Professional Engineering Consultants, P.A.
303 S. TOPEKA ▪ WICHITA, KANSAS 67202 ▪ 316-262-2691 ▪ FAX 316-262-3003
www.pec1.com ▪ designers@pec1.com

FEB 24 2009

TO: Scott Lindebak, P.E.
City of Wichita
Storm Water Management
7th Floor, City Hall
Wichita, KS 67202

DATE: 2/23/09
PROJECT NO.: 08571
PROJECT: Wichita Regional Fire Training Addition

ATTENTION: Scott Lindebak, P.E.
FROM: Joe Hickle, P.E.

REFERENCE: Revised Drainage Report

WE ARE SENDING YOU: ☒ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change order ☐ _____

COPIES	DATE	NO.	DESCRIPTION
1	02/23/2009		Revised Wichita Regional Fire Drainage Report

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval
☐ For your use ☐ *Approved as noted* ☐ Submit _____ copies for distribution
☒ As requested ☐ Returned for corrections ☐ Return _____ corrected prints
☐ For review and comment ☐ _____
☐ FOR BIDS DUE _____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS:

COPIES TO: _____ **By:** Joe Hickle

If enclosures are not as noted, kindly notify us at once.

LETTER OF TRANSMITTAL

WICHITA REGIONAL FIRE TRAINING ADDITION

STORM WATER DRAINAGE REPORT

BY

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.

WICHITA, KANSAS

February 2, 2009

Professional Engineering Consultants, P.A.

February 3, 2009

City of Wichita
Storm Water Management
7th Floor, City Hall
Wichita, KS 67202

Attention: Mr. Scott Lindebak, P.E.

Reference: Wichita Regional Fire Training Addition
Drainage and Plat Submittal
PEC Project No. 08571

Dear Scott:

Enclosed is the drainage report for the Wichita Regional Fire Training Addition for purposes of filing the plat. If you have any questions regarding this submittal please feel free to call.

Please review for approval.

Joe Hickle, P.E.
Project Manager

303 SOUTH TOPEKA WICHITA, KANSAS 67202 316-262-2691 FAX 316-262-3003 ▪ www.pec1.com
WICHITA TOPEKA TULSA LAWRENCE PITTSBURG

Adopted: February 23, 2007

WICHITA

Public Works, Engineering Division
Final Drainage Plan Submittal Checklist

Reviewer:_____ Date:_____

Subdivision Name:_____ Location:_____

Total Land Area Of Ownership:_____ Acres

Type: _____Residential _____Commercial _____Industrial _____Recreation _____Municipal _____Other

Applicant:_____ Contact:_____ Phone #:_____

Engineer:_____ Contact:_____ Phone #_____

Please check the appropriate box: I = Included; NA = Non-Applicable; R= Required prior to development
(If "NA" is checked, an explanation must be entered)

	Applicant			Engr	
Tab 1. Project Narrative	**I**	**NA**	**Explanation / Location in Plan**	**I**	**NA**
A. Site Location Map, using USGS Map	✓				
B. Discussion of development, existing conditions, and proposed impacts on stormwater, wetland, riparian, and flood plain	✓				
C. Discussion of offsite conditions	✓				
D. Summary of runoff calculations (pre/post development) No increase in peak discharge for all storm series	✓				
E. Narrative description of the type and function of the permanent best management practices that are incorporated into the site design	✓				
F. Copy of the plat	✓				
G. Preliminary grading plan (The final grading plan shall be sealed, signed and dated prior to Engineering receiving the final sanitary sewer plans. One plan sheet and PDF shall be submitted to the Subdivision Engineer.)		✓	Will be submitted at a later date		
H. Professional Engineer seal, signature and date on cover of report	✓				
I. CD of drainage plan in PDF format (one file) and one paper copy bound with this checklist included behind the cover	✓				

	Applicant			Engr	
Tab 2. Existing Conditions Runoff Calculations	**I**	**NA**	**Explanation / Location in Plan**	**I**	**NA**
A. Copy of applicable orthophoto showing proposed project boundaries (preferable in color)	✓				
B. Runoff Method (Rational, Hydrograph Method, or other approved methods by Engineering)	✓		Rational Method		
C. Existing topography (no greater than 2-foot contours, 1-foot recommend)	✓				
D. Total Site Area and Total Impervious Area (acres)	✓		Shown as a percentage		
E. Benchmarks used for site control	✓				
F. Streams, creeks, and waterway labeled		✓			
G. Predominant soils from USDA soil surveys, and/or on site soil borings	✓				
H. Location and boundaries of natural features such as wetlands, lakes, and ponds with the normal water elevation noted		✓			
I. Location of existing roads, buildings, parking lots and other impervious areas.	✓				

Consulting Engineer Initials _____

J. Location of existing utilities (e.g., water, sewer, gas, electric) and easements	✓				
K. Location of existing conveyance systems such as storm drains, inlets, catch basins, channels, swales, and areas of overland flow	✓				
L. Flow paths	✓				
M. Location and dimensions of existing channels, bridges or culvert crossings	✓				
N. Existing conditions hydrologic analysis for runoff rates, volumes and velocities showing methodologies used and supporting calculations (2, 5, 10, 25 & 100 year, 24-hour storm events) or Critical Duration	✓		100 yr. peak rate is the applicable concern for this project.		
O. Assumed pre-developed runoff curve numbers	✓				
P. Existing time of concentrations used in calculations	✓				
Q. Evaluate immediate downstream drainage capacity, not to exceed more than 0.25 miles downstream of site	✓				
R. Existing structural elevations (e.g., invert of pipes, manholes, etc.)	✓				
S. Cross-section data for open channels		✓			
T. Ground water elevations, if applicable		✓			

	Applicant			Engr	
Tab 3. Post-Development Hydrologic Analysis	**I**	**NA**	**Explanation / Location in Plan**	**I**	**NA**
A. Proposed (post-development) conditions hydrologic and hydraulic analysis for runoff rates, volumes, HGL, and velocities showing the methodologies used and supporting calculations for all applicable design storms (2, 5, 10, 25 & 100 year, 24-hour storm events)	✓				
B. Proposed time of concentrations used in calculations	✓				
C. Assumed post-developed runoff curve numbers	✓				
D. Proposed contours for detention facilities (to equal area used in outlet rating curves)		✓			
E. Preliminary sizing calculations for stormwater controls including contributing drainage area, storage, and outlet configuration		✓			
F. Stage-storage-discharge or outlet rating curves and inflow and outflow hydrographs for storage facilities		✓			
G. Final analysis of potential upstream/downstream impact/effects of project, where necessary	✓				
H. Existing and proposed structural elevations (e.g., invert of pipes, manholes, etc.)		✓			
I. Design water surface elevations and normal pool elevation for ponds.	✓				
J. Typical detail for outlet structures, embankments, spillways, grade control structures, conveyance channels, etc. To include height, width, elevation, and/or diameter.		✓			
K. Proposed limits of clearing and grading	✓				
L. Location of existing and proposed roads, buildings, parking lots and other impervious areas.	✓				
M. Location of existing and proposed utilities (e.g., water, sewer) and easements	✓				
N. Location of existing and proposed conveyance systems such as storm drains, inlets, catch basins, channels, swales, and areas of overland flow	✓				
O. Preliminary location and dimensions of proposed channel modifications, such as bridge or culvert crossings		✓			

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P. Preliminary selection and location of stormwater controls	✓				
Q. Emergency overflow structure's flow path		✓			
R. Detention facility provides one-foot of freeboard above the HWL and emergency outfall shown (top of berm elevation shown)		✓			
S. The 100-year 24-hour HWL delineated on the plan for detention pond	✓				
T. Lowest opening elevations table on the plat for structures located adjacent to channels or ponds		✓			
U. Stormwater Management Facilities located within a Reserve		✓			
V. Maintenance responsibility of stormwater management facility shall be specified in the platters text. (e.g. HOA, Lot Owners Association, or lot)	✓		City of Wichita will maintain the property		
W. Off-site drainage easements or agreements required, where necessary		✓			

	Applicant			Engr	
Tab 4. Floodplain Submittal	**I**	**NA**	**Explanation / Location in Plan**	**I**	**NA**
A. Provide source of flood profile		✓			
B. Nearest base flood elevations		✓			
C. Delineation of pre-developed regulatory floodplain/floodway limits		✓			
D. Delineation of post-developed regulatory floodplain and floodway limits		✓			
E. Floodplain boundary determination per elevation (project limits shown)		✓			
F. Provide source of floodway data table and discharges		✓			
G. Provide all hydrologic and hydraulic study information for site-specific floodplain studies, unnumbered Zone A area elevation determinations and flood plain map revisions or required permits		✓			
H. Provide regulatory floodway and four natural profile models (10,50,100, and 500-yr) for existing and future watershed conditions		✓			
I. Location of floodplain/floodway limits and relationship of site to upstream/downstream properties (floodplain limits to be per elevation and scaled location)		✓			
J. Flood plains and floodways located within a Reserve, where necessary		✓			

	Applicant			Engr	
Tab 5. Federal, State and Local Permits (to be provided prior to construction unless otherwise specified)	**I/R**	**NA**	**Explanation / Location in Plan**	**I/R**	**NA**
A. US Army Corps of Engineers - Regulatory program permits (404 water quality certification)		✓			
B. Kansas Department of Agriculture - Division of Water Resources Permits (Stream Obstruction, Channel Change, Flood Plain Fill, Levee, Water Appropriations, Dam safety permit, etc.)		✓			
C. Federal Emergency Management Agency (FEMA) Letter of Map Changes (LOMA, LOMR, LOMR-f, CLOMR, etc.) Shall be included and approved when project modifies the limits of the floodway.		✓			
D. Kansas Department of Transportation		✓			
E. Sedgwick County Right-of-way Permit		✓			

Consulting Engineer Initials _____

Wichita Regional Fire Training Addition
Wichita, Sedgwick County, Kansas
12/18/08

Project Narrative:

Wichita Regional Fire Training Addition is a 12.34 acre development located on the northwest corner of 31st Street South and Oliver within the city limits of Wichita in Sedgwick County, Kansas. The proposed development will develop an existing site adding additional parking areas, and buildings.

