

## **ANIMAL SERVICES CAMPUS ADDITION**

### **Wichita, Sedgwick County, Kansas**

06/23/06, Revised 08/07/06

Animal Services Campus Addition is a 22.9 acre, industrial/business development in Wichita, Sedgwick County, Kansas. The development consists of streets, buildings and a proposed detention basin located in the southern portion of the lot. This report contains a drawing of the drainage plan along with supporting calculations. The project location is shown in Figure 1 (FIGURES).

#### **Existing Conditions**

The plat lies in the SE 1/4, Section 34, T26S, R1E. The soil on-site mostly consists of Farnum Loam (1 to 3 percent slopes) and Elandco Slit Loam classified in hydrologic group B (FIGURES, Figure 3). The land is classified as 30% Industrial and 70% Undeveloped Area with slopes ranging from 1% to 3%.

Under existing conditions, just west of the plat is a ridge, and the site generally drains southeast. From the ridge mentioned, an approximately area of 1.2 acres drains onto the site and contributes to the total runoff. The north property line is adjacent to a K-96 off-ramp and drainage ditch, which drains east into a 14" x 23" RCPHE heading north away from the property. Hillside Avenue which abuts the east line of the plat drains south towards Chisholm Creek. This runoff does not contribute to the site. A Missouri & Pacific Railroad embankment and railroad line follows the southern border of the property and the majority of the runoff, under existing conditions, flows through a 3'x5' RCB under this embankment. An HY-8 Model was constructed to evaluate the capacity of this 3'x5' RCB and it can be found in the EXISTING CONDITIONS portion of this report.

The development can be divided into 3 basins (Labeled Basins A, B and C on Drainage Plan Map). The majority of existing runoff leaves the site through a 3'x5' RCB located in the southern portion of Basin A. The peak discharge (Q100) leaving the site at this location under existing conditions is 52 cfs.

## Hydrology

The objective of the hydrologic analysis was to ensure that developed conditions would not worsen flooding conditions to downstream properties. Since Basins B & C are not disturbed with the development, the conditions in these basins will not change. Basin A is where all the construction is planned (DEVELOPED CONDITIONS, Development Concept Plan). Based on preliminary calculations, sufficient storage must reduce the 63 cfs for the proposed development to no greater than 52 cfs. Peak discharges were first estimated using the Rational Method, and then refined by developing a hydrologic model of the entire basin using the USACE HEC-1 computer program HEC-1 enables the user to consider in detail the effects of detention storage in the basin.

The HEC-1 program is capable of performing complex hydrologic computations that relate detention storage to pond elevations and discharge rates during the occurrence of a major storm, and therefore was used to analyze the effects of planned detention storage.

Hydrology calculations were provided to estimate peak discharges for “pre” and “post” project conditions. Computations were made for both the undeveloped and developed condition of the basin.

### Existing Pre-developed Conditions for Basin A

Drainage Area= 20.1 AC

Estimated  $T_c = \frac{1200 \text{ ft.}}{0.50 \text{ ft./sec}} = 2400 \text{ sec.} = 40 \text{ min.}$

$C_{100} = 0.57$

$i_{100} = 4.66 \text{ in./hr.}$

$Q_{100} = (0.57)(4.66)(20.1) = 53.4 \text{ cfs}$

### Developed Conditions for Basin A

Drainage Area= 20.1 AC

Estimated  $T_c = \frac{1200 \text{ ft.}}{0.60 \text{ ft./sec}} = 1980 \text{ sec.} = 33 \text{ min.}$

$C_{100} = 0.61$

$i_{100} = 5.14 \text{ in./hr.}$

$Q_{100} = (0.61)(5.14)(20.1) = 63.0 \text{ cfs}$

The HEC-1 Analysis computed the Q100 to be a comparable 68.0 cfs.

### **Developed Conditions**

Development of any rural basin almost always increases the impervious area, shortens flow paths, and makes them hydraulically more efficient. The resulting effect is to increase both the volume and rate of runoff caused by a major storm. In order to offset these effects, it is proposed to construct a detention basin in southern portion of the development. This dry detention basin will be approximately 0.63 acres at the floor elevation of 1333.0 and will have a 5 foot weir for outlet control. All of Basin A will be routed through this detention pond under the proposed development.

### **Results**

The final results of the analysis confirm that by adding the detention basin in the southern portion of the development, the runoff leaving the site during the 100-year, 24-hour storm will not be increased.

As shown in the HEC-1 analysis (DEVELOPED CONDITIONS), the Q100 leaving the site controlled by a 5 foot weir is 52 cfs, which is equal to the existing conditions.

## **References**

Design of Urban Highway Drainage – The State of the Art, by Reitz & Jens, Inc., April 1980.

Drainage of Highway Pavements, Hydraulic Engineering Circular #12, by Tye Engineering, Inc., March 1984.

Soil Survey of Sedgwick County, Kansas, US Department of Agriculture, Soil Conservation Service, 1979.

# EXISTING CONDITIONS

Project: **ANIMAL SERVICES CAMPUS ADDITION**  
 Date: 6/22/2006  
 Prep. By: BMM

Manual Input

**EXISTING BASIN A**

Total Area 20.10 Acres 1.2 acres of which is from offsite

Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total
	0%	95%	0%	5%	100%
Acres	0.00	19.10	0.00	1.01	20.10

Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
	0%	35%	0%	0%	0%	65%
Acres	0.00	7.04	0.00	0.00	0.00	13.07

**Existing**

Length of Flow 1200 ft  
 Slope 1.52 %  
 Waterflow Desc bare / short grass  
 Avg Velocity 0.50 ft/sec  
 Tc 0.67 hours

15 min <= Tc <= 24 hrs

40 min.

Project: **ANIMAL SERVICES CAMPUS ADDITION**  
 Date: 6/22/2006  
 Prep. By: BMM

Manual Input

**EXISTING BASIN A (CONT.)**

Runoff Coefficients \* Used Soil Group D To Be Conservative

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.24
5	0.69	0.69	0.73	0.51	0.54	0.26
10	0.73	0.73	0.79	0.56	0.62	0.32
25	0.75	0.75	0.81	0.59	0.66	0.36
50	0.77	0.77	0.83	0.62	0.70	0.42
100	0.80	0.80	0.86	0.66	0.76	0.45

**Existing Conditions**

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.39	2.24	20.10	17.74
5	0.41	2.76	20.10	22.77
10	0.46	3.22	20.10	30.00
25	0.50	3.76	20.10	37.52
50	0.54	4.25	20.10	46.34
100	0.57	4.66	20.10	53.62

Project: **ANIMAL SERVICES CAMPUS ADDITION**  
 Date: 6/22/2006  
 Prep. By: BMM

Manual Input

**EXISTING BASIN B**

Total Area	3.20 Acres					
Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total	
	0%	100%	0%	0%	100%	
Acres	0.00	3.20	0.00	0.00	3.20	
Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
	0%	0%	0%	0%	0%	100%
Acres	0.00	0.00	0.00	0.00	0.00	3.20

**Existing**  
 Length of Flow 885 ft  
 Slope 1.70 %  
 Waterflow Desc bare / short grass  
 Avg Velocity 0.50 ft/sec  
 Tc 0.49 hours

30 min.

