0.0195	41.9	42.01
77	770	0.0057	0.0214	2.6299	0.8733	0.0142	2.3999	0.0213	0.0155	33.3	41.18
78	780	0.0057	0.0214	2.6513	0.8876	0.0143	2.4212	0.0213	0.0155	33.4	39.71
79	790	0.0057	0.0214	2.6726	0.9020	0.0143	2.4424	0.0213	0.0156	33.5	38.53
80	800	0.0057	0.0214	2.6940	0.9164	0.0144	2.4637	0.0213	0.0156	33.6	37.60
81	810	0.0057	0.0214	2.7154	0.9308	0.0145	2.4849	0.0213	0.0157	33.7	36.86
82	820	0.0057	0.0214	2.7368	0.9454	0.0145	2.5062	0.0213	0.0157	33.9	36.28
83	830	0.0057	0.0214	2.7581	0.9600	0.0146	2.5275	0.0213	0.0158	34.0	35.84
84	840	0.0057	0.0214	2.7795	0.9746	0.0146	2.5488	0.0213	0.0158	34.1	35.49
85	850	0.0057	0.0214	2.8009	0.9893	0.0147	2.5700	0.0213	0.0159	34.2	35.23
86	860	0.0057	0.0214	2.8223	1.0041	0.0148	2.5913	0.0213	0.0159	34.3	35.04
87	870	0.0057	0.0214	2.8436	1.0189	0.0148	2.6126	0.0213	0.0160	34.4	34.90
88	880	0.0057	0.0214	2.8650	1.0337	0.0149	2.6339	0.0213	0.0160	34.5	34.81
89	890	0.0050	0.0188	2.8838	1.0468	0.0131	2.6525	0.0187	0.0141	30.3	34.35
90	900	0.0050	0.0188	2.9025	1.0599	0.0131	2.6712	0.0187	0.0141	30.4	33.59
91	910	0.0050	0.0188	2.9213	1.0731	0.0132	2.6899	0.0187	0.0142	30.4	32.99
92	920	0.0050	0.0188	2.9400	1.0863	0.0132	2.7085	0.0187	0.0142	30.5	32.52
93	930	0.0050	0.0188	2.9588	1.0996	0.0132	2.7272	0.0187	0.0142	30.6	32.15
94	940	0.0050	0.0188	2.9775	1.1128	0.0133	2.7459	0.0187	0.0143	30.7	31.86
95	950	0.0050	0.0188	2.9963	1.1262	0.0133	2.7645	0.0187	0.0143	30.7	31.64
96	960	0.0050	0.0188	3.0150	1.1395	0.0134	2.7832	0.0187	0.0143	30.8	31.47
97	970	0.0050	0.0188	3.0338	1.1529	0.0134	2.8019	0.0187	0.0144	30.9	31.35
98	980	0.0050	0.0188	3.0525	1.1664	0.0134	2.8206	0.0187	0.0144	30.9	31.27
99	990	0.0050	0.0188	3.0713	1.1798	0.0135	2.8392	0.0187	0.0144	31.0	31.21
100	1000	0.0050	0.0188	3.0900	1.1934	0.0135	2.8579	0.0187	0.0144	31.1	31.18
101	1010	0.0040	0.0150	3.1050	1.2042	0.0108	2.8728	0.0149	0.0116	24.9	30.57
102	1020	0.0040	0.0150	3.1200	1.2151	0.0109	2.8878	0.0149	0.0116	24.9	29.51
103	1030	0.0040	0.0150	3.1350	1.2259	0.0109	2.9027	0.0149	0.0116	25.0	28.65
104	1040	0.0040	0.0150	3.1500	1.2368	0.0109	2.9177	0.0149	0.0116	25.0	27.96
105	1050	0.0040	0.0150	3.1650	1.2478	0.0109	2.9326	0.0149	0.0117	25.1	27.41
106	1060	0.0040	0.0150	3.1800	1.2587	0.0110	2.9476	0.0149	0.0117	25.1	26.97
107	1070	0.0040	0.0150	3.1950	1.2697	0.0110	2.9625	0.0149	0.0117	25.1	26.62
108	1080	0.0040	0.0150	3.2100	1.2807	0.0110	2.9774	0.0149	0.0117	25.2	26.34
109	1090	0.0040	0.0150	3.2250	1.2917	0.0110	2.9924	0.0149	0.0117	25.2	26.13
110	1100	0.0040	0.0150	3.2400	1.3027	0.0110	3.0073	0.0149	0.0117	25.3	25.96
111	1110	0.0040	0.0150	3.2550	1.3138	0.0111	3.0223	0.0149	0.0118	25.3	25.83
112	1120	0.0040	0.0150	3.2700	1.3249	0.0111	3.0372	0.0149	0.0118	25.3	25.73
113	1130	0.0040	0.0150	3.2850	1.3360	0.0111	3.0522	0.0149	0.0118	25.4	25.66
114	1140	0.0040	0.0150	3.3000	1.3471	0.0111	3.0671	0.0149	0.0118	25.4	25.61
115	1150	0.0040	0.0150	3.3150	1.3583	0.0111	3.0821	0.0149	0.0118	25.4	25.57
116	1160	0.0040	0.0150	3.3300	1.3694	0.0112	3.0970	0.0149	0.0118	25.5	25.55
117	1170	0.0040	0.0150	3.3450	1.3806	0.0112	3.1120	0.0149	0.0119	25.5	25.54
118	1180	0.0040	0.0150	3.3600	1.3918	0.0112	3.1269	0.0149	0.0119	25.6	25.54
119	1190	0.0040	0.0150	3.3750	1.4030	0.0112	3.1419	0.0149	0.0119	25.6	25.55
120	1200	0.0040	0.0150	3.3900	1.4143	0.0112	3.1568	0.0150	0.0119	25.6	25.56
121	1210	0.0040	0.0150	3.4050	1.4256	0.0113	3.1718	0.0150	0.0119	25.7	25.57
122	1220	0.0040	0.0150	3.4200	1.4369	0.0113	3.1867	0.0150	0.0119	25.7	25.59
123	1230	0.0040	0.0150	3.4350	1.4482	0.0113	3.2017	0.0150	0.0120	25.7	25.62
124	1240	0.0040	0.0150	3.4500	1.4595	0.0113	3.2166	0.0150	0.0120	25.8	25.64
125	1250	0.0040	0.0150	3.4650	1.4708	0.0113	3.2316	0.0150	0.0120	25.8	25.67
126	1260	0.0040	0.0150	3.4800	1.4822	0.0114	3.2465	0.0150	0.0120	25.8	25.69
127	1270	0.0040	0.0150	3.4950	1.4936	0.0114	3.2615	0.0150	0.0120	25.9	25.72
128	1280	0.0040	0.0150	3.5100	1.5050	0.0114	3.2764	0.0150	0.0120	25.9	25.75
129	1290	0.0040	0.0150	3.5250	1.5164	0.0114	3.2914	0.0150	0.0121	25.9	25.78
130	1300	0.0040	0.0150	3.5400	1.5278	0.0114	3.3063	0.0150	0.0121	26.0	25.81
131	1310	0.0040	0.0150	3.5550	1.5393	0.0115	3.3213	0.0150	0.0121	26.0	25.85
132	1320	0.0040	0.0150	3.5700	1.5508	0.0115	3.3363	0.0150	0.0121	26.0	25.88
133	1330	0.0040	0.0150	3.5850	1.5623	0.0115	3.3512	0.0150	0.0121	26.1	25.91
134	1340	0.0040	0.0150	3.6000	1.5738	0.0115	3.3662	0.0150	0.0121	26.1	25.94
135	1350	0.0040	0.0150	3.6150	1.5853	0.0115	3.3811	0.0150	0.0121	26.1	25.97
136	1360	0.0040	0.0150	3.6300	1.5969	0.0115	3.3961	0.0150	0.0122	26.2	26.00
137	1370	0.0040	0.0150	3.6450	1.6084	0.0116	3.4110	0.0150	0.0122	26.2	26.04
138	1380	0.0040	0.0150	3.6600	1.6200	0.0116	3.4260	0.0150	0.0122	26.2	26.07
139	1390	0.0040	0.0150	3.6750	1.6316	0.0116	3.4410	0.0150	0.0122	26.2	26.10
140	1400	0.0040	0.0150	3.6900	1.6432	0.0116	3.4559	0.0150	0.0122	26.3	26.13
141	1410	0.0040	0.0150	3.7050	1.6548	0.0116	3.4709	0.0150	0.0122	26.3	26.16
142	1420	0.0040	0.0150	3.7200	1.6665	0.0117	3.4858	0.0150	0.0122	26.3	26.19
143	1430	0.0040	0.0150	3.7350	1.6782	0.0117	3.5008	0.0150	0.0123	26.4	26.22
144	1440	0.0040	0.0150	3.7500	1.6899	0.0117	3.5157	0.0150	0.0123	26.4	26.25

Total Volume of Runoff¹ = 2,529,236 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \text{Sum} Q \times dt$$

$$V(\text{cu.ft.}) = \text{Sum} Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

City of Arlington
Time of Concentration
Prairie Creek Subbasin

Calculate Time of Concentration (Tc)

$$T_c = \text{Sum}(T_t)$$

Where:

Tt = travel time (min) =

$$\frac{L}{(60 \times V)} \quad (\text{for shallow concentrated flow or channel flow})$$

Tt = travel time (min) =

$$\frac{0.42(n_s L)^{0.8}}{(P_2)^{0.5}(s_o)^{0.4}} \quad (\text{for sheet flow})$$

Where:

V = avg. velocity (ft/s) = $V = k(s_o)^{0.5}$

k = time of concentration velocity factor (ft/s)

L = flow length (ft)

n_s = sheet flow Manning's effective roughness coefficient

P_2 = 2-year, 24-hour rainfall (in)

s_o = slope of hydraulic grade line (land slope, ft/ft)

	L (ft)	$k_{s/c}$	V (fps)	n_s	P_2	s_o (ft/ft)	Tt (min)
a - sheet (surface flow)	100	NA	NA	0.15	1.8	0.020	13.1
b - culvert (pipe)	150	42	5.9	NA	NA	0.020	0.4
c - shallow (pond)	500	11	0.3	NA	NA	0.001	24.0
d - channel (stream/ditch)	16,000	17	2.4	NA	NA	0.020	110.9
Total (Tc)							148.4

* All lengths are rough estimates. Slope values obtained from XP-SWMM model, with the exception of the pond.

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Prairie Creek Subbasin
Storm Event: 2-YEAR, 24-HOUR
Given:

Area = 1099.30 acres
P_t = 1.80 inches
d_t = 10 min.
T_c = 148.4 min.
PERVIOUS AREA
(Interim Final Cover Area)
Area = 675.00 acres
CN = 81
S = 2.35
0.2S = 0.47
IMPERVIOUS AREA
(Roads)
Area = 424.30 acres
CN = 98
S = 0.20
0.2S = 0.04

SUMMARY	
T _{pk} (hrs) = 7.83	
T _c (min) = 148.4	
Q _{pk} (cfs) = 75.19	
Vol (cf) = 3,291,024	

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution
Column (4) = Col. (3) x P_t
Column (5) = Accumulated Sum of Col. (4)
Column (6) = If P ≤ 0.2S = 0; Note, use PERVIOUS Area "S" value.
If P > 0.2S = (Col.(5) - 0.2S)² / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.
Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step
Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.
Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.
Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))
Column (11) = (60.5 x Col.(10) x Total Area) / 10 (dt = 10 minutes)
Routing Constant, w = dt / (2T_c + dt) = 0.0326
Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step
+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

(1) Time Increment	(2) Time min.	(3) Rainfall distribu- tion % of P _t	(4) Rainfall in.	(5) Accumulated Rainfall in.	(6) Accumulated Runoff in.	(7) Incre- mental Runoff in.	(8) Accumulated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0072	0.0072	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0072	0.0144	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0072	0.0216	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
4	40	0.0040	0.0072	0.0288	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
5	50	0.0040	0.0072	0.0360	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
6	60	0.0040	0.0072	0.0432	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.00
7	70	0.0040	0.0072	0.0504	0.0000	0.0000	0.0004	0.0004	0.0002	1.0	0.04
8	80	0.0040	0.0072	0.0576	0.0000	0.0000	0.0013	0.0008	0.0003	2.2	0.14
9	90	0.0040	0.0072	0.0648	0.0000	0.0000	0.0025	0.0012	0.0005	3.2	0.31
10	100	0.0040	0.0072	0.0720	0.0000	0.0000	0.0041	0.0016	0.0006	4.1	0.53
11	110	0.0050	0.0090	0.0810	0.0000	0.0000	0.0066	0.0025	0.0010	6.4	0.83
12	120	0.0050	0.0090	0.0900	0.0000	0.0000	0.0096	0.0029	0.0011	7.5	1.23
13	130	0.0050	0.0090	0.0990	0.0000	0.0000	0.0129	0.0034	0.0013	8.6	1.68
14	140	0.0050	0.0090	0.1080	0.0000	0.0000	0.0166	0.0037	0.0014	9.6	2.16
15	150	0.0050	0.0090	0.1170	0.0000	0.0000	0.0207	0.0041	0.0016	10.4	2.67
16	160	0.0050	0.0090	0.1260	0.0000	0.0000	0.0251	0.0044	0.0017	11.2	3.21
17	170	0.0060	0.0108	0.1368	0.0000	0.0000	0.0307	0.0056	0.0022	14.4	3.83
18	180	0.0060	0.0108	0.1476	0.0000	0.0000	0.0367	0.0060	0.0023	15.3	4.55
19	190	0.0060	0.0108	0.1584	0.0000	0.0000	0.0430	0.0063	0.0024	16.2	5.28
20	200	0.0060	0.0108	0.1692	0.0000	0.0000	0.0496	0.0066	0.0025	16.9	6.02
21	210	0.0060	0.0108	0.1800	0.0000	0.0000	0.0564	0.0069	0.0026	17.6	6.75
22	220	0.0060	0.0108	0.1908	0.0000	0.0000	0.0635	0.0071	0.0027	18.2	7.48
23	230	0.0070	0.0126	0.2034	0.0000	0.0000	0.0721	0.0086	0.0033	22.0	8.30
24	240	0.0070	0.0126	0.2160	0.0000	0.0000	0.0809	0.0088	0.0034	22.7	9.22
25	250	0.0070	0.0126	0.2286	0.0000	0.0000	0.0900	0.0091	0.0035	23.3	10.11
26	260	0.0070	0.0126	0.2412	0.0000	0.0000	0.0993	0.0093	0.0036	23.8	10.99
27	270	0.0070	0.0126	0.2538	0.0000	0.0000	0.1088	0.0095	0.0037	24.4	11.84
28	280	0.0070	0.0126	0.2664	0.0000	0.0000	0.1184	0.0097	0.0037	24.8	12.67
29	290	0.0082	0.0148	0.2812	0.0000	0.0000	0.1300	0.0115	0.0045	29.6	13.62
30	300	0.0082	0.0148	0.2959	0.0000	0.0000	0.1417	0.0117	0.0045	30.2	14.68
31	310	0.0082	0.0148	0.3107	0.0000	0.0000	0.1537	0.0119	0.0046	30.6	15.71
32	320	0.0082	0.0148	0.3254	0.0000	0.0000	0.1658	0.0121	0.0047	31.1	16.70
33	330	0.0082	0.0148	0.3402	0.0000	0.0000	0.1780	0.0123	0.0047	31.5	17.65
34	340	0.0082	0.0148	0.3550	0.0000	0.0000	0.1904	0.0124	0.0048	31.8	18.56
35	350	0.0095	0.0171	0.3721	0.0000	0.0000	0.2050	0.0145	0.0056	37.3	19.60
36	360	0.0095	0.0171	0.3892	0.0000	0.0000	0.2197	0.0147	0.0057	37.7	20.77
37	370	0.0095	0.0171	0.4063	0.0000	0.0000	0.2345	0.0148	0.0057	38.1	21.89
38	380	0.0095	0.0171	0.4234	0.0000	0.0000	0.2495	0.0150	0.0058	38.4	22.95
39	390	0.0095	0.0171	0.4405	0.0000	0.0000	0.2645	0.0151	0.0058	38.7	23.97
40	400	0.0095	0.0171	0.4576	0.0000	0.0000	0.2797	0.0152	0.0059	39.0	24.94
41	410	0.0134	0.0241	0.4817	0.0001	0.0001	0.3014	0.0216	0.0084	55.7	26.41
42	420	0.0134	0.0241	0.5058	0.0006	0.0005	0.3232	0.0218	0.0087	58.0	28.39
43	430	0.0134	0.0241	0.5299	0.0015	0.0010	0.3451	0.0220	0.0091	60.3	30.40
44	440	0.0180	0.0324	0.5623	0.0036	0.0020	0.3748	0.0297	0.0127	84.6	33.14
45	450	0.0180	0.0324	0.5947	0.0064	0.0028	0.4048	0.0299	0.0133	88.4	36.61
46	460	0.0340	0.0612	0.6559	0.0138	0.0074	0.4619	0.0571	0.0266	176.8	42.87
47	470	0.0540	0.0972	0.7531	0.0307	0.0169	0.5537	0.0918	0.0458	304.7	55.77
48	480	0.0270	0.0486	0.8017	0.0413	0.0106	0.6000	0.0463	0.0244	162.3	67.35 Q peak
49	490	0.0180	0.0324	0.8341	0.0491	0.0078	0.6310	0.0310	0.0168	111.6	71.89
50	500	0.0134	0.0241	0.8582	0.0554	0.0062	0.6541	0.0231	0.0127	84.8	73.60
51	510	0.0134	0.0241	0.8824	0.0619	0.0065	0.6773	0.0232	0.0130	86.2	74.38
52	520	0.0134	0.0241	0.9065	0.0687	0.0068	0.7005	0.0232	0.0132	87.5	75.19
53	530	0.0088	0.0158	0.9223	0.0734	0.0047	0.7158	0.0153	0.0088	58.2	75.04
54	540	0.0088	0.0158	0.9382	0.0782	0.0048	0.7311	0.0153	0.0088	58.8	73.96
55	550	0.0088	0.0158	0.9540	0.0831	0.0049	0.7464	0.0153	0.0089	59.3	72.99
56	560	0.0088	0.0158	0.9698	0.0881	0.0050	0.7617	0.0153	0.0090	59.8	72.11
57	570	0.0088	0.0158	0.9857	0.0932	0.0051	0.7770	0.0153	0.0091	60.4	71.33
58	580	0.0088	0.0158	1.0015	0.0985	0.0053	0.7924	0.0153	0.0092	60.9	70.63
59	590	0.0088	0.0158	1.0174	0.1039	0.0054	0.8077	0.0154	0.0092	61.4	70.01
60	600	0.0088	0.0158	1.0332	0.1093	0.0055	0.8231	0.0154	0.0093	61.9	69.46
61	610	0.0088	0.0158	1.0490	0.1149	0.0056	0.8385	0.0154	0.0094	62.4	68.99
62	620	0.0088	0.0158	1.0649	0.1207	0.0057	0.8539	0.0154	0.0095	62.9	68.57
63	630	0.0088	0.0158	1.0807	0.1265	0.0058	0.8693	0.0154	0.0095	63.3	68.21
64	640	0.0088	0.0158	1.0966	0.1324	0.0059	0.8847	0.0154	0.0096	63.8	67.91
65	650	0.0072	0.0130	1.1095	0.1373	0.0049	0.8973	0.0126	0.0079	52.5	67.27
66	660	0.0072	0.0130	1.1225	0.1423	0.0050	0.9100	0.0126	0.0079	52.8	66.32
67	670	0.0072	0.0130	1.1354	0.1474	0.0051	0.9226	0.0126	0.0080	53.1	65.45

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of Pt	(4) Incremental Rainfall in.	(5) Accumulated Rainfall in.	Pervious Area (6) Accumulated Runoff in.	(7) Incremental Runoff in.	Impervious Area (8) Accumulated Runoff in.	(9) Incremental Runoff in.	(10) Total Runoff in.	(11) Instant hydrograph cfs	(12) design hydrograph cfs
68	680	0.0072	0.0130	1.1484	0.1525	0.0051	0.9353	0.0126	0.0080	53.4	64.66
69	690	0.0072	0.0130	1.1614	0.1577	0.0052	0.9479	0.0126	0.0081	53.7	63.93
70	700	0.0072	0.0130	1.1743	0.1630	0.0053	0.9606	0.0127	0.0081	54.0	63.28
71	710	0.0072	0.0130	1.1873	0.1683	0.0053	0.9732	0.0127	0.0082	54.3	62.68
72	720	0.0072	0.0130	1.2002	0.1737	0.0054	0.9859	0.0127	0.0082	54.5	62.14
73	730	0.0072	0.0130	1.2132	0.1792	0.0055	0.9986	0.0127	0.0082	54.8	61.66
74	740	0.0072	0.0130	1.2262	0.1847	0.0055	1.0112	0.0127	0.0083	55.1	61.22
75	750	0.0072	0.0130	1.2391	0.1903	0.0056	1.0239	0.0127	0.0083	55.4	60.83
76	760	0.0072	0.0130	1.2521	0.1959	0.0056	1.0366	0.0127	0.0084	55.6	60.48
77	770	0.0057	0.0103	1.2623	0.2004	0.0045	1.0467	0.0100	0.0066	44.2	59.79
78	780	0.0057	0.0103	1.2726	0.2050	0.0045	1.0567	0.0101	0.0067	44.4	58.78
79	790	0.0057	0.0103	1.2829	0.2096	0.0046	1.0668	0.0101	0.0067	44.5	57.85
80	800	0.0057	0.0103	1.2931	0.2142	0.0046	1.0768	0.0101	0.0067	44.7	56.99
81	810	0.0057	0.0103	1.3034	0.2189	0.0047	1.0869	0.0101	0.0067	44.9	56.19
82	820	0.0057	0.0103	1.3136	0.2236	0.0047	1.0969	0.0101	0.0068	45.0	55.46
83	830	0.0057	0.0103	1.3239	0.2283	0.0047	1.1070	0.0101	0.0068	45.2	54.78
84	840	0.0057	0.0103	1.3342	0.2331	0.0048	1.1171	0.0101	0.0068	45.3	54.16
85	850	0.0057	0.0103	1.3444	0.2379	0.0048	1.1271	0.0101	0.0068	45.5	53.58
86	860	0.0057	0.0103	1.3547	0.2427	0.0048	1.1372	0.0101	0.0069	45.6	53.06
87	870	0.0057	0.0103	1.3649	0.2476	0.0049	1.1473	0.0101	0.0069	45.8	52.58
88	880	0.0057	0.0103	1.3752	0.2525	0.0049	1.1574	0.0101	0.0069	45.9	52.14
89	890	0.0050	0.0090	1.3842	0.2568	0.0043	1.1662	0.0088	0.0061	40.4	51.55
90	900	0.0050	0.0090	1.3932	0.2612	0.0044	1.1751	0.0088	0.0061	40.5	50.83
91	910	0.0050	0.0090	1.4022	0.2655	0.0044	1.1839	0.0088	0.0061	40.6	50.16
92	920	0.0050	0.0090	1.4112	0.2699	0.0044	1.1928	0.0088	0.0061	40.7	49.54
93	930	0.0050	0.0090	1.4202	0.2744	0.0044	1.2016	0.0088	0.0061	40.8	48.97
94	940	0.0050	0.0090	1.4292	0.2788	0.0045	1.2105	0.0089	0.0062	40.9	48.44
95	950	0.0050	0.0090	1.4382	0.2833	0.0045	1.2193	0.0089	0.0062	41.0	47.95
96	960	0.0050	0.0090	1.4472	0.2878	0.0045	1.2282	0.0089	0.0062	41.1	47.50
97	970	0.0050	0.0090	1.4562	0.2923	0.0045	1.2370	0.0089	0.0062	41.2	47.09
98	980	0.0050	0.0090	1.4652	0.2969	0.0046	1.2459	0.0089	0.0062	41.3	46.71
99	990	0.0050	0.0090	1.4742	0.3015	0.0046	1.2547	0.0089	0.0062	41.4	46.36
100	1000	0.0050	0.0090	1.4832	0.3061	0.0046	1.2636	0.0089	0.0062	41.5	46.05
101	1010	0.0040	0.0072	1.4904	0.3098	0.0037	1.2707	0.0071	0.0050	33.3	45.48
102	1020	0.0040	0.0072	1.4976	0.3135	0.0037	1.2778	0.0071	0.0050	33.4	44.69
103	1030	0.0040	0.0072	1.5048	0.3172	0.0037	1.2849	0.0071	0.0050	33.4	43.96
104	1040	0.0040	0.0072	1.5120	0.3210	0.0037	1.2920	0.0071	0.0050	33.5	43.27
105	1050	0.0040	0.0072	1.5192	0.3247	0.0038	1.2991	0.0071	0.0050	33.6	42.64
106	1060	0.0040	0.0072	1.5264	0.3285	0.0038	1.3062	0.0071	0.0051	33.6	42.05
107	1070	0.0040	0.0072	1.5336	0.3323	0.0038	1.3132	0.0071	0.0051	33.7	41.50
108	1080	0.0040	0.0072	1.5408	0.3361	0.0038	1.3203	0.0071	0.0051	33.7	40.99
109	1090	0.0040	0.0072	1.5480	0.3399	0.0038	1.3274	0.0071	0.0051	33.8	40.52
110	1100	0.0040	0.0072	1.5552	0.3437	0.0038	1.3345	0.0071	0.0051	33.9	40.08
111	1110	0.0040	0.0072	1.5624	0.3476	0.0038	1.3416	0.0071	0.0051	33.9	39.68
112	1120	0.0040	0.0072	1.5696	0.3514	0.0039	1.3487	0.0071	0.0051	34.0	39.31
113	1130	0.0040	0.0072	1.5768	0.3553	0.0039	1.3558	0.0071	0.0051	34.0	38.96
114	1140	0.0040	0.0072	1.5840	0.3592	0.0039	1.3629	0.0071	0.0051	34.1	38.64
115	1150	0.0040	0.0072	1.5912	0.3631	0.0039	1.3700	0.0071	0.0051	34.2	38.35
116	1160	0.0040	0.0072	1.5984	0.3670	0.0039	1.3771	0.0071	0.0051	34.2	38.07
117	1170	0.0040	0.0072	1.6056	0.3709	0.0039	1.3842	0.0071	0.0052	34.3	37.82
118	1180	0.0040	0.0072	1.6128	0.3748	0.0039	1.3914	0.0071	0.0052	34.3	37.59
119	1190	0.0040	0.0072	1.6200	0.3788	0.0040	1.3985	0.0071	0.0052	34.4	37.38
120	1200	0.0040	0.0072	1.6272	0.3828	0.0040	1.4056	0.0071	0.0052	34.4	37.19
121	1210	0.0040	0.0072	1.6344	0.3867	0.0040	1.4127	0.0071	0.0052	34.5	37.01
122	1220	0.0040	0.0072	1.6416	0.3907	0.0040	1.4198	0.0071	0.0052	34.6	36.85
123	1230	0.0040	0.0072	1.6488	0.3947	0.0040	1.4269	0.0071	0.0052	34.6	36.70
124	1240	0.0040	0.0072	1.6560	0.3988	0.0040	1.4340	0.0071	0.0052	34.7	36.57
125	1250	0.0040	0.0072	1.6632	0.4028	0.0040	1.4411	0.0071	0.0052	34.7	36.44
126	1260	0.0040	0.0072	1.6704	0.4068	0.0040	1.4482	0.0071	0.0052	34.8	36.33
127	1270	0.0040	0.0072	1.6776	0.4109	0.0041	1.4553	0.0071	0.0052	34.8	36.23
128	1280	0.0040	0.0072	1.6848	0.4150	0.0041	1.4624	0.0071	0.0052	34.9	36.14
129	1290	0.0040	0.0072	1.6920	0.4190	0.0041	1.4696	0.0071	0.0053	34.9	36.06
130	1300	0.0040	0.0072	1.6992	0.4231	0.0041	1.4767	0.0071	0.0053	35.0	35.99
131	1310	0.0040	0.0072	1.7064	0.4273	0.0041	1.4838	0.0071	0.0053	35.0	35.93
132	1320	0.0040	0.0072	1.7136	0.4314	0.0041	1.4909	0.0071	0.0053	35.1	35.87
133	1330	0.0040	0.0072	1.7208	0.4355	0.0041	1.4980	0.0071	0.0053	35.1	35.82
134	1340	0.0040	0.0072	1.7280	0.4397	0.0041	1.5051	0.0071	0.0053	35.2	35.78
135	1350	0.0040	0.0072	1.7352	0.4438	0.0042	1.5122	0.0071	0.0053	35.2	35.74
136	1360	0.0040	0.0072	1.7424	0.4480	0.0042	1.5194	0.0071	0.0053	35.3	35.71
137	1370	0.0040	0.0072	1.7496	0.4522	0.0042	1.5265	0.0071	0.0053	35.3	35.69
138	1380	0.0040	0.0072	1.7568	0.4564	0.0042	1.5336	0.0071	0.0053	35.4	35.67
139	1390	0.0040	0.0072	1.7640	0.4606	0.0042	1.5407	0.0071	0.0053	35.4	35.65
140	1400	0.0040	0.0072	1.7712	0.4648	0.0042	1.5478	0.0071	0.0053	35.5	35.64
141	1410	0.0040	0.0072	1.7784	0.4690	0.0042	1.5550	0.0071	0.0053	35.5	35.63
142	1420	0.0040	0.0072	1.7856	0.4732	0.0042	1.5621	0.0071	0.0054	35.6	35.63
143	1430	0.0040	0.0072	1.7928	0.4775	0.0043	1.5692	0.0071	0.0054	35.6	35.63
144	1440	0.0040	0.0072	1.8000	0.4818	0.0043	1.5763	0.0071	0.0054	35.7	35.63