The existing site has two main drainage basins flow patterns with approximately ¼ of the site draining into a ditch system that cuts through the eastern 1/3 of the property. The remaining 3/4 drains to the north/northwest into a 42" RCP under the Kansas Turnpike. The existing 42" RCP has a calculated flow capacity of approximately 52 CFS, which is equivalent to the 10 year storm event runoff. During larger storm events the water ponds in a low area (acting as detention) and then is released as capacity in the pipe is restored. The low area is located adjacent to and is part of the Turnpike right-of-way ditch, which has an overflow at elevation 1331.30 located approximately 200 feet NE of the site's property line. The overflow discharges into the drainage ditch, within Plainview Park, before in flows under the Turnpike again further to the north.

The existing drainage basin to the Turnpike 42" culvert is 13.6 acres in size with an impervious area of 44%. The proposed condition will increase the percent impervious to 70%.

The proposed development will remove approximately 16,000 S.F. of building and concrete structures from the site. This will be offset by constructing a maintenance building, training center with parking lots and site driveways. This development will add 2.54 acres of impervious area to the site after construction. The development can be reviewed in the "Drainage Plan" located behind tab "Drainage Plan".

Impervious area added to a development site will increase the peak discharge rate from the site and increase the volume of runoff from the site. Currently the City of Wichita regulates the peak flow rate criteria with the post-development, Q, being equal to or less than the pre-development discharge rate.

The site runoff flows to an existing swale system which outfalls into a 24 inch RCP. Discharge continues into the right-of-way of the Kansas Turnpike and through a 42" RCP under the highway. A complete drainage basin of 13.6 acres to this 42" pipe was developed based on recent LIDAR topography. A Rational Method pre-post runoff analysis was conducted to determine any increase in runoff coming from the subject project.

The site plan area is approximately 12.34 acres. Its existing condition is the current Fire Training Facility. The Hydrologic Soil Group of the area is D soils. An existing Rational Method runoff coefficient C of 0.65 is applicable for urban lawn areas and a C of 0.91 for pavement and buildings for the 100-year storm. It is estimated that 56% of the site is pervious and 44% impervious from applicable curve numbers for different types of land uses.

The time of concentration to the outfall is approximately 16 minutes. A resulting peak runoff rate from the area to the main culvert under the turnpike is 74.5 for the 100-year storm.

The post developed conditions would change the percentage of pervious area to 30% and impervious area to 70%. The time of concentration to the outfall would reduce to approximately 9 minutes. A resulting peak runoff rate from the area to the main culvert under the turnpike is 100.4 cfs for the 100-year storm. The pre vs. post discharge rates have been summarized below.

Discharge, Q, CFS	2-Yr., 24-Hr.	5-Yr., 24-Hr.	10-Yr., 24-Hr.	25-Yr., 24-Hr.	100-Yr., 24-Hr.
Qpre	26.9	35.0	44.2	55.0	74.5
Qpost	42.8	53.9	65.0	78.0	100.4
Difference	15.9	18.9	20.8	23.0	25.9

Utilizing culvert flow charts included in the Design Aids section of this report, we estimate a headwater depth for the 42 inch culvert for both the pre and post conditions.

Plans of the 42 inch culvert were obtained from the Kansas Turnpike Authority and shows an approximate pipe invert elevation of 1328 NAVD.

The elevation of the pre condition and post condition culvert headwater depth are shown on the Drainage Plan. It is apparent that this main culvert underneath the turnpike ultimately controls how runoff is stored and conveyed away from the project site. Construction of an offsite retention pond on the Planview Park is not warranted.

Minimum finished floor elevations on the project site should be two feet above the 100-year flood level as predicted or NAVD 1337 feet.

The proposed site development runoff will not have an affect downstream based on the peak discharge criteria. The property located directly to the north is owned by the City of Wichita and is a City Park that is maintained by the Parks Department. The rest of the site is surrounded by City or State transportation system.

Hydrology

The soil map indicates that the soil on-site is comprised primarily of Rosehill silty clay, Rd, which is classified in hydrologic group D. The Runoff curve number was determined to be 80 for the site and is based on tables presented in the Design Aids section of this report.

The analysis was made based on the available site data which includes the following: 1" = 100' topographic map with 1' contours of the site, 2008 Sedgwick County LiDar Mapping, a Sedgwick County Soil Survey Map and noted references.

Storm Sewer Design

Currently there is no proposed stormwater pipe designed for the site. It is anticipated that all drainage will be accommodated by overland flow. If during design this cannot be achieved then an updated drainage plan along with drainage calculations will be submitted to the City of Wichita for review and approval.

Regulatory Permits:

FEMA:

The proposed construction is located outside of any regulated flood zone by FEMA. Therefore, no submittal to FEMA will be required.

Department of Water Resources:

The proposed construction is located outside of any regulated stream by DWR. Therefore, no submittal to DWR will be required.

Army Corp of Engineers:

The proposed construction is located outside of any regulated stream by the CORP. Therefore, no submittal to the CORP will be required.

Department of Transportation:

The proposed construction is located outside of any regulated KDOT right-of-way. Therefore, no submittal to KDOT will be required.

Sedgwick County:

The property is located within the city limits of Wichita; therefore, no permit from Sedgwick County will be required.

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.

Interim Drainage and Storm Sewer Policy for Design Criteria and Documentation, City of Wichita, Kansas, 1985.

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

Hydrology

Fire Training Site

Hydrology Calculations

Impervious CN = 98

Pervious CN = 80

PRE CONDITIONS				
BASIN	Area (sf)	Area (acres)	CN	Area*CN (acres)
A	2,535	0.058	98	5.703
B	4,265	0.098	98	9.595
C	118,767	2.727	98	267.198
D	3,702	0.085	98	8.329
E	4,549	0.104	98	10.234
F	4,035	0.093	98	9.078
G	11,961	0.275	98	26.910
H	407	0.009	98	0.916
I	84,792	1.947	80	155.725
J	41,745	0.958	80	76.667
K	7,648	0.176	80	14.046
L	5,301	0.122	98	11.926
M	3,903	0.090	80	7.168
N	1,629	0.037	80	2.992
O	1,630	0.037	80	2.994
P	4,035	0.093	98	9.078
Q	11,961	0.275	98	26.910
R	5,166	0.119	80	9.488
S	497	0.011	80	0.913
PARK SITE	122,681	2.816	80	225.309

			Rational %
PERVIOUS	80	495.30	56.21%
IMPERVIOUS	98	385.88	43.79%
TOTAL		**881.18**	

POST CONDITIONS				
BASIN	Area (sf)	Area (acres)	CN	Area*CN (acres)
A	2,535	0.058	98	5.703
B	4,265	0.098	98	9.595
C	118,767	2.727	98	267.198
D	3,702	0.085	98	8.329
E	4,549	0.104	98	10.234
F	4,035	0.093	98	9.078
G	11,961	0.275	98	26.910
H	407	0.009	98	0.916
I	84,792	1.947	98	190.763
J	41,745	0.958	98	93.917
K	7,648	0.176	98	17.206
L	5,301	0.122	98	11.926
M	3,903	0.090	80	7.168
N	1,629	0.037	80	2.992
O	1,630	0.037	80	2.994
P	4,035	0.093	80	7.410
Q	11,961	0.275	80	21.967
R	5,166	0.119	80	9.488
S	497	0.011	80	0.913
PARK SITE	122,681	2.816	80	225.309

			Rational %
PERVIOUS	80	278.24	29.92%
IMPERVIOUS	98	651.77	70.08%
TOTAL		**930.01**	

Existing Conditions

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 1/28/2009

42"
Turnpike Culvert Flows
Existing Conditions
Tc = 16 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.3	7.616	2.28
Paved	0.835	5.984	5.00
Total		**13.6**	**7.28**
C (weighted) = total product/total area		Use C =	**0.54**