15 min <= Tc <= 24 hrs

Project: **ANIMAL SERVICES CAMPUS ADDITION**  
 Date: 6/22/2006  
 Prep. By: BMM

Manual Input

**EXISTING BASIN B (CONT.)**

Runoff Coefficients \* Used Soil Group D To Be Conservative

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.24
5	0.69	0.69	0.73	0.51	0.54	0.26
10	0.73	0.73	0.79	0.56	0.62	0.32
25	0.75	0.75	0.81	0.59	0.66	0.36
50	0.77	0.77	0.83	0.62	0.70	0.42
100	0.80	0.80	0.86	0.66	0.76	0.45

**Existing Conditions**

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.24	2.67	3.20	2.05
5	0.26	3.24	3.20	2.70
10	0.32	3.76	3.20	3.85
25	0.36	4.39	3.20	5.06
50	0.42	4.94	3.20	6.64
100	0.45	5.40	3.20	7.78

Project: **ANIMAL SERVICES CAMPUS ADDITION**  
 Date: 6/22/2006  
 Prep. By: BMM

Manual Input

**EXISTING BASIN C**

Total Area	0.80 Acres					
Soil Group	A (% of Total Area)	B (% of Total Area)	C (% of Total Area)	D (% of Total Area)	Total	
	0%	100%	0%	0%	100%	
Acres	0.00	0.80	0.00	0.00	0.80	
Land Use	Commercial (% of Total Area)	Industrial (% of Total Area)	Multi-Family (% of Total Area)	Public (% of Total Area)	Single Family (% of Total Area)	Vacant/Agriculture (% of Total Area)
	0%	0%	0%	0%	0%	100%
Acres	0.00	0.00	0.00	0.00	0.00	0.80

Length of Flow	Existing
Slope	325 ft 4.30 %
Waterflow Desc	bare / short grass
Avg Velocity	1.00 ft/sec
Tc	0.09 hours

15 min <= Tc <= 24 hrs

15 min.

Project: **ANIMAL SERVICES CAMPUS ADDITION**  
 Date: 6/22/2006  
 Prep. By: BMM

Manual Input

**EXISTING BASIN C (CONT.)**

Runoff Coefficients \* Used Soil Group D To Be Conservative

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.24
5	0.69	0.69	0.73	0.51	0.54	0.26
10	0.73	0.73	0.79	0.56	0.62	0.32
25	0.75	0.75	0.81	0.59	0.66	0.36
50	0.77	0.77	0.83	0.62	0.70	0.42
100	0.80	0.80	0.86	0.66	0.76	0.45

**Existing Conditions**

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.24	3.83	0.80	0.74
5	0.26	4.56	0.80	0.95
10	0.32	5.22	0.80	1.34
25	0.36	6.06	0.80	1.75
50	0.42	6.78	0.80	2.28
100	0.45	7.37	0.80	2.65

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* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
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* RUN DATE 07AUG06 TIME 16:51:24
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*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RPIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-SIYLE INPUT STRUCTURE. THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION NEW OPTIONS: DAMBREAK OUELOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY, DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

LINE	ID	1	2	3	4	5	6	7	8	9	10
1	ID	Animal Services Campus Addition (PEC Proj. No. 36-05028-002-1324)									
2	ID	Existing Drainage									
3	ID	By BMM DATE 08-07-06									
*** LIST ***											
*** FREE ***											
*DIAGRAM											
4	IT	15	01JAN06	1200		0	02JAN06	2000			
5	IN	15	01JAN06	1200							
6	IO	0	5								
7	JR	PREC	3.5	4.5	5.3	6.1	7.0	7.8			
* * *											
8	KK	BASA									
9	KO	5									
* * 20.1 ACRES *											
10	BA	0.032									
11	EB	1.00									
12	PC	0.000	0.003	0.006	0.008	0.011	0.014	0.017	0.019	0.022	0.025
13	PC	0.029	0.032	0.035	0.038	0.042	0.045	0.048	0.052	0.056	0.060
14	PC	0.064	0.068	0.072	0.076	0.080	0.085	0.090	0.095	0.100	0.105
15	PC	0.110	0.115	0.120	0.127	0.134	0.140	0.147	0.155	0.163	0.172
16	PC	0.181	0.193	0.204	0.220	0.235	0.259	0.283	0.387	0.663	0.699
17	PC	0.735	0.754	0.772	0.786	0.799	0.810	0.820	0.828	0.835	0.843
18	PC	0.850	0.858	0.865	0.873	0.880	0.885	0.889	0.894	0.898	0.903
19	PC	0.907	0.912	0.916	0.921	0.925	0.929	0.934	0.938	0.943	0.947
20	PC	0.952	0.955	0.958	0.961	0.964	0.967	0.970	0.973	0.976	0.979
21	PC	0.982	0.985	0.988	0.991	0.994	0.997	1.000			
22	LS	0	77	0							
23	UD	0.600									
* * *											
24	ZZ										

1 SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT  
LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW  
NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW

8 BASA

(\*\*\*) RUNOFF ALSO COMPUTED AT THIS LOCATION

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*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
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* RUN DATE 07AUG06 TIME 16:51:24
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* 609 SECOND STREET
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*
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Animal Services Campus Addition (PEC Proj. No. 36-05028-002-1324)  
Existing Drainage  
By BMM DATE 08-07-06

IPRNT 0 PRINT CONTROL  
 IPLOT 5 PLOT CONTROL  
 QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA  
 NMIN 15 MINUTES IN COMPUTATION INTERVAL  
 IDATE 1JAN 6 STARTING DATE  
 ITIME 1200 STARTING TIME  
 NQ 129 NUMBER OF HYDROGRAPH ORDINATES  
 NDDATE 2JAN 6 ENDING DATE  
 NDTIME 2000 ENDING TIME  
 ICENT 19 CENTURY MARK  
 COMPUTATION INTERVAL .25 HOURS  
 TOTAL TIME BASE 32.00 HOURS

ENGLISH UNITS  
 DRAINAGE AREA SQUARE MILES  
 PRECIPITATION DEPTH INCHES  
 LENGTH, ELEVATION FEET  
 FLOW CUBIC FEET PER SECOND  
 STORAGE VOLUME ACRE-Feet  
 SURFACE AREA ACRES  
 TEMPERATURE DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION  
 NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION  
 RATIOS OF PRECIPITATION  
 3.50 4.50 5.30 6.10 7.00 7.80

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 \* \*  
 8 KK \* BASA \*  
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9 KO OUTPUT CONTROL VARIABLES  
 IPRNT 5 PRINT CONTROL  
 IPLOT 5 PLOT CONTROL  
 QSCAL 0. HYDROGRAPH PLOT SCALE

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES  
 TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION						
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	
				3.50	4.50	5.30	6.10	7.00	7.80	
HYDROGRAPH AT										
+	BASA	.03	1	FLOW	14.	22.	29.	36.	44.	52.
				TIME	12.50	12.50	12.50	12.50	12.50	12.50