Total Volume of Runoff¹ = 3,291,024 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \sum Q \times dt$$

$$V(\text{cu.ft.}) = \sum Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Prairie Creek Subbasin
Storm Event: 10-YEAR, 24-HOUR
Given:

Area = 1099.30 acres
P_t = 2.75 inches
d_t = 10 min.
T_c = 148.4 min.
PERVIOUS AREA
(Interim Final Cover Area)
Area = 675.00 acres
CN = 81
S = 2.35
0.2S = 0.47
IMPERVIOUS AREA
(Roads)
Area = 424.30 acres
CN = 98
S = 0.20
0.2S = 0.04

SUMMARY	
T _{pk} (hrs) =	7.83
T _c (min) =	148.4
Q _{pk} (cfs) =	146.25
Vol (cf) =	6,085,059

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution
Column (4) = Col. (3) x P_t
Column (5) = Accumulated Sum of Col. (4)
Column (6) = [If P ≤ 0.2S] = 0; Note, use PERVIOUS Area "S" value.
[If P > 0.2S] = (Col.(5) - 0.2S) / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.
Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step
Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.
Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.
Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))
Column (11) = (60.5 x Col.(10) x Total Area) / 10 (dt = 10 minutes)
Routing Constant, w = dt / (2T_c + dt) = 0.0326
Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step
+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

(1) Time Increment	(2) Time min.	(3) Rainfall distrib- ution % of P _t	(4) Incre- mental Rainfall in.	(5) Accum- ulated Rainfall in.	(6) Accum- ulated Runoff in.	(7) Incre- mental Runoff in.	(8) Accum- ulated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0110	0.0110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0110	0.0220	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0110	0.0330	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
4	40	0.0040	0.0110	0.0440	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.00
5	50	0.0040	0.0110	0.0550	0.0000	0.0000	0.0000	0.0000	0.0000	2.2	0.08
6	60	0.0040	0.0110	0.0660	0.0000	0.0000	0.0000	0.0000	0.0000	4.7	0.30
7	70	0.0040	0.0110	0.0770	0.0000	0.0000	0.0000	0.0000	0.0000	6.9	0.66
8	80	0.0040	0.0110	0.0880	0.0000	0.0000	0.0000	0.0000	0.0000	8.8	1.13
9	90	0.0040	0.0110	0.0990	0.0000	0.0000	0.0000	0.0000	0.0000	10.4	1.68
10	100	0.0040	0.0110	0.1100	0.0000	0.0000	0.0000	0.0000	0.0000	11.8	2.29
11	110	0.0050	0.0138	0.1238	0.0000	0.0000	0.0000	0.0000	0.0000	16.6	3.07
12	120	0.0050	0.0138	0.1375	0.0000	0.0000	0.0000	0.0000	0.0000	18.3	4.00
13	130	0.0050	0.0138	0.1513	0.0000	0.0000	0.0000	0.0000	0.0000	19.8	4.98
14	140	0.0050	0.0138	0.1650	0.0000	0.0000	0.0000	0.0000	0.0000	21.1	5.99
15	150	0.0050	0.0138	0.1788	0.0000	0.0000	0.0000	0.0000	0.0000	22.2	7.01
16	160	0.0050	0.0138	0.1925	0.0000	0.0000	0.0000	0.0000	0.0000	23.2	8.03
17	170	0.0060	0.0165	0.2090	0.0000	0.0000	0.0000	0.0000	0.0000	29.0	9.21
18	180	0.0060	0.0165	0.2255	0.0000	0.0000	0.0000	0.0000	0.0000	30.2	10.54
19	190	0.0060	0.0165	0.2420	0.0000	0.0000	0.0000	0.0000	0.0000	31.2	11.85
20	200	0.0060	0.0165	0.2585	0.0000	0.0000	0.0000	0.0000	0.0000	32.0	13.14
21	210	0.0060	0.0165	0.2750	0.0000	0.0000	0.0000	0.0000	0.0000	32.8	14.40
22	220	0.0060	0.0165	0.2915	0.0000	0.0000	0.0000	0.0000	0.0000	33.5	15.62
23	230	0.0070	0.0193	0.3108	0.0000	0.0000	0.0000	0.0000	0.0000	39.9	16.99
24	240	0.0070	0.0193	0.3300	0.0000	0.0000	0.0000	0.0000	0.0000	40.6	18.51
25	250	0.0070	0.0193	0.3493	0.0000	0.0000	0.0000	0.0000	0.0000	41.3	19.97
26	260	0.0070	0.0193	0.3685	0.0000	0.0000	0.0000	0.0000	0.0000	41.9	21.38
27	270	0.0070	0.0193	0.3878	0.0000	0.0000	0.0000	0.0000	0.0000	42.4	22.73
28	280	0.0070	0.0193	0.4070	0.0000	0.0000	0.0000	0.0000	0.0000	42.9	24.03
29	290	0.0082	0.0226	0.4296	0.0000	0.0000	0.0000	0.0000	0.0000	50.8	25.51
30	300	0.0082	0.0226	0.4521	0.0000	0.0000	0.0000	0.0000	0.0000	51.3	27.18
31	310	0.0082	0.0226	0.4747	0.0000	0.0000	0.0000	0.0000	0.0000	51.8	28.76
32	320	0.0082	0.0226	0.4972	0.0000	0.0000	0.0000	0.0000	0.0000	53.5	30.32
33	330	0.0082	0.0226	0.5198	0.0011	0.0007	0.0000	0.0000	0.0000	55.6	31.90
34	340	0.0082	0.0226	0.5423	0.0022	0.0011	0.0000	0.0000	0.0000	57.6	33.50
35	350	0.0095	0.0261	0.5684	0.0040	0.0018	0.0000	0.0000	0.0000	69.1	35.45
36	360	0.0095	0.0261	0.5946	0.0064	0.0023	0.0000	0.0000	0.0000	71.6	37.72
37	370	0.0095	0.0261	0.6207	0.0092	0.0028	0.0000	0.0000	0.0000	73.9	40.00
38	380	0.0095	0.0261	0.6468	0.0125	0.0033	0.0000	0.0000	0.0000	76.2	42.29
39	390	0.0095	0.0261	0.6729	0.0163	0.0038	0.0000	0.0000	0.0000	78.4	44.57
40	400	0.0095	0.0261	0.6991	0.0205	0.0042	0.0000	0.0000	0.0000	80.5	46.84
41	410	0.0134	0.0369	0.7359	0.0272	0.0067	0.0000	0.0000	0.0000	116.9	50.22
42	420	0.0134	0.0369	0.7728	0.0348	0.0076	0.0000	0.0000	0.0000	120.8	54.70
43	430	0.0134	0.0369	0.8096	0.0432	0.0084	0.0000	0.0000	0.0000	124.4	59.12
44	440	0.0180	0.0495	0.8591	0.0556	0.0124	0.0000	0.0000	0.0000	172.5	64.95
45	450	0.0180	0.0495	0.9086	0.0693	0.0138	0.0000	0.0000	0.0000	178.4	72.15
46	460	0.0340	0.0935	1.0021	0.0987	0.0293	0.0000	0.0000	0.0000	351.8	84.73
47	470	0.0540	0.1485	1.1506	0.1534	0.0547	0.0000	0.0000	0.0000	594.4	110.05
48	480	0.0270	0.0743	1.2249	0.1841	0.0307	0.0000	0.0000	0.0000	311.8	132.41 Q peak
49	490	0.0180	0.0495	1.2744	0.2058	0.0216	0.0000	0.0000	0.0000	212.7	140.87
50	500	0.0134	0.0369	1.3112	0.2224	0.0167	0.0000	0.0000	0.0000	160.8	143.86
51	510	0.0134	0.0369	1.3481	0.2396	0.0171	0.0000	0.0000	0.0000	162.8	145.03
52	520	0.0134	0.0369	1.3849	0.2571	0.0176	0.0000	0.0000	0.0000	164.7	146.25
53	530	0.0088	0.0242	1.4091	0.2689	0.0118	0.0000	0.0000	0.0000	109.1	145.64
54	540	0.0088	0.0242	1.4333	0.2809	0.0120	0.0000	0.0000	0.0000	109.9	143.29
55	550	0.0088	0.0242	1.4575	0.2930	0.0121	0.0000	0.0000	0.0000	110.7	141.13
56	560	0.0088	0.0242	1.4817	0.3053	0.0123	0.0000	0.0000	0.0000	111.4	139.17
57	570	0.0088	0.0242	1.5059	0.3178	0.0125	0.0000	0.0000	0.0000	112.1	137.39
58	580	0.0088	0.0242	1.5301	0.3304	0.0126	0.0000	0.0000	0.0000	112.8	135.76
59	590	0.0088	0.0242	1.5543	0.3432	0.0128	0.0000	0.0000	0.0000	113.5	134.29
60	600	0.0088	0.0242	1.5785	0.3562	0.0130	0.0000	0.0000	0.0000	114.2	132.96
61	610	0.0088	0.0242	1.6027	0.3693	0.0131	0.0000	0.0000	0.0000	114.9	131.76
62	620	0.0088	0.0242	1.6269	0.3826	0.0133	0.0000	0.0000	0.0000	115.5	130.68
63	630	0.0088	0.0242	1.6511	0.3960	0.0134	0.0000	0.0000	0.0000	116.2	129.71
64	640	0.0088	0.0242	1.6753	0.4096	0.0136	0.0000	0.0000	0.0000	116.8	128.85
65	650	0.0072	0.0198	1.6995	0.4208	0.0112	0.0000	0.0000	0.0000	96.0	127.38
66	660	0.0072	0.0198	1.7149	0.4321	0.0113	0.0000	0.0000	0.0000	96.4	125.35
67	670	0.0072	0.0198	1.7347	0.4435	0.0114	0.0000	0.0000	0.0000	96.8	123.48

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of Pt	(4) Incremental Rainfall in.	Pervious Area		Impervious Area		(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
				(5) Accumulated Rainfall in.	(6) Accumulated Runoff in.	(7) Incremental Runoff in.	(8) Accumulated Runoff in.			
68	680	0.0072	0.0198	1.7545	0.4550	0.0115	1.5313	0.0196	0.0146	97.2
69	690	0.0072	0.0198	1.7743	0.4668	0.0116	1.5509	0.0196	0.0147	97.6
70	700	0.0072	0.0198	1.7941	0.4783	0.0117	1.5705	0.0196	0.0147	97.9
71	710	0.0072	0.0198	1.8139	0.4900	0.0118	1.5901	0.0196	0.0148	98.3
72	720	0.0072	0.0198	1.8337	0.5019	0.0118	1.6097	0.0196	0.0148	98.7
73	730	0.0072	0.0198	1.8535	0.5138	0.0119	1.6293	0.0196	0.0149	99.0
74	740	0.0072	0.0198	1.8733	0.5258	0.0120	1.6489	0.0196	0.0149	99.4
75	750	0.0072	0.0198	1.8931	0.5379	0.0121	1.6685	0.0196	0.0150	99.7
76	760	0.0072	0.0198	1.9129	0.5501	0.0122	1.6881	0.0196	0.0150	100.0
77	770	0.0057	0.0157	1.9286	0.5598	0.0097	1.7036	0.0155	0.0119	79.4
78	780	0.0057	0.0157	1.9443	0.5695	0.0097	1.7191	0.0155	0.0120	79.6
79	790	0.0057	0.0157	1.9599	0.5793	0.0098	1.7346	0.0155	0.0120	79.8
80	800	0.0057	0.0157	1.9756	0.5891	0.0098	1.7502	0.0155	0.0120	80.0
81	810	0.0057	0.0157	1.9913	0.5990	0.0099	1.7657	0.0155	0.0121	80.2
82	820	0.0057	0.0157	2.0070	0.6090	0.0099	1.7812	0.0155	0.0121	80.4
83	830	0.0057	0.0157	2.0226	0.6189	0.0100	1.7968	0.0155	0.0121	80.6
84	840	0.0057	0.0157	2.0383	0.6290	0.0100	1.8123	0.0155	0.0122	80.8
85	850	0.0057	0.0157	2.0540	0.6390	0.0101	1.8279	0.0155	0.0122	81.0
86	860	0.0057	0.0157	2.0697	0.6491	0.0101	1.8434	0.0155	0.0122	81.2
87	870	0.0057	0.0157	2.0853	0.6593	0.0102	1.8589	0.0155	0.0122	81.4
88	880	0.0057	0.0157	2.1010	0.6695	0.0102	1.8745	0.0155	0.0123	81.6
89	890	0.0050	0.0138	2.1148	0.6785	0.0090	1.8881	0.0136	0.0108	71.7
90	900	0.0050	0.0138	2.1285	0.6875	0.0090	1.9018	0.0136	0.0108	71.8
91	910	0.0050	0.0138	2.1423	0.6966	0.0090	1.9154	0.0136	0.0108	72.0
92	920	0.0050	0.0138	2.1560	0.7056	0.0091	1.9291	0.0136	0.0108	72.1
93	930	0.0050	0.0138	2.1698	0.7148	0.0091	1.9427	0.0136	0.0109	72.2
94	940	0.0050	0.0138	2.1835	0.7239	0.0091	1.9563	0.0136	0.0109	72.4
95	950	0.0050	0.0138	2.1973	0.7331	0.0092	1.9700	0.0136	0.0109	72.5
96	960	0.0050	0.0138	2.2110	0.7423	0.0092	1.9836	0.0136	0.0109	72.6
97	970	0.0050	0.0138	2.2248	0.7515	0.0092	1.9973	0.0136	0.0109	72.8
98	980	0.0050	0.0138	2.2385	0.7608	0.0093	2.0109	0.0137	0.0110	72.9
99	990	0.0050	0.0138	2.2523	0.7701	0.0093	2.0246	0.0137	0.0110	73.0
100	1000	0.0050	0.0138	2.2660	0.7794	0.0093	2.0382	0.0137	0.0110	73.1
101	1010	0.0040	0.0110	2.2770	0.7869	0.0075	2.0492	0.0109	0.0088	58.6
102	1020	0.0040	0.0110	2.2880	0.7944	0.0075	2.0601	0.0109	0.0088	58.7
103	1030	0.0040	0.0110	2.2990	0.8019	0.0075	2.0710	0.0109	0.0088	58.7
104	1040	0.0040	0.0110	2.3100	0.8094	0.0075	2.0819	0.0109	0.0088	58.8
105	1050	0.0040	0.0110	2.3210	0.8170	0.0076	2.0929	0.0109	0.0089	58.9
106	1060	0.0040	0.0110	2.3320	0.8246	0.0076	2.1038	0.0109	0.0089	59.0
107	1070	0.0040	0.0110	2.3430	0.8322	0.0076	2.1147	0.0109	0.0089	59.1
108	1080	0.0040	0.0110	2.3540	0.8398	0.0076	2.1256	0.0109	0.0089	59.1
109	1090	0.0040	0.0110	2.3650	0.8474	0.0076	2.1366	0.0109	0.0089	59.2
110	1100	0.0040	0.0110	2.3760	0.8550	0.0076	2.1475	0.0109	0.0089	59.3
111	1110	0.0040	0.0110	2.3870	0.8627	0.0077	2.1584	0.0109	0.0089	59.3
112	1120	0.0040	0.0110	2.3980	0.8704	0.0077	2.1694	0.0109	0.0089	59.4
113	1130	0.0040	0.0110	2.4090	0.8781	0.0077	2.1803	0.0109	0.0089	59.5
114	1140	0.0040	0.0110	2.4200	0.8858	0.0077	2.1912	0.0109	0.0090	59.6
115	1150	0.0040	0.0110	2.4310	0.8935	0.0077	2.2022	0.0109	0.0090	59.6
116	1160	0.0040	0.0110	2.4420	0.9013	0.0077	2.2131	0.0109	0.0090	59.7
117	1170	0.0040	0.0110	2.4530	0.9090	0.0078	2.2240	0.0109	0.0090	59.8
118	1180	0.0040	0.0110	2.4640	0.9168	0.0078	2.2350	0.0109	0.0090	59.8
119	1190	0.0040	0.0110	2.4750	0.9246	0.0078	2.2459	0.0109	0.0090	59.9
120	1200	0.0040	0.0110	2.4860	0.9324	0.0078	2.2568	0.0109	0.0090	60.0
121	1210	0.0040	0.0110	2.4970	0.9403	0.0078	2.2678	0.0109	0.0090	60.0
122	1220	0.0040	0.0110	2.5080	0.9481	0.0078	2.2787	0.0109	0.0090	60.1
123	1230	0.0040	0.0110	2.5190	0.9560	0.0079	2.2896	0.0109	0.0090	60.2
124	1240	0.0040	0.0110	2.5300	0.9638	0.0079	2.3006	0.0109	0.0091	60.2
125	1250	0.0040	0.0110	2.5410	0.9717	0.0079	2.3115	0.0109	0.0091	60.3
126	1260	0.0040	0.0110	2.5520	0.9796	0.0079	2.3224	0.0109	0.0091	60.4
127	1270	0.0040	0.0110	2.5630	0.9875	0.0079	2.3334	0.0109	0.0091	60.4
128	1280	0.0040	0.0110	2.5740	0.9955	0.0079	2.3443	0.0109	0.0091	60.5
129	1290	0.0040	0.0110	2.5850	1.0034	0.0080	2.3553	0.0109	0.0091	60.6
130	1300	0.0040	0.0110	2.5960	1.0114	0.0080	2.3662	0.0109	0.0091	60.6
131	1310	0.0040	0.0110	2.6070	1.0194	0.0080	2.3771	0.0109	0.0091	60.7
132	1320	0.0040	0.0110	2.6180	1.0274	0.0080	2.3881	0.0109	0.0091	60.7
133	1330	0.0040	0.0110	2.6290	1.0354	0.0080	2.3990	0.0109	0.0091	60.8
134	1340	0.0040	0.0110	2.6400	1.0434	0.0080	2.4100	0.0109	0.0092	60.9
135	1350	0.0040	0.0110	2.6510	1.0515	0.0080	2.4209	0.0109	0.0092	60.9
136	1360	0.0040	0.0110	2.6620	1.0595	0.0081	2.4318	0.0109	0.0092	61.0
137	1370	0.0040	0.0110	2.6730	1.0676	0.0081	2.4428	0.0109	0.0092	61.0
138	1380	0.0040	0.0110	2.6840	1.0757	0.0081	2.4537	0.0109	0.0092	61.1
139	1390	0.0040	0.0110	2.6950	1.0838	0.0081	2.4647	0.0109	0.0092	61.2
140	1400	0.0040	0.0110	2.7060	1.0919	0.0081	2.4756	0.0109	0.0092	61.2
141	1410	0.0040	0.0110	2.7170	1.1000	0.0081	2.4866	0.0109	0.0092	61.3
142	1420	0.0040	0.0110	2.7280	1.1081	0.0081	2.4975	0.0109	0.0092	61.3
143	1430	0.0040	0.0110	2.7390	1.1163	0.0082	2.5085	0.0109	0.0092	61.4
144	1440	0.0040	0.0110	2.7500	1.1245	0.0082	2.5194	0.0109	0.0092	61.4

Total Volume of Runoff = 6,085,059 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \sum Q \times dt$$

$$V(\text{cu.ft.}) = \sum Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Prairie Creek Subbasin
Storm Event: 25-YEAR, 24-HOUR
Given:

Area = 1099.30 acres
P_t = 3.20 inches
dt = 10 min.
T_c = 148.4 min.
PERVIOUS AREA (Interim Final Cover Area)
Area = 675.00 acres
CN = 81
S = 2.35
0.2S = 0.47
IMPERVIOUS AREA (Roads)
Area = 424.30 acres
CN = 98
S = 0.20
0.2S = 0.04

SUMMARY
T _{pk} (hrs) = 7.83
T _c (min) = 148.4
Q _{pk} (cfs) = 183.57
Vol (cf) = 7,506,949