Frequency	(years)	2
Intensity, i	(in/hour)	3.69
Runoff, Q=C*i*A	(cfs)	26.87

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 1/28/2009

42"
Turnpike Culvert Flows
Existing Conditions
Tc = 16 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.35	7.616	2.67
Paved	0.86	5.984	5.15
Total		**13.6**	**7.81**
C (weighted) = total product/total area		Use C =	**0.57**

Frequency	(years)	5
Intensity, i	(in/hour)	4.48
Runoff, Q=C*i*A	(cfs)	35.00

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

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42"
Turnpike Culvert Flows
Existing Conditions
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Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.45	7.616	3.43
Paved	0.89	5.984	5.33
Total		**13.6**	**8.75**
C (weighted) = total product/total area		Use C =	**0.64**

Frequency	(years)	10
Intensity, i	(in/hour)	5.05
Runoff, Q=C*i*A	(cfs)	44.20

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

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42"
Turnpike Culvert Flows
Existing Conditions
Tc = 16 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.52	7.616	3.96
Paved	0.9	5.984	5.39
Total		**13.6**	**9.35**
C (weighted) = total product/total area		Use C =	**0.69**

Frequency	(years)	25
Intensity, i	(in/hour)	5.88
Runoff, Q=C*i*A	(cfs)	54.95

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

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Project No. : # 08571
By : ABB
Date : 1/28/2009

42"
Turnpike Culvert Flows
Existing Conditions
Tc = 16 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.65	7.616	4.95
Paved	0.91	5.984	5.45
Total		**13.6**	**10.40**
C (weighted) = total product/total area		Use C =	**0.76**

Frequency	(years)	100
Intensity, i	(in/hour)	7.17
Runoff, Q=C*i*A	(cfs)	74.54

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Existing Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.3	3.17	0.95
Paved	0.835	1.04	0.87
Total		**4.21**	**1.82**
C (weighted) = total product/total area		Use C =	**0.43**

Frequency	(years)	2
Intensity, i	(in/hour)	4.5
Runoff, Q=C*i*A	(cfs)	8.19

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

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By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Existing Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.35	3.17	1.11
Paved	0.86	1.04	0.89
Total		**4.21**	**2.00**
C (weighted) = total product/total area		Use C =	**0.48**

Frequency	(years)	5
Intensity, i	(in/hour)	5.42
Runoff, Q=C*i*A	(cfs)	10.86

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Existing Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.45	3.17	1.43
Paved	0.89	1.04	0.93
Total		**4.21**	**2.35**
C (weighted) = total product/total area		Use C =	**0.56**

Frequency	(years)	10
Intensity, i	(in/hour)	6.08
Runoff, Q=C*i*A	(cfs)	14.30

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

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Project No. : # 08571
By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Existing Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.52	3.17	1.65
Paved	0.9	1.04	0.94
Total		**4.21**	**2.58**
C (weighted) = total product/total area		Use C =	**0.61**

Frequency	(years)	25
Intensity, i	(in/hour)	7.06
Runoff, Q=C*i*A	(cfs)	18.25

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

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By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Existing Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.65	3.17	2.06
Paved	0.91	1.04	0.95
Total		**4.21**	**3.01**
C (weighted) = total product/total area		Use C =	**0.71**

Frequency	(years)	100
Intensity, i	(in/hour)	8.58
Runoff, Q=C*i*A	(cfs)	25.80

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Developed Conditions

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 1/28/2009

42"
Turnpike Culvert Flows
Post Conditions
Tc = 9 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.3	4.08	1.22
Paved	0.835	9.52	7.95
Total		**13.6**	**9.17**
C (weighted) = total product/total area		Use C =	**0.67**

Frequency	(years)	2
Intensity, i	(in/hour)	4.67
Runoff, Q=C*i*A	(cfs)	42.84

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 1/28/2009

42"
Turnpike Culvert Flows
Post Conditions
Tc = 9 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.35	4.08	1.43
Paved	0.86	9.52	8.19
Total		**13.6**	**9.62**
C (weighted) = total product/total area		Use C =	**0.71**

Frequency	(years)	5
Intensity, i	(in/hour)	5.61
Runoff, Q=C*i*A	(cfs)	53.94

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 1/28/2009

42"
Turnpike Culvert Flows
Post Conditions
Tc = 9 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.45	4.08	1.84
Paved	0.89	9.52	8.47
Total		**13.6**	**10.31**
C (weighted) = total product/total area		Use C =	**0.76**

Frequency	(years)	10
Intensity, i	(in/hour)	6.3
Runoff, Q=C*i*A	(cfs)	64.95

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 1/28/2009

42"
Turnpike Culvert Flows
Post Conditions
Tc = 9 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.52	4.08	2.12
Paved	0.9	9.52	8.57
Total		**13.6**	**10.69**
C (weighted) = total product/total area		Use C =	**0.79**

Frequency	(years)	25
Intensity, i	(in/hour)	7.3
Runoff, Q=C*i*A	(cfs)	78.03

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 1/28/2009

42"
Turnpike Culvert Flows
Post Conditions
Tc = 9 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.65	4.08	2.65
Paved	0.91	9.52	8.66
Total		**13.6**	**11.32**
C (weighted) = total product/total area		Use C =	**0.83**

Frequency	(years)	100
Intensity, i	(in/hour)	8.87
Runoff, Q=C*i*A	(cfs)	100.37

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Post Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.3	2.96	0.89
Paved	0.835	1.25	1.04
Total		**4.21**	**1.93**
C (weighted) = total product/total area		Use C =	**0.46**

Frequency	(years)	2
Intensity, i	(in/hour)	4.5
Runoff, Q=C*i*A	(cfs)	8.69

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Post Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.35	2.96	1.04
Paved	0.86	1.25	1.08
Total		**4.21**	**2.11**
C (weighted) = total product/total area		Use C =	**0.50**

Frequency	(years)	5
Intensity, i	(in/hour)	5.42
Runoff, Q=C*i*A	(cfs)	11.44

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Post Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.45	2.96	1.33
Paved	0.89	1.25	1.11
Total		**4.21**	**2.44**
C (weighted) = total product/total area		Use C =	**0.58**

Frequency	(years)	10
Intensity, i	(in/hour)	6.08
Runoff, Q=C*i*A	(cfs)	14.86

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Post Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.52	2.96	1.54
Paved	0.9	1.25	1.13
Total		**4.21**	**2.66**
C (weighted) = total product/total area		Use C =	**0.63**

Frequency	(years)	25
Intensity, i	(in/hour)	7.06
Runoff, Q=C*i*A	(cfs)	18.81

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Numbers and Runoff Worksheet

Project : Wichita Regional Fire Training Addition
Project No. : # 08571
By : ABB
Date : 2/18/2009

24"
Turnpike Culvert Flows
Post Conditions
Tc = 10 min

Cover Description, Cover Type, Treatment, Hydrologic Condtion	C	Area (acres)	Product of C x area
Lawn	0.65	2.96	1.92
Paved	0.91	1.25	1.14
Total		**4.21**	**3.06**
C (weighted) = total product/total area		Use C =	**0.73**