\*\*\* NORMAL END OF HEC-1 \*\*\*

# **DEVELOPED CONDITIONS**



Project: **ANIMAL SERVICES CAMPUS ADDITION**  
 Date: 6/22/2006  
 Prep. By: BMIM

Manual Input

**DEVELOPED BASIN A (CONT.)**

Runoff Coefficients \* Used Soil Group D To Be Conservative

Return Period (Years)	Commercial	Industrial	Multi-Family	Public	Single Family	Vacant/Agriculture
2	0.68	0.68	0.70	0.49	0.50	0.24
5	0.69	0.69	0.73	0.51	0.54	0.26
10	0.73	0.73	0.79	0.56	0.62	0.32
25	0.75	0.75	0.81	0.59	0.66	0.36
50	0.77	0.77	0.83	0.62	0.70	0.42
100	0.80	0.80	0.86	0.66	0.76	0.45

**Existing Conditions**

Return Period (Years)	Runoff Coefficient *	Rainfall Intensity (in/hr)	Area (Acres)	Runoff (cfs)
2	0.50	2.67	20.10	27.05
5	0.52	3.24	20.10	33.73
10	0.57	3.76	20.10	42.78
25	0.59	4.39	20.10	52.41
50	0.63	4.94	20.10	62.56
100	0.66	5.14	20.10	68.19

Developed Condition Stage-Storage Relationships used for HEC-1 Analysis

	<u>Static Pond Elevation (FT)</u>	<u>Surface Area (Acres)</u>	<u>Surface Area (S.F.)</u>	<u>Perimeter (L.F.)</u>	<u>Equiv. Rectangle Length (FT)</u>	<u>Equiv. Rectangle Width (FT)</u>
DRY	1333.00	0.626	27269	810	319.71	85.29
DETENTION	1334.00	0.702	30573		327.71	93.29
BASIN	1335.00	0.781	34005		335.71	101.29
	1336.00	0.862	37565		343.71	109.29
	1337.00	0.947	41253		351.71	117.29

## ANIMAL SERVICES CAMPUS ADDITION DRAINAGE PLAN

### Assumed Outlet Condition for Proposed Dry Detention Basin

**80.0** Maximum Q (cfs)  
**5.000** Weir Width (feet)  
**1333.00** Weir Elevation  
**2.700** Weir Flow Coefficient (Never > 3.089)

<u>Q</u> (cfs)	<u>Weir</u> <u>Width</u> (feet)	<u>Weir</u> <u>Elevation</u>	<u>q</u>	<u>Weir</u> <u>Flow</u> <u>Coeff.</u>	<u>Energy</u> <u>Head</u> (feet)	<u>Water</u> <u>Surface</u> <u>Elevation</u>
0.0	5.000	1333.00	0.0	2.700	0.00	<b>1333.00</b>
8.0	5.000	1333.00	1.6	2.700	0.71	<b>1333.71</b>
16.0	5.000	1333.00	3.2	2.700	1.12	<b>1334.12</b>
24.0	5.000	1333.00	4.8	2.700	1.47	<b>1334.47</b>
32.0	5.000	1333.00	6.4	2.700	1.78	<b>1334.78</b>
40.0	5.000	1333.00	8.0	2.700	2.06	<b>1335.06</b>
48.0	5.000	1333.00	9.6	2.700	2.33	<b>1335.33</b>
56.0	5.000	1333.00	11.2	2.700	2.58	<b>1335.58</b>
64.0	5.000	1333.00	12.8	2.700	2.82	<b>1335.82</b>
72.0	5.000	1333.00	14.4	2.700	3.05	<b>1336.05</b>
80.0	5.000	1333.00	16.0	2.700	3.27	<b>1336.27</b>

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* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
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* RUN DATE 08AUG06 TIME 07:31:00
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*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.

THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION

NEW OPTIONS: DAMBREAK OUIFLOW SUBMERGENCE, SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY, DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION

KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

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LINE ID 1 2 3 4 5 6 7 8 9 10
1 ID Animal Services Campus Addition (PEC Proj. No. 36-05028-002-1324)
2 ID Proposed Drainage
3 ID By EMM DATE 08-07-06
*** LIST ***
*** FREE ***
*DIAGRAM
4 IT 15 01JAN06 1200 0 02JAN06 2000
5 IN 15 01JAN06 1200
6 IO 0 5
7 JR PREC 3.5 4.5 5.3 6.1 7.0 7.8
*
*
*
8 KK BASA
9 KO 5
*
* 20.1 ACRES
*
10 BA 0.032
11 PB 1.00
12 PC 0.000 0.003 0.006 0.008 0.011 0.014 0.017 0.019 0.022 0.025
13 PC 0.029 0.032 0.035 0.038 0.042 0.045 0.048 0.052 0.056 0.060
14 PC 0.064 0.068 0.072 0.076 0.080 0.085 0.090 0.095 0.100 0.105
15 PC 0.110 0.115 0.120 0.127 0.134 0.140 0.147 0.155 0.163 0.172
16 PC 0.181 0.193 0.204 0.220 0.235 0.259 0.283 0.387 0.663 0.699
17 PC 0.735 0.754 0.772 0.786 0.799 0.810 0.820 0.828 0.835 0.843
18 PC 0.850 0.858 0.865 0.873 0.880 0.885 0.889 0.894 0.898 0.903
19 PC 0.907 0.912 0.916 0.921 0.925 0.929 0.934 0.938 0.943 0.947
20 PC 0.952 0.955 0.958 0.961 0.964 0.967 0.970 0.973 0.976 0.979
21 PC 0.982 0.985 0.988 0.991 0.994 0.997 1.000
22 LS 0 85 0
23 UD 0.550
*
*
*
24 KK DEI
25 KO 5
*
* 5' WIDE WEIR AT ELEVATION 1333.00 ASSUMED AS A WEIR TO MODEL OVERLAND FLOW
* LEAVING DRY DETENTION BASIN.
*
26 RS 1 ELEV 1333.0
27 SA 0.626 0.702 0.781 0.862 0.947
28 SE 1333.0 1334.0 1335.0 1336.0 1337.0
29 SQ 0 8 16 24 32 40 48 56 64 72
30 SQ 80
31 SE 1333.0 1333.71 1334.12 1334.47 1334.78 1335.06 1335.33 1335.58 1335.82 1336.0
32 SE 1336.3
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33 ZZ

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1 SCHEMATIC DIAGRAM OF SIREAM NETWORK
INPUT
LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW
NO. (.) CONNECTOR (<---) RETURN OF DIVERIED OR PUMPED FLOW
8 BASA
V
V
24 DET

```

```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 08AUG06 TIME 07:31:00
*
*****