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution
Column (4) = Col. (3) x P_t
Column (5) = Accumulated Sum of Col. (4)
Column (6) = [If P ≤ 0.2S] = 0; Note, use PERVIOUS Area "S" value.
[If P > 0.2S] = (Col.(5) - 0.2S) / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.
Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step
Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.
Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.
Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))
Column (11) = (60.5 x Col.(10) x Total area) / 10 (dt = 10 minutes)
Routing Constant, w = dt / (2T_c + dt) = 0.0326
Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step + Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of P _t	(4) Incre- mental Rainfall in.	(5) Accum- ulated Rainfall in.	(6) Accum- ulated Runoff in.	(7) Incre- mental Runoff in.	(8) Accum- ulated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0128	0.0128	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0128	0.0256	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0128	0.0384	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
4	40	0.0040	0.0128	0.0512	0.0000	0.0000	0.0005	0.0005	0.0002	1.3	0.04
5	50	0.0040	0.0128	0.0640	0.0000	0.0000	0.0024	0.0019	0.0007	4.8	0.24
6	60	0.0040	0.0128	0.0768	0.0000	0.0000	0.0054	0.0030	0.0012	7.8	0.63
7	70	0.0040	0.0128	0.0896	0.0000	0.0000	0.0094	0.0040	0.0016	10.3	1.18
8	80	0.0040	0.0128	0.1024	0.0000	0.0000	0.0143	0.0049	0.0019	12.5	1.85
9	90	0.0040	0.0128	0.1152	0.0000	0.0000	0.0199	0.0056	0.0022	14.4	2.60
10	100	0.0040	0.0128	0.1280	0.0000	0.0000	0.0261	0.0082	0.0024	16.0	3.42
11	110	0.0050	0.0160	0.1440	0.0000	0.0000	0.0347	0.0086	0.0033	22.0	4.43
12	120	0.0050	0.0160	0.1600	0.0000	0.0000	0.0439	0.0093	0.0036	23.9	5.64
13	130	0.0050	0.0160	0.1760	0.0000	0.0000	0.0539	0.0099	0.0038	25.5	6.88
14	140	0.0050	0.0160	0.1920	0.0000	0.0000	0.0643	0.0105	0.0040	26.9	8.14
15	150	0.0050	0.0160	0.2080	0.0000	0.0000	0.0753	0.0109	0.0042	28.1	9.40
16	160	0.0050	0.0160	0.2240	0.0000	0.0000	0.0866	0.0114	0.0044	29.2	10.65
17	170	0.0060	0.0192	0.2432	0.0000	0.0000	0.1008	0.0141	0.0054	36.2	12.09
18	180	0.0060	0.0192	0.2624	0.0000	0.0000	0.1153	0.0146	0.0056	37.4	13.70
19	190	0.0060	0.0192	0.2816	0.0000	0.0000	0.1303	0.0150	0.0058	38.4	15.28
20	200	0.0060	0.0192	0.3008	0.0000	0.0000	0.1457	0.0153	0.0059	39.3	16.82
21	210	0.0060	0.0192	0.3200	0.0000	0.0000	0.1613	0.0156	0.0060	40.1	18.32
22	220	0.0060	0.0192	0.3392	0.0000	0.0000	0.1772	0.0159	0.0061	40.8	19.76
23	230	0.0070	0.0224	0.3616	0.0000	0.0000	0.1961	0.0189	0.0073	48.4	21.38
24	240	0.0070	0.0224	0.3840	0.0000	0.0000	0.2152	0.0192	0.0074	49.2	23.17
25	250	0.0070	0.0224	0.4064	0.0000	0.0000	0.2346	0.0194	0.0075	49.8	24.88
26	260	0.0070	0.0224	0.4288	0.0000	0.0000	0.2542	0.0196	0.0076	50.4	26.53
27	270	0.0070	0.0224	0.4512	0.0000	0.0000	0.2741	0.0198	0.0077	50.9	28.10
28	280	0.0070	0.0224	0.4736	0.0000	0.0000	0.2941	0.0200	0.0077	51.4	29.61
29	290	0.0082	0.0262	0.4998	0.0004	0.0004	0.3178	0.0237	0.0094	62.3	31.38
30	300	0.0082	0.0262	0.5261	0.0013	0.0010	0.3416	0.0238	0.0098	65.1	33.49
31	310	0.0082	0.0262	0.5523	0.0028	0.0015	0.3656	0.0240	0.0102	67.8	35.64
32	320	0.0082	0.0262	0.5786	0.0049	0.0020	0.3898	0.0242	0.0106	70.4	37.82
33	330	0.0082	0.0262	0.6048	0.0074	0.0025	0.4141	0.0243	0.0109	72.8	40.02
34	340	0.0082	0.0262	0.6310	0.0105	0.0030	0.4386	0.0244	0.0113	75.2	42.23
35	350	0.0095	0.0304	0.6614	0.0146	0.0041	0.4670	0.0285	0.0135	89.9	44.86
36	360	0.0095	0.0304	0.6918	0.0193	0.0047	0.4956	0.0286	0.0140	92.8	47.89
37	370	0.0095	0.0304	0.7222	0.0247	0.0053	0.5244	0.0287	0.0144	95.6	50.91
38	380	0.0095	0.0304	0.7526	0.0306	0.0059	0.5532	0.0288	0.0148	98.2	53.90
39	390	0.0095	0.0304	0.7830	0.0370	0.0065	0.5822	0.0289	0.0151	100.7	56.87
40	400	0.0095	0.0304	0.8134	0.0441	0.0070	0.6112	0.0290	0.0155	103.2	59.81
41	410	0.0134	0.0429	0.8563	0.0549	0.0108	0.6523	0.0411	0.0225	149.5	64.15
42	420	0.0134	0.0429	0.8992	0.0666	0.0118	0.6935	0.0412	0.0231	153.9	69.86
43	430	0.0134	0.0429	0.9421	0.0794	0.0127	0.7349	0.0414	0.0238	158.1	75.48
44	440	0.0180	0.0576	0.9997	0.0979	0.0185	0.7906	0.0557	0.0329	218.6	82.84
45	450	0.0180	0.0576	1.0573	0.1179	0.0200	0.8465	0.0559	0.0339	225.4	91.91
46	460	0.0340	0.1088	1.1661	0.1596	0.0417	0.9525	0.1060	0.0665	442.6	107.69
47	470	0.0540	0.1728	1.3389	0.2353	0.0756	1.1217	0.1692	0.1117	743.1	139.32
48	480	0.0270	0.0864	1.4253	0.2769	0.0416	1.2066	0.0849	0.0583	387.9	167.10 Q peak
49	490	0.0180	0.0576	1.4829	0.3059	0.0290	1.2633	0.0567	0.0397	264.0	177.46
50	500	0.0134	0.0429	1.5258	0.3281	0.0222	1.3055	0.0422	0.0300	199.2	180.99
51	510	0.0134	0.0429	1.5686	0.3509	0.0228	1.3478	0.0423	0.0303	201.4	182.25
52	520	0.0134	0.0429	1.6115	0.3741	0.0232	1.3901	0.0423	0.0306	203.5	183.57
53	530	0.0088	0.0282	1.6397	0.3897	0.0155	1.4179	0.0278	0.0203	134.8	182.63
54	540	0.0088	0.0282	1.6678	0.4054	0.0157	1.4457	0.0278	0.0204	135.6	179.53
55	550	0.0088	0.0282	1.6960	0.4213	0.0159	1.4735	0.0278	0.0205	136.4	176.70
56	560	0.0088	0.0282	1.7242	0.4374	0.0161	1.5013	0.0278	0.0206	137.2	174.10
57	570	0.0088	0.0282	1.7523	0.4537	0.0163	1.5292	0.0278	0.0208	138.0	171.72
58	580	0.0088	0.0282	1.7805	0.4702	0.0165	1.5570	0.0278	0.0209	138.8	169.55
59	590	0.0088	0.0282	1.8086	0.4869	0.0167	1.5849	0.0279	0.0210	139.5	167.57
60	600	0.0088	0.0282	1.8368	0.5037	0.0168	1.6127	0.0279	0.0211	140.3	165.77
61	610	0.0088	0.0282	1.8650	0.5207	0.0170	1.6406	0.0279	0.0212	141.0	164.13
62	620	0.0088	0.0282	1.8931	0.5379	0.0172	1.6685	0.0279	0.0213	141.7	162.64
63	630	0.0088	0.0282	1.9213	0.5552	0.0173	1.6964	0.0279	0.0214	142.4	161.30
64	640	0.0088	0.0282	1.9494	0.5727	0.0175	1.7243	0.0279	0.0215	143.1	160.09
65	650	0.0072	0.0230	1.9725	0.5872	0.0144	1.7471	0.0228	0.0177	117.5	158.15
66	660	0.0072	0.0230	1.9955	0.6017	0.0145	1.7699	0.0228	0.0177	118.0	155.51
67	670	0.0072	0.0230	2.0186	0.6163	0.0146	1.7928	0.0228	0.0178	118.4	153.08

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distrib- ution % of Pt	(4) Incre- mental Rainfall in.	(5) Accumu- lated Rainfall in.	Pervious Area		Impervious Area		(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
					(6) Accumu- lated Runoff in.	(7) Incre- mental Runoff in.	(8) Accumu- lated Runoff in.	(9) Incre- mental Runoff in.			
68	680	0.0072	0.0230	2.0416	0.6311	0.0147	1.8156	0.0228	0.0179	118.8	150.83
69	690	0.0072	0.0230	2.0646	0.6459	0.0148	1.8384	0.0228	0.0179	119.2	148.76
70	700	0.0072	0.0230	2.0877	0.6608	0.0149	1.8613	0.0228	0.0180	119.6	146.84
71	710	0.0072	0.0230	2.1107	0.6759	0.0150	1.8841	0.0229	0.0180	120.0	145.08
72	720	0.0072	0.0230	2.1338	0.6910	0.0151	1.9070	0.0229	0.0181	120.4	143.46
73	730	0.0072	0.0230	2.1568	0.7062	0.0152	1.9299	0.0229	0.0182	120.8	141.97
74	740	0.0072	0.0230	2.1798	0.7215	0.0153	1.9527	0.0229	0.0182	121.1	140.60
75	750	0.0072	0.0230	2.2029	0.7368	0.0154	1.9756	0.0229	0.0183	121.5	139.34
76	760	0.0072	0.0230	2.2259	0.7523	0.0155	1.9985	0.0229	0.0183	121.9	138.19
77	770	0.0057	0.0182	2.2442	0.7646	0.0123	2.0166	0.0181	0.0145	96.7	136.31
78	780	0.0057	0.0182	2.2624	0.7770	0.0124	2.0347	0.0181	0.0146	96.9	133.73
79	790	0.0057	0.0182	2.2806	0.7894	0.0124	2.0528	0.0181	0.0146	97.2	131.34
80	800	0.0057	0.0182	2.2989	0.8018	0.0125	2.0709	0.0181	0.0146	97.4	129.12
81	810	0.0057	0.0182	2.3171	0.8143	0.0125	2.0890	0.0181	0.0147	97.6	127.06
82	820	0.0057	0.0182	2.3354	0.8269	0.0126	2.1071	0.0181	0.0147	97.8	125.14
83	830	0.0057	0.0182	2.3536	0.8395	0.0126	2.1253	0.0181	0.0147	98.0	123.37
84	840	0.0057	0.0182	2.3718	0.8522	0.0127	2.1434	0.0181	0.0148	98.2	121.72
85	850	0.0057	0.0182	2.3901	0.8649	0.0127	2.1615	0.0181	0.0148	98.4	120.19
86	860	0.0057	0.0182	2.4083	0.8776	0.0128	2.1796	0.0181	0.0148	98.6	118.78
87	870	0.0057	0.0182	2.4266	0.8904	0.0128	2.1977	0.0181	0.0149	98.8	117.47
88	880	0.0057	0.0182	2.4448	0.9032	0.0128	2.2159	0.0181	0.0149	99.0	116.26
89	890	0.0050	0.0160	2.4608	0.9146	0.0113	2.2318	0.0159	0.0131	87.0	114.74
90	900	0.0050	0.0160	2.4768	0.9259	0.0113	2.2477	0.0159	0.0131	87.1	112.94
91	910	0.0050	0.0160	2.4928	0.9373	0.0114	2.2636	0.0159	0.0131	87.3	111.26
92	920	0.0050	0.0160	2.5088	0.9487	0.0114	2.2795	0.0159	0.0131	87.4	109.70
93	930	0.0050	0.0160	2.5248	0.9601	0.0114	2.2954	0.0159	0.0132	87.5	108.25
94	940	0.0050	0.0160	2.5408	0.9716	0.0115	2.3113	0.0159	0.0132	87.7	106.90
95	950	0.0050	0.0160	2.5568	0.9831	0.0115	2.3272	0.0159	0.0132	87.8	105.66
96	960	0.0050	0.0160	2.5728	0.9946	0.0115	2.3431	0.0159	0.0132	88.0	104.50
97	970	0.0050	0.0160	2.5888	1.0062	0.0116	2.3590	0.0159	0.0132	88.1	103.42
98	980	0.0050	0.0160	2.6048	1.0178	0.0116	2.3749	0.0159	0.0133	88.2	102.43
99	990	0.0050	0.0160	2.6208	1.0294	0.0116	2.3909	0.0159	0.0133	88.4	101.51
100	1000	0.0050	0.0160	2.6368	1.0411	0.0117	2.4068	0.0159	0.0133	88.5	100.65
101	1010	0.0040	0.0128	2.6496	1.0504	0.0094	2.4195	0.0127	0.0107	70.9	99.29
102	1020	0.0040	0.0128	2.6624	1.0598	0.0094	2.4322	0.0127	0.0107	71.0	97.44
103	1030	0.0040	0.0128	2.6752	1.0692	0.0094	2.4450	0.0127	0.0107	71.0	95.71
104	1040	0.0040	0.0128	2.6880	1.0786	0.0094	2.4577	0.0127	0.0107	71.1	94.11
105	1050	0.0040	0.0128	2.7008	1.0880	0.0094	2.4704	0.0127	0.0107	71.2	92.61
106	1060	0.0040	0.0128	2.7136	1.0975	0.0094	2.4832	0.0127	0.0107	71.3	91.22
107	1070	0.0040	0.0128	2.7264	1.1070	0.0095	2.4959	0.0127	0.0107	71.4	89.92
108	1080	0.0040	0.0128	2.7392	1.1164	0.0095	2.5087	0.0127	0.0107	71.4	88.71
109	1090	0.0040	0.0128	2.7520	1.1259	0.0095	2.5214	0.0127	0.0108	71.5	87.59
110	1100	0.0040	0.0128	2.7648	1.1355	0.0095	2.5341	0.0127	0.0108	71.6	86.54
111	1110	0.0040	0.0128	2.7776	1.1450	0.0095	2.5469	0.0127	0.0108	71.7	85.57
112	1120	0.0040	0.0128	2.7904	1.1546	0.0096	2.5596	0.0127	0.0108	71.7	84.66
113	1130	0.0040	0.0128	2.8032	1.1641	0.0096	2.5723	0.0127	0.0108	71.8	83.82
114	1140	0.0040	0.0128	2.8160	1.1737	0.0096	2.5851	0.0127	0.0108	71.9	83.04
115	1150	0.0040	0.0128	2.8288	1.1833	0.0096	2.5978	0.0127	0.0108	72.0	82.32
116	1160	0.0040	0.0128	2.8416	1.1930	0.0096	2.6106	0.0127	0.0108	72.0	81.64
117	1170	0.0040	0.0128	2.8544	1.2026	0.0096	2.6233	0.0127	0.0108	72.1	81.02
118	1180	0.0040	0.0128	2.8672	1.2123	0.0097	2.6360	0.0127	0.0109	72.2	80.44
119	1190	0.0040	0.0128	2.8800	1.2220	0.0097	2.6488	0.0127	0.0109	72.2	79.90
120	1200	0.0040	0.0128	2.8928	1.2316	0.0097	2.6615	0.0127	0.0109	72.3	79.40
121	1210	0.0040	0.0128	2.9056	1.2414	0.0097	2.6743	0.0127	0.0109	72.4	78.94
122	1220	0.0040	0.0128	2.9184	1.2511	0.0097	2.6870	0.0127	0.0109	72.4	78.52
123	1230	0.0040	0.0128	2.9312	1.2608	0.0097	2.6998	0.0127	0.0109	72.5	78.12
124	1240	0.0040	0.0128	2.9440	1.2706	0.0098	2.7125	0.0127	0.0109	72.6	77.76
125	1250	0.0040	0.0128	2.9568	1.2804	0.0098	2.7253	0.0127	0.0109	72.6	77.42
126	1260	0.0040	0.0128	2.9696	1.2902	0.0098	2.7380	0.0127	0.0109	72.7	77.12
127	1270	0.0040	0.0128	2.9824	1.3000	0.0098	2.7507	0.0127	0.0109	72.8	76.83
128	1280	0.0040	0.0128	2.9952	1.3098	0.0098	2.7635	0.0127	0.0110	72.8	76.57
129	1290	0.0040	0.0128	3.0080	1.3196	0.0098	2.7762	0.0127	0.0110	72.9	76.33
130	1300	0.0040	0.0128	3.0208	1.3295	0.0099	2.7890	0.0127	0.0110	73.0	76.11
131	1310	0.0040	0.0128	3.0336	1.3394	0.0099	2.8017	0.0127	0.0110	73.0	75.90
132	1320	0.0040	0.0128	3.0464	1.3493	0.0099	2.8145	0.0127	0.0110	73.1	75.72
133	1330	0.0040	0.0128	3.0592	1.3592	0.0099	2.8272	0.0127	0.0110	73.2	75.55
134	1340	0.0040	0.0128	3.0720	1.3691	0.0099	2.8400	0.0127	0.0110	73.2	75.40
135	1350	0.0040	0.0128	3.0848	1.3790	0.0099	2.8527	0.0127	0.0110	73.3	75.26
136	1360	0.0040	0.0128	3.0976	1.3889	0.0099	2.8655	0.0127	0.0110	73.3	75.13
137	1370	0.0040	0.0128	3.1104	1.3989	0.0100	2.8782	0.0128	0.0110	73.4	75.02
138	1380	0.0040	0.0128	3.1232	1.4089	0.0100	2.8910	0.0128	0.0110	73.5	74.91
139	1390	0.0040	0.0128	3.1360	1.4189	0.0100	2.9037	0.0128	0.0111	73.5	74.82
140	1400	0.0040	0.0128	3.1488	1.4289	0.0100	2.9165	0.0128	0.0111	73.6	74.74
141	1410	0.0040	0.0128	3.1616	1.4389	0.0100	2.9292	0.0128	0.0111	73.6	74.67
142	1420	0.0040	0.0128	3.1744	1.4489	0.0100	2.9420	0.0128	0.0111	73.7	74.60
143	1430	0.0040	0.0128	3.1872	1.4590	0.0100	2.9547	0.0128	0.0111	73.8	74.54
144	1440	0.0040	0.0128	3.2000	1.4690	0.0101	2.9675	0.0128	0.0111	73.8	74.50

Total Volume of Runoff¹ = 7,506,949 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \sum Q \times dt$$

$$V(\text{cu.ft.}) = \sum Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

5/90

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Prairie Creek Subbasin
Storm Event: 100-YEAR, 24-HOUR
Given:

Area = 1099.30 acres
Pt = 3.75 inches
dt = 10 min.
Tc = 148.4 min.
PERVIOUS AREA
(Interim Final Cover Area)
Area = 675.00 acres
CN = 81
S = 2.35
0.2S = 0.47
IMPERVIOUS AREA
(Roads)
Area = 424.30 acres
CN = 98
S = 0.20
0.2S = 0.04

SUMMARY	
T _{pk} (hrs) =	7.83
T _c (min) =	148.4
Q _{pk} (cfs) =	231.28
Vol (cf) =	9,301,279

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution
Column (4) = Col. (3) x Pt
Column (5) = Accumulated Sum of Col. (4)
Column (6) = If P <= 0.2S = 0; Note, use PERVIOUS Area "S" value.
If P > 0.2S = (Col.(5) - 0.2S)/2 / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.
Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step
Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.
Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.
Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))
Column (11) = (60.5 x Col.(10) x Total Area) / 10 (dt = 10 minutes)
Routing Constant, w = dt / (2Tc + dt) = 0.0326
Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step
+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

(1) Time Increment	(2) Time min.	(3) Rainfall distribu- tion % of Pt	(4) Incre- mental Rainfall in.	(5) Accumu- lated Rainfall in.	Pervious Area (6) Accumu- lated Runoff in.	(7) Incre- mental Runoff in.	Impervious Area (8) Accumu- lated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0150	0.0150	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0150	0.0300	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0150	0.0450	0.0000	0.0000	0.0001	0.0001	0.0000	0.2	0.01
4	40	0.0040	0.0150	0.0600	0.0000	0.0000	0.0016	0.0016	0.0006	4.0	0.14
5	50	0.0040	0.0150	0.0750	0.0000	0.0000	0.0049	0.0033	0.0013	8.4	0.54
6	60	0.0040	0.0150	0.0900	0.0000	0.0000	0.0096	0.0046	0.0018	11.9	1.16
7	70	0.0040	0.0150	0.1050	0.0000	0.0000	0.0154	0.0058	0.0022	14.9	1.96
8	80	0.0040	0.0150	0.1200	0.0000	0.0000	0.0221	0.0068	0.0026	17.4	2.89
9	90	0.0040	0.0150	0.1350	0.0000	0.0000	0.0297	0.0076	0.0029	19.5	3.90
10	100	0.0040	0.0150	0.1500	0.0000	0.0000	0.0381	0.0083	0.0032	21.3	4.98
11	110	0.0050	0.0188	0.1688	0.0000	0.0000	0.0493	0.0112	0.0043	28.9	6.29
12	120	0.0050	0.0188	0.1875	0.0000	0.0000	0.0613	0.0120	0.0046	30.9	7.83
13	130	0.0050	0.0188	0.2063	0.0000	0.0000	0.0741	0.0127	0.0049	32.7	9.39
14	140	0.0050	0.0188	0.2250	0.0000	0.0000	0.0874	0.0133	0.0051	34.2	10.96
15	150	0.0050	0.0188	0.2438	0.0000	0.0000	0.1012	0.0138	0.0053	35.4	12.51
16	160	0.0050	0.0188	0.2625	0.0000	0.0000	0.1154	0.0142	0.0055	36.6	14.04
17	170	0.0060	0.0225	0.2850	0.0000	0.0000	0.1330	0.0176	0.0068	45.2	15.79
18	180	0.0060	0.0225	0.3075	0.0000	0.0000	0.1511	0.0181	0.0070	46.4	17.75
19	190	0.0060	0.0225	0.3300	0.0000	0.0000	0.1695	0.0185	0.0071	47.4	19.64
20	200	0.0060	0.0225	0.3525	0.0000	0.0000	0.1884	0.0188	0.0073	48.3	21.48
21	210	0.0060	0.0225	0.3750	0.0000	0.0000	0.2075	0.0191	0.0074	49.1	23.26
22	220	0.0060	0.0225	0.3975	0.0000	0.0000	0.2269	0.0194	0.0075	49.8	24.96
23	230	0.0070	0.0263	0.4238	0.0000	0.0000	0.2498	0.0229	0.0088	58.9	26.88
24	240	0.0070	0.0263	0.4500	0.0000	0.0000	0.2730	0.0232	0.0090	59.6	28.99
25	250	0.0070	0.0263	0.4763	0.0000	0.0000	0.2965	0.0235	0.0091	60.3	31.01
26	260	0.0070	0.0263	0.5025	0.0005	0.0004	0.3202	0.0237	0.0094	62.6	32.99
27	270	0.0070	0.0263	0.5288	0.0015	0.0010	0.3440	0.0239	0.0098	65.4	35.01
28	280	0.0070	0.0263	0.5550	0.0030	0.0016	0.3681	0.0241	0.0102	68.1	37.08
29	290	0.0082	0.0308	0.5858	0.0055	0.0025	0.3965	0.0284	0.0125	83.0	39.59
30	300	0.0082	0.0308	0.6165	0.0087	0.0032	0.4250	0.0286	0.0130	86.3	42.53
31	310	0.0082	0.0308	0.6473	0.0126	0.0039	0.4537	0.0287	0.0135	89.5	45.49
32	320	0.0082	0.0308	0.6780	0.0171	0.0045	0.4826	0.0289	0.0139	92.5	48.45
33	330	0.0082	0.0308	0.7088	0.0222	0.0051	0.5116	0.0290	0.0143	95.4	51.42
34	340	0.0082	0.0308	0.7395	0.0279	0.0057	0.5407	0.0291	0.0148	98.2	54.38
35	350	0.0095	0.0356	0.7751	0.0353	0.0074	0.5745	0.0339	0.0176	117.0	57.85
36	360	0.0095	0.0356	0.8108	0.0434	0.0081	0.6086	0.0340	0.0181	120.4	61.82
37	370	0.0095	0.0356	0.8464	0.0523	0.0088	0.6427	0.0341	0.0186	123.7	65.74
38	380	0.0095	0.0356	0.8820	0.0618	0.0095	0.6769	0.0342	0.0191	126.8	69.62
39	390	0.0095	0.0356	0.9176	0.0720	0.0102	0.7113	0.0343	0.0195	129.7	73.44
40	400	0.0095	0.0356	0.9533	0.0828	0.0108	0.7457	0.0344	0.0199	132.5	77.20
41	410	0.0134	0.0503	1.0035	0.0991	0.0163	0.7943	0.0486	0.0288	191.5	82.73
42	420	0.0134	0.0503	1.0538	0.1166	0.0175	0.8431	0.0488	0.0296	196.6	89.99
43	430	0.0134	0.0503	1.1040	0.1352	0.0186	0.8920	0.0489	0.0303	201.4	97.10
44	440	0.0180	0.0675	1.1715	0.1618	0.0266	0.9578	0.0658	0.0418	277.7	106.39
45	450	0.0180	0.0675	1.2390	0.1902	0.0284	1.0238	0.0660	0.0429	285.4	117.80
46	460	0.0340	0.1275	1.3665	0.2483	0.0581	1.1488	0.1250	0.0839	558.1	137.62
47	470	0.0540	0.2025	1.5690	0.3511	0.1028	1.3481	0.1993	0.1400	931.4	177.19
48	480	0.0270	0.1013	1.6703	0.4068	0.0557	1.4481	0.0999	0.0727	483.8	211.77 Q peak
49	490	0.0180	0.0675	1.7378	0.4453	0.0385	1.5148	0.0667	0.0494	328.5	224.44
50	500	0.0134	0.0503	1.7880	0.4747	0.0294	1.5644	0.0497	0.0372	247.5	228.59
51	510	0.0134	0.0503	1.8383	0.5046	0.0299	1.6142	0.0497	0.0376	249.9	229.90
52	520	0.0134	0.0503	1.8885	0.5351	0.0305	1.6639	0.0497	0.0379	252.2	231.28
53	530	0.0088	0.0330	1.9215	0.5554	0.0203	1.6966	0.0327	0.0251	166.8	229.86
54	540	0.0088	0.0330	1.9545	0.5759	0.0205	1.7293	0.0327	0.0252	167.7	225.78
55	550	0.0088	0.0330	1.9875	0.5966	0.0207	1.7620	0.0327	0.0254	168.6	222.02
56	560	0.0088	0.0330	2.0205	0.6176	0.0209	1.7947	0.0327	0.0255	169.5	218.57
57	570	0.0088	0.0330	2.0535	0.6387	0.0211	1.8274	0.0327	0.0256	170.3	215.39
58	580	0.0088	0.0330	2.0865	0.6601	0.0213	1.8601	0.0327	0.0257	171.2	212.48
59	590	0.0088	0.0330	2.1195	0.6816	0.0215	1.8928	0.0327	0.0259	172.0	209.82
60	600	0.0088	0.0330	2.1525	0.7033	0.0217	1.9256	0.0327	0.0260	172.8	207.37
61	610	0.0088	0.0330	2.1855	0.7252	0.0219	1.9583	0.0327	0.0261	173.5	205.14
62	620	0.0088	0.0330	2.2185	0.7473	0.0221	1.9911	0.0328	0.0262	174.3	203.11
63	630	0.0088	0.0330	2.2515	0.7696	0.0223	2.0238	0.0328	0.0263	175.0	201.25
64	640	0.0088	0.0330	2.2845	0.7920	0.0224	2.0566	0.0328	0.0264	175.7	199.56
65	650	0.0072	0.0270	2.3115	0.8105	0.0185	2.0834	0.0268	0.0217	144.3	196.98
66	660	0.0072	0.0270	2.3385	0.8291	0.0186	2.1103	0.0268	0.0218	144.7	193.56
67	670	0.0072	0.0270	2.3655	0.8478	0.0187	2.1371	0.0268	0.0218	145.2	190.39