Frequency	(years)	100
Intensity, i	(in/hour)	8.58
Runoff, Q=C*i*A	(cfs)	26.27

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Pipe Capacity

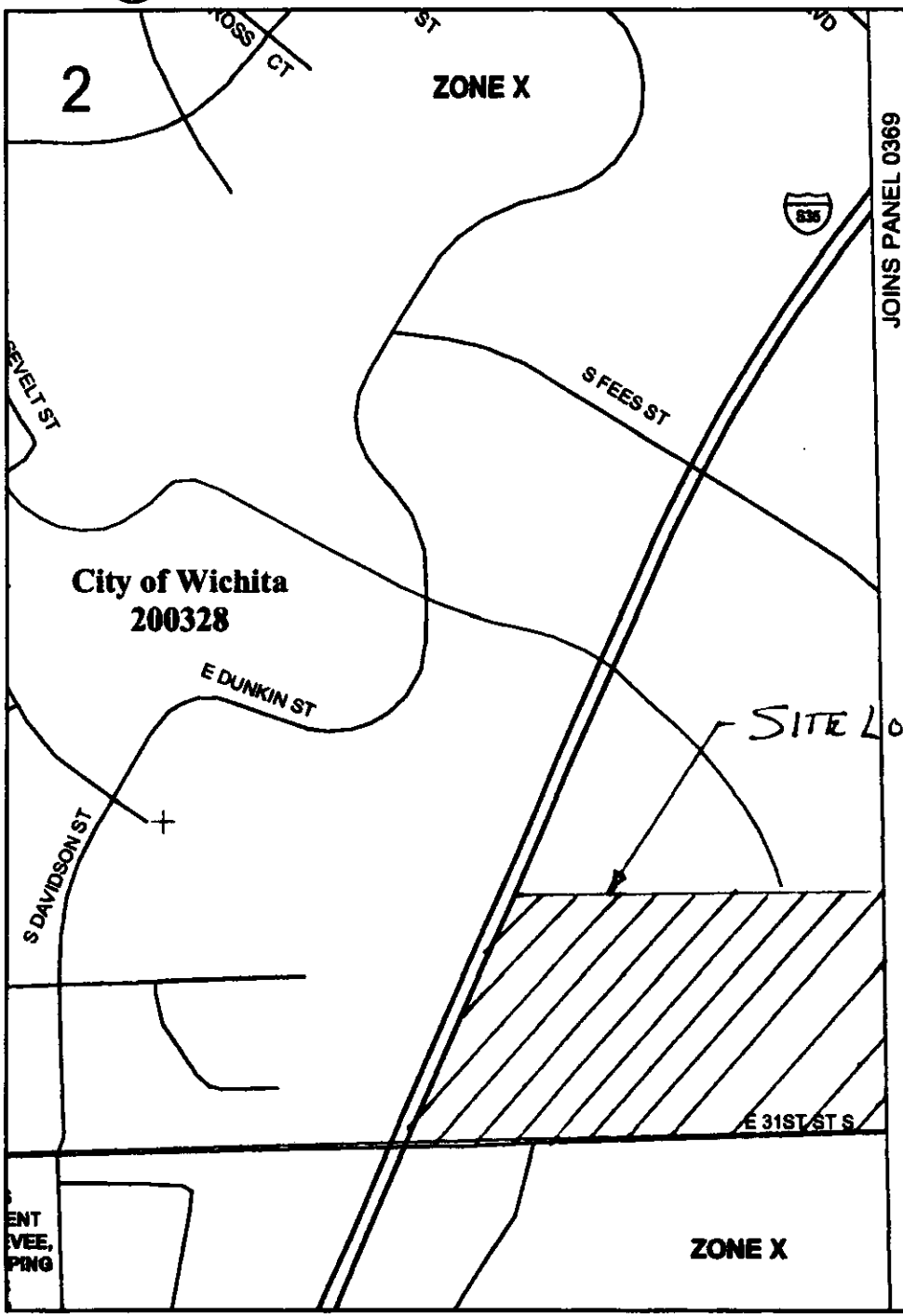
Project	:	Wichita Regional Fire Training Addition
Project No.	:	# 08571
By	:	ABB
Date	:	2/19/2009

24"
Turnpike Culvert Flows

Q = (1.486/n)*A*R^(2/3)*S^(1/2)

n=	0.013	
D=	2	ft
S=	3%	
A=	3.14	square ft
P=	6.28	ft
R=	0.50	ft
Q=	39.16	cubic feet squared (cfs)

FIS
Information



MAP SCALE 1" = 500'

500 1000 FEET

METERS 0 150 300

PANEL 0368E

FIRM

FLOOD INSURANCE RATE MAP

SEDGWICK COUNTY, KANSAS AND INCORPORATED AREAS

PANEL 368 OF 700

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

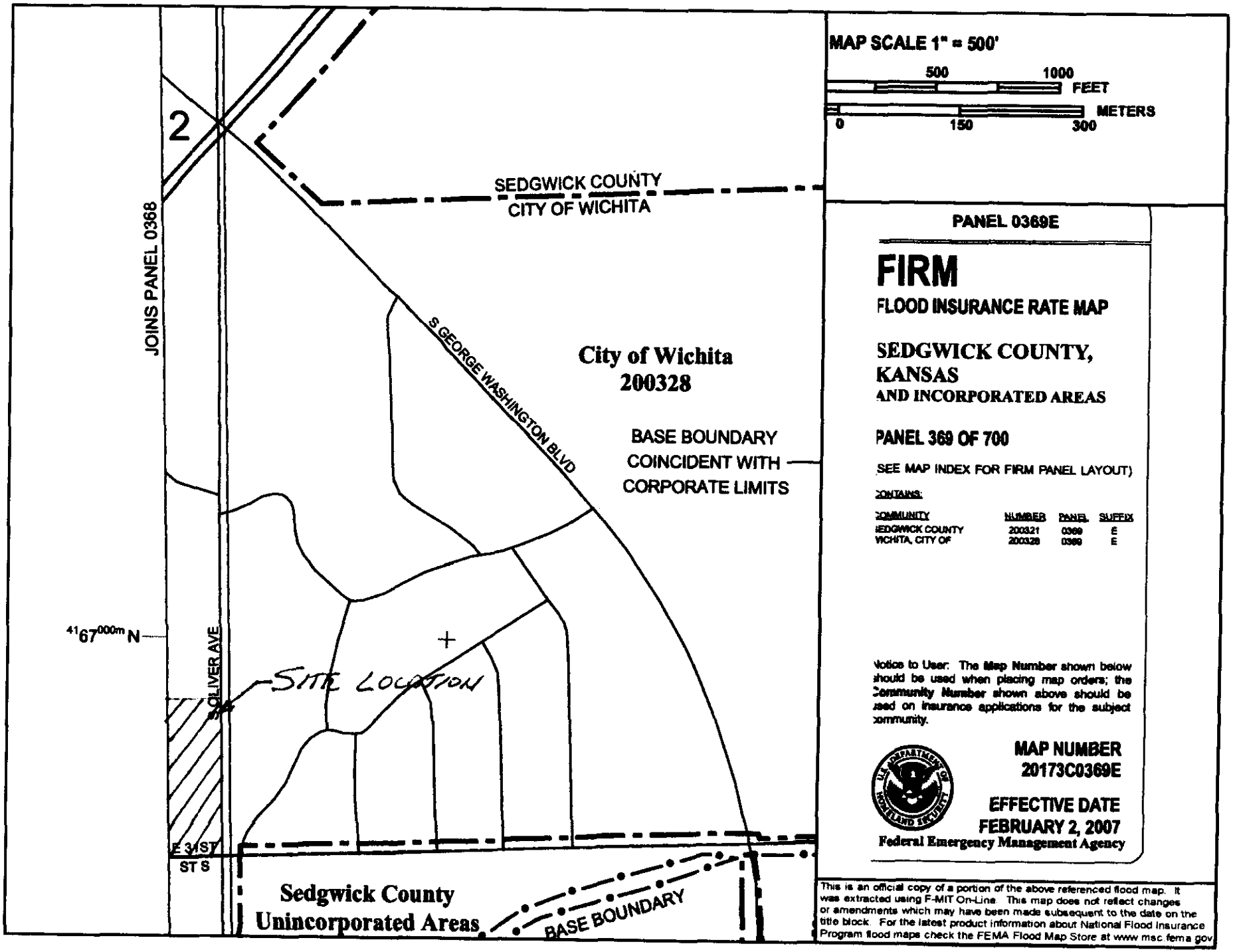
COMMUNITY	NUMBER	PANEL	SUFFIX
SEDGWICK COUNTY	200321	0368	E
WICHITA, CITY OF	200328	0368	E

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
20173C0368E

EFFECTIVE DATE
FEBRUARY 2, 2007

Federal Emergency Management Agency


MAP SCALE 1" = 500'
500
1000
FEET
METERS
0
150
300
2
JOINS PANEL 0368
SEDGWICK COUNTY
CITY OF WICHITA
S GEORGE WASHINGTON BLVD
City of Wichita
200328
BASE BOUNDARY
COINCIDENT WITH
CORPORATE LIMITS
4167000m N
SOLIVER AVE
SITE LOCATION
E 31ST
ST S
Sedgwick County
Unincorporated Areas
BASE BOUNDARY
PANEL 0369E
FIRM
FLOOD INSURANCE RATE MAP
SEDGWICK COUNTY,
KANSAS
AND INCORPORATED AREAS
PANEL 369 OF 700
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
SEDGWICK COUNTY 200321 0369 E
WICHITA, CITY OF 200328 0369 E
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
20173C0369E
EFFECTIVE DATE
FEBRUARY 2, 2007
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