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*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

```

Animal Services Campus Addition (PEC Proj. No. 36-05028-002-1324)  
Proposed Drainage  
By EMM DATE 08-07-06

6 IO OUIPUT CONTROL VARIABLES  
IPRNT 0 PRINT CONTROL  
IPLOT 5 PLOT CONTROL  
QSCAL 0. HYDROGRAPH PLOT SCALE

II HYDROGRAPH TIME DATA  
NMIN 15 MINUTES IN COMPUTATION INTERVAL  
IDATE 1JAN 6 STARTING DATE  
ITIME 1200 STARTING TIME  
NQ 129 NUMBER OF HYDROGRAPH ORDINAIES  
NDDATE 2JAN 6 ENDING DATE  
NDTIME 2000 ENDING TIME  
ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .25 HOURS  
TOTAL TIME BASE 32.00 HOURS

ENGLISH UNITS  
DRAINAGE AREA SQUARE MILES  
PRECIPITATION DEPTH INCHES  
LENGTH, ELEVATION FEET  
FLOW CUBIC FEET PER SECOND  
STORAGE VOLUME ACRE-FEET  
SURFACE AREA ACRES  
TEMPERATURE DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION  
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION  
RATIOS OF PRECIPITATION  
3.50 4.50 5.30 6.10 7.00 7.80

\*\*\* \*\*

\*\*\*\*\*  
\* \*  
8 KK \* BASA \*  
\* \*  
\*\*\*\*\*

9 KO OUIPUI CONIROL VARIABLES  
IPRNT 5 PRINT CONTROL  
IPLOT 5 PLOT CONTROL  
QSCAL 0. HYDROGRAPH PLOT SCALE

\*\*\* \*\*

\*\*\*\*\*  
\* \*  
24 KK \* DET \*  
\* \*  
\*\*\*\*\*

25 KO OUIPUI CONIROL VARIABLES  
IPRNT 5 PRINT CONTROL  
IPLOT 5 PLOT CONTROL  
QSCAL 0. HYDROGRAPH PLOT SCALE

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES  
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION						
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	
				3.50	4.50	5.30	6.10	7.00	7.80	
HYDROGRAPH AI										
+	BASA	.03	1	FLOW	21.	31.	38.	46.	55.	63.
				TIME	12.50	12.50	12.50	12.50	12.50	12.50
ROUTED TO										
+	DET	.03	1	FLOW	15.	23.	30.	37.	45.	52.
				TIME	12.75	12.75	12.75	12.75	12.75	12.75
				** PEAK STAGES IN FEET **						
			1	STAGE	1334.08	1334.45	1334.71	1334.96	1335.22	1335.44
				TIME	12.75	12.75	12.75	12.75	12.75	12.75

\*\*\* NORMAL END OF HEC-1 \*\*\*

# FIGURES





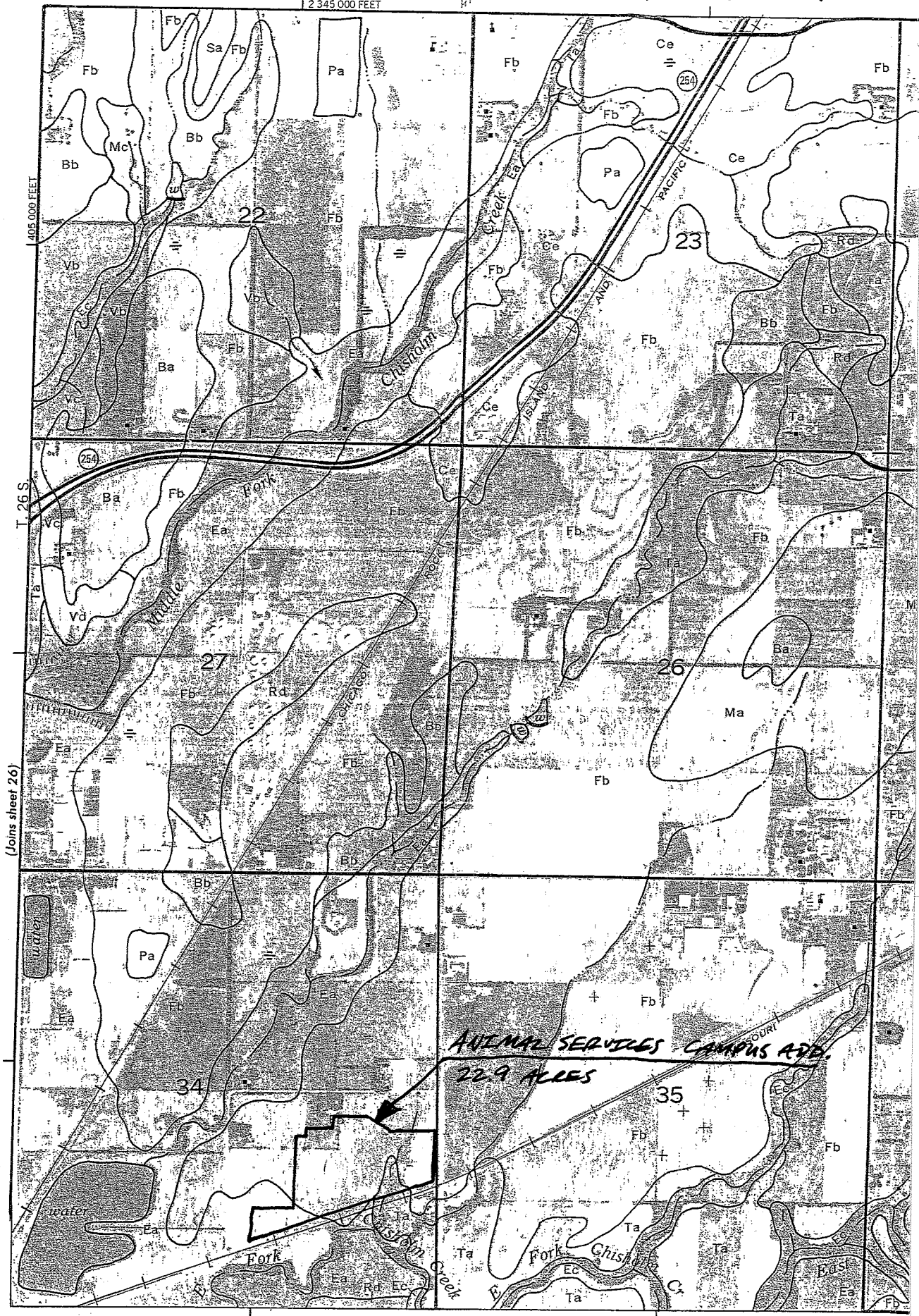
2 345 000 FEET

25



5 000 Feet

Scale 1:20000



**ANIMAL SERVICES CAMPUS AFB**  
**22.9 ACRES**

(Joins sheet 26)

T. 26 S.

23

22

27

26

34

35

water

Fork

Chisholm Creek

Fork

Chisholm Creek

Fork

Chisholm Creek

Fork

## EXHIBIT NO. 1

## SOIL LEGEND

<u>SYMBOL</u>	<u>HYDROLOGIC GROUP</u>	<u>NAME</u>
Aa	B	Albion-Shellabarger sandy loams, 1 to 4 percent slopes
Ab	B	Albion and Shellabarger sandy loams, 7 to 15 percent slopes
Ba	C	Blanket silt loam, 0 to 1 percent slopes
Bb	C	Blanket silt loam, 1 to 3 percent slopes
Ca	B	Canadian fine sandy loam
Cb	B	Canadian-Waldeck fine sandy loams
Cc	D	Carwile fine sandy loam
Cd	B	Clark-Ost clay loams, 1 to 4 percent slopes
Ce	C	Clime silty clay, 3 to 6 percent slopes
Ea	B	Elandco silt loam
Eb	B	Elandco silt loam, occasionally flooded
Ec	B	Elandco silt loam, frequently flooded
Fa	B	Farnum loam, 0 to 1 percent slopes
Fb	B	Farnum loam, 1 to 3 percent slopes
Fc	B	Farnum loam, sandy substratum, 0 to 1 percent slopes
Ga	D	Goessel silty clay, 0 to 1 percent slopes
Gb	D	Goessel silty clay, 1 to 2 percent slopes
Ia	D	Irwin silty clay loam, 1 to 3 percent slopes
Ib	D	Irwin silty clay loam, 3 to 6 percent slopes
Ic	D	Irwin silty clay loam, 2 to 6 percent slopes, eroded
La	C	Lesho loam
Lb	A	Lincoln soils
Ma	B	Milan loam, 1 to 3 percent slopes
Mb	B	Milan form, 3 to 6 percent slopes
Mc	B	Milan clay loam, 2 to 6 percent slopes, eroded
Na	B	Naron fine sandy loam
Oc	D	Owens clay loam, 1 to 3 percent slopes
Od	D	Owens-Rock outcrop complex, 3 to 10 percent slopes
Pa		Pits
Pb	D	Plevna fine sandy loam