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distribu- tion % of Pt	(4) Incremental Rainfall in.	(5) Accumulated Rainfall in.	Pervious Area		Impervious Area		(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
					(6) Accumulated Runoff in.	(7) Incremental Runoff in.	(8) Accumulated Runoff in.	(9) Incremental Runoff in.			
68	680	0.0072	0.0270	2.3925	0.8665	0.0188	2.1639	0.0288	0.0219	145.6	187.46
69	690	0.0072	0.0270	2.4195	0.8854	0.0189	2.1907	0.0288	0.0220	146.1	184.75
70	700	0.0072	0.0270	2.4465	0.9044	0.0190	2.2176	0.0288	0.0220	146.5	182.24
71	710	0.0072	0.0270	2.4735	0.9235	0.0191	2.2444	0.0288	0.0221	146.9	179.92
72	720	0.0072	0.0270	2.5005	0.9427	0.0192	2.2712	0.0288	0.0221	147.3	177.78
73	730	0.0072	0.0270	2.5275	0.9620	0.0193	2.2981	0.0288	0.0222	147.7	175.81
74	740	0.0072	0.0270	2.5545	0.9814	0.0194	2.3249	0.0288	0.0223	148.1	173.99
75	750	0.0072	0.0270	2.5815	1.0009	0.0195	2.3518	0.0288	0.0223	148.5	172.31
76	760	0.0072	0.0270	2.6085	1.0205	0.0196	2.3786	0.0289	0.0224	148.8	170.77
77	770	0.0057	0.0214	2.6299	1.0360	0.0156	2.3999	0.0213	0.0178	118.1	168.34
78	780	0.0057	0.0214	2.6513	1.0516	0.0156	2.4212	0.0213	0.0178	118.3	165.07
79	790	0.0057	0.0214	2.6726	1.0673	0.0157	2.4424	0.0213	0.0178	118.6	162.03
80	800	0.0057	0.0214	2.6940	1.0830	0.0157	2.4637	0.0213	0.0179	118.8	159.20
81	810	0.0057	0.0214	2.7154	1.0988	0.0158	2.4849	0.0213	0.0179	119.0	156.58
82	820	0.0057	0.0214	2.7368	1.1146	0.0158	2.5062	0.0213	0.0179	119.2	154.13
83	830	0.0057	0.0214	2.7581	1.1305	0.0159	2.5275	0.0213	0.0180	119.4	151.86
84	840	0.0057	0.0214	2.7795	1.1464	0.0159	2.5488	0.0213	0.0180	119.6	149.76
85	850	0.0057	0.0214	2.8009	1.1624	0.0160	2.5700	0.0213	0.0180	119.8	147.80
86	860	0.0057	0.0214	2.8223	1.1784	0.0160	2.5913	0.0213	0.0181	120.0	145.98
87	870	0.0057	0.0214	2.8436	1.1945	0.0161	2.6126	0.0213	0.0181	120.3	144.30
88	880	0.0057	0.0214	2.8650	1.2108	0.0161	2.6339	0.0213	0.0181	120.4	142.74
89	890	0.0050	0.0188	2.8838	1.2248	0.0142	2.6525	0.0187	0.0159	105.8	140.81
90	900	0.0050	0.0188	2.9025	1.2390	0.0142	2.6712	0.0187	0.0159	106.0	138.53
91	910	0.0050	0.0188	2.9213	1.2533	0.0143	2.6899	0.0187	0.0160	106.1	136.41
92	920	0.0050	0.0188	2.9400	1.2675	0.0143	2.7085	0.0187	0.0160	106.3	134.44
93	930	0.0050	0.0188	2.9588	1.2819	0.0143	2.7272	0.0187	0.0160	106.4	132.61
94	940	0.0050	0.0188	2.9775	1.2962	0.0144	2.7459	0.0187	0.0160	106.5	130.91
95	950	0.0050	0.0188	2.9963	1.3106	0.0144	2.7645	0.0187	0.0160	106.7	129.32
96	960	0.0050	0.0188	3.0150	1.3250	0.0144	2.7832	0.0187	0.0161	106.8	127.85
97	970	0.0050	0.0188	3.0338	1.3395	0.0145	2.8019	0.0187	0.0161	107.0	126.49
98	980	0.0050	0.0188	3.0525	1.3540	0.0145	2.8206	0.0187	0.0161	107.1	125.22
99	990	0.0050	0.0188	3.0713	1.3685	0.0145	2.8392	0.0187	0.0161	107.2	124.04
100	1000	0.0050	0.0188	3.0900	1.3830	0.0146	2.8579	0.0187	0.0161	107.4	122.95
101	1010	0.0040	0.0150	3.1050	1.3947	0.0117	2.8728	0.0149	0.0129	86.0	121.24
102	1020	0.0040	0.0150	3.1200	1.4064	0.0117	2.8878	0.0149	0.0129	86.1	118.94
103	1030	0.0040	0.0150	3.1350	1.4181	0.0117	2.9027	0.0149	0.0130	86.2	116.80
104	1040	0.0040	0.0150	3.1500	1.4298	0.0117	2.9177	0.0149	0.0130	86.2	114.81
105	1050	0.0040	0.0150	3.1650	1.4416	0.0117	2.9326	0.0149	0.0130	86.3	112.95
106	1060	0.0040	0.0150	3.1800	1.4533	0.0118	2.9476	0.0149	0.0130	86.4	111.21
107	1070	0.0040	0.0150	3.1950	1.4651	0.0118	2.9625	0.0149	0.0130	86.5	109.60
108	1080	0.0040	0.0150	3.2100	1.4769	0.0118	2.9774	0.0149	0.0130	86.6	108.09
109	1090	0.0040	0.0150	3.2250	1.4887	0.0118	2.9924	0.0149	0.0130	86.6	106.69
110	1100	0.0040	0.0150	3.2400	1.5006	0.0118	3.0073	0.0149	0.0130	86.7	105.39
111	1110	0.0040	0.0150	3.2550	1.5124	0.0119	3.0223	0.0149	0.0130	86.8	104.17
112	1120	0.0040	0.0150	3.2700	1.5243	0.0119	3.0372	0.0149	0.0131	86.9	103.04
113	1130	0.0040	0.0150	3.2850	1.5362	0.0119	3.0522	0.0149	0.0131	86.9	101.99
114	1140	0.0040	0.0150	3.3000	1.5481	0.0119	3.0671	0.0149	0.0131	87.0	101.01
115	1150	0.0040	0.0150	3.3150	1.5600	0.0119	3.0821	0.0149	0.0131	87.1	100.10
116	1160	0.0040	0.0150	3.3300	1.5720	0.0119	3.0970	0.0149	0.0131	87.2	99.25
117	1170	0.0040	0.0150	3.3450	1.5839	0.0120	3.1120	0.0149	0.0131	87.2	98.47
118	1180	0.0040	0.0150	3.3600	1.5959	0.0120	3.1269	0.0149	0.0131	87.3	97.74
119	1190	0.0040	0.0150	3.3750	1.6079	0.0120	3.1419	0.0149	0.0131	87.4	97.06
120	1200	0.0040	0.0150	3.3900	1.6199	0.0120	3.1568	0.0150	0.0131	87.4	96.43
121	1210	0.0040	0.0150	3.4050	1.6320	0.0120	3.1718	0.0150	0.0132	87.5	95.85
122	1220	0.0040	0.0150	3.4200	1.6440	0.0120	3.1867	0.0150	0.0132	87.6	95.31
123	1230	0.0040	0.0150	3.4350	1.6561	0.0121	3.2017	0.0150	0.0132	87.7	94.81
124	1240	0.0040	0.0150	3.4500	1.6682	0.0121	3.2166	0.0150	0.0132	87.7	94.34
125	1250	0.0040	0.0150	3.4650	1.6803	0.0121	3.2316	0.0150	0.0132	87.8	93.91
126	1260	0.0040	0.0150	3.4800	1.6924	0.0121	3.2465	0.0150	0.0132	87.9	93.52
127	1270	0.0040	0.0150	3.4950	1.7045	0.0121	3.2615	0.0150	0.0132	87.9	93.15
128	1280	0.0040	0.0150	3.5100	1.7167	0.0121	3.2764	0.0150	0.0132	88.0	92.81
129	1290	0.0040	0.0150	3.5250	1.7288	0.0122	3.2914	0.0150	0.0132	88.1	92.50
130	1300	0.0040	0.0150	3.5400	1.7410	0.0122	3.3063	0.0150	0.0133	88.1	92.21
131	1310	0.0040	0.0150	3.5550	1.7532	0.0122	3.3213	0.0150	0.0133	88.2	91.95
132	1320	0.0040	0.0150	3.5700	1.7654	0.0122	3.3363	0.0150	0.0133	88.3	91.70
133	1330	0.0040	0.0150	3.5850	1.7776	0.0122	3.3512	0.0150	0.0133	88.3	91.48
134	1340	0.0040	0.0150	3.6000	1.7899	0.0122	3.3662	0.0150	0.0133	88.4	91.28
135	1350	0.0040	0.0150	3.6150	1.8021	0.0123	3.3811	0.0150	0.0133	88.4	91.09
136	1360	0.0040	0.0150	3.6300	1.8144	0.0123	3.3961	0.0150	0.0133	88.5	90.92
137	1370	0.0040	0.0150	3.6450	1.8267	0.0123	3.4110	0.0150	0.0133	88.6	90.76
138	1380	0.0040	0.0150	3.6600	1.8390	0.0123	3.4260	0.0150	0.0133	88.6	90.62
139	1390	0.0040	0.0150	3.6750	1.8513	0.0123	3.4410	0.0150	0.0133	88.7	90.49
140	1400	0.0040	0.0150	3.6900	1.8636	0.0123	3.4559	0.0150	0.0133	88.7	90.38
141	1410	0.0040	0.0150	3.7050	1.8760	0.0123	3.4709	0.0150	0.0134	88.8	90.27
142	1420	0.0040	0.0150	3.7200	1.8883	0.0124	3.4858	0.0150	0.0134	88.9	90.18
143	1430	0.0040	0.0150	3.7350	1.9007	0.0124	3.5008	0.0150	0.0134	88.9	90.10
144	1440	0.0040	0.0150	3.7500	1.9131	0.0124	3.5157	0.0150	0.0134	89.0	90.02

Total Volume of Runoff¹ = 9,301,279 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \text{Sum} Q \times dt$$

$$V(\text{cu.ft.}) = \text{Sum} Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

City of Arlington
Time of Concentration
Upper Portage Creek Subbasin

Calculate Time of Concentration (Tc)

$$T_c = \text{Sum}(T_t)$$

Where:

$$T_t = \text{travel time (min)} = \frac{L}{(60 \times V)} \quad (\text{for shallow concentrated flow or channel flow})$$

$$T_t = \text{travel time (min)} = \frac{0.42(n_s L)^{0.8}}{(P_2)^{0.5}(s_o)^{0.4}} \quad (\text{for sheet flow})$$

Where:

$$V = \text{avg. velocity (ft/s)} = V = k(s_o)^{0.5}$$

k = time of concentration velocity factor (ft/s)

L = flow length (ft)

n_s = sheet flow Manning's effective roughness coefficient

P_2 = 2-year, 24-hour rainfall (in)

s_o = slope of hydraulic grade line (land slope, ft/ft)

	L (ft)	$k_{s/c}$	V (fps)	n_s	P_2	s_o (ft/ft)	Tt (min)
a - sheet (surface flow)	100	NA	NA	0.15	1.8	0.020	13.1
b - culvert (pipe)	400	42	5.9	NA	NA	0.020	1.1
C - channel (stream/ditch)	13,500	17	2.4	NA	NA	0.020	93.6
Total (Tc)							107.8

* All lengths are rough estimates. Slope values obtained from XP-SWMM model, with the exception of the pond.

54/90

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Upper Portage Creek Subbasin
Storm Event: 2-YEAR, 24-HOUR
Given:

Area = 1340.80 acres
P_t = 1.80 inches
d_t = 10 min.
T_c = 107.8 min.
PERVIOUS AREA
(Interim Final Cover Area)
Area = 1048.50 acres
CN = 77
S = 2.99
0.2S = 0.60
IMPERVIOUS AREA
(Roads)
Area = 292.30 acres
CN = 98
S = 0.20
0.2S = 0.04

SUMMARY	
T _{pk} (hrs) =	7.83
T _c (min) =	107.8
Q _{pk} (cfs) =	60.40
Vol (cf) =	2,764,564

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution
Column (4) = Col. (3) x P_t
Column (5) = Accumulated Sum of Col. (4)
Column (6) = [if P ≤ 0.2S] = 0; Note, use PERVIOUS Area "S" value.
[if P > 0.2S] = (Col.(5) - 0.2S) / (2(Col.(5) + 0.8S)); Using the PERVIOUS Area "S" value.
Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step
Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.
Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.
Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))
Column (11) = (60.5 x Col.(10) x Total area) / 10 (dt = 10 minutes)
Routing Constant, w = dt / (2T_c + dt) = 0.0443
Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step
+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

(1) Time Increment	(2) Time min.	(3) Rainfall distrib- ution % of P _t	(4) Incre- mental Rainfall in.	(5) Accumu- lated Rainfall in.	(6) Accumu- lated Runoff in.	(7) Incre- mental Runoff in.	(8) Accumu- lated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0072	0.0072	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0072	0.0144	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0072	0.0216	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
4	40	0.0040	0.0072	0.0288	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
5	50	0.0040	0.0072	0.0360	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
6	60	0.0040	0.0072	0.0432	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
7	70	0.0040	0.0072	0.0504	0.0000	0.0000	0.0004	0.0004	0.0004	0.7	0.04
8	80	0.0040	0.0072	0.0576	0.0000	0.0000	0.0013	0.0008	0.0008	1.5	0.13
9	90	0.0040	0.0072	0.0648	0.0000	0.0000	0.0025	0.0012	0.0012	2.2	0.28
10	100	0.0040	0.0072	0.0720	0.0000	0.0000	0.0041	0.0016	0.0016	2.8	0.48
11	110	0.0050	0.0090	0.0810	0.0000	0.0000	0.0066	0.0025	0.0025	4.4	0.76
12	120	0.0050	0.0090	0.0900	0.0000	0.0000	0.0096	0.0029	0.0054	5.2	1.12
13	130	0.0050	0.0090	0.0990	0.0000	0.0000	0.0129	0.0034	0.0088	5.9	1.51
14	140	0.0050	0.0090	0.1080	0.0000	0.0000	0.0166	0.0037	0.0125	6.6	1.93
15	150	0.0050	0.0090	0.1170	0.0000	0.0000	0.0207	0.0041	0.0166	7.2	2.37
16	160	0.0050	0.0090	0.1260	0.0000	0.0000	0.0251	0.0044	0.0210	7.7	2.82
17	170	0.0060	0.0108	0.1368	0.0000	0.0000	0.0307	0.0056	0.0266	9.9	3.36
18	180	0.0060	0.0108	0.1476	0.0000	0.0000	0.0367	0.0060	0.0326	10.6	3.97
19	190	0.0060	0.0108	0.1584	0.0000	0.0000	0.0430	0.0063	0.0389	11.1	4.58
20	200	0.0060	0.0108	0.1692	0.0000	0.0000	0.0496	0.0066	0.0455	11.7	5.18
21	210	0.0060	0.0108	0.1800	0.0000	0.0000	0.0564	0.0069	0.0524	12.1	5.78
22	220	0.0060	0.0108	0.1908	0.0000	0.0000	0.0635	0.0071	0.0595	12.6	6.36
23	230	0.0070	0.0126	0.2034	0.0000	0.0000	0.0721	0.0086	0.0681	15.1	7.02
24	240	0.0070	0.0126	0.2160	0.0000	0.0000	0.0809	0.0088	0.0769	15.6	7.76
25	250	0.0070	0.0126	0.2286	0.0000	0.0000	0.0900	0.0091	0.0860	16.0	8.48
26	260	0.0070	0.0126	0.2412	0.0000	0.0000	0.0993	0.0093	0.0953	16.4	9.17
27	270	0.0070	0.0126	0.2538	0.0000	0.0000	0.1088	0.0095	0.1048	16.8	9.83
28	280	0.0070	0.0126	0.2664	0.0000	0.0000	0.1184	0.0097	0.1145	17.1	10.46
29	290	0.0082	0.0148	0.2812	0.0000	0.0000	0.1300	0.0115	0.1260	20.4	11.19
30	300	0.0082	0.0148	0.2959	0.0000	0.0000	0.1417	0.0117	0.1377	20.8	12.03
31	310	0.0082	0.0148	0.3107	0.0000	0.0000	0.1537	0.0119	0.1496	21.1	12.82
32	320	0.0082	0.0148	0.3254	0.0000	0.0000	0.1658	0.0121	0.1617	21.4	13.56
33	330	0.0082	0.0148	0.3402	0.0000	0.0000	0.1780	0.0123	0.1740	21.7	14.27
34	340	0.0082	0.0148	0.3550	0.0000	0.0000	0.1904	0.0124	0.1864	21.9	14.94
35	350	0.0095	0.0171	0.3721	0.0000	0.0000	0.2050	0.0145	0.2009	25.7	15.73
36	360	0.0095	0.0171	0.3892	0.0000	0.0000	0.2197	0.0147	0.2156	26.0	16.62
37	370	0.0095	0.0171	0.4063	0.0000	0.0000	0.2345	0.0148	0.2304	26.2	17.46
38	380	0.0095	0.0171	0.4234	0.0000	0.0000	0.2495	0.0150	0.2454	26.5	18.25
39	390	0.0095	0.0171	0.4405	0.0000	0.0000	0.2645	0.0151	0.2604	26.7	18.99
40	400	0.0095	0.0171	0.4576	0.0000	0.0000	0.2797	0.0152	0.2756	26.9	19.68
41	410	0.0134	0.0241	0.4817	0.0000	0.0000	0.3014	0.0216	0.3000	38.2	20.82
42	420	0.0134	0.0241	0.5058	0.0000	0.0000	0.3232	0.0218	0.3218	38.5	22.38
43	430	0.0134	0.0241	0.5299	0.0000	0.0000	0.3451	0.0220	0.3437	38.8	23.82
44	440	0.0180	0.0324	0.5623	0.0000	0.0000	0.3748	0.0297	0.3728	52.6	25.76
45	450	0.0180	0.0324	0.5947	0.0000	0.0000	0.4048	0.0299	0.4028	53.0	28.15
46	460	0.0340	0.0612	0.6559	0.0011	0.0011	0.4619	0.0571	0.4610	108.1	32.80
47	470	0.0540	0.0972	0.7531	0.0077	0.0066	0.5537	0.0918	0.5528	204.2	43.73
48	480	0.0270	0.0486	0.8017	0.0131	0.0054	0.6000	0.0463	0.5966	115.9	54.04 Q peak
49	490	0.0180	0.0324	0.8341	0.0174	0.0043	0.6310	0.0310	0.6150	82.1	58.03
50	500	0.0134	0.0241	0.8582	0.0209	0.0036	0.6541	0.0231	0.6310	63.5	59.34
51	510	0.0134	0.0241	0.8824	0.0248	0.0039	0.6773	0.0232	0.6078	65.5	59.80
52	520	0.0134	0.0241	0.9065	0.0290	0.0042	0.7005	0.0232	0.5846	67.5	60.40
53	530	0.0088	0.0158	0.9223	0.0319	0.0029	0.7158	0.0153	0.5693	45.4	60.04
54	540	0.0088	0.0158	0.9382	0.0349	0.0030	0.7311	0.0153	0.5440	46.2	58.78
55	550	0.0088	0.0158	0.9540	0.0380	0.0031	0.7464	0.0153	0.5187	47.0	57.70
56	560	0.0088	0.0158	0.9698	0.0413	0.0033	0.7617	0.0153	0.4934	47.8	56.78
57	570	0.0088	0.0158	0.9857	0.0447	0.0034	0.7770	0.0153	0.4681	48.5	56.02
58	580	0.0088	0.0158	1.0015	0.0482	0.0035	0.7924	0.0153	0.4428	49.3	55.39
59	590	0.0088	0.0158	1.0174	0.0518	0.0036	0.8077	0.0154	0.4175	50.0	54.88
60	600	0.0088	0.0158	1.0332	0.0555	0.0037	0.8231	0.0154	0.3922	50.8	54.48
61	610	0.0088	0.0158	1.0490	0.0593	0.0038	0.8385	0.0154	0.3669	51.5	54.19
62	620	0.0088	0.0158	1.0649	0.0633	0.0039	0.8539	0.0154	0.3416	52.2	53.98
63	630	0.0088	0.0158	1.0807	0.0673	0.0041	0.8693	0.0154	0.3163	52.9	53.86
64	640	0.0088	0.0158	1.0966	0.0715	0.0042	0.8847	0.0154	0.2910	53.6	53.81
65	650	0.0072	0.0130	1.1095	0.0750	0.0035	0.8973	0.0126	0.2657	44.4	53.39
66	660	0.0072	0.0130	1.1225	0.0785	0.0036	0.9100	0.0126	0.2404	44.9	52.61
67	670	0.0072	0.0130	1.1354	0.0821	0.0036	0.9226	0.0126	0.2151	45.3	51.94