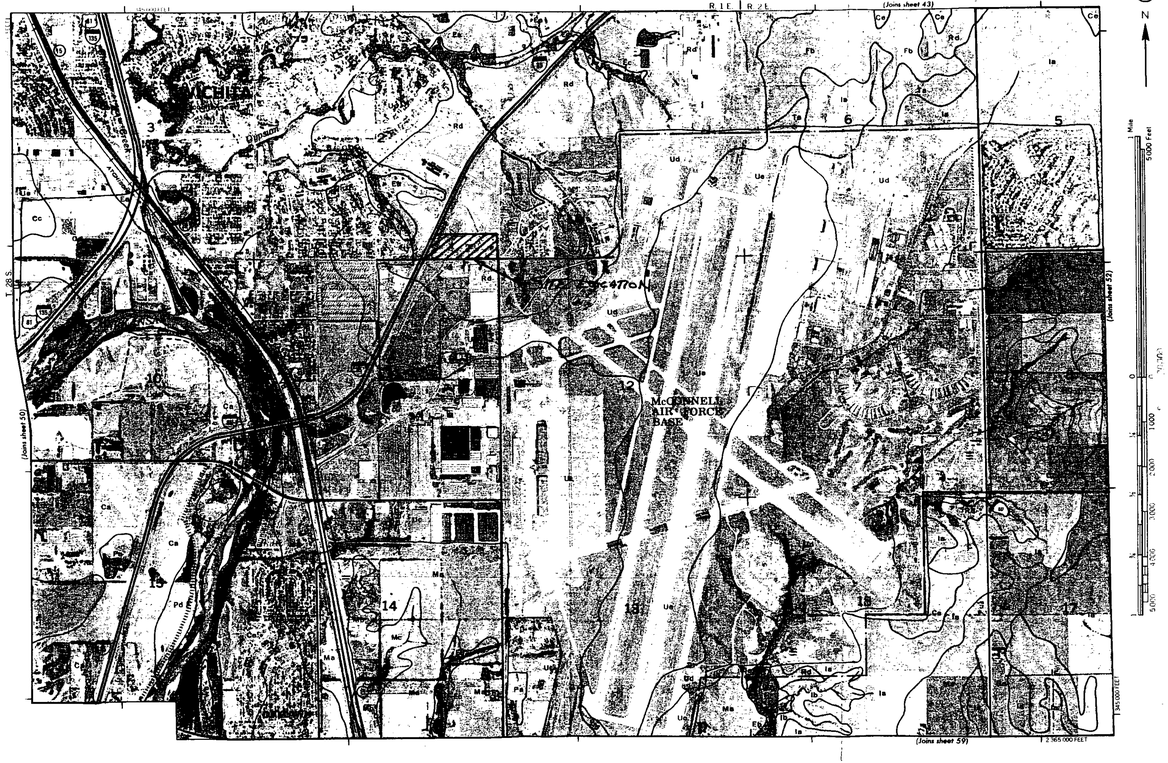
Soils Information

TABLE 16.--SOIL AND WATER FEATURES--Continued

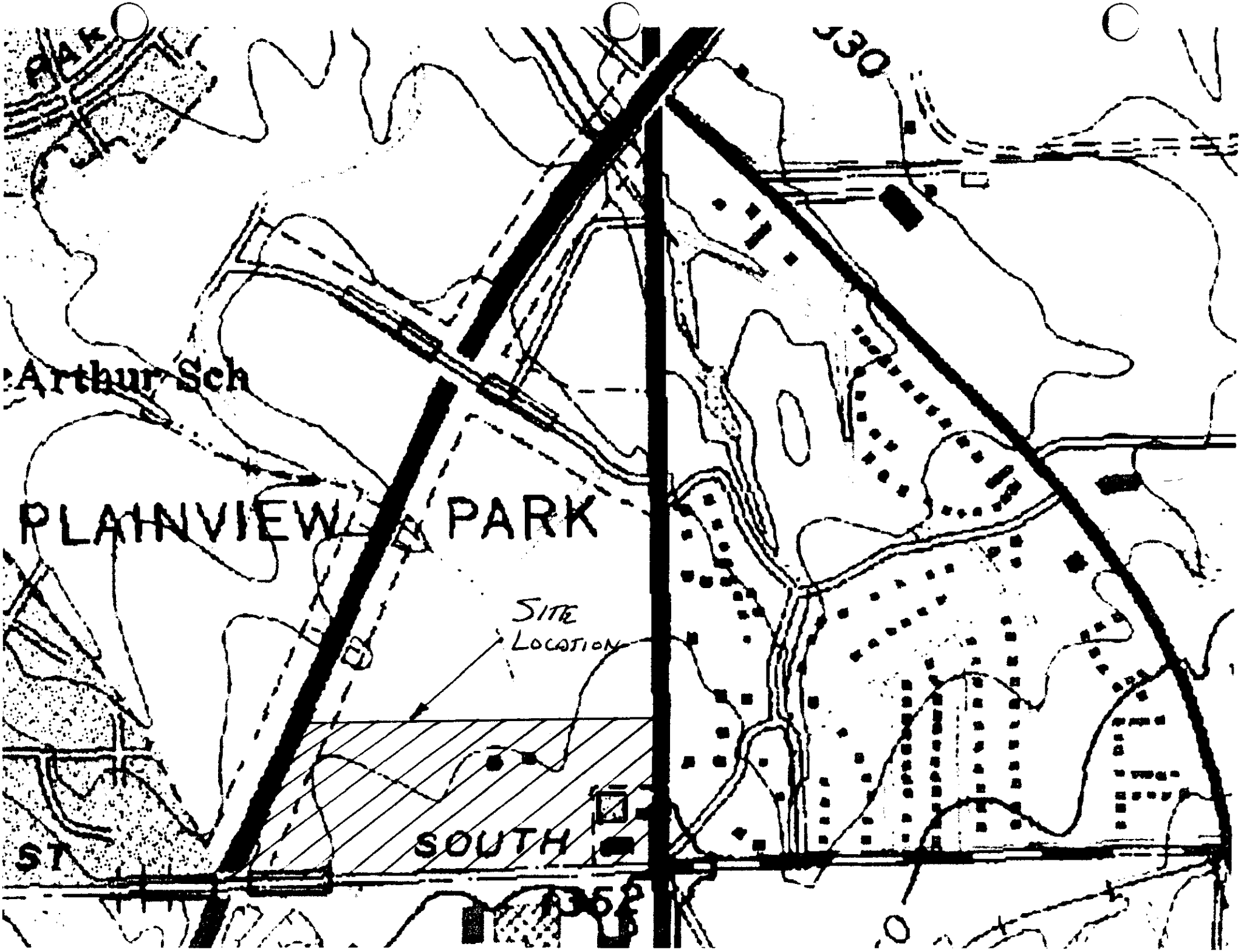
ınd	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			In	
------	B	None--------	---	---	>6.0	---	---	>60	---
------	D	None--------	---	---	>6.0	---	---	10-20	Rippable
t-----	D	None--------	---	---	>6.0	---	---	10-20	Rippable
rop									
------	D	Frequent----	Brief to long.	Mar-Oct	0-4.0	Apparent	Jan-Dec	>60	---
------	A	None--------	---	---	>6.0	---	---	>60	---
-t-----	A	None--------	---	---	>6.0	---	---	>60	---
ırt----	A	None--------	---	---	>6.0	---	---	>60	---
------	D	None--------	---	---	>6.0	---	---	>60	---
part---	D	None--------	---	---	>6.0	---	---	>60	---
rt-----	D	None--------	---	---	>6.0	---	---	10-20	Rippable
------	D	None--------	---	---	>6.0	---	---	20-40	Rippable
r:									
------	B	None--------	---	---	>6.0	---	---	>60	---
------	D	None--------	---	---	2.5-3.5	Perched	Oct-Apr	>60	---
)art----	D	None--------	---	---	2.5-3.5	Perched	Oct-Apr	>60	---
l part--	D	Rare--------	---	---	2.0-6.0	Apparent	Nov-Apr	>60	---
:									
and									
n part--	B	Rare--------	---	---	>6.0	---	---	>60	---
and									
part---	B	Rare to common.	Brief-----	Oct-May	>6.0	---	---	>60	---
and									
part----	B	None--------	---	---	>6.0	---	---	>60	---

)otnote at end of table.

SEDGWICK COUNTY, KANSAS — SHEET NUMBER 51



USGS
map


PARK
Arthur Sch
PLAINVIEW PARK
SITE LOCATION
SOUTH
ST

Design Aids

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information compiled by Engman (1986).