Pc	A	Pratt loamy fine sand, undulating
Pd	A	Pratt-Tivoli complex, rolling
Ra	D	Renfrow silty clay loam, 1 to 3 percent slopes
Rb	D	Renfrow silty clay loam, 3 to 6 percent slopes
Rc	D	Renfrow-Owens clay loams, 1 to 4 percent slopes
Rd	D	Rosehill silty clay, 1 to 3 percent slopes
Sa	B	Shellabarger sandy loam, 1 to 3 percent slopes
Sb	B	Shellabarger sandy loam, 3 to 6 percent slopes
Sc	B	Shellabarger sandy loam, 3 to 6 percent slopes, eroded
Ta	D	Tabler silty clay loam
Tb	D	Tabler-Drummond complex
Ua	B	Urban land-Canadian complex
Ub	B	Urban land-Elandco complex
Uc	B	Urban land-Farnum complex, 0 to 3 percent slopes
Ud	D	Urban land-Irwin complex, 1 to 3 percent slopes
Ue	D	Urban land-Tabler complex
Va	B	Vanoss silt loam, 0 to 1 percent slopes
Vb	B	Vanoss silt loam, 1 to 3 percent slopes
Vc	B	Vanoss silt loam, 3 to 6 percent slopes
Vd	B	Vanoss silt loam, 3 to 6 percent slopes, eroded
Ve	D	Vernon sandy loam, 1 to 3 percent slopes
Vf	D	Vernon sandy loam, 3 to 6 percent slopes
Wa	C	Waldeck sandy loam
Wb	D	Waurika silt loam

# DESIGN AIDS

KS-2-5

County	Expected 24-hour Storm Rainfall in Inches						Normal Annual Precipitation Inches
	Storm Frequency in Years						
	100	50	25	10	5	2	
Pawnee	6.6	6.0	5.2	4.5	3.7	2.8	23.3
Phillips	6.0	5.5	4.8	4.1	3.4	2.5	23.6
Pottawatomie	7.5	6.6	5.9	5.1	4.3	3.4	33.6
Pratt	7.2	6.4	5.6	4.8	4.1	3.0	24.6
Rawlins	5.5	5.0	4.3	3.6	3.1	2.3	21.0
Reno	7.4	6.6	5.8	5.0	4.2	3.2	27.7
Republic	6.8	6.0	5.4	4.6	3.9	2.9	28.6
Rice	7.3	6.4	5.6	4.8	4.1	3.0	26.6
Riley	7.4	6.5	5.8	5.1	4.3	3.3	33.5
Rooks	6.1	5.7	4.9	4.1	3.4	2.5	23.9
Rush	6.5	5.9	5.0	4.3	3.6	2.7	23.3
Russell	6.7	5.9	5.2	4.4	3.7	2.8	26.8
Saline	7.3	6.4	5.7	4.9	4.1	3.1	28.4
Scott	5.7	5.3	4.5	3.8	3.2	2.4	20.2
Sedgwick	7.8	7.0	6.1	5.3	4.5	3.5	30.6
Seward	6.0	5.7	4.8	4.2	3.5	2.6	19.8
Shawnee	7.8	6.8	6.1	5.3	4.5	3.5	34.7
Sheridan	5.7	5.3	4.5	3.8	3.2	2.4	21.3
Sherman	5.3	4.8	4.2	3.5	3.0	2.2	16.7
Smith	6.3	5.7	5.0	4.2	3.5	2.6	24.4
Stafford	7.1	6.2	5.5	4.7	4.0	2.9	25.1
Stanton	5.6	5.2	4.5	3.8	3.2	2.4	15.8
Stevens	5.9	5.5	4.7	4.1	3.4	2.5	19.7
Sumner	8.0	7.1	6.2	5.4	4.6	3.6	34.0

- ATTACHMENT A  
DRAINAGE CRITERIA MANUAL

RAINFALL INTENSITY TABLE FOR SEDGWICK COUNTY, KANSAS

The following tabulation contains rainfall intensity in inches per hour as derived from ESSA Weather Bureau Technical Paper 40 Modified to NWS Hydro-35, 1977 During First Hour

$(\frac{1}{2})$ DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	$i = 4.18$	5.57	6.53	7.41	8.52	9.48	10.32
6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
10	3.39	4.52	5.34	6.09	7.04	7.86	8.54
11	3.27	4.36	5.16	5.89	6.81	7.61	8.27
12	3.18	4.21	4.99	5.71	6.60	7.38	8.02
13	3.05	4.08	4.84	5.53	6.41	7.17	7.79
14	2.96	3.95	4.69	5.37	6.23	6.97	7.57
15	2.87	3.83	4.56	5.22	6.06	6.78	7.37
16	2.78	3.72	4.43	5.08	5.90	6.60	7.18
17	2.71	3.61	4.31	4.95	5.75	6.44	7.00
18	2.63	3.51	4.20	4.83	5.61	6.29	6.84
19	2.56	3.42	4.10	4.71	5.47	6.14	6.68
20	2.50	3.33	4.00	4.60	5.35	6.00	6.53
21	2.44	3.25	3.90	4.50	5.23	5.87	6.39
22	2.38	3.17	3.81	4.40	5.12	5.75	6.26
23	2.32	3.10	3.73	4.31	5.01	5.63	6.13
24	2.27	3.03	3.65	4.22	4.91	5.52	6.01
25	2.22	2.96	3.57	4.13	4.81	5.41	5.90
26	2.20	2.90	3.50	4.05	4.72	5.31	5.79
27	2.16	2.84	3.43	3.98	4.63	5.21	5.69
28	2.14	2.78	3.37	3.90	4.55	5.12	5.59
29	2.11	2.72	3.30	3.83	4.47	5.03	5.49
30	2.08	2.67	3.24	3.76	4.39	4.94	5.40
31	2.05	2.62	3.19	3.70	4.32	4.86	5.32
32	2.02	2.57	3.10	3.63	4.25	4.79	5.22
33	1.99	2.52	3.05	3.57	4.18	4.71	5.14
34	1.96	2.48	3.01	3.51	4.11	4.63	5.07
35	1.93	2.44	2.98	3.46	4.05	4.56	5.00
36	1.91	2.39	2.93	3.41	3.99	4.50	4.93
37	1.89	2.35	2.88	3.36	3.93	4.43	4.86