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distrib- ution % of Pt	(4) Incremental Rainfall in.	(5) Accumulated Rainfall in.	Pervious Area		Impervious Area		(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
					(6) Accumulated Runoff in.	(7) Incremental Runoff in.	(8) Accumulated Runoff in.	(9) Incremental Runoff in.			
68	680	0.0072	0.0130	1.1484	0.0858	0.0037	0.9353	0.0126	0.0056	45.8	51.37
69	690	0.0072	0.0130	1.1614	0.0896	0.0038	0.9479	0.0126	0.0057	46.2	50.90
70	700	0.0072	0.0130	1.1743	0.0934	0.0038	0.9606	0.0127	0.0057	46.6	50.50
71	710	0.0072	0.0130	1.1873	0.0973	0.0039	0.9732	0.0127	0.0058	47.1	50.17
72	720	0.0072	0.0130	1.2002	0.1012	0.0040	0.9859	0.0127	0.0059	47.5	49.92
73	730	0.0072	0.0130	1.2132	0.1053	0.0040	0.9986	0.0127	0.0059	47.9	49.72
74	740	0.0072	0.0130	1.2262	0.1093	0.0041	1.0112	0.0127	0.0060	48.3	49.58
75	750	0.0072	0.0130	1.2391	0.1135	0.0041	1.0239	0.0127	0.0060	48.7	49.49
76	760	0.0072	0.0130	1.2521	0.1177	0.0042	1.0366	0.0127	0.0061	49.1	49.44
77	770	0.0057	0.0103	1.2623	0.1211	0.0034	1.0467	0.0100	0.0048	39.2	48.97
78	780	0.0057	0.0103	1.2726	0.1245	0.0034	1.0567	0.0101	0.0049	39.4	48.11
79	790	0.0057	0.0103	1.2829	0.1279	0.0035	1.0668	0.0101	0.0049	39.7	47.36
80	800	0.0057	0.0103	1.2931	0.1314	0.0035	1.0768	0.0101	0.0049	39.9	46.69
81	810	0.0057	0.0103	1.3034	0.1350	0.0035	1.0869	0.0101	0.0050	40.2	46.10
82	820	0.0057	0.0103	1.3136	0.1385	0.0036	1.0969	0.0101	0.0050	40.4	45.58
83	830	0.0057	0.0103	1.3239	0.1421	0.0036	1.1070	0.0101	0.0050	40.7	45.14
84	840	0.0057	0.0103	1.3342	0.1458	0.0036	1.1171	0.0101	0.0050	40.9	44.75
85	850	0.0057	0.0103	1.3444	0.1494	0.0037	1.1271	0.0101	0.0051	41.1	44.42
86	860	0.0057	0.0103	1.3547	0.1532	0.0037	1.1372	0.0101	0.0051	41.4	44.14
87	870	0.0057	0.0103	1.3649	0.1569	0.0037	1.1473	0.0101	0.0051	41.6	43.90
88	880	0.0057	0.0103	1.3752	0.1607	0.0038	1.1574	0.0101	0.0052	41.8	43.71
89	890	0.0050	0.0090	1.3842	0.1640	0.0033	1.1682	0.0088	0.0045	36.9	43.32
90	900	0.0050	0.0090	1.3932	0.1674	0.0034	1.1751	0.0088	0.0046	37.0	42.76
91	910	0.0050	0.0090	1.4022	0.1708	0.0034	1.1839	0.0088	0.0046	37.2	42.26
92	920	0.0050	0.0090	1.4112	0.1742	0.0034	1.1928	0.0088	0.0046	37.4	41.82
93	930	0.0050	0.0090	1.4202	0.1777	0.0035	1.2016	0.0088	0.0046	37.6	41.44
94	940	0.0050	0.0090	1.4292	0.1812	0.0035	1.2105	0.0089	0.0047	37.7	41.10
95	950	0.0050	0.0090	1.4382	0.1847	0.0035	1.2193	0.0089	0.0047	37.9	40.81
96	960	0.0050	0.0090	1.4472	0.1882	0.0035	1.2282	0.0089	0.0047	38.1	40.56
97	970	0.0050	0.0090	1.4562	0.1918	0.0036	1.2370	0.0089	0.0047	38.2	40.34
98	980	0.0050	0.0090	1.4652	0.1954	0.0036	1.2459	0.0089	0.0047	38.4	40.16
99	990	0.0050	0.0090	1.4742	0.1990	0.0036	1.2547	0.0089	0.0048	38.6	40.01
100	1000	0.0050	0.0090	1.4832	0.2026	0.0036	1.2636	0.0089	0.0048	38.7	39.89
101	1010	0.0040	0.0072	1.4904	0.2055	0.0029	1.2707	0.0071	0.0038	31.1	39.45
102	1020	0.0040	0.0072	1.4976	0.2085	0.0029	1.2778	0.0071	0.0038	31.2	38.71
103	1030	0.0040	0.0072	1.5048	0.2114	0.0030	1.2849	0.0071	0.0039	31.3	38.05
104	1040	0.0040	0.0072	1.5120	0.2144	0.0030	1.2920	0.0071	0.0039	31.4	37.46
105	1050	0.0040	0.0072	1.5192	0.2174	0.0030	1.2991	0.0071	0.0039	31.5	36.92
106	1060	0.0040	0.0072	1.5264	0.2204	0.0030	1.3062	0.0071	0.0039	31.6	36.45
107	1070	0.0040	0.0072	1.5336	0.2234	0.0030	1.3133	0.0071	0.0039	31.7	36.02
108	1080	0.0040	0.0072	1.5408	0.2264	0.0030	1.3203	0.0071	0.0039	31.8	35.64
109	1090	0.0040	0.0072	1.5480	0.2295	0.0030	1.3274	0.0071	0.0039	31.9	35.31
110	1100	0.0040	0.0072	1.5552	0.2326	0.0031	1.3345	0.0071	0.0039	32.0	35.01
111	1110	0.0040	0.0072	1.5624	0.2356	0.0031	1.3416	0.0071	0.0040	32.1	34.74
112	1120	0.0040	0.0072	1.5696	0.2387	0.0031	1.3487	0.0071	0.0040	32.2	34.51
113	1130	0.0040	0.0072	1.5768	0.2418	0.0031	1.3558	0.0071	0.0040	32.3	34.31
114	1140	0.0040	0.0072	1.5840	0.2450	0.0031	1.3629	0.0071	0.0040	32.4	34.14
115	1150	0.0040	0.0072	1.5912	0.2481	0.0031	1.3700	0.0071	0.0040	32.5	33.98
116	1160	0.0040	0.0072	1.5984	0.2513	0.0032	1.3771	0.0071	0.0040	32.6	33.85
117	1170	0.0040	0.0072	1.6056	0.2544	0.0032	1.3842	0.0071	0.0040	32.7	33.74
118	1180	0.0040	0.0072	1.6128	0.2576	0.0032	1.3914	0.0071	0.0040	32.8	33.65
119	1190	0.0040	0.0072	1.6200	0.2608	0.0032	1.3985	0.0071	0.0040	32.8	33.58
120	1200	0.0040	0.0072	1.6272	0.2640	0.0032	1.4056	0.0071	0.0041	32.9	33.52
121	1210	0.0040	0.0072	1.6344	0.2672	0.0032	1.4127	0.0071	0.0041	33.0	33.47
122	1220	0.0040	0.0072	1.6416	0.2705	0.0032	1.4198	0.0071	0.0041	33.1	33.43
123	1230	0.0040	0.0072	1.6488	0.2737	0.0033	1.4269	0.0071	0.0041	33.2	33.41
124	1240	0.0040	0.0072	1.6560	0.2770	0.0033	1.4340	0.0071	0.0041	33.3	33.40
125	1250	0.0040	0.0072	1.6632	0.2803	0.0033	1.4411	0.0071	0.0041	33.4	33.39
126	1260	0.0040	0.0072	1.6704	0.2836	0.0033	1.4482	0.0071	0.0041	33.5	33.40
127	1270	0.0040	0.0072	1.6776	0.2869	0.0033	1.4553	0.0071	0.0041	33.6	33.41
128	1280	0.0040	0.0072	1.6848	0.2902	0.0033	1.4624	0.0071	0.0041	33.7	33.43
129	1290	0.0040	0.0072	1.6920	0.2935	0.0033	1.4696	0.0071	0.0042	33.7	33.45
130	1300	0.0040	0.0072	1.6992	0.2969	0.0034	1.4767	0.0071	0.0042	33.8	33.48
131	1310	0.0040	0.0072	1.7064	0.3003	0.0034	1.4838	0.0071	0.0042	33.9	33.52
132	1320	0.0040	0.0072	1.7136	0.3036	0.0034	1.4909	0.0071	0.0042	34.0	33.56
133	1330	0.0040	0.0072	1.7208	0.3070	0.0034	1.4980	0.0071	0.0042	34.1	33.60
134	1340	0.0040	0.0072	1.7280	0.3104	0.0034	1.5051	0.0071	0.0042	34.2	33.65
135	1350	0.0040	0.0072	1.7352	0.3139	0.0034	1.5122	0.0071	0.0042	34.3	33.70
136	1360	0.0040	0.0072	1.7424	0.3173	0.0034	1.5194	0.0071	0.0042	34.3	33.75
137	1370	0.0040	0.0072	1.7496	0.3207	0.0034	1.5265	0.0071	0.0042	34.4	33.81
138	1380	0.0040	0.0072	1.7568	0.3242	0.0035	1.5336	0.0071	0.0043	34.5	33.87
139	1390	0.0040	0.0072	1.7640	0.3277	0.0035	1.5407	0.0071	0.0043	34.6	33.93
140	1400	0.0040	0.0072	1.7712	0.3311	0.0035	1.5478	0.0071	0.0043	34.7	33.99
141	1410	0.0040	0.0072	1.7784	0.3346	0.0035	1.5550	0.0071	0.0043	34.8	34.06
142	1420	0.0040	0.0072	1.7856	0.3381	0.0035	1.5621	0.0071	0.0043	34.8	34.12
143	1430	0.0040	0.0072	1.7928	0.3417	0.0035	1.5692	0.0071	0.0043	34.9	34.19
144	1440	0.0040	0.0072	1.8000	0.3452	0.0035	1.5763	0.0071	0.0043	35.0	34.26

Total Volume of Runoff¹ = 2,764,564 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \text{Sum} Q \times dt$$

$$V(\text{cu.ft.}) = \text{Sum} Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

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SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Upper Portage Creek Subbasin
Storm Event: 10-YEAR, 24-HOUR
Given:

Area = 1340.80 acres
P_t = 2.75 inches
d_t = 10 min.
T_c = 107.8 min.
PERVIOUS AREA
(Interim Final Cover Area)
Area = 1048.50 acres
CN = 77
S = 2.99
0.2S = 0.60
IMPERVIOUS AREA
(Roads)
Area = 292.30 acres
CN = 98
S = 0.20
0.2S = 0.04

SUMMARY	
T _{pk} (hrs) =	7.83
T _e (min) =	107.8
Q _{pk} (cfs) =	138.71
Vol (cf) =	5,685,933

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution
Column (4) = Col. (3) x P_t
Column (5) = Accumulated Sum of Col. (4)
Column (6) = [If P ≤ 0.2S] = 0; Note, use PERVIOUS Area "S" value.
[If P > 0.2S] = (Col.(5) - 0.2S)² / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.
Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step
Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.
Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.
Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))
Column (11) = (60.5 x Col.(10) x Total area) / 10 (dt = 10 minutes)
Routing Constant, w = dt / (2T_c + dt) = 0.0443
Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step
+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of P _t	(4) Incre- mental Rainfall in.	(5) Accum- ulated Rainfall in.	(6) Accum- ulated Runoff in.	(7) Incre- mental Runoff in.	(8) Accum- ulated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0110	0.0110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0110	0.0220	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0110	0.0330	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
4	40	0.0040	0.0110	0.0440	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.00
5	50	0.0040	0.0110	0.0550	0.0000	0.0000	0.0009	0.0009	0.0002	1.5	0.08
6	60	0.0040	0.0110	0.0660	0.0000	0.0000	0.0028	0.0018	0.0004	3.3	0.28
7	70	0.0040	0.0110	0.0770	0.0000	0.0000	0.0054	0.0027	0.0006	4.7	0.61
8	80	0.0040	0.0110	0.0880	0.0000	0.0000	0.0089	0.0034	0.0007	6.0	1.04
9	90	0.0040	0.0110	0.0990	0.0000	0.0000	0.0129	0.0040	0.0009	7.2	1.53
10	100	0.0040	0.0110	0.1100	0.0000	0.0000	0.0175	0.0046	0.0010	8.1	2.07
11	110	0.0050	0.0138	0.1238	0.0000	0.0000	0.0240	0.0064	0.0014	11.4	2.75
12	120	0.0050	0.0138	0.1375	0.0000	0.0000	0.0311	0.0071	0.0016	12.6	3.57
13	130	0.0050	0.0138	0.1513	0.0000	0.0000	0.0388	0.0077	0.0017	13.6	4.42
14	140	0.0050	0.0138	0.1650	0.0000	0.0000	0.0470	0.0082	0.0018	14.5	5.27
15	150	0.0050	0.0138	0.1788	0.0000	0.0000	0.0556	0.0086	0.0019	15.3	6.13
16	160	0.0050	0.0138	0.1925	0.0000	0.0000	0.0647	0.0090	0.0020	16.0	6.97
17	170	0.0060	0.0165	0.2090	0.0000	0.0000	0.0760	0.0113	0.0025	20.0	7.95
18	180	0.0060	0.0165	0.2255	0.0000	0.0000	0.0877	0.0118	0.0026	20.8	9.05
19	190	0.0060	0.0165	0.2420	0.0000	0.0000	0.0999	0.0121	0.0026	21.5	10.12
20	200	0.0060	0.0165	0.2585	0.0000	0.0000	0.1124	0.0125	0.0027	22.1	11.15
21	210	0.0060	0.0165	0.2750	0.0000	0.0000	0.1251	0.0128	0.0028	22.6	12.14
22	220	0.0060	0.0165	0.2915	0.0000	0.0000	0.1382	0.0131	0.0028	23.1	13.09
23	230	0.0070	0.0193	0.3108	0.0000	0.0000	0.1537	0.0155	0.0034	27.5	14.17
24	240	0.0070	0.0193	0.3300	0.0000	0.0000	0.1695	0.0158	0.0034	28.0	15.37
25	250	0.0070	0.0193	0.3493	0.0000	0.0000	0.1856	0.0161	0.0035	28.4	16.51
26	260	0.0070	0.0193	0.3685	0.0000	0.0000	0.2019	0.0163	0.0036	28.8	17.59
27	270	0.0070	0.0193	0.3878	0.0000	0.0000	0.2184	0.0165	0.0036	29.2	18.60
28	280	0.0070	0.0193	0.4070	0.0000	0.0000	0.2351	0.0167	0.0036	29.5	19.55
29	290	0.0082	0.0226	0.4296	0.0000	0.0000	0.2549	0.0198	0.0043	35.0	20.68
30	300	0.0082	0.0226	0.4521	0.0000	0.0000	0.2749	0.0200	0.0044	35.3	21.96
31	310	0.0082	0.0226	0.4747	0.0000	0.0000	0.2950	0.0202	0.0044	35.6	23.16
32	320	0.0082	0.0226	0.4972	0.0000	0.0000	0.3154	0.0203	0.0044	35.9	24.28
33	330	0.0082	0.0226	0.5198	0.0000	0.0000	0.3358	0.0205	0.0045	36.2	25.33
34	340	0.0082	0.0226	0.5423	0.0000	0.0000	0.3564	0.0206	0.0045	36.4	26.30
35	350	0.0095	0.0261	0.5684	0.0000	0.0000	0.3804	0.0240	0.0052	42.5	27.47
36	360	0.0095	0.0261	0.5946	0.0000	0.0000	0.4046	0.0242	0.0053	42.7	28.81
37	370	0.0095	0.0261	0.6207	0.0002	0.0002	0.4289	0.0243	0.0054	44.1	30.10
38	380	0.0095	0.0261	0.6468	0.0008	0.0006	0.4533	0.0244	0.0056	47.1	31.48
39	390	0.0095	0.0261	0.6729	0.0019	0.0011	0.4778	0.0245	0.0062	50.1	33.00
40	400	0.0095	0.0261	0.6991	0.0033	0.0015	0.5025	0.0246	0.0065	52.9	34.64
41	410	0.0134	0.0369	0.7359	0.0061	0.0028	0.5373	0.0349	0.0098	79.4	37.43
42	420	0.0134	0.0369	0.7728	0.0097	0.0036	0.5723	0.0350	0.0104	84.7	41.38
43	430	0.0134	0.0369	0.8096	0.0141	0.0044	0.6075	0.0352	0.0111	89.8	45.45
44	440	0.0180	0.0495	0.8591	0.0211	0.0070	0.6549	0.0474	0.0158	128.3	51.09
45	450	0.0180	0.0495	0.9086	0.0294	0.0083	0.7026	0.0476	0.0169	136.7	58.31
46	460	0.0340	0.0935	1.0021	0.0483	0.0189	0.7929	0.0904	0.0345	279.9	71.61
47	470	0.0540	0.1485	1.1506	0.0864	0.0382	0.9374	0.1445	0.0613	497.5	99.72
48	480	0.0270	0.0743	1.2249	0.1089	0.0225	1.0100	0.0726	0.0334	270.9	124.94 Q peak
49	490	0.0180	0.0495	1.2744	0.1251	0.0162	1.0584	0.0485	0.0232	188.2	134.21
50	500	0.0134	0.0369	1.3112	0.1377	0.0126	1.0945	0.0361	0.0177	143.8	137.03
51	510	0.0134	0.0369	1.3481	0.1508	0.0131	1.1307	0.0362	0.0181	146.9	137.77
52	520	0.0134	0.0369	1.3849	0.1643	0.0135	1.1669	0.0362	0.0185	148.9	138.71
53	530	0.0088	0.0242	1.4091	0.1734	0.0091	1.1907	0.0238	0.0123	100.0	137.50
54	540	0.0088	0.0242	1.4333	0.1828	0.0093	1.2145	0.0238	0.0125	101.3	134.23
55	550	0.0088	0.0242	1.4575	0.1923	0.0095	1.2383	0.0238	0.0126	102.5	131.36
56	560	0.0088	0.0242	1.4817	0.2020	0.0097	1.2621	0.0238	0.0128	103.7	128.66
57	570	0.0088	0.0242	1.5059	0.2119	0.0099	1.2860	0.0238	0.0129	104.8	126.67
58	580	0.0088	0.0242	1.5301	0.2219	0.0101	1.3098	0.0238	0.0131	106.0	124.79
59	590	0.0088	0.0242	1.5543	0.2322	0.0102	1.3337	0.0239	0.0132	107.1	123.17
60	600	0.0088	0.0242	1.5785	0.2426	0.0104	1.3575	0.0239	0.0133	108.2	121.79
61	610	0.0088	0.0242	1.6027	0.2531	0.0106	1.3814	0.0239	0.0135	109.3	120.64
62	620	0.0088	0.0242	1.6269	0.2639	0.0107	1.4053	0.0239	0.0136	110.3	119.68
63	630	0.0088	0.0242	1.6511	0.2748	0.0109	1.4292	0.0239	0.0137	111.4	118.89
64	640	0.0088	0.0242	1.6753	0.2858	0.0111	1.4531	0.0239	0.0139	112.4	118.27
65	650	0.0072	0.0198	1.6951	0.2950	0.0092	1.4726	0.0196	0.0114	92.7	116.88
66	660	0.0072	0.0198	1.7149	0.3043	0.0093	1.4922	0.0196	0.0115	93.4	114.76
67	670	0.0072	0.0198	1.7347	0.3136	0.0094	1.5117	0.0196	0.0116	94.0	112.89

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of Pt	(4) Incremental Rainfall in.	(5) Accumulated Rainfall in.	Pervious Area		Impervious Area		(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
					(6) Accumulated Runoff in.	(7) Incremental Runoff in.	(8) Accumulated Runoff in.	(9) Incremental Runoff in.			
68	680	0.0072	0.0198	1.7545	0.3231	0.0095	1.5313	0.0196	0.0117	94.6	111.25
69	690	0.0072	0.0198	1.7743	0.3326	0.0096	1.5509	0.0196	0.0117	95.3	109.80
70	700	0.0072	0.0198	1.7941	0.3423	0.0097	1.5705	0.0196	0.0118	95.9	108.54
71	710	0.0072	0.0198	1.8139	0.3521	0.0098	1.5901	0.0196	0.0119	96.5	107.45
72	720	0.0072	0.0198	1.8337	0.3619	0.0098	1.6097	0.0196	0.0120	97.1	106.51
73	730	0.0072	0.0198	1.8535	0.3718	0.0099	1.6293	0.0196	0.0120	97.7	105.70
74	740	0.0072	0.0198	1.8733	0.3819	0.0100	1.6489	0.0196	0.0121	98.3	105.02
75	750	0.0072	0.0198	1.8931	0.3920	0.0101	1.6685	0.0196	0.0122	98.9	104.45
76	760	0.0072	0.0198	1.9129	0.4022	0.0102	1.6881	0.0196	0.0123	99.5	103.98
77	770	0.0057	0.0157	1.9286	0.4104	0.0081	1.7036	0.0155	0.0098	79.1	102.68
78	780	0.0057	0.0157	1.9443	0.4186	0.0082	1.7191	0.0155	0.0098	79.5	100.61
79	790	0.0057	0.0157	1.9599	0.4268	0.0083	1.7346	0.0155	0.0098	79.8	98.75
80	800	0.0057	0.0157	1.9756	0.4351	0.0083	1.7502	0.0155	0.0099	80.2	97.09
81	810	0.0057	0.0157	1.9913	0.4435	0.0084	1.7657	0.0155	0.0099	80.5	95.60
82	820	0.0057	0.0157	2.0070	0.4519	0.0084	1.7812	0.0155	0.0100	80.8	94.28
83	830	0.0057	0.0157	2.0226	0.4604	0.0085	1.7968	0.0155	0.0100	81.2	93.10
84	840	0.0057	0.0157	2.0383	0.4689	0.0085	1.8123	0.0155	0.0100	81.5	92.06
85	850	0.0057	0.0157	2.0540	0.4775	0.0086	1.8279	0.0155	0.0101	81.8	91.14
86	860	0.0057	0.0157	2.0697	0.4861	0.0086	1.8434	0.0155	0.0101	82.1	90.33
87	870	0.0057	0.0157	2.0853	0.4947	0.0087	1.8589	0.0155	0.0102	82.5	89.62
88	880	0.0057	0.0157	2.1010	0.5035	0.0087	1.8745	0.0155	0.0102	82.8	89.00
89	890	0.0050	0.0138	2.1148	0.5111	0.0077	1.8881	0.0136	0.0090	72.9	88.01
90	900	0.0050	0.0138	2.1285	0.5189	0.0077	1.9018	0.0136	0.0090	73.1	86.67
91	910	0.0050	0.0138	2.1423	0.5266	0.0078	1.9154	0.0136	0.0090	73.3	85.48
92	920	0.0050	0.0138	2.1560	0.5344	0.0078	1.9291	0.0136	0.0091	73.6	84.42
93	930	0.0050	0.0138	2.1698	0.5422	0.0078	1.9427	0.0136	0.0091	73.8	83.46
94	940	0.0050	0.0138	2.1835	0.5501	0.0079	1.9563	0.0136	0.0091	74.0	82.62
95	950	0.0050	0.0138	2.1973	0.5580	0.0079	1.9700	0.0136	0.0092	74.3	81.87
96	960	0.0050	0.0138	2.2110	0.5659	0.0079	1.9836	0.0136	0.0092	74.5	81.20
97	970	0.0050	0.0138	2.2248	0.5739	0.0080	1.9973	0.0136	0.0092	74.7	80.62
98	980	0.0050	0.0138	2.2385	0.5819	0.0080	2.0109	0.0137	0.0092	74.9	80.10
99	990	0.0050	0.0138	2.2523	0.5900	0.0080	2.0246	0.0137	0.0093	75.1	79.65
100	1000	0.0050	0.0138	2.2660	0.5980	0.0081	2.0382	0.0137	0.0093	75.4	79.26
101	1010	0.0040	0.0110	2.2770	0.6045	0.0065	2.0492	0.0109	0.0075	60.4	78.25
102	1020	0.0040	0.0110	2.2880	0.6110	0.0065	2.0601	0.0109	0.0075	60.6	76.68
103	1030	0.0040	0.0110	2.2990	0.6175	0.0065	2.0710	0.0109	0.0075	60.7	75.26
104	1040	0.0040	0.0110	2.3100	0.6241	0.0065	2.0819	0.0109	0.0075	60.8	73.97
105	1050	0.0040	0.0110	2.3210	0.6307	0.0066	2.0929	0.0109	0.0075	61.0	72.82
106	1060	0.0040	0.0110	2.3320	0.6372	0.0066	2.1038	0.0109	0.0075	61.1	71.77
107	1070	0.0040	0.0110	2.3430	0.6439	0.0066	2.1147	0.0109	0.0075	61.2	70.83
108	1080	0.0040	0.0110	2.3540	0.6505	0.0066	2.1256	0.0109	0.0076	61.4	69.99
109	1090	0.0040	0.0110	2.3650	0.6571	0.0066	2.1366	0.0109	0.0076	61.5	69.23
110	1100	0.0040	0.0110	2.3760	0.6638	0.0067	2.1475	0.0109	0.0076	61.6	68.55
111	1110	0.0040	0.0110	2.3870	0.6705	0.0067	2.1584	0.0109	0.0076	61.8	67.94
112	1120	0.0040	0.0110	2.3980	0.6772	0.0067	2.1694	0.0109	0.0076	61.9	67.40
113	1130	0.0040	0.0110	2.4090	0.6839	0.0067	2.1803	0.0109	0.0076	62.0	66.92
114	1140	0.0040	0.0110	2.4200	0.6907	0.0067	2.1912	0.0109	0.0077	62.1	66.49
115	1150	0.0040	0.0110	2.4310	0.6974	0.0068	2.2022	0.0109	0.0077	62.3	66.11
116	1160	0.0040	0.0110	2.4420	0.7042	0.0068	2.2131	0.0109	0.0077	62.4	65.77
117	1170	0.0040	0.0110	2.4530	0.7110	0.0068	2.2240	0.0109	0.0077	62.5	65.47
118	1180	0.0040	0.0110	2.4640	0.7179	0.0068	2.2350	0.0109	0.0077	62.6	65.22
119	1190	0.0040	0.0110	2.4750	0.7247	0.0068	2.2459	0.0109	0.0077	62.7	64.99
120	1200	0.0040	0.0110	2.4860	0.7316	0.0069	2.2568	0.0109	0.0077	62.9	64.80
121	1210	0.0040	0.0110	2.4970	0.7384	0.0069	2.2678	0.0109	0.0078	63.0	64.63
122	1220	0.0040	0.0110	2.5080	0.7453	0.0069	2.2787	0.0109	0.0078	63.1	64.49
123	1230	0.0040	0.0110	2.5190	0.7523	0.0069	2.2896	0.0109	0.0078	63.2	64.37
124	1240	0.0040	0.0110	2.5300	0.7592	0.0069	2.3006	0.0109	0.0078	63.3	64.28
125	1250	0.0040	0.0110	2.5410	0.7661	0.0070	2.3115	0.0109	0.0078	63.5	64.20
126	1260	0.0040	0.0110	2.5520	0.7731	0.0070	2.3224	0.0109	0.0078	63.6	64.14
127	1270	0.0040	0.0110	2.5630	0.7801	0.0070	2.3334	0.0109	0.0079	63.7	64.09
128	1280	0.0040	0.0110	2.5740	0.7871	0.0070	2.3443	0.0109	0.0079	63.8	64.06
129	1290	0.0040	0.0110	2.5850	0.7941	0.0070	2.3553	0.0109	0.0079	63.9	64.04
130	1300	0.0040	0.0110	2.5960	0.8012	0.0070	2.3662	0.0109	0.0079	64.0	64.04
131	1310	0.0040	0.0110	2.6070	0.8082	0.0071	2.3771	0.0109	0.0079	64.1	64.04
132	1320	0.0040	0.0110	2.6180	0.8153	0.0071	2.3881	0.0109	0.0079	64.2	64.05
133	1330	0.0040	0.0110	2.6290	0.8224	0.0071	2.3990	0.0109	0.0079	64.4	64.07
134	1340	0.0040	0.0110	2.6400	0.8295	0.0071	2.4100	0.0109	0.0079	64.5	64.10
135	1350	0.0040	0.0110	2.6510	0.8367	0.0071	2.4209	0.0109	0.0080	64.6	64.14
136	1360	0.0040	0.0110	2.6620	0.8438	0.0071	2.4318	0.0109	0.0080	64.7	64.18
137	1370	0.0040	0.0110	2.6730	0.8510	0.0072	2.4428	0.0109	0.0080	64.8	64.23
138	1380	0.0040	0.0110	2.6840	0.8581	0.0072	2.4537	0.0109	0.0080	64.9	64.29
139	1390	0.0040	0.0110	2.6950	0.8653	0.0072	2.4647	0.0109	0.0080	65.0	64.34
140	1400	0.0040	0.0110	2.7060	0.8726	0.0072	2.4756	0.0109	0.0080	65.1	64.41
141	1410	0.0040	0.0110	2.7170	0.8798	0.0072	2.4866	0.0109	0.0080	65.2	64.47
142	1420	0.0040	0.0110	2.7280	0.8870	0.0072	2.4975	0.0109	0.0081	65.3	64.54
143	1430	0.0040	0.0110	2.7390	0.8943	0.0073	2.5085	0.0109	0.0081	65.4	64.62
144	1440	0.0040	0.0110	2.7500	0.9016	0.0073	2.5194	0.0109	0.0081	65.5	64.69