[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

[3] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

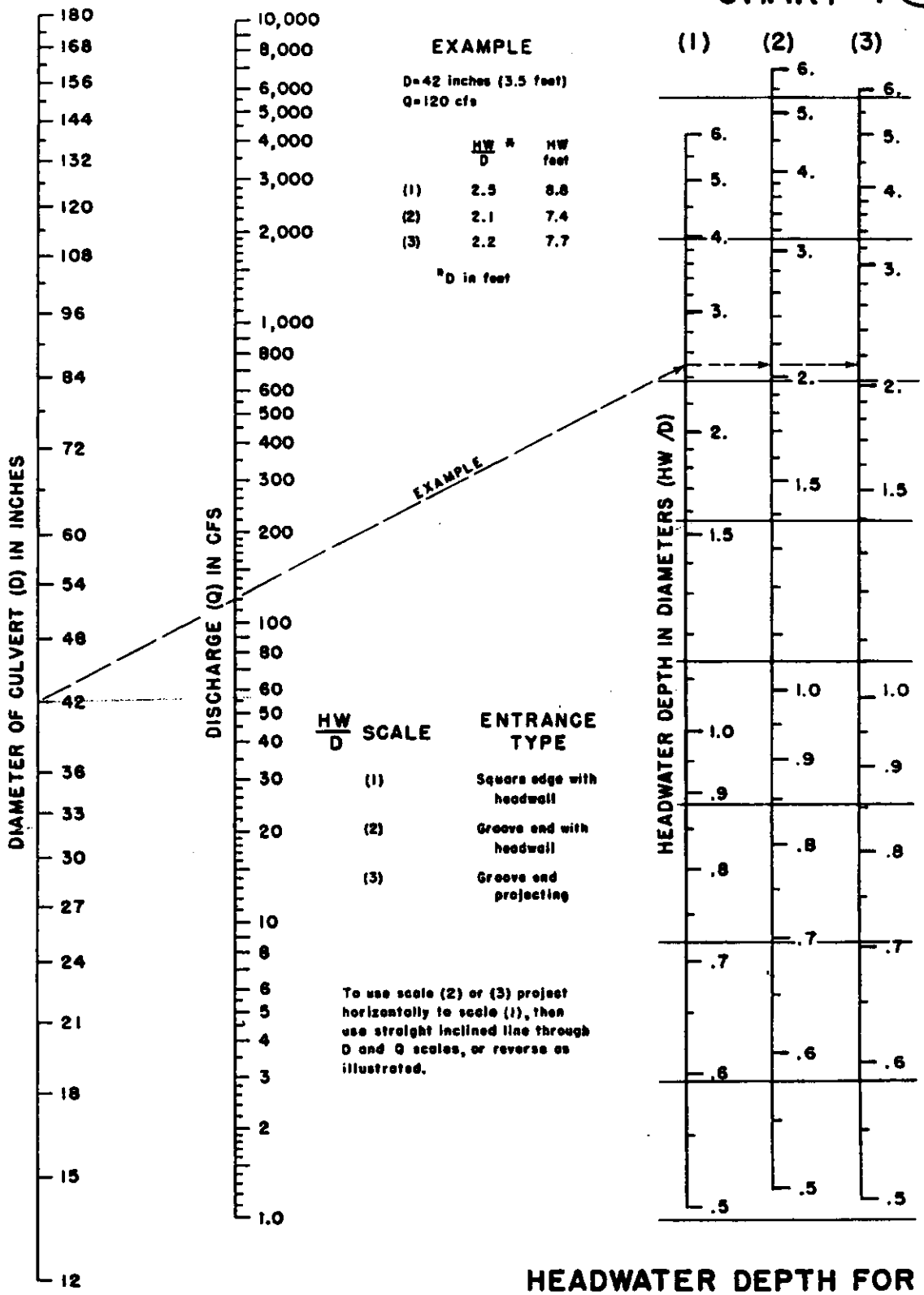
After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull elevation.

CHART 1



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

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Table 2-11 Curve Numbers for Soil Groupings in Terms of Use for Antecedent Moisture Condition II (38)

Cover			Hydrologic Soil Group			
Land Use	Treatment or Practice	Hydrologic Condition	A	B	C	D
Fallow	Straight row	—	77	86	91	94
Row crops	Straight row	Poor	72	81	88	91
	Straight row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured and terraced	Poor	66	74	80	82
	Contoured and terraced	Good	62	71	78	81
Small Grain	Straight row	Poor	65	76	84	88
	Straight row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Contoured and terraced	Poor	61	72	79	82
	Contoured and terraced	Good	59	70	78	81
Close-seeded	Straight row	Poor	66	77	85	89
Legumes*	Straight row	Good	58	72	81	85
or Rotation	Contoured	Poor	64	75	83	85
Meadow	Contoured	Good	55	69	78	83
	Contoured and terraced	Poor	63	73	80	83
	Contoured and terraced	Good	51	67	76	80
Pasture or		Poor	68	79	86	89
Range		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		—	59	74	82	86
Roads						
Dirt†		—	72	82	87	89
Hard surface†		—	74	84	90	92

* Close-drilled or broadcast-seeded

† Including right-of-way

also increase. The SCS curve number method assumes that, as time passes and the rainfall rate continues to exceed the infiltration capacity, the curve developed by plotting accumulated runoff versus accumulated precipitation will become parallel to a 45° line (on an arithmetic plot). That is, this model assumes that the infiltration rate ultimately becomes zero, and thus, the incremental increase in rainfall excess (surface runoff)

RAINFALL INTENSITY TABLE

SEDGWICK COUNTY
KANSAS

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION, HR:MIN	RETURN PERIOD 1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
0:05	4.77	5.52	6.56	7.32	8.44	9.32	10.20
0:06	4.53	5.26	6.27	7.02	8.11	8.96	9.81
0:07	4.33	5.04	6.03	6.76	7.82	8.65	9.48
0:08	4.16	4.85	5.82	6.52	7.55	8.36	9.17
0:09	4.00	4.67	5.61	6.30	7.30	8.09	8.87
0:10	3.85	4.50	5.42	6.08	7.06	7.82	8.58
0:11	3.71	4.34	5.23	5.88	6.83	7.56	8.30
0:12	3.58	4.19	5.06	5.69	6.60	7.32	8.04
0:13	3.45	4.05	4.90	5.51	6.40	7.10	7.79
0:14	3.34	3.92	4.75	5.34	6.21	6.89	7.57
0:15	3.23	3.80	4.61	5.19	6.04	6.70	7.36
0:16	3.13	3.69	4.48	5.05	5.88	6.53	7.17
0:17	3.03	3.58	4.36	4.92	5.73	6.37	7.00
0:18	2.94	3.48	4.25	4.80	5.60	6.22	6.84
0:19	2.86	3.39	4.14	4.69	5.47	6.09	6.70
0:20	2.78	3.30	4.05	4.58	5.35	5.96	6.56
0:21	2.70	3.21	3.95	4.48	5.24	5.84	6.43
0:22	2.63	3.14	3.87	4.39	5.14	5.72	6.30
0:23	2.56	3.06	3.78	4.30	5.04	5.61	6.19
0:24	2.50	2.99	3.71	4.21	4.94	5.51	6.07
0:25	2.44	2.93	3.63	4.13	4.85	5.41	5.97
0:26	2.38	2.86	3.56	4.05	4.76	5.31	5.86
0:27	2.33	2.80	3.49	3.98	4.68	5.22	5.76
0:28	2.28	2.75	3.43	3.91	4.59	5.13	5.66
0:29	2.23	2.69	3.36	3.84	4.52	5.04	5.57
0:30	2.19	2.64	3.30	3.77	4.44	4.96	5.48
0:31	2.14	2.59	3.24	3.71	4.37	4.88	5.39
0:32	2.10	2.54	3.19	3.64	4.30	4.80	5.31
0:33	2.06	2.50	3.14	3.58	4.23	4.73	5.22
0:34	2.02	2.45	3.08	3.53	4.16	4.65	5.14
0:35	1.99	2.41	3.03	3.47	4.10	4.58	5.07
0:36	1.95	2.37	2.99	3.42	4.03	4.51	4.99
0:37	1.92	2.33	2.94	3.36	3.97	4.45	4.92
0:38	1.89	2.30	2.89	3.31	3.91	4.38	4.84
0:39	1.86	2.26	2.85	3.27	3.86	4.32	4.77
0:40	1.83	2.23	2.81	3.22	3.80	4.26	4.71
0:41	1.80	2.19	2.77	3.17	3.75	4.20	4.64
0:42	1.77	2.16	2.73	3.13	3.70	4.14	4.58
0:43	1.75	2.13	2.69	3.08	3.65	4.08	4.52
0:44	1.72	2.10	2.65	3.04	3.60	4.03	4.46
0:45	1.70	2.07	2.62	3.00	3.55	3.97	4.40