38	1.87	2.32	2.84	3.31	3.87	4.37	4.79
39	1.85	2.28	2.80	3.26	3.82	4.31	4.73
40	1.83	2.24	2.76	3.22	3.76	4.25	4.66
41	1.81	2.21	2.72	3.17	3.71	4.19	4.60
42	1.79	2.18	2.68	3.13	3.66	4.13	4.54
43	1.77	2.14	2.64	3.09	3.61	4.08	4.49
44	1.75	2.11	2.61	3.05	3.57	4.03	4.43
45	1.73	2.08	2.57	3.01	3.52	3.98	4.38

ATTACHMENT A CONTINUED  
Page 2

<u>DURATION IN MINUTES</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>.5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
46	1.70	2.05	2.54	2.97	3.48	3.93	4.33
47	1.67	2.02	2.50	2.93	3.44	3.88	4.28
48	1.66	2.00	2.47	2.90	3.39	3.84	4.23
49	1.64	1.97	2.44	2.86	3.35	3.79	4.18
50	1.61	1.95	2.41	2.83	3.32	3.75	4.13
51	1.59	1.92	2.38	2.79	3.28	3.71	4.09
52	1.56	1.89	2.35	2.76	3.24	3.67	4.05
53	1.54	1.86	2.33	2.73	3.20	3.63	4.00
54	1.52	1.84	2.30	2.70	3.17	3.59	3.96
55	1.50	1.81	2.27	2.67	3.14	3.55	3.92
56	1.47	1.79	2.25	2.64	3.10	3.51	3.88
57	1.45	1.76	2.22	2.61	3.07	3.48	3.84
58	1.43	1.74	2.20	2.59	3.04	3.44	3.81
59	1.42	1.72	2.18	2.56	3.01	3.41	3.77
60	1.40	1.69	2.15	2.53	2.98	3.37	3.73
61	1.38	1.67	2.13	2.51	2.95	3.34	3.70
62	1.36	1.65	2.11	2.48	2.92	3.31	3.67
63	1.34	1.63	2.09	2.46	2.89	3.28	3.63
64	1.33	1.61	2.07	2.44	2.86	3.25	3.60
65	1.31	1.59	2.05	2.41	2.84	3.22	3.57
66	1.30	1.57	2.03	2.39	2.81	3.19	3.54
67	1.28	1.56	2.01	2.37	2.79	3.16	3.51
68	1.26	1.54	1.99	2.35	2.76	3.13	3.48
69	1.25	1.52	1.97	2.33	2.74	3.10	3.45
70	1.24	1.50	1.95	2.31	2.71	3.08	3.42
71	1.22	1.49	1.93	2.28	2.69	3.05	3.39
72	1.21	1.47	1.92	2.26	2.67	3.02	3.36
73	1.20	1.46	1.90	2.25	2.64	3.00	3.34
74	1.18	1.44	1.88	2.23	2.63	2.98	3.31
75	1.17	1.43	1.86	2.21	2.61	2.95	3.29
76	1.16	1.41	1.85	2.19	2.58	2.93	3.26
77	1.15	1.40	1.83	2.17	2.55	2.90	3.24
78	1.13	1.38	1.82	2.15	2.53	2.88	3.22
79	1.12	1.37	1.80	2.14	2.50	2.86	3.19
80	1.11	1.36	1.79	2.12	2.48	2.84	3.16
81	1.10	1.34	1.77	2.10	2.46	2.82	3.13
82	1.09	1.33	1.76	2.08	2.43	2.79	3.10
83	1.08	1.32	1.74	2.06	2.41	2.76	3.07
84	1.07	1.31	1.73	2.04	2.39	2.74	3.04
85	1.06	1.30	1.72	2.02	2.37	2.71	3.01
86	1.05	1.28	1.70	2.00	2.34	2.69	2.99
87	1.04	1.27	1.69	1.99	2.32	2.66	2.96
88	1.03	1.26	1.68	1.97	2.30	2.64	2.93
89	1.02	1.25	1.68	1.95	2.28	2.62	2.91
90	1.01	1.24	1.66	1.93	2.26	2.59	2.88

ATTACHMENT A CONTINUED  
Page 3

<u>DURATION IN MINUTES</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
91	1.00	1.23	1.65	1.92	2.24	2.57	2.86
92	1.00	1.22	1.63	1.90	2.22	2.55	2.83
93	0.99	1.21	1.62	1.89	2.20	2.53	2.81
94	0.98	1.20	1.61	1.87	2.19	2.51	2.79
95	0.97	1.19	1.59	1.85	2.17	2.49	2.76
96	0.96	1.18	1.58	1.84	2.15	2.46	2.74
97	0.96	1.17	1.57	1.82	2.13	2.44	2.72
98	0.95	1.16	1.56	1.81	2.12	2.42	2.70
99	0.94	1.15	1.54	1.80	2.10	2.41	2.67
100	0.93	1.14	1.53	1.78	2.08	2.39	2.65
101	0.93	1.13	1.52	1.77	2.07	2.39	2.65
102	0.92	1.13	1.51	1.75	2.05	2.35	2.61
103	0.91	1.12	1.50	1.74	2.04	2.33	2.59
104	0.90	1.11	1.49	1.73	2.02	2.31	2.57
105	0.90	1.10	1.47	1.72	2.01	2.30	2.55
106	0.89	1.09	1.46	1.70	1.99	2.28	2.54
107	0.88	1.09	1.45	1.69	1.98	2.26	2.52
108	0.88	1.08	1.44	1.68	1.96	2.25	2.50
109	0.87	1.07	1.43	1.67	1.95	2.23	2.48
110	0.87	1.06	1.42	1.65	1.93	2.21	2.46
111	0.86	1.06	1.41	1.64	1.92	2.20	2.45
112	0.85	1.05	1.40	1.63	1.91	2.18	2.43
113	0.85	1.04	1.39	1.62	1.89	2.17	2.41
114	0.84	1.03	1.38	1.61	1.88	2.15	2.40
115	0.84	1.03	1.37	1.60	1.87	2.14	2.38
116	0.83	1.02	1.36	1.59	1.86	2.12	2.36
117	0.82	1.01	1.36	1.58	1.84	2.11	2.35
118	0.82	1.01	1.35	1.57	1.83	2.09	2.33
119	0.81	1.00	1.34	1.56	1.82	2.08	2.32
120	0.81	0.99	1.33	1.55	1.81	2.07	2.30

<u>DURATION IN HOURS</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
2	0.81	0.99	1.33	1.55	1.81	2.07	2.30
3	0.59	0.72	0.97	1.13	1.32	1.51	1.68