Total Volume of Runoff¹ = 5,685,933 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \text{Sum} Q \times dt$$

$$V(\text{cu.ft.}) = \text{Sum} Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Upper Portage Creek Subbasin
Storm Event: 25-YEAR, 24-HOUR
Given:

Area = 1340.80 acres
P_t = 3.20 inches
d_t = 10 min.
T_c = 107.8 min.
PERVIOUS AREA
(Interim Final Cover Area)
Area = 1048.50 acres
CN = 77
S = 2.99
0.2S = 0.60
IMPERVIOUS AREA
(Roads)
Area = 292.30 acres
CN = 98
S = 0.20
0.2S = 0.04

SUMMARY	
T _{pk} (hrs) =	7.83
T _c (min) =	107.8
Q _{pk} (cfs) =	183.49
Vol (cf) =	7,245,047

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution
Column (4) = Col. (3) x P_t
Column (5) = Accumulated Sum of Col. (4)
Column (6) = [If P ≤ 0.2S] = 0; Note, use PERVIOUS Area "S" value.
[If P > 0.2S] = (Col.(5) - 0.2S) / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.
Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step
Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.
Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.
Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))
Column (11) = (60.5 x Col.(10) x Total Area) / 10 (dt = 10 minutes)
Routing Constant, w = dt / (2T_c + dt) = 0.0443
Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step
+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of P _t	(4) Incre- mental Rainfall in.	(5) Accum- ulated Rainfall in.	(6) Pervious Area Accum- ulated Runoff in.	(7) Incre- mental Runoff in.	(8) Impervius Area Accum- ulated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
1	10	0.0040	0.0128	0.0128	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0128	0.0256	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0128	0.0384	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
4	40	0.0040	0.0128	0.0512	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
5	50	0.0040	0.0128	0.0640	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
6	60	0.0040	0.0128	0.0768	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
7	70	0.0040	0.0128	0.0896	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
8	80	0.0040	0.0128	0.1024	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
9	90	0.0040	0.0128	0.1152	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
10	100	0.0040	0.0128	0.1280	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
11	110	0.0050	0.0160	0.1440	0.0000	0.0000	0.0347	0.0086	0.0019	15.1	3.96
12	120	0.0050	0.0160	0.1600	0.0000	0.0000	0.0439	0.0093	0.0020	16.4	5.01
13	130	0.0050	0.0160	0.1760	0.0000	0.0000	0.0539	0.0099	0.0022	17.5	6.07
14	140	0.0050	0.0160	0.1920	0.0000	0.0000	0.0643	0.0105	0.0023	18.5	7.13
15	150	0.0050	0.0160	0.2080	0.0000	0.0000	0.0753	0.0109	0.0024	19.4	8.18
16	160	0.0050	0.0160	0.2240	0.0000	0.0000	0.0866	0.0114	0.0025	20.1	9.20
17	170	0.0060	0.0192	0.2432	0.0000	0.0000	0.1008	0.0141	0.0031	25.0	10.38
18	180	0.0060	0.0192	0.2624	0.0000	0.0000	0.1153	0.0146	0.0032	25.8	11.71
19	190	0.0060	0.0192	0.2816	0.0000	0.0000	0.1303	0.0150	0.0033	26.5	12.99
20	200	0.0060	0.0192	0.3008	0.0000	0.0000	0.1457	0.0153	0.0033	27.1	14.21
21	210	0.0060	0.0192	0.3200	0.0000	0.0000	0.1613	0.0156	0.0034	27.6	15.38
22	220	0.0060	0.0192	0.3392	0.0000	0.0000	0.1772	0.0159	0.0035	28.1	16.49
23	230	0.0070	0.0224	0.3616	0.0000	0.0000	0.1961	0.0189	0.0041	33.4	17.75
24	240	0.0070	0.0224	0.3840	0.0000	0.0000	0.2152	0.0192	0.0042	33.9	19.16
25	250	0.0070	0.0224	0.4064	0.0000	0.0000	0.2346	0.0194	0.0042	34.3	20.48
26	260	0.0070	0.0224	0.4288	0.0000	0.0000	0.2542	0.0196	0.0043	34.7	21.73
27	270	0.0070	0.0224	0.4512	0.0000	0.0000	0.2741	0.0198	0.0043	35.1	22.90
28	280	0.0070	0.0224	0.4736	0.0000	0.0000	0.2941	0.0200	0.0044	35.4	23.99
29	290	0.0082	0.0262	0.4998	0.0000	0.0000	0.3178	0.0237	0.0052	41.8	25.29
30	300	0.0082	0.0262	0.5261	0.0000	0.0000	0.3416	0.0238	0.0052	42.2	26.77
31	310	0.0082	0.0262	0.5523	0.0000	0.0000	0.3656	0.0240	0.0052	42.5	28.15
32	320	0.0082	0.0262	0.5786	0.0000	0.0000	0.3898	0.0242	0.0053	42.8	29.43
33	330	0.0082	0.0262	0.6048	0.0000	0.0000	0.4141	0.0243	0.0053	43.1	30.63
34	340	0.0082	0.0262	0.6310	0.0004	0.0004	0.4386	0.0244	0.0056	45.5	31.84
35	350	0.0095	0.0304	0.6614	0.0013	0.0010	0.4670	0.0285	0.0070	56.5	33.54
36	360	0.0095	0.0304	0.6918	0.0029	0.0016	0.4956	0.0286	0.0074	60.4	35.75
37	370	0.0095	0.0304	0.7222	0.0050	0.0021	0.5244	0.0287	0.0079	64.2	38.10
38	380	0.0095	0.0304	0.7526	0.0077	0.0027	0.5532	0.0288	0.0084	67.9	40.58
39	390	0.0095	0.0304	0.7830	0.0109	0.0032	0.5822	0.0289	0.0088	71.4	43.16
40	400	0.0095	0.0304	0.8134	0.0146	0.0037	0.6112	0.0290	0.0092	74.9	45.82
41	410	0.0134	0.0429	0.8563	0.0207	0.0061	0.6523	0.0411	0.0137	111.2	50.00
42	420	0.0134	0.0429	0.8992	0.0277	0.0070	0.6935	0.0412	0.0145	117.6	55.71
43	430	0.0134	0.0429	0.9421	0.0357	0.0080	0.7349	0.0414	0.0152	123.7	61.47
44	440	0.0180	0.0576	0.9997	0.0477	0.0121	0.7906	0.0557	0.0216	175.2	69.27
45	450	0.0180	0.0576	1.0573	0.0614	0.0136	0.8465	0.0559	0.0228	185.2	79.10
46	460	0.0340	0.1088	1.1661	0.0910	0.0296	0.9525	0.1060	0.0463	375.2	96.93
47	470	0.0540	0.1728	1.3389	0.1475	0.0565	1.1217	0.1692	0.0811	657.6	134.12
48	480	0.0270	0.0864	1.4253	0.1797	0.0322	1.2066	0.0849	0.0437	354.4	167.09 Q peak
49	490	0.0180	0.0576	1.4829	0.2025	0.0228	1.2633	0.0567	0.0302	244.9	178.84
50	500	0.0134	0.0429	1.5258	0.2201	0.0176	1.3055	0.0422	0.0230	186.6	182.12
51	510	0.0134	0.0429	1.5686	0.2383	0.0182	1.3478	0.0423	0.0234	190.2	182.68
52	520	0.0134	0.0429	1.6115	0.2570	0.0187	1.3901	0.0423	0.0239	193.6	183.49
53	530	0.0088	0.0282	1.6397	0.2696	0.0126	1.4179	0.0278	0.0159	128.9	181.52
54	540	0.0088	0.0282	1.6678	0.2824	0.0128	1.4457	0.0278	0.0161	130.3	176.92
55	550	0.0088	0.0282	1.6960	0.2954	0.0130	1.4735	0.0278	0.0162	131.7	172.85
56	560	0.0088	0.0282	1.7242	0.3086	0.0132	1.5013	0.0278	0.0164	133.0	169.26
57	570	0.0088	0.0282	1.7523	0.3220	0.0134	1.5292	0.0278	0.0166	134.3	166.10
58	580	0.0088	0.0282	1.7805	0.3356	0.0136	1.5570	0.0278	0.0167	135.6	163.34
59	590	0.0088	0.0282	1.8086	0.3495	0.0138	1.5849	0.0279	0.0169	136.9	160.94
60	600	0.0088	0.0282	1.8368	0.3635	0.0140	1.6127	0.0279	0.0170	138.1	158.86
61	610	0.0088	0.0282	1.8650	0.3776	0.0142	1.6406	0.0279	0.0172	139.3	157.07
62	620	0.0088	0.0282	1.8931	0.3920	0.0144	1.6685	0.0279	0.0173	140.5	155.54
63	630	0.0088	0.0282	1.9213	0.4066	0.0146	1.6964	0.0279	0.0175	141.6	154.26
64	640	0.0088	0.0282	1.9494	0.4213	0.0147	1.7243	0.0279	0.0176	142.8	153.19
65	650	0.0072	0.0230	1.9725	0.4355	0.0122	1.7471	0.0228	0.0145	117.6	151.15
66	660	0.0072	0.0230	1.9955	0.4458	0.0123	1.7699	0.0228	0.0146	118.4	148.21
67	670	0.0072	0.0230	2.0186	0.4562	0.0124	1.7928	0.0228	0.0147	119.1	145.59

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of Pt	(4) Incremental Rainfall in.	Pervious Area		Impervious Area		(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
				(5) Accumulated Rainfall in.	(6) Accumulated Runoff in.	(7) Incremental Runoff in.	(8) Accumulated Runoff in.			
68	680	0.0072	0.0230	2.0416	0.4707	0.0125	1.8156	0.0228	0.0148	119.8
69	690	0.0072	0.0230	2.0646	0.4833	0.0126	1.8384	0.0228	0.0149	120.5
70	700	0.0072	0.0230	2.0877	0.4960	0.0127	1.8613	0.0228	0.0149	121.2
71	710	0.0072	0.0230	2.1107	0.5089	0.0128	1.8841	0.0229	0.0150	121.8
72	720	0.0072	0.0230	2.1338	0.5218	0.0129	1.9070	0.0229	0.0151	122.5
73	730	0.0072	0.0230	2.1568	0.5349	0.0130	1.9299	0.0229	0.0152	123.2
74	740	0.0072	0.0230	2.1798	0.5480	0.0131	1.9527	0.0229	0.0153	123.8
75	750	0.0072	0.0230	2.2029	0.5613	0.0132	1.9756	0.0229	0.0153	124.5
76	760	0.0072	0.0230	2.2259	0.5746	0.0133	1.9985	0.0229	0.0154	125.1
77	770	0.0057	0.0182	2.2442	0.5852	0.0106	2.0166	0.0181	0.0123	99.5
78	780	0.0057	0.0182	2.2624	0.5959	0.0107	2.0347	0.0181	0.0123	99.8
79	790	0.0057	0.0182	2.2806	0.6067	0.0107	2.0528	0.0181	0.0124	100.2
80	800	0.0057	0.0182	2.2989	0.6175	0.0108	2.0709	0.0181	0.0124	100.6
81	810	0.0057	0.0182	2.3171	0.6283	0.0109	2.0890	0.0181	0.0124	101.0
82	820	0.0057	0.0182	2.3354	0.6393	0.0109	2.1071	0.0181	0.0125	101.3
83	830	0.0057	0.0182	2.3536	0.6502	0.0110	2.1253	0.0181	0.0125	101.7
84	840	0.0057	0.0182	2.3718	0.6613	0.0110	2.1434	0.0181	0.0126	102.0
85	850	0.0057	0.0182	2.3901	0.6724	0.0111	2.1615	0.0181	0.0126	102.4
86	860	0.0057	0.0182	2.4083	0.6835	0.0111	2.1796	0.0181	0.0127	102.7
87	870	0.0057	0.0182	2.4266	0.6947	0.0112	2.1977	0.0181	0.0127	103.1
88	880	0.0057	0.0182	2.4448	0.7060	0.0113	2.2159	0.0181	0.0127	103.4
89	890	0.0050	0.0160	2.4608	0.7159	0.0099	2.2318	0.0159	0.0112	91.0
90	900	0.0050	0.0160	2.4768	0.7258	0.0100	2.2477	0.0159	0.0112	91.3
91	910	0.0050	0.0160	2.4928	0.7358	0.0100	2.2636	0.0159	0.0113	91.5
92	920	0.0050	0.0160	2.5088	0.7458	0.0100	2.2795	0.0159	0.0113	91.8
93	930	0.0050	0.0160	2.5248	0.7559	0.0101	2.2954	0.0159	0.0113	92.0
94	940	0.0050	0.0160	2.5408	0.7660	0.0101	2.3113	0.0159	0.0114	92.3
95	950	0.0050	0.0160	2.5568	0.7762	0.0101	2.3272	0.0159	0.0114	92.5
96	960	0.0050	0.0160	2.5728	0.7864	0.0102	2.3431	0.0159	0.0114	92.7
97	970	0.0050	0.0160	2.5888	0.7966	0.0102	2.3590	0.0159	0.0115	93.0
98	980	0.0050	0.0160	2.6048	0.8068	0.0103	2.3749	0.0159	0.0115	93.2
99	990	0.0050	0.0160	2.6208	0.8171	0.0103	2.3909	0.0159	0.0115	93.4
100	1000	0.0050	0.0160	2.6368	0.8275	0.0103	2.4068	0.0159	0.0115	93.7
101	1010	0.0040	0.0128	2.6496	0.8357	0.0083	2.4195	0.0127	0.0093	75.1
102	1020	0.0040	0.0128	2.6624	0.8441	0.0083	2.4322	0.0127	0.0093	75.3
103	1030	0.0040	0.0128	2.6752	0.8524	0.0083	2.4450	0.0127	0.0093	75.4
104	1040	0.0040	0.0128	2.6880	0.8608	0.0084	2.4577	0.0127	0.0093	75.5
105	1050	0.0040	0.0128	2.7008	0.8691	0.0084	2.4704	0.0127	0.0093	75.7
106	1060	0.0040	0.0128	2.7136	0.8775	0.0084	2.4832	0.0127	0.0093	75.8
107	1070	0.0040	0.0128	2.7264	0.8860	0.0084	2.4959	0.0127	0.0094	76.0
108	1080	0.0040	0.0128	2.7392	0.8944	0.0084	2.5087	0.0127	0.0094	76.1
109	1090	0.0040	0.0128	2.7520	0.9029	0.0085	2.5214	0.0127	0.0094	76.2
110	1100	0.0040	0.0128	2.7648	0.9114	0.0085	2.5341	0.0127	0.0094	76.4
111	1110	0.0040	0.0128	2.7776	0.9199	0.0085	2.5469	0.0127	0.0094	76.5
112	1120	0.0040	0.0128	2.7904	0.9284	0.0085	2.5596	0.0127	0.0095	76.7
113	1130	0.0040	0.0128	2.8032	0.9370	0.0086	2.5723	0.0127	0.0095	76.8
114	1140	0.0040	0.0128	2.8160	0.9456	0.0086	2.5851	0.0127	0.0095	76.9
115	1150	0.0040	0.0128	2.8288	0.9541	0.0086	2.5978	0.0127	0.0095	77.1
116	1160	0.0040	0.0128	2.8416	0.9628	0.0086	2.6106	0.0127	0.0095	77.2
117	1170	0.0040	0.0128	2.8544	0.9714	0.0086	2.6233	0.0127	0.0095	77.3
118	1180	0.0040	0.0128	2.8672	0.9801	0.0087	2.6360	0.0127	0.0095	77.4
119	1190	0.0040	0.0128	2.8800	0.9887	0.0087	2.6488	0.0127	0.0096	77.6
120	1200	0.0040	0.0128	2.8928	0.9974	0.0087	2.6615	0.0127	0.0096	77.7
121	1210	0.0040	0.0128	2.9056	1.0061	0.0087	2.6743	0.0127	0.0096	77.8
122	1220	0.0040	0.0128	2.9184	1.0149	0.0087	2.6870	0.0127	0.0096	78.0
123	1230	0.0040	0.0128	2.9312	1.0236	0.0088	2.6998	0.0127	0.0096	78.1
124	1240	0.0040	0.0128	2.9440	1.0324	0.0088	2.7125	0.0127	0.0096	78.2
125	1250	0.0040	0.0128	2.9568	1.0412	0.0088	2.7253	0.0127	0.0097	78.3
126	1260	0.0040	0.0128	2.9696	1.0500	0.0088	2.7380	0.0127	0.0097	78.5
127	1270	0.0040	0.0128	2.9824	1.0589	0.0088	2.7507	0.0127	0.0097	78.6
128	1280	0.0040	0.0128	2.9952	1.0677	0.0089	2.7635	0.0127	0.0097	78.7
129	1290	0.0040	0.0128	3.0080	1.0766	0.0089	2.7762	0.0127	0.0097	78.8
130	1300	0.0040	0.0128	3.0208	1.0855	0.0089	2.7890	0.0127	0.0097	78.9
131	1310	0.0040	0.0128	3.0336	1.0944	0.0089	2.8017	0.0127	0.0097	79.0
132	1320	0.0040	0.0128	3.0464	1.1033	0.0089	2.8145	0.0127	0.0098	79.2
133	1330	0.0040	0.0128	3.0592	1.1123	0.0089	2.8272	0.0127	0.0098	79.3
134	1340	0.0040	0.0128	3.0720	1.1212	0.0090	2.8400	0.0127	0.0098	79.4
135	1350	0.0040	0.0128	3.0848	1.1302	0.0090	2.8527	0.0127	0.0098	79.5
136	1360	0.0040	0.0128	3.0976	1.1392	0.0090	2.8655	0.0127	0.0098	79.6
137	1370	0.0040	0.0128	3.1104	1.1482	0.0090	2.8782	0.0128	0.0098	79.7
138	1380	0.0040	0.0128	3.1232	1.1572	0.0090	2.8910	0.0128	0.0098	79.9
139	1390	0.0040	0.0128	3.1360	1.1663	0.0091	2.9037	0.0128	0.0099	80.0
140	1400	0.0040	0.0128	3.1488	1.1754	0.0091	2.9165	0.0128	0.0099	80.1
141	1410	0.0040	0.0128	3.1616	1.1844	0.0091	2.9292	0.0128	0.0099	80.2
142	1420	0.0040	0.0128	3.1744	1.1935	0.0091	2.9420	0.0128	0.0099	80.3
143	1430	0.0040	0.0128	3.1872	1.2027	0.0091	2.9547	0.0128	0.0099	80.4
144	1440	0.0040	0.0128	3.2000	1.2118	0.0091	2.9675	0.0128	0.0099	80.5

Total Volume of Runoff = 7,245,047 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \sum Q \times dt$$

$$V(\text{cu.ft.}) = \sum Q(\text{cu.ft/s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

60/90

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

Project: City of Arlington
Basin: Upper Portage Creek Subbasin
Storm Event: 100-YEAR, 24-HOUR
Given:

Area = 1340.80 acres
P_t = 3.75 inches
dt = 10 min.
T_c = 107.8 min.
PERVIOUS AREA
(Interim Final Cover Area)
Area = 1048.50 acres
CN = 77
S = 2.99
0.2S = 0.60
IMPERVIOUS AREA
(Roads)
Area = 292.30 acres
CN = 98
S = 0.20
0.2S = 0.04

SUMMARY	
T _{pk} (hrs) =	7.83
T _c (min) =	107.8
Q _{pk} (cfs) =	242.63
Vol (cf) =	9,255,669