RAINFALL INTENSITY TABLE

SEDGWICK COUNTY
KANSAS

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION, HR:MIN	RETURN PERIOD 1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
0:46	1.67	2.04	2.58	2.96	3.50	3.92	4.34
0:47	1.65	2.01	2.55	2.92	3.46	3.87	4.29
0:48	1.63	1.98	2.51	2.88	3.41	3.82	4.23
0:49	1.60	1.96	2.48	2.85	3.37	3.78	4.18
0:50	1.58	1.93	2.45	2.81	3.33	3.73	4.13
0:51	1.56	1.91	2.42	2.78	3.29	3.68	4.08
0:52	1.54	1.88	2.39	2.74	3.25	3.64	4.03
0:53	1.52	1.86	2.36	2.71	3.21	3.60	3.98
0:54	1.50	1.84	2.33	2.68	3.17	3.55	3.94
0:55	1.48	1.81	2.30	2.65	3.13	3.51	3.89
0:56	1.46	1.79	2.28	2.62	3.10	3.47	3.85
0:57	1.45	1.77	2.25	2.59	3.06	3.43	3.80
0:58	1.43	1.75	2.23	2.56	3.03	3.40	3.76
0:59	1.41	1.73	2.20	2.53	3.00	3.36	3.72
1:00	1.39	1.71	2.18	2.50	2.96	3.32	3.68
1:05	1.32	1.62	2.06	2.37	2.81	3.15	3.49
1:10	1.25	1.53	1.96	2.25	2.67	3.00	3.33
1:15	1.18	1.46	1.87	2.15	2.55	2.86	3.17
1:20	1.13	1.39	1.78	2.05	2.44	2.74	3.04
1:25	1.07	1.33	1.70	1.97	2.34	2.63	2.91
1:30	1.03	1.27	1.63	1.89	2.24	2.52	2.80
1:35	0.98	1.22	1.57	1.81	2.16	2.43	2.69
1:40	0.94	1.17	1.51	1.75	2.08	2.34	2.60
1:45	0.91	1.13	1.46	1.69	2.01	2.26	2.51
1:50	0.87	1.09	1.41	1.63	1.94	2.18	2.42
1:55	0.84	1.05	1.36	1.57	1.88	2.11	2.35
2:00	0.81	1.02	1.32	1.52	1.82	2.05	2.28
2:05	0.79	0.98	1.28	1.48	1.76	1.99	2.21
2:10	0.76	0.95	1.24	1.43	1.71	1.93	2.14
2:15	0.74	0.92	1.20	1.39	1.67	1.88	2.08
2:20	0.72	0.90	1.17	1.36	1.62	1.82	2.03
2:25	0.70	0.87	1.14	1.32	1.58	1.78	1.98
2:30	0.68	0.85	1.11	1.29	1.54	1.73	1.93
2:35	0.66	0.83	1.08	1.25	1.50	1.69	1.88
2:40	0.64	0.81	1.05	1.22	1.46	1.65	1.83
2:45	0.62	0.79	1.03	1.19	1.43	1.61	1.79
2:50	0.61	0.77	1.00	1.17	1.40	1.57	1.75
2:55	0.59	0.75	0.98	1.14	1.37	1.54	1.71
3:00	0.58	0.73	0.96	1.12	1.34	1.51	1.68

RAINFALL INTENSITY TABLE

SEDGWICK COUNTY
KANSAS

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES
IN INCHES PER HOUR.

DURATION, HR:MIN	RETURN PERIOD 1 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
3:15	0.54	0.69	0.90	1.05	1.26	1.42	1.58
3:30	0.51	0.65	0.85	0.99	1.19	1.34	1.49
3:45	0.48	0.61	0.80	0.94	1.12	1.27	1.41
4:00	0.46	0.58	0.76	0.89	1.07	1.21	1.34
4:15	0.44	0.55	0.73	0.85	1.02	1.15	1.28
4:30	0.42	0.53	0.70	0.81	0.98	1.10	1.23
4:45	0.40	0.51	0.67	0.78	0.94	1.06	1.18
5:00	0.38	0.49	0.64	0.75	0.90	1.02	1.13
5:15	0.37	0.47	0.62	0.72	0.87	0.98	1.09
5:30	0.35	0.45	0.60	0.70	0.83	0.94	1.05
5:45	0.34	0.44	0.58	0.67	0.81	0.91	1.01
6:00	0.33	0.42	0.56	0.65	0.78	0.88	0.98
6:30	0.31	0.40	0.52	0.61	0.73	0.83	0.92
7:00	0.30	0.38	0.50	0.58	0.69	0.78	0.87
7:30	0.28	0.36	0.47	0.55	0.66	0.74	0.83
8:00	0.27	0.34	0.45	0.52	0.62	0.70	0.78
8:30	0.26	0.33	0.43	0.50	0.60	0.67	0.75
9:00	0.25	0.31	0.41	0.48	0.57	0.64	0.72
9:30	0.24	0.30	0.39	0.46	0.55	0.62	0.69
10:00	0.23	0.29	0.38	0.44	0.52	0.59	0.66
10:30	0.22	0.28	0.36	0.42	0.50	0.57	0.63
11:00	0.21	0.27	0.35	0.41	0.49	0.55	0.61
11:30	0.21	0.26	0.34	0.39	0.47	0.53	0.59
12:00	0.20	0.25	0.33	0.38	0.45	0.51	0.57
13:00	0.19	0.24	0.31	0.36	0.43	0.48	0.53
14:00	0.18	0.22	0.29	0.34	0.40	0.45	0.50
15:00	0.17	0.21	0.27	0.32	0.38	0.43	0.47
16:00	0.16	0.20	0.26	0.30	0.36	0.40	0.45
17:00	0.15	0.19	0.25	0.29	0.34	0.38	0.43
18:00	0.15	0.18	0.24	0.27	0.33	0.37	0.41
19:00	0.14	0.18	0.23	0.26	0.31	0.35	0.39
20:00	0.14	0.17	0.22	0.25	0.30	0.34	0.37
21:00	0.13	0.16	0.21	0.24	0.29	0.32	0.36
22:00	0.13	0.16	0.20	0.23	0.28	0.31	0.34
23:00	0.12	0.15	0.19	0.22	0.27	0.30	0.33
24:00	0.12	0.15	0.19	0.22	0.26	0.29	0.32

Figure 2-7 —**Precipitation values for the Eastern United States—100-year 24-hour rainfall (inches)**

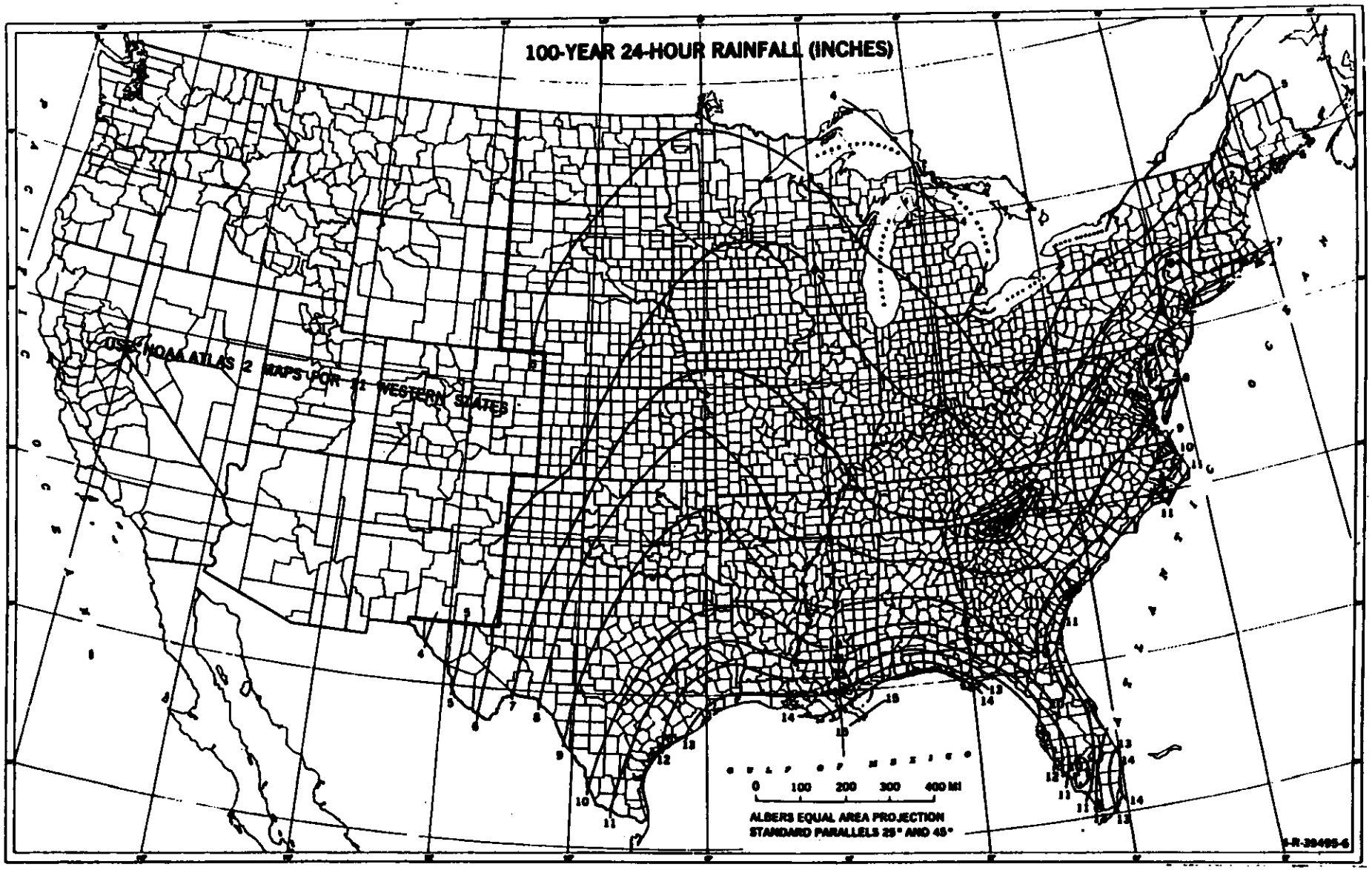
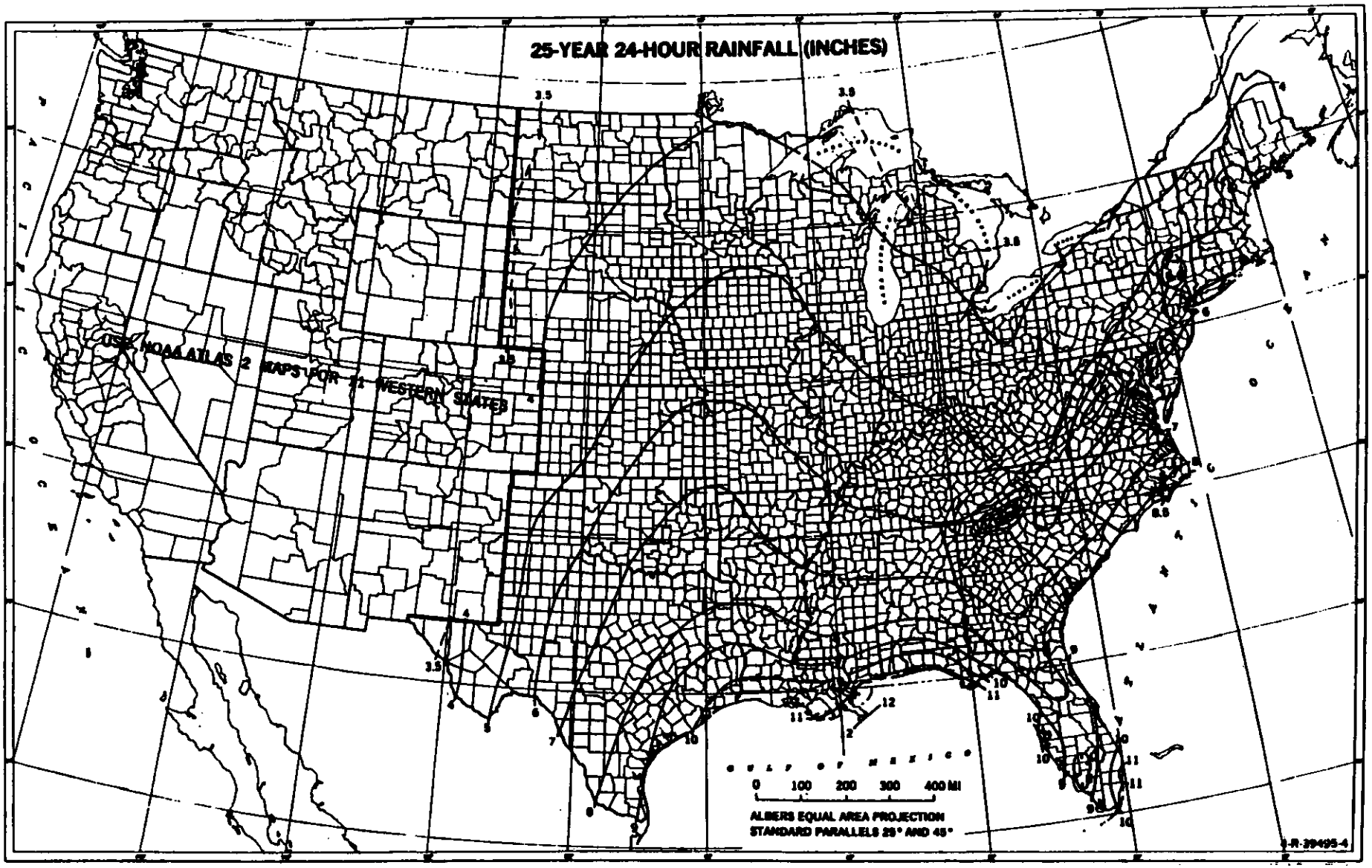