4	0.47	0.58	0.78	0.91	1.06	1.21	1.35
5	0.40	0.49	0.66	0.77	0.89	1.02	1.14
6	0.35	0.42	0.57	0.67	0.78	0.89	0.99
8	0.28	0.34	0.46	0.53	0.62	0.71	0.79
10	0.23	0.29	0.39	0.45	0.52	0.60	0.67
12	0.20	0.25	0.33	0.39	0.45	0.52	0.58
18	0.15	0.18	0.24	0.28	0.33	0.38	0.42
24	0.12	0.15	0.20	0.23	0.27	0.31	0.34

ATTACHMENT B  
DRAINAGE CRITERIA MANUAL

INCREMENTAL INFILTRATION VALUES IN INCHES

Time Minutes**	SCS Hydrologic Soil Group			
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
5	.33	.26	.19	.12
10	.25	.17	.09	.04
15	.18	.11	.05	.02
20	.13	.07	.03	.02
25	.10	.05	.03	.02
30	.08	.05	.03	.02
35	.08	.05	.03	.02
40	.08	.05	.03	.02
45	.08	.05	.03	.02
50	.08	.05	.03	.02
55	.08	.05	.03	.02
60	.08	.05	.03	.02
65	.08	.05	.03	.02
70	.08	.05	.03	.02
75	.08	.05	.03	.02
80	.08	.05	.03	.02
85	.08	.05	.03	.02
90	.08	.05	.03	.02
95	.08	.05	.03	.02
100	.08	.05	.03	.02
105	.08	.05	.03	.02
110	.08	.05	.03	.02
115	.08	.05	.03	.02
120	.08	.05	.03	.02

\*\*Time at end of the time increment

NOTE: Values for 125 minutes and additional 5 minute increments shall be the same as those shown for 120 minutes.

ATTACHMENT C

DRAINAGE CRITERIA MANUAL

DEPRESSION STORAGE LOSSES

<u>Surface Type</u>	<u>Total Loss (Inches)</u>
Impervious:	
Paved Areas	0.1
Flat Roofs	0.1
Sloped Roofs	0.05
Pervious:	
Lawns and Grass	0.3
Wooded Areas and Open Fields	0.4

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ATTACHMENT D  
DRAINAGE CRITERIA

RECOMMENDED RUNOFF COEFFICIENTS FOR RATIONAL METHOD  
AND PERCENT IMPERVIOUS FOR UNIT HYDROGRAPH METHOD

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		2	5	10	100
<b>1. Business:</b>					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
<b>2. Residential:</b>					
<u>Single Family (Soil Group D)</u>					
1/8 Acre	50	0.57	0.61	0.66	0.79
1/4 Acre	38	0.50	0.54	0.62	0.76
1/3 Acre	30	0.46	0.50	0.59	0.73
1/2 Acre	25	0.42	0.48	0.56	0.72
3/4 Acre	22	0.42	0.46	0.55	0.71
1 Acre	20	0.41	0.45	0.54	0.71
<u>Multi-Family (Soil Group D)</u>					
Multi-Unit (detached)	60	0.62	0.66	0.72	0.82
Multi-Unit (attached)	65	0.64	0.68	0.73	0.83
Apartments	75	0.70	0.73	0.79	0.86
<u>Single Family (Soil Group C)</u>					
1/8 Acre	50	0.55	0.58	0.64	0.73
1/4 Acre	38	0.48	0.51	0.57	0.68
1/3 Acre	30	0.43	0.46	0.53	0.65
1/2 Acre	25	0.40	0.43	0.50	0.63
3/4 Acre	22	0.39	0.42	0.49	0.62
1 Acre	20	0.37	0.40	0.48	0.61
<u>Multi-Family (Soil Group C)</u>					
Multi-Unit (detached)	60	0.60	0.63	0.69	0.77
Multi-Unit (attached)	65	0.63	0.66	0.71	0.79
Apartments	75	0.68	0.72	0.77	0.83
<u>Single-Family (Soil Group B)</u>					
1/8 Acre	50	0.52	0.54	0.59	0.67
1/4 Acre	38	0.44	0.46	0.52	0.61
1/3 Acre	30	0.39	0.41	0.47	0.57
1/2 Acre	25	0.36	0.38	0.44	0.54
3/4 Acre	22	0.34	0.36	0.42	0.52
1 Acre	20	0.33	0.35	0.40	0.51
<u>Multi-Family (Soil Group B)</u>					
Multi-Unit (detached)	60	0.58	0.60	0.65	0.72
Multi-Unit (attached)	65	0.61	0.64	0.68	0.75
Apartments	75	0.67	0.70	0.74	0.80

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>Single Family (Soil Group A)</u>					
1/8 Acre	50	0.47	0.50	0.54	0.60
1/4 Acre	38	0.39	0.41	0.45	0.52
1/3 Acre	30	0.33	0.35	0.39	0.47
1/2 Acre	25	0.30	0.31	0.35	0.44
3/4 Acre	22	0.28	0.29	0.33	0.42
1 Acre	20	0.26	0.28	0.32	0.40
<u>Multi-Family (Soil Group A)</u>					
Multi-Unit (detached)	60	0.55	0.57	0.61	0.67
Multi-Unit (attached)	65	0.58	0.60	0.64	0.70
Apartments	75	0.65	0.68	0.72	0.77
3. Industrial:					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
4. Playgrounds:	15	0.33	0.35	0.42	0.55
5. Schools:	40	0.49	0.51	0.56	0.66
6. Railroad Yard Areas:	30	0.43	0.45	0.50	0.62
Undeveloped Urban Areas: Offsite Flow Analysis (when land use not defined)					