Compute: Runoff Hydrograph

Column (3) = SCS Type IA Rainfall Distribution
Column (4) = Col. (3) x P_t
Column (5) = Accumulated Sum of Col. (4)
Column (6) = If P ≤ 0.2S = 0; Note, use PERVIOUS Area "S" value.
If P > 0.2S = (Col.(5) - 0.2S) / (Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.
Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step
Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.
Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.
Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))
Column (11) = (60.5 x Col.(10) x Total Area) / 10 (dt = 10 minutes)
Routing Constant, w = dt / (2T_c + dt) = 0.0443
Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step + Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of P _t	(4) Rainfall in.	(5) Accumulated Rainfall in.	(6) Accumulated Runoff in.	(7) Incremental Runoff in.	(8) Accumulated Runoff in.	(9) Incremental Runoff in.	(10) Total Runoff in.	(11) Instant hydrograph cfs	(12) design hydrograph cfs
1	10	0.0040	0.0150	0.0150	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
2	20	0.0040	0.0150	0.0300	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.00
3	30	0.0040	0.0150	0.0450	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.01
4	40	0.0040	0.0150	0.0600	0.0000	0.0000	0.0016	0.0016	0.0003	2.8	0.14
5	50	0.0040	0.0150	0.0750	0.0000	0.0000	0.0049	0.0033	0.0007	5.8	0.50
6	60	0.0040	0.0150	0.0900	0.0000	0.0000	0.0096	0.0046	0.0010	8.2	1.08
7	70	0.0040	0.0150	0.1050	0.0000	0.0000	0.0154	0.0058	0.0013	10.3	1.80
8	80	0.0040	0.0150	0.1200	0.0000	0.0000	0.0221	0.0068	0.0015	12.0	2.63
9	90	0.0040	0.0150	0.1350	0.0000	0.0000	0.0297	0.0076	0.0017	13.4	3.52
10	100	0.0040	0.0150	0.1500	0.0000	0.0000	0.0381	0.0083	0.0018	14.7	4.46
11	110	0.0050	0.0188	0.1688	0.0000	0.0000	0.0493	0.0112	0.0025	19.9	5.59
12	120	0.0050	0.0188	0.1875	0.0000	0.0000	0.0613	0.0120	0.0026	21.3	6.92
13	130	0.0050	0.0188	0.2063	0.0000	0.0000	0.0741	0.0127	0.0028	22.5	8.25
14	140	0.0050	0.0188	0.2250	0.0000	0.0000	0.0874	0.0133	0.0029	23.5	9.56
15	150	0.0050	0.0188	0.2438	0.0000	0.0000	0.1012	0.0138	0.0030	24.4	10.84
16	160	0.0050	0.0188	0.2625	0.0000	0.0000	0.1154	0.0142	0.0031	25.2	12.08
17	170	0.0060	0.0225	0.2850	0.0000	0.0000	0.1330	0.0176	0.0038	31.1	13.50
18	180	0.0060	0.0225	0.3075	0.0000	0.0000	0.1511	0.0181	0.0039	31.9	15.10
19	190	0.0060	0.0225	0.3300	0.0000	0.0000	0.1695	0.0185	0.0040	32.7	16.62
20	200	0.0060	0.0225	0.3525	0.0000	0.0000	0.1884	0.0188	0.0041	33.3	18.07
21	210	0.0060	0.0225	0.3750	0.0000	0.0000	0.2075	0.0191	0.0042	33.8	19.44
22	220	0.0060	0.0225	0.3975	0.0000	0.0000	0.2269	0.0194	0.0042	34.3	20.74
23	230	0.0070	0.0263	0.4238	0.0000	0.0000	0.2498	0.0229	0.0050	40.5	22.22
24	240	0.0070	0.0263	0.4500	0.0000	0.0000	0.2730	0.0232	0.0051	41.1	23.87
25	250	0.0070	0.0263	0.4763	0.0000	0.0000	0.2965	0.0235	0.0051	41.5	25.41
26	260	0.0070	0.0263	0.5025	0.0000	0.0000	0.3202	0.0237	0.0052	41.9	26.85
27	270	0.0070	0.0263	0.5288	0.0000	0.0000	0.3440	0.0239	0.0052	42.2	28.20
28	280	0.0070	0.0263	0.5550	0.0000	0.0000	0.3681	0.0241	0.0052	42.5	29.46
29	290	0.0082	0.0308	0.5858	0.0000	0.0000	0.3965	0.0284	0.0062	50.2	30.95
30	300	0.0082	0.0308	0.6165	0.0001	0.0001	0.4250	0.0286	0.0063	51.3	32.71
31	310	0.0082	0.0308	0.6473	0.0008	0.0007	0.4537	0.0287	0.0068	55.2	34.53
32	320	0.0082	0.0308	0.6780	0.0021	0.0013	0.4826	0.0289	0.0073	59.3	36.54
33	330	0.0082	0.0308	0.7088	0.0040	0.0019	0.5116	0.0290	0.0078	63.2	38.73
34	340	0.0082	0.0308	0.7395	0.0065	0.0025	0.5407	0.0291	0.0083	67.1	41.08
35	350	0.0095	0.0356	0.7751	0.0100	0.0035	0.5746	0.0339	0.0101	82.3	44.05
36	360	0.0095	0.0356	0.8108	0.0142	0.0042	0.6086	0.0340	0.0107	87.0	47.65
37	370	0.0095	0.0356	0.8464	0.0192	0.0049	0.6427	0.0341	0.0113	91.6	51.35
38	380	0.0095	0.0356	0.8820	0.0248	0.0056	0.6769	0.0342	0.0118	96.0	55.11
39	390	0.0095	0.0356	0.9176	0.0310	0.0062	0.7113	0.0343	0.0124	100.3	58.93
40	400	0.0095	0.0356	0.9533	0.0379	0.0069	0.7457	0.0344	0.0129	104.4	62.78
41	410	0.0134	0.0503	1.0035	0.0486	0.0107	0.7943	0.0486	0.0190	154.0	68.68
42	420	0.0134	0.0503	1.0538	0.0605	0.0119	0.8431	0.0488	0.0199	161.6	76.58
43	430	0.0134	0.0503	1.1040	0.0735	0.0130	0.8920	0.0489	0.0208	168.8	84.43
44	440	0.0180	0.0675	1.1715	0.0926	0.0191	0.9578	0.0658	0.0293	237.5	94.96
45	450	0.0180	0.0675	1.2390	0.1134	0.0209	1.0238	0.0660	0.0307	249.2	108.12
46	460	0.0340	0.1275	1.3665	0.1575	0.0440	1.1488	0.1250	0.0617	500.4	131.76
47	470	0.0540	0.2025	1.5690	0.2385	0.0810	1.3481	0.1993	0.1068	866.2	180.66
48	480	0.0270	0.1013	1.6703	0.2835	0.0450	1.4481	0.0999	0.0570	462.4	223.54 Q peak
49	490	0.0180	0.0675	1.7378	0.3151	0.0316	1.5148	0.0667	0.0392	318.1	238.32
50	500	0.0134	0.0503	1.7880	0.3393	0.0242	1.5644	0.0497	0.0298	241.7	242.01
51	510	0.0134	0.0503	1.8383	0.3642	0.0249	1.6142	0.0497	0.0303	245.7	242.15
52	520	0.0134	0.0503	1.8885	0.3896	0.0255	1.6639	0.0497	0.0308	249.5	242.63
53	530	0.0088	0.0330	1.9215	0.4067	0.0170	1.6966	0.0327	0.0204	165.9	239.53
54	540	0.0088	0.0330	1.9545	0.4240	0.0173	1.7293	0.0327	0.0206	167.4	233.07
55	550	0.0088	0.0330	1.9875	0.4415	0.0175	1.7620	0.0327	0.0208	168.9	227.32
56	560	0.0088	0.0330	2.0205	0.4592	0.0177	1.7947	0.0327	0.0210	170.4	222.21
57	570	0.0088	0.0330	2.0535	0.4772	0.0180	1.8274	0.0327	0.0212	171.9	217.68
58	580	0.0088	0.0330	2.0865	0.4954	0.0182	1.8601	0.0327	0.0214	173.3	213.68
59	590	0.0088	0.0330	2.1195	0.5138	0.0184	1.8928	0.0327	0.0215	174.7	210.16
60	600	0.0088	0.0330	2.1525	0.5324	0.0186	1.9256	0.0327	0.0217	176.0	207.08
61	610	0.0088	0.0330	2.1855	0.5513	0.0188	1.9583	0.0327	0.0219	177.4	204.38
62	620	0.0088	0.0330	2.2185	0.5703	0.0190	1.9911	0.0328	0.0220	178.7	202.05
63	630	0.0088	0.0330	2.2515	0.5895	0.0192	2.0238	0.0328	0.0222	179.9	200.03
64	640	0.0088	0.0330	2.2845	0.6089	0.0194	2.0566	0.0328	0.0223	181.2	198.30
65	650	0.0072	0.0270	2.3115	0.6250	0.0160	2.0834	0.0268	0.0184	149.1	195.37
66	660	0.0072	0.0270	2.3385	0.6411	0.0162	2.1103	0.0268	0.0185	149.9	191.30
67	670	0.0072	0.0270	2.3655	0.6574	0.0163	2.1371	0.0268	0.0186	150.7	187.67

SANTA BARBARA URBAN HYDROGRAPH (SBUH) METHOD
RUNOFF VOLUME CALCULATION

(1) Time Increment	(2) Time min.	(3) Rainfall distribution % of Pt	(4) Incre- mental Rainfall in.	(5) Accum- ulated Rainfall in.	Pervious Area (6) Accum- ulated Runoff in.	(7) Incre- mental Runoff in.	Impervious Area (8) Accum- ulated Runoff in.	(9) Incre- mental Runoff in.	(10) Total Runoff in.	(11) Instant hydro- graph cfs	(12) design hydro- graph cfs
68	680	0.0072	0.0270	2.3925	0.6738	0.0164	2.1639	0.0268	0.0187	151.5	184.43
69	690	0.0072	0.0270	2.4195	0.6904	0.0165	2.1907	0.0268	0.0188	152.3	181.55
70	700	0.0072	0.0270	2.4465	0.7070	0.0166	2.2176	0.0268	0.0189	153.0	178.99
71	710	0.0072	0.0270	2.4735	0.7238	0.0168	2.2444	0.0268	0.0190	153.8	176.72
72	720	0.0072	0.0270	2.5005	0.7406	0.0169	2.2712	0.0268	0.0190	154.5	174.71
73	730	0.0072	0.0270	2.5275	0.7576	0.0170	2.2981	0.0268	0.0191	155.2	172.95
74	740	0.0072	0.0270	2.5545	0.7747	0.0171	2.3249	0.0268	0.0192	155.9	171.41
75	750	0.0072	0.0270	2.5815	0.7919	0.0172	2.3518	0.0268	0.0193	156.6	170.06
76	760	0.0072	0.0270	2.6085	0.8092	0.0173	2.3786	0.0269	0.0194	157.3	168.90
77	770	0.0057	0.0214	2.6299	0.8230	0.0138	2.3999	0.0213	0.0154	125.0	166.43
78	780	0.0057	0.0214	2.6513	0.8368	0.0138	2.4212	0.0213	0.0155	125.4	162.78
79	790	0.0057	0.0214	2.6726	0.8507	0.0139	2.4424	0.0213	0.0155	125.8	159.48
80	800	0.0057	0.0214	2.6940	0.8647	0.0140	2.4637	0.0213	0.0156	126.2	156.51
81	810	0.0057	0.0214	2.7154	0.8787	0.0140	2.4849	0.0213	0.0156	126.6	153.84
82	820	0.0057	0.0214	2.7368	0.8928	0.0141	2.5062	0.0213	0.0157	127.0	151.44
83	830	0.0057	0.0214	2.7581	0.9069	0.0141	2.5275	0.0213	0.0157	127.4	149.29
84	840	0.0057	0.0214	2.7795	0.9212	0.0142	2.5488	0.0213	0.0157	127.7	147.36
85	850	0.0057	0.0214	2.8009	0.9354	0.0143	2.5700	0.0213	0.0158	128.1	145.64
86	860	0.0057	0.0214	2.8223	0.9497	0.0143	2.5913	0.0213	0.0158	128.5	144.10
87	870	0.0057	0.0214	2.8436	0.9641	0.0144	2.6126	0.0213	0.0159	128.9	142.73
88	880	0.0057	0.0214	2.8650	0.9786	0.0144	2.6339	0.0213	0.0159	129.2	141.52
89	890	0.0050	0.0188	2.8838	0.9913	0.0127	2.6525	0.0187	0.0140	113.6	139.74
90	900	0.0050	0.0188	2.9025	1.0040	0.0128	2.6712	0.0187	0.0140	113.9	137.44
91	910	0.0050	0.0188	2.9213	1.0168	0.0128	2.6899	0.0187	0.0141	114.2	135.37
92	920	0.0050	0.0188	2.9400	1.0297	0.0128	2.7085	0.0187	0.0141	114.5	133.50
93	930	0.0050	0.0188	2.9588	1.0426	0.0129	2.7272	0.0187	0.0141	114.7	131.82
94	940	0.0050	0.0188	2.9775	1.0555	0.0129	2.7459	0.0187	0.0142	115.0	130.32
95	950	0.0050	0.0188	2.9963	1.0684	0.0130	2.7645	0.0187	0.0142	115.2	128.97
96	960	0.0050	0.0188	3.0150	1.0814	0.0130	2.7832	0.0187	0.0142	115.5	127.77
97	970	0.0050	0.0188	3.0338	1.0945	0.0130	2.8019	0.0187	0.0143	115.8	126.69
98	980	0.0050	0.0188	3.0525	1.1076	0.0131	2.8206	0.0187	0.0143	116.0	125.73
99	990	0.0050	0.0188	3.0713	1.1207	0.0131	2.8392	0.0187	0.0143	116.3	124.88
100	1000	0.0050	0.0188	3.0900	1.1338	0.0132	2.8579	0.0187	0.0144	116.5	124.13
101	1010	0.0040	0.0150	3.1050	1.1444	0.0106	2.8728	0.0149	0.0115	93.4	122.43
102	1020	0.0040	0.0150	3.1200	1.1550	0.0106	2.8878	0.0149	0.0115	93.5	119.86
103	1030	0.0040	0.0150	3.1350	1.1656	0.0106	2.9027	0.0149	0.0115	93.7	117.53
104	1040	0.0040	0.0150	3.1500	1.1762	0.0106	2.9177	0.0149	0.0116	93.8	115.42
105	1050	0.0040	0.0150	3.1650	1.1869	0.0107	2.9326	0.0149	0.0116	94.0	113.52
106	1060	0.0040	0.0150	3.1800	1.1975	0.0107	2.9476	0.0149	0.0116	94.1	111.79
107	1070	0.0040	0.0150	3.1950	1.2082	0.0107	2.9625	0.0149	0.0116	94.3	110.23
108	1080	0.0040	0.0150	3.2100	1.2190	0.0107	2.9774	0.0149	0.0116	94.4	108.83
109	1090	0.0040	0.0150	3.2250	1.2297	0.0107	2.9924	0.0149	0.0117	94.6	107.56
110	1100	0.0040	0.0150	3.2400	1.2405	0.0108	3.0073	0.0149	0.0117	94.7	106.41
111	1110	0.0040	0.0150	3.2550	1.2513	0.0108	3.0223	0.0149	0.0117	94.9	105.38
112	1120	0.0040	0.0150	3.2700	1.2621	0.0108	3.0372	0.0149	0.0117	95.0	104.46
113	1130	0.0040	0.0150	3.2850	1.2729	0.0108	3.0522	0.0149	0.0117	95.2	103.63
114	1140	0.0040	0.0150	3.3000	1.2837	0.0109	3.0671	0.0149	0.0117	95.3	102.88
115	1150	0.0040	0.0150	3.3150	1.2946	0.0109	3.0821	0.0149	0.0118	95.4	102.21
116	1160	0.0040	0.0150	3.3300	1.3055	0.0109	3.0970	0.0149	0.0118	95.6	101.62
117	1170	0.0040	0.0150	3.3450	1.3164	0.0109	3.1120	0.0149	0.0118	95.7	101.09
118	1180	0.0040	0.0150	3.3600	1.3274	0.0109	3.1269	0.0149	0.0118	95.8	100.62
119	1190	0.0040	0.0150	3.3750	1.3383	0.0110	3.1419	0.0149	0.0118	96.0	100.20
120	1200	0.0040	0.0150	3.3900	1.3493	0.0110	3.1568	0.0150	0.0118	96.1	99.83
121	1210	0.0040	0.0150	3.4050	1.3603	0.0110	3.1718	0.0150	0.0119	96.2	99.51
122	1220	0.0040	0.0150	3.4200	1.3714	0.0110	3.1867	0.0150	0.0119	96.4	99.22
123	1230	0.0040	0.0150	3.4350	1.3824	0.0110	3.2017	0.0150	0.0119	96.5	98.98
124	1240	0.0040	0.0150	3.4500	1.3935	0.0111	3.2166	0.0150	0.0119	96.6	98.76
125	1250	0.0040	0.0150	3.4650	1.4046	0.0111	3.2316	0.0150	0.0119	96.8	98.58
126	1260	0.0040	0.0150	3.4800	1.4157	0.0111	3.2465	0.0150	0.0119	96.9	98.42
127	1270	0.0040	0.0150	3.4950	1.4268	0.0111	3.2615	0.0150	0.0120	97.0	98.29
128	1280	0.0040	0.0150	3.5100	1.4379	0.0111	3.2764	0.0150	0.0120	97.1	98.19
129	1290	0.0040	0.0150	3.5250	1.4491	0.0112	3.2914	0.0150	0.0120	97.3	98.10
130	1300	0.0040	0.0150	3.5400	1.4603	0.0112	3.3063	0.0150	0.0120	97.4	98.03
131	1310	0.0040	0.0150	3.5550	1.4715	0.0112	3.3213	0.0150	0.0120	97.5	97.98
132	1320	0.0040	0.0150	3.5700	1.4827	0.0112	3.3363	0.0150	0.0120	97.6	97.94
133	1330	0.0040	0.0150	3.5850	1.4939	0.0112	3.3512	0.0150	0.0121	97.8	97.92
134	1340	0.0040	0.0150	3.6000	1.5052	0.0113	3.3662	0.0150	0.0121	97.9	97.91
135	1350	0.0040	0.0150	3.6150	1.5165	0.0113	3.3811	0.0150	0.0121	98.0	97.91
136	1360	0.0040	0.0150	3.6300	1.5278	0.0113	3.3961	0.0150	0.0121	98.1	97.93
137	1370	0.0040	0.0150	3.6450	1.5391	0.0113	3.4110	0.0150	0.0121	98.2	97.95
138	1380	0.0040	0.0150	3.6600	1.5504	0.0113	3.4260	0.0150	0.0121	98.3	97.98
139	1390	0.0040	0.0150	3.6750	1.5618	0.0114	3.4410	0.0150	0.0121	98.5	98.02
140	1400	0.0040	0.0150	3.6900	1.5732	0.0114	3.4559	0.0150	0.0122	98.6	98.06
141	1410	0.0040	0.0150	3.7050	1.5845	0.0114	3.4709	0.0150	0.0122	98.7	98.11
142	1420	0.0040	0.0150	3.7200	1.5959	0.0114	3.4858	0.0150	0.0122	98.8	98.17
143	1430	0.0040	0.0150	3.7350	1.6074	0.0114	3.5008	0.0150	0.0122	98.9	98.23
144	1440	0.0040	0.0150	3.7500	1.6188	0.0114	3.5157	0.0150	0.0122	99.0	98.30

Total Volume of Runoff = 9,255,669 cu. ft.

Notes:

1. Total Runoff Volume is found by summing column (12) and multiplying by the time step, dt as follows:

$$V = \sum Q \times dt$$

$$V(\text{cu.ft.}) = \sum Q(\text{cu.ft./s}) \times dt(\text{min.}) \times (60 \text{ s/min.})$$

ATTACHMENT 5
FlowMaster Results

Kruger Creek Subbasin - Burn Rd Culvert, 10 Yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013
Channel Slope	0.02000 ft/ft
Normal Depth	2.43 ft
Diameter	2.43 ft
Discharge	53.70 ft ³ /s

Results

Diameter	2.43 ft
Normal Depth	2.43 ft
Flow Area	4.63 ft ²
Wetted Perimeter	7.63 ft
Top Width	0.00 ft
Critical Depth	2.31 ft
Percent Full	100.0 %
Critical Slope	0.01733 ft/ft
Velocity	11.59 ft/s
Velocity Head	2.09 ft
Specific Energy	4.52 ft
Froude Number	0.00
Maximum Discharge	57.77 ft ³ /s
Discharge Full	53.70 ft ³ /s
Slope Full	0.02000 ft/ft
Flow Type	SubCritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.00 ft
Profile Description	
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.00 %
Normal Depth Over Rise	100.00 %

Kruger Creek Subbasin - Burn Rd Culvert, 10 Yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.43	ft
Critical Depth	2.31	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01733	ft/ft

Kruger Creek Subbasin - Burn Rd Culvert, 25 Yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013
Channel Slope	0.02000 ft/ft
Normal Depth	2.71 ft
Diameter	2.71 ft
Discharge	72.10 ft ³ /s

Results

Diameter	2.71 ft
Normal Depth	2.71 ft
Flow Area	5.78 ft ²
Wetted Perimeter	8.52 ft
Top Width	0.00 ft
Critical Depth	2.59 ft
Percent Full	100.0 %
Critical Slope	0.01735 ft/ft
Velocity	12.48 ft/s
Velocity Head	2.42 ft
Specific Energy	5.13 ft
Froude Number	0.00
Maximum Discharge	77.56 ft ³ /s
Discharge Full	72.10 ft ³ /s
Slope Full	0.02000 ft/ft
Flow Type	SubCritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.00 ft
Profile Description	
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.00 %
Normal Depth Over Rise	100.00 %

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Kruger Creek Subbasin - Burn Rd Culvert, 25 Yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.71	ft
Critical Depth	2.59	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01735	ft/ft

Kruger Creek Subbasin - Burn Rd Culvert, 100 Yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02000	ft/ft
Normal Depth	3.02	ft
Diameter	3.02	ft
Discharge	96.10	ft ³ /s

Results

Diameter	3.02	ft
Normal Depth	3.02	ft
Flow Area	7.17	ft ²
Wetted Perimeter	9.49	ft
Top Width	0.00	ft
Critical Depth	2.89	ft
Percent Full	100.0	%
Critical Slope	0.01738	ft/ft
Velocity	13.41	ft/s
Velocity Head	2.79	ft
Specific Energy	5.81	ft
Froude Number	0.00	
Maximum Discharge	103.38	ft ³ /s
Discharge Full	96.10	ft ³ /s
Slope Full	0.02000	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

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Kruger Creek Subbasin - Burn Rd Culvert, 100 Yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.02	ft
Critical Depth	2.89	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01738	ft/ft

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Prairie Creek Subbasin - 67th Avenue Culvert, 10 Yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02000	ft/ft
Normal Depth	3.54	ft
Diameter	3.54	ft
Discharge	146.30	ft ³ /s

Results

Diameter	3.54	ft
Normal Depth	3.54	ft
Flow Area	9.82	ft ²
Wetted Perimeter	11.11	ft
Top Width	0.00	ft
Critical Depth	3.40	ft
Percent Full	100.0	%
Critical Slope	0.01744	ft/ft
Velocity	14.89	ft/s
Velocity Head	3.45	ft
Specific Energy	6.98	ft
Froude Number	0.00	
Maximum Discharge	157.38	ft ³ /s
Discharge Full	146.30	ft ³ /s
Slope Full	0.02000	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Prairie Creek Subbasin - 67th Avenue Culvert, 10 Yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.54	ft
Critical Depth	3.40	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01744	ft/ft

71/90

Prairie Creek Subbasin - 67th Avenue Culvert, 25 Yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02000	ft/ft
Normal Depth	3.85	ft
Diameter	3.85	ft
Discharge	183.60	ft³/s

Results

Diameter	3.85	ft
Normal Depth	3.85	ft
Flow Area	11.65	ft²
Wetted Perimeter	12.10	ft
Top Width	0.00	ft
Critical Depth	3.71	ft
Percent Full	100.0	%
Critical Slope	0.01747	ft/ft
Velocity	15.76	ft/s
Velocity Head	3.86	ft
Specific Energy	7.71	ft
Froude Number	0.00	
Maximum Discharge	197.49	ft³/s
Discharge Full	183.59	ft³/s
Slope Full	0.02000	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

72/90

Prairie Creek Subbasin - 67th Avenue Culvert, 25 Yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.85	ft
Critical Depth	3.71	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01747	ft/ft

Prairie Creek Subbasin - 67th Avenue Culvert, 100 Yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02000	ft/ft
Normal Depth	4.20	ft
Diameter	4.20	ft
Discharge	231.30	ft ³ /s

Results

Diameter	4.20	ft
Normal Depth	4.20	ft
Flow Area	13.85	ft ²
Wetted Perimeter	13.19	ft
Top Width	0.00	ft
Critical Depth	4.05	ft
Percent Full	100.0	%
Critical Slope	0.01750	ft/ft
Velocity	16.70	ft/s
Velocity Head	4.33	ft
Specific Energy	8.53	ft
Froude Number	0.00	
Maximum Discharge	248.81	ft ³ /s
Discharge Full	231.30	ft ³ /s
Slope Full	0.02000	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

74/90

Prairie Creek Subbasin - 67th Avenue Culvert, 100 Yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	4.20	ft
Critical Depth	4.05	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01750	ft/ft

75/90

Upper Portage Creek Subbasin - Culvert near 69th Ave under R/R, 10-Yr**Project Description**

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02000	ft/ft
Normal Depth	3.47	ft
Diameter	3.47	ft
Discharge	138.70	ft ³ /s

Results

Diameter	3.47	ft
Normal Depth	3.47	ft
Flow Area	9.44	ft ²
Wetted Perimeter	10.89	ft
Top Width	0.00	ft
Critical Depth	3.33	ft
Percent Full	100.0	%
Critical Slope	0.01743	ft/ft
Velocity	14.69	ft/s
Velocity Head	3.36	ft
Specific Energy	6.82	ft
Froude Number	0.00	
Maximum Discharge	149.20	ft ³ /s
Discharge Full	138.70	ft ³ /s
Slope Full	0.02000	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Upper Portage Creek Subbasin - Culvert near 69th Ave under R/R, 10-Yr**GVF Output Data**

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.47	ft
Critical Depth	3.33	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01743	ft/ft

Upper Portage Creek Subbasin - Culvert near 69th Ave under R/R, 25-Yr**Project Description**

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013
Channel Slope	0.02000 ft/ft
Normal Depth	3.85 ft
Diameter	3.85 ft
Discharge	183.50 ft ³ /s

Results

Diameter	3.85 ft
Normal Depth	3.85 ft
Flow Area	11.64 ft ²
Wetted Perimeter	12.10 ft
Top Width	0.00 ft
Critical Depth	3.71 ft
Percent Full	100.0 %
Critical Slope	0.01747 ft/ft
Velocity	15.76 ft/s
Velocity Head	3.86 ft
Specific Energy	7.71 ft
Froude Number	0.00
Maximum Discharge	197.38 ft ³ /s
Discharge Full	183.49 ft ³ /s
Slope Full	0.02000 ft/ft
Flow Type	SubCritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.00 ft
Profile Description	
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.00 %
Normal Depth Over Rise	100.00 %

78/90

Upper Portage Creek Subbasin - Culvert near 69th Ave under R/R, 25-Yr**GVF Output Data**

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.85	ft
Critical Depth	3.71	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01747	ft/ft

79/90

Upper Portage Creek Subbasin - Culvert near 69th Ave under R/R, 100-**Project Description**

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013
Channel Slope	0.02000 ft/ft
Normal Depth	4.28 ft
Diameter	4.28 ft
Discharge	242.60 ft ³ /s

Results

Diameter	4.28 ft
Normal Depth	4.28 ft
Flow Area	14.36 ft ²
Wetted Perimeter	13.43 ft
Top Width	0.00 ft
Critical Depth	4.13 ft
Percent Full	100.0 %
Critical Slope	0.01751 ft/ft
Velocity	16.90 ft/s
Velocity Head	4.44 ft
Specific Energy	8.71 ft
Froude Number	0.00
Maximum Discharge	260.97 ft ³ /s
Discharge Full	242.60 ft ³ /s
Slope Full	0.02000 ft/ft
Flow Type	SubCritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.00 ft
Profile Description	
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.00 %
Normal Depth Over Rise	100.00 %

80/90

Upper Portage Creek Subbasin - Culvert near 69th Ave under R/R, 100-**GVF Output Data**

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	4.28	ft
Critical Depth	4.13	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01751	ft/ft

	Area (Ac)	Peak Flow 10 yr		Peak Flow 25 yr		Peak Flow 100	
		SWMM	SBUH	SWMM	SBUH	SWMM	SBUH
Kruger	355.5	31.7	53.7	39.3	72.05	49.	96.1
Prairie	1099.3	120.2	146.3	148.6	183.6	184.7	231
Upper Portage	1340.8	122.53	138.7	151.8	183.5	189.6	243

→ USE SBUH VALUES.