	45	0.52	0.54	0.59	0.68
8. Streets:					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
9. Drive, Parking Lots and Walks:	96	0.87	0.87	0.88	0.89
10. Roofs:	90	0.80	0.85	0.90	0.93
11. Urban Lawn Areas (See Note No. 1 below):					
<u>Soil Group A</u>					
Slope less than 1%	00	0.08	0.09	0.13	0.23
Slope 1% to 4%	00	0.12	0.13	0.17	0.27
Slope more than 4%	00	0.16	0.17	0.21	0.31
<u>Soil Group B</u>					
Slope less than 1%	00	0.16	0.18	0.24	0.37
Slope 1% to 4%	00	0.20	0.22	0.28	0.41
Slope more than 4%	00	0.24	0.26	0.32	0.45
<u>Soil Group C</u>					
Slope less than 1%	00	0.24	0.27	0.35	0.51
Slope 1% to 4%	00	0.26	0.29	0.37	0.53
Slope more than 4%	00	0.28	0.31	0.39	0.55

<u>Land Use or Surface Characteristics</u>	<u>Percent Impervious</u>	<u>Frequency</u>			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>Soil Group D</u>					
Slope less than 1%	00	0.28	0.33	0.43	0.63
Slope 1% to 4%	00	0.30	0.35	0.45	0.65
Slope more than 4%	00	0.32	0.37	0.47	0.67

Note No. 1: Coefficients shown in the above table are for pervious open space areas with thick turf which includes pervious areas in parks and cemeteries. Coefficients shown above must be increased 0.02 for use with agricultural pasture areas. Coefficients shown above must be reduced by 0.04 for use with agricultural cultivated areas. Group A soils are well-drained, coarse textured sands with high infiltration rates. Group B soils are moderately well-drained, moderately coarse textured soils with moderate infiltration rates. Group C soils are moderately poor-drained, moderately fine textured soils with slow infiltration rates. Group D soils are poor-drained, fine textured soils with very slow infiltration rates.

GENERAL NOTE: These Rational Formula Coefficients may not be valid for basins 320 acres or larger.

ATTACHMENT E

DRAINAGE CRITERIA

AVERAGE OVERLAND FLOW VELOCITY FOR USE WITH URBANIZED AREAS.

Surface Type	VELOCITY IN FEET/SECOND FOR SLOPES IN PERCENT SHOWN																			
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	20.0
Forest with Heavy Ground Litter or Meadow	0.03	0.04	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.16	0.21	0.28	0.33	0.39	0.46	0.53	0.60	0.72	1.10
Fallow or Minimum Tillage Cultivation	0.06	0.08	0.10	0.12	0.13	0.14	0.16	0.17	0.18	0.19	0.29	0.40	0.51	0.66	0.78	0.91	1.05	1.20	1.44	2.10
Short Grass Pasture or Lawns	0.09	0.13	0.15	0.18	0.20	0.21	0.23	0.25	0.26	0.28	0.45	0.60	0.77	0.96	1.17	1.33	1.50	1.68	1.98	3.20
Almost Bare Ground	0.16	0.22	0.28	0.31	0.35	0.38	0.41	0.44	0.46	0.49	0.70	0.85	1.05	1.26	1.50	1.75	2.03	2.32	2.79	4.40
Grassed Waterway	0.35	0.48	0.58	0.67	0.77	0.84	0.91	0.98	1.05	1.12	1.54	1.82	2.10	2.38	2.78	3.20	3.66	4.14	4.56	7.00
Paved Areas (Sheet Flow) or Shallow Gutter Flow	0.44	0.62	0.77	0.91	1.05	1.12	1.19	1.26	1.33	1.40	2.00	2.55	3.20	3.83	4.41	5.04	5.70	6.00	6.20	9.00

ATTACHMENT F

DETERMINATION OF DIMENSIONLESS  
WATERSHED CONVEYANCE FACTOR ( $\emptyset$ )

$$\emptyset = \emptyset_1 + \emptyset_2$$

$\emptyset_1$	Classification
0.6	Extensive channel improvement and storm sewer system, closed conduit channel system
0.7	Moderate channel improvement and storm sewer system.
0.8	Some channel improvement and storm sewers, mainly cleaning and enlargement of existing channel.
0.9	Little channel improvement and storm sewers.
1.0	Natural channel conditions.
$\emptyset_2$	Classification
0.0	No channel vegetation.
0.1	Light channel vegetation.
0.2	Moderate channel vegetation.
0.3	Heavy channel vegetation.

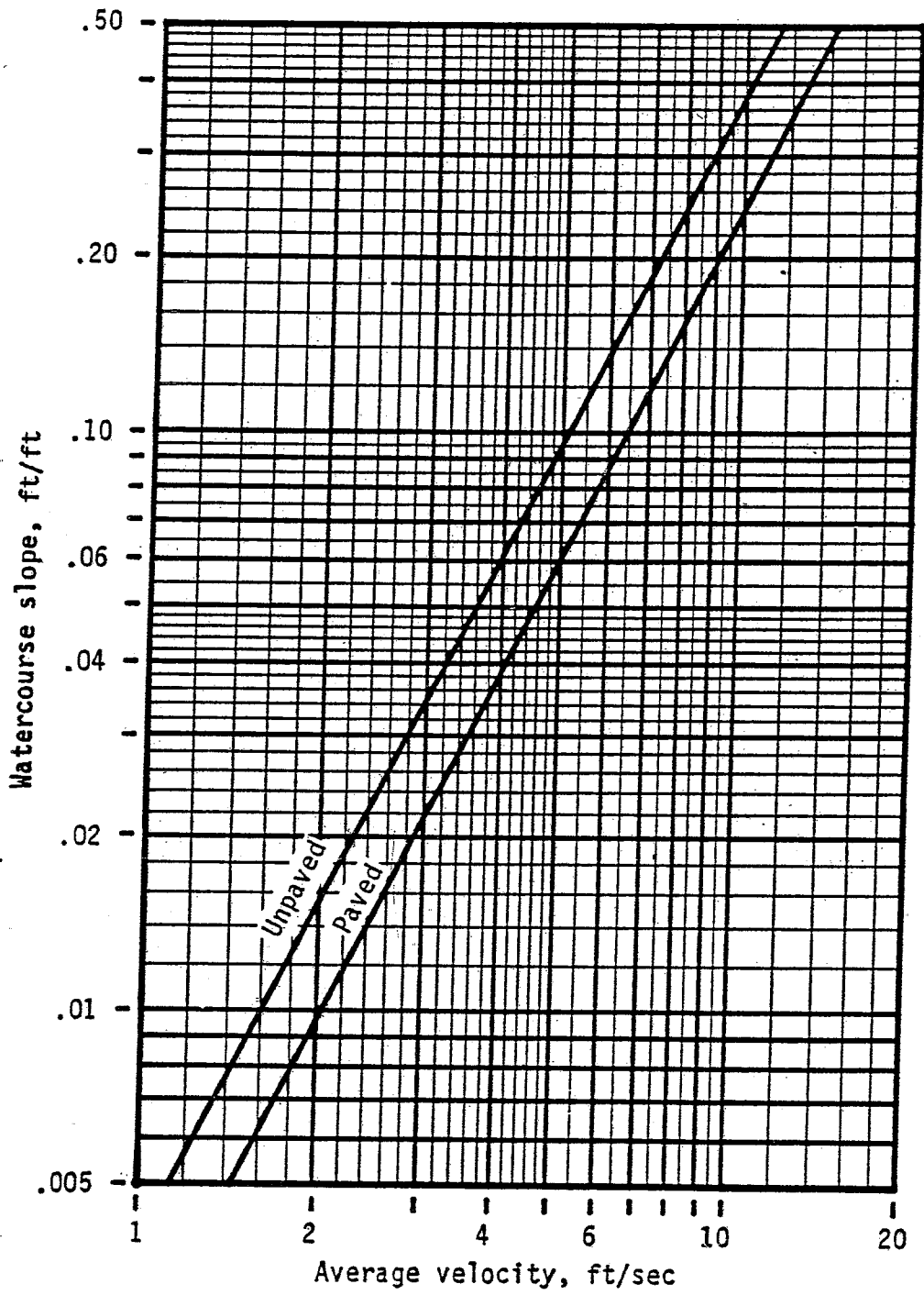


Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

# PLAN MAP