→ OPEN CHANNEL. WANT $\frac{HW}{D} = 1$

KRUGER $Q_{100} = 96 \text{ cfs}$ $D = 54"$ + debris $\Rightarrow 60" \phi$
 $Q_{25} = 72 \text{ cfs}$ $D = 48"$ + 0.72 ϕ

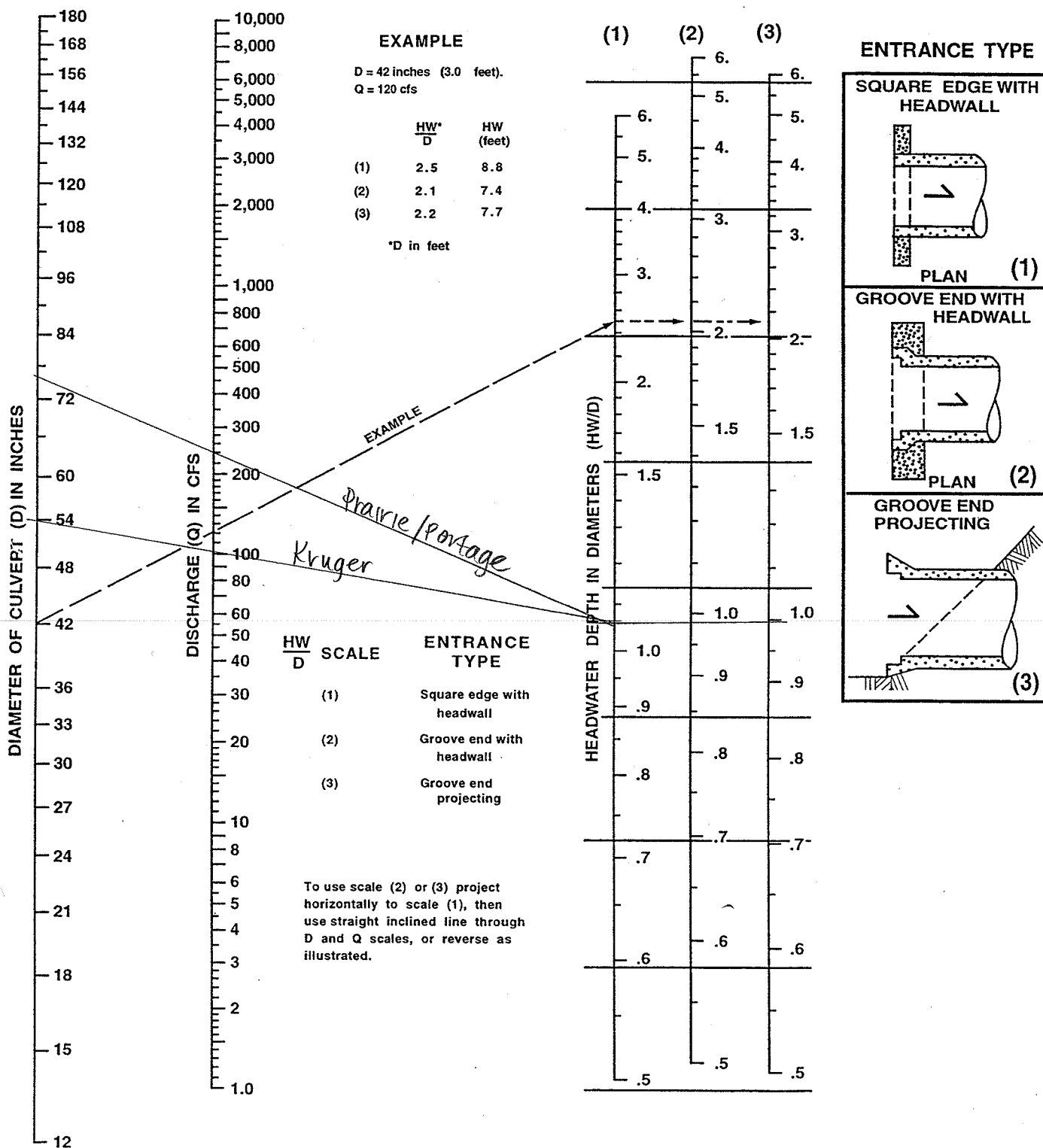
PRAIRIE $Q_{100} = 231 \text{ cfs}$ $D \approx 72"$ + debris $\Rightarrow 84" \phi$
 $Q_{25} = 184 \text{ cfs}$ $D = 72"$ + 0.96 ϕ

UPPER
PORTAGE $Q_{100} = 243$ $D \approx 72"$ + debris $\Rightarrow 84" \phi$
 $Q_{25} = 184 \text{ cfs}$ $D = 72"$ + 0.96 ϕ

NOTE PROJECT DESCRIPTIONS IN COST ESTIMATES

USE 8' ϕ (96") CULVERTS. $\therefore$ OK.

FIGURE 4.3.1.B
HEADWATER DEPTH FOR SMOOTH INTERIOR PIPE CULVERTS WITH INLET CONTROL



ATTACHMENT 6
Existing Project Descriptions

Kruger Creek Basin

Problem Identified:

The culvert crossing at Burn Road requires annual sediment removal; the sediment comes from roadway runoff. Burn Road follows the Kruger Creek ravine which is characterized by steep vegetated slopes on both sides. There are areas of failure along these slopes causing the excessive sediments. East of the City, County development is delivering increasing stormwater runoff to the creek, which is making the erosion worse.

Proposed Project:

This project consists of removing and replacing an existing culvert, assume replace with 60-ft long 8-ft wide culvert.

ITEM NO.	ITEM	Quantity	Units	Unit Price	Total Price	2006 Unit Price	2006 Total Price
206 Culvert Replacement at Burn Road							
1	Roadway Excavation, w/ Haul*	100	CY	\$8.50	\$850	\$25	\$2,500
2	Arch Culvert (8-feet)	60	LF		\$0	\$0	\$0
3	Head Wall & Wing Wall	2	EA	\$2,400	\$4,800	\$4,000	\$8,000
4	Culvert Backfill & Compaction*	10	CY	\$20	\$200	\$25	\$250
5	Aggregate Base & Surfacing Coarse	10	CY	\$18	\$180	\$25	\$250
6	Stream Reconstruction	1	LS		\$0	\$0	\$0
7	Protect Existing Utilities & One Call Services	1	LS	\$750	\$750	\$2,000	\$2,000
8	Trench Safety	60	LF	\$2	\$120	\$18	\$1,080
9	SPCC Plan, Silt Fence, & TESC Measures	100	LF	\$5	\$500	\$50	\$5,000
10	Roadway Restoration	60	LF		\$0	\$0	\$0
11	Traffic Control Labor	100	Hours	\$35	\$3,500	\$40	\$4,000
	Subtotal				\$10,900		\$23,080
12	Mobilization/Demob/Overhead & Profit	1	LS	10%	\$1,090	10%	\$2,308
13	Contingency	1	LS	30%	\$3,597	30%	\$7,616
14	Sales Tax	1	LS	8.5%	\$1,325	8.5%	\$2,805
	Estimated Construction Cost				\$16,912		\$35,810
15	Geotech Borings & Soil Tests	1	LS			\$10,000	\$10,000
16	Eng'r, Permitting, Legal, Admin (15%)	1	LS	15%	\$2,537	25%	\$8,952
17	Surveying (Property, Design & Const.)	1	LS	4%	\$676	4%	\$1,432
18	Construction Management (4%)	1	LS	4%	\$676	4%	\$1,432
CITY'S ESTIMATE (2007)							
TOTAL 2002 DOLLARS					\$20,802		
TOTAL 2006 DOLLARS							\$57,627

Notes:

- Quantities based on discussions with City of Arlington staff 12/10/2002.
- (*) Indicates Unit Prices from 67th Ave. NE Bid Tab opened March 15, 2001.
- (RSM) Indicates Unit Prices from RS Means.
- Assumes a single contractor to perform all projects in the area under one contract.
- See accompanying text for more detailed description.

Prairie Creek Basin

Problem Identified:

At 71st Ave, the sidewalk is collapsing. A new culvert is required as it is undersized. The most recent culvert installed on Prairie creek was an 8-foot diameter squashed culvert to meet WDFW standards.

Proposed Project:

This project consists of removing and replacing an existing culvert, assume replace with 60-ft long 8-ft wide culvert.

ITEM NO.	ITEM	Quantity	Units	Unit Price	Total Price	2006 Unit Price	2006 Total Price
210 Culvert Replacement at 71st Avenue							
1	Roadway Excavation, w/ Haul*	100	CY	\$8.50	\$850	\$10	\$957
2	Arch Culvert (8-feet)	60	LF			\$400	\$24,000
3	Head Wall (8-feet) & Wing Wall (8-feet)	2	EA			\$2,500	\$5,000
4	Culvert Backfill & Compaction*	10	CY	\$20	\$200	\$23	\$225
5	Aggregate Base & Surfacing Coarse	10	CY	\$18	\$180	\$20	\$203
6	Stream Reconstruction	1	LS			\$10,000	\$10,000
7	Protect Existing Utilities & One Call Services	1	LS	\$750	\$750	\$844	\$844
8	Trench Safety	60	LF	\$2	\$120	\$2	\$135
9	SPCC Plan, Silt Fence, & TESC Measures	100	LF	\$5	\$500	\$6	\$563
10	Roadway Restoration	100	CY			\$50	\$5,000
11	Traffic Control Labor	100	Hours	\$35	\$3,500	\$39	\$3,939
	Subtotal				\$6,100		\$50,866
12	Mobilization/Demob/Overhead & Profit	1	LS	10%	\$610	10%	\$5,087
13	Contingency	1	LS	30%	\$2,013	30%	\$16,786
14	Sales Tax	1	LS	8.5%	\$741	8.5%	\$6,183
	Estimated Construction Cost				\$9,464		\$78,921
15	Eng'r, Permitting, Legal, Admin (25%)	1	LS	25%	\$2,366	25%	\$19,730
16	Geotech Borings & Soil Tests	1	LS			\$10,000	\$10,000
17	Surveying (Property, Design & Const.)	1	LS	4%	\$379	4%	\$3,157
18	Construction Management (4%)	1	LS	4%	\$379	4%	\$3,157
CITY'S ESTIMATE (2003)					-		
TOTAL 2002 DOLLARS					\$12,588		
TOTAL 2006 DOLLARS							\$114,964

Prairie Creek Basin

Problem Identified:

Upsized culvert is needed to resolve capacity issues for the culvert under 67th Avenue.

Proposed Project:

This project consists of removing and replacing an existing culvert, assume replace with 60-ft long 8-ft wide culvert.

ITEM NO.	ITEM	Quantity	Units	Unit Price	Total Price	2006 Unit Price	2006 Total Price
211 Prairie Creek Culvert Replacement at 67th							
1	Roadway Excavation, w/ Haul*	100	CY	\$8.50	\$850	\$10	\$957
2	Arch Culvert (8-feet)	60	LF			\$400	\$24,000
3	Head Wall (8-feet) & Wing Wall (8-feet)	2	EA			\$2,500	\$5,000
4	Culvert Backfill & Compaction*	10	CY	\$20	\$200	\$23	\$225
5	Aggregate Base & Surfacing Coarse	10	CY	\$18	\$180	\$20	\$203
6	Stream Reconstruction	1	LS			\$10,000	\$10,000
7	Protect Existing Utilities & One Call Services	1	LS	\$750	\$750	\$844	\$844
8	Trench Safety	60	LF	\$2	\$120	\$2	\$135
9	SPCC Plan, Silt Fence, & TESC Measures	100	LF	\$5	\$500	\$6	\$563
10	Roadway Restoration	100	CY			\$50	\$5,000
11	Traffic Control Labor	100	Hours	\$35	\$3,500	\$39	\$3,939
	Subtotal				\$6,100		\$50,866
12	Mobilization/Demob/Overhead & Profit	1	LS	10%	\$610	10%	\$5,087
13	Contingency	1	LS	30%	\$2,013	30%	\$16,786
14	Sales Tax	1	LS	8.5%	\$741	8.5%	\$6,183
	Estimated Construction Cost				\$9,464		\$78,921
15	Eng'r, Permitting, Legal, Admin (25%)	1	LS	25%	\$2,366	25%	\$19,730
16	Geotech Borings & Soil Tests	1	LS			\$10,000	\$10,000
17	Surveying (Property, Design & Const.)	1	LS	4%	\$379	4%	\$3,157
18	Construction Management (4%)	1	LS	4%	\$379	4%	\$3,157
CITY'S ESTIMATE (2003)					-		
TOTAL 2002 DOLLARS					\$12,588		
TOTAL 2006 DOLLARS							\$114,964

Prairie Creek Basin

Problem Identified:

Upsized culvert is needed to resolve capacity issues for the culvert under McKinley Avenue.

Proposed Project:

This project consists of removing and replacing an existing culvert, assume replace with 60-ft long 8-ft wide culvert.

ITEM NO.	ITEM	Quantity	Units	Unit Price	Total Price	2006 Unit Price	2006 Total Price
212 Prairie Creek Culvert Replacement at McKinley							
1	Roadway Excavation, w/ Haul*	100	CY	\$8.50	\$850	\$10	\$957
2	Arch Culvert (8-feet)	60	LF			\$400	\$24,000
3	Head Wall (8-feet) & Wing Wall (8-feet)	2	EA			\$2,500	\$5,000
4	Culvert Backfill & Compaction*	10	CY	\$20	\$200	\$23	\$225
5	Aggregate Base & Surfacing Coarse	10	CY	\$18	\$180	\$20	\$203
6	Stream Reconstruction	1	LS			\$10,000	\$10,000
7	Protect Existing Utilities & One Call Services	1	LS	\$750	\$750	\$844	\$844
8	Trench Safety	60	LF	\$2	\$120	\$2	\$135
9	SPCC Plan, Silt Fence, & TESC Measures	100	LF	\$5	\$500	\$6	\$563
10	Roadway Restoration	100	CY			\$50	\$5,000
11	Traffic Control Labor	100	Hours	\$35	\$3,500	\$39	\$3,939
	Subtotal				\$6,100		\$50,866
12	Mobilization/Demob/Overhead & Profit	1	LS	10%	\$610	10%	\$5,087
13	Contingency	1	LS	30%	\$2,013	30%	\$16,786
14	Sales Tax	1	LS	8.5%	\$741	8.5%	\$6,183
	Estimated Construction Cost				\$9,464		\$78,921
15	Eng'r, Permitting, Legal, Admin (25%)	1	LS	25%	\$2,366	25%	\$19,730
16	Geotech Borings & Soil Tests	1	LS			\$10,000	\$10,000
17	Surveying (Property, Design & Const.)	1	LS	4%	\$379	4%	\$3,157
18	Construction Management (4%)	1	LS	4%	\$379	4%	\$3,157
CITY'S ESTIMATE (2003)					-		
TOTAL 2002 DOLLARS					\$12,588		
TOTAL 2006 DOLLARS							\$114,964

88/90

Prairie Creek Basin

Problem Identified:

Upsized culvert is needed to resolve capacity issues for the culvert under Railroad Tracks.

Proposed Project:

This project consists of removing and replacing an existing culvert, assume replace with 60-ft long 8-ft wide culvert.

ITEM NO.	ITEM	Quantity	Units	Unit Price	Total Price	2006 Unit Price	2006 Total Price
213 Prairie Creek Culvert Replacement at Railroad Tracks							
1	Roadway Excavation, w/ Haul*	100	CY	\$8.50	\$850	\$10	\$957
2	Arch Culvert (8-feet)	60	LF			\$400	\$24,000
3	Head Wall (8-feet) & Wing Wall (8-feet)	2	EA			\$2,500	\$5,000
4	Culvert Backfill & Compaction*	10	CY	\$20	\$200	\$23	\$225
5	Aggregate Base & Surfacing Coarse	10	CY	\$18	\$180	\$20	\$203
6	Stream Reconstruction	1	LS			\$10,000	\$10,000
7	Protect Existing Utilities & One Call Services	1	LS	\$750	\$750	\$844	\$844
8	Trench Safety	60	LF	\$2	\$120	\$2	\$135
9	SPCC Plan, Silt Fence, & TESC Measures	100	LF	\$5	\$500	\$6	\$563
10	Roadway Restoration	100	CY			\$50	\$5,000
11	Traffic Control Labor	100	Hours	\$35	\$3,500	\$39	\$3,939
	Subtotal				\$6,100		\$50,866
12	Mobilization/Demob/Overhead & Profit	1	LS	10%	\$610	10%	\$5,087
13	Contingency	1	LS	30%	\$2,013	30%	\$16,786
14	Sales Tax	1	LS	8.5%	\$741	8.5%	\$6,183
	Estimated Construction Cost				\$9,464		\$78,921
15	Eng'r, Permitting, Legal, Admin (25%)	1	LS	25%	\$2,366	25%	\$19,730
16	Geotech Borings & Soil Tests	1	LS			\$10,000	\$10,000
17	Surveying (Property, Design & Const.)	1	LS	4%	\$379	4%	\$3,157
18	Construction Management (4%)	1	LS	4%	\$379	4%	\$3,157
CITY'S ESTIMATE (2003)					-		
TOTAL 2002 DOLLARS					\$12,588		
TOTAL 2006 DOLLARS							\$114,964

89/90

Prairie Creek Basin

Problem Identified:

Upsized culvert is needed to resolve capacity issues for the culvert at Sweetwater.

Proposed Project:

This project consists of removing and replacing an existing culvert, assume replace with 60-ft long 8-ft wide culvert.

ITEM NO.	ITEM	Quantity	Units	Unit Price	Total Price	2006 Unit Price	2006 Total Price
214 Prairie Creek Culvert Replacement at Sweetwater							
1	Roadway Excavation, w/ Haul*	100	CY	\$8.50	\$850	\$10	\$957
2	Arch Culvert (8-feet)	60	LF			\$400	\$24,000
3	Head Wall (8-feet) & Wing Wall (8-feet)	2	EA			\$2,500	\$5,000
4	Culvert Backfill & Compaction*	10	CY	\$20	\$200	\$23	\$225
5	Aggregate Base & Surfacing Coarse	10	CY	\$18	\$180	\$20	\$203
6	Stream Reconstruction	1	LS			\$10,000	\$10,000
7	Protect Existing Utilities & One Call Services	1	LS	\$750	\$750	\$844	\$844
8	Trench Safety	60	LF	\$2	\$120	\$2	\$135
9	SPCC Plan, Silt Fence, & TESC Measures	100	LF	\$5	\$500	\$6	\$563
10	Roadway Restoration	100	CY			\$50	\$5,000
11	Traffic Control Labor	100	Hours	\$35	\$3,500	\$39	\$3,939
	Subtotal				\$6,100		\$50,866
12	Mobilization/Demob/Overhead & Profit	1	LS	10%	\$610	10%	\$5,087
13	Contingency	1	LS	30%	\$2,013	30%	\$16,786
14	Sales Tax	1	LS	8.5%	\$741	8.5%	\$6,183
	Estimated Construction Cost				\$9,464		\$78,921
15	Eng'r, Permitting, Legal, Admin (25%)	1	LS	25%	\$2,366	25%	\$19,730
16	Geotech Borings & Soil Tests	1	LS			\$10,000	\$10,000
17	Surveying (Property, Design & Const.)	1	LS	4%	\$379	4%	\$3,157
18	Construction Management (4%)	1	LS	4%	\$379	4%	\$3,157
CITY'S ESTIMATE (2003)					-		
TOTAL 2002 DOLLARS					\$12,588		
TOTAL 2006 DOLLARS							\$114,964

90/90

Upper Portage Creek Basin

Problem Identified:

Listed in the 1995 Stormwater Master Plan, this project is intended to address capacity issues along this stretch of the drainage system.

Proposed Project:

Project would replace two culverts directly upstream of 69th Avenue NE. One culvert would be replaced under a 15-foot wide gravel road, and a second under the Burlington Northern Santa Fe Rail Road (BNSF) tracks. The cost estimate is based on designing and installing a total of 60 feet of culvert per fish passage guidelines.

ITEM NO.	ITEM	Quantity	Units	Unit Price	Total Price	2006 Unit Price	2006 Total Price
4 Portage Creek at 69th Avenue NE							
1	Roadway Excavation, w/ Haul*	100	CY	\$8.50	\$850	\$10	\$957
2	Arch Culvert, 96" (Quantity = 2 @ 60 LF each)	120	LF	\$135	\$16,200	\$152	\$18,233
3	Headwall / wing wall	8	EA	\$2,000	\$16,000	\$2,251	\$18,008
4	Culvert Backfill and Compaction*	60	CY	\$65	\$3,900	\$73	\$4,389
5	Aggregate Base & Surfacing Course	20	CY	\$18	\$360	\$20	\$405
6	Stream Reconstruction	80	CY	\$25	\$2,000	\$28	\$2,251
7	Protect Existing Utilities & One Call Services	1	LS	\$750	\$750	\$844	\$844
8	Trench Safety	120	LF	\$2	\$240	\$2	\$270
9	SPCC Plan, Silt Fence, & TESC Measures	100	LF	\$5	\$500	\$6	\$563
10	Paving Restoration	1,440	SF	\$0	\$0	\$0	\$0
11	Traffic Safety Control Devices	1	LS	\$2,500	\$2,500	\$2,814	\$2,814
12	Traffic Control Labor	40	HR	\$35	\$1,400	\$39	\$1,576
	Subtotal				\$44,700		\$50,310
13	Mobilization/Overhead & Profit	1	LS	10%	\$4,470	10%	\$5,031
14	Contingency	1	LS	30%	\$13,410	30%	\$15,093
15	Sales Tax (8.5%)	1	LS	8.5%	\$5,319	8.5%	\$5,987
	Estimated Construction Cost				\$67,899		\$76,421
16	Geotech Borings & Soil Tests	1	LS	\$6,000	\$6,000	\$10,000	\$10,000
17	Eng'r, Permitting, Legal, Admin (25%)	1	LS	25%	\$1,500	25%	\$19,105
18	Surveying (Property, Design & Const.)	1	LS	4%	\$240	4%	\$3,057
19	Construction Management (4%)	1	LS	4%	\$240	4%	\$3,057
CITY'S ESTIMATE (2003)					\$13,000		
TOTAL 2002 DOLLARS					\$75,879		
TOTAL 2006 DOLLARS							\$111,640

Notes:

- 1 Estimates based 1995 Comprehensive Plan Sizing of Culverts.
- 2 (*) Indicates Unit Prices from 67th Ave. NE Bid Tab opened March 15, 2001.
- 3 (RSM) Indicates Unit Prices from RS Means.
- 4 Assumes a single contractor (or City) to perform all projects in the area under one contract.
- 5 See accompanying text for more detailed description.