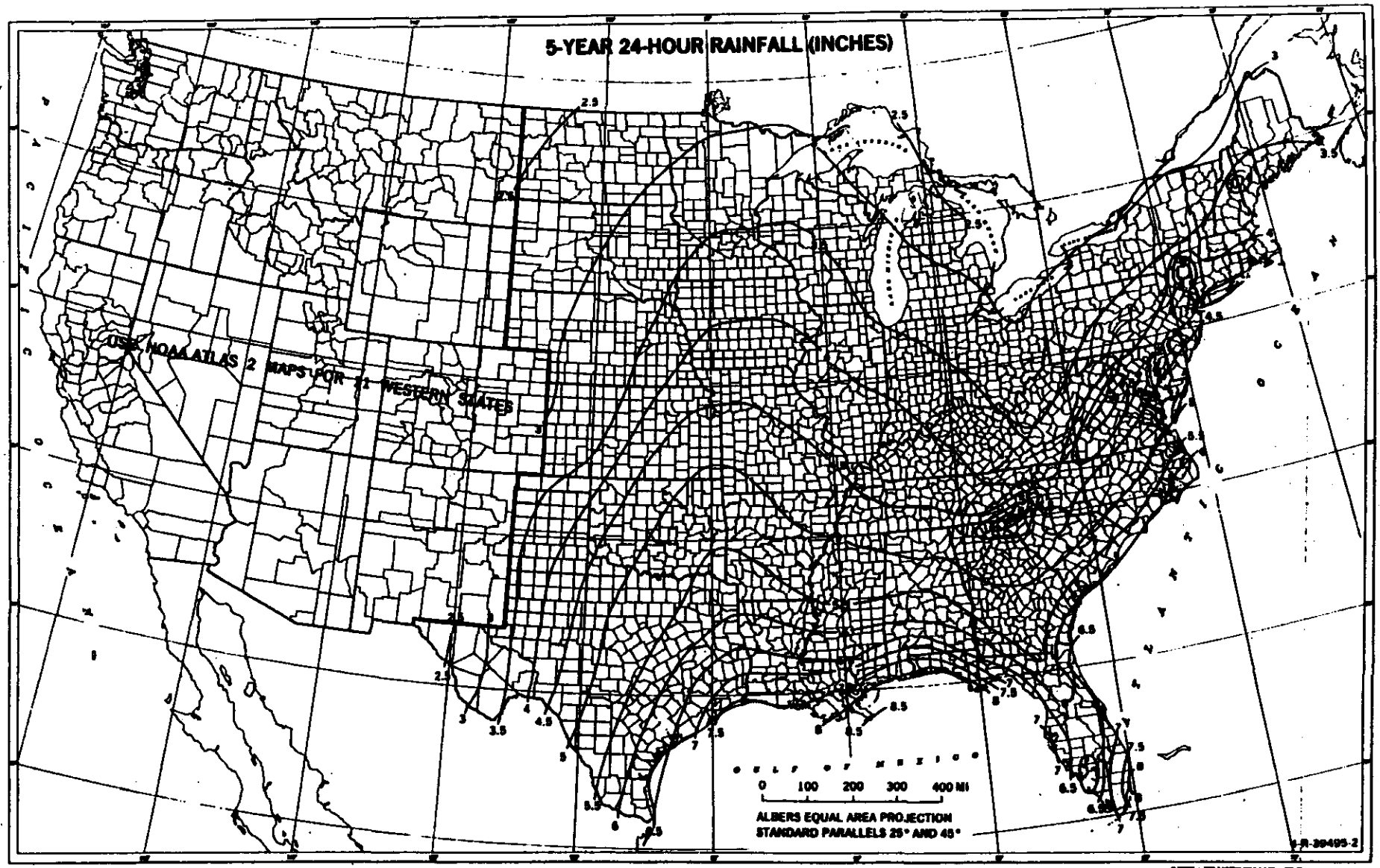
Figure 2-5 —**Precipitation values for the Eastern United States—25-year 24-hour rainfall (inches)**



Status of Computers for: WEB1_FS	Generated: 9/18/2006 9:55 AM
Computer group:	All Computers
Status:	Needed

Computer Name	Installed	Needed	Not needed	Unknown	Failed	Last Updated
90x-022	76	9	807	0	0	9/18/2006
71x-005	91	9	792	0	0	9/18/2006
70x-036	65	26	769	32	0	8/10/2006
70x-029	74	8	810	0	0	9/18/2006
60x-012	76	8	808	0	0	9/14/2006
60x-009	79	7	806	0	0	9/18/2006
40x-049	75	9	808	0	0	9/14/2006
40x-029	75	3	814	0	0	9/14/2006
35x-057	75	8	809	0	0	9/18/2006
35x-055	76	8	808	0	0	9/18/2006
35x-053	75	8	809	0	0	9/18/2006
35x-051	76	8	808	0	0	9/14/2006
34x-050	76	7	809	0	0	9/13/2006
34x-049	79	3	810	0	0	9/15/2006
32x-067	77	8	807	0	0	9/14/2006
32x-064	74	8	810	0	0	9/18/2006
32x-061	75	8	809	0	0	9/18/2006
32x-058	76	7	809	0	0	9/13/2006
20x-044	76	8	808	0	0	9/18/2006
10x-017	78	3	811	0	0	9/17/2006

Figure 2-3 —**Precipitation values for the Eastern United States—5-year 24-hour rainfall (inches)**



Prepared by U.S. Weather Bureau

Figure 2-4 —**Precipitation values for the Eastern United States—10-year 24-hour rainfall (inches)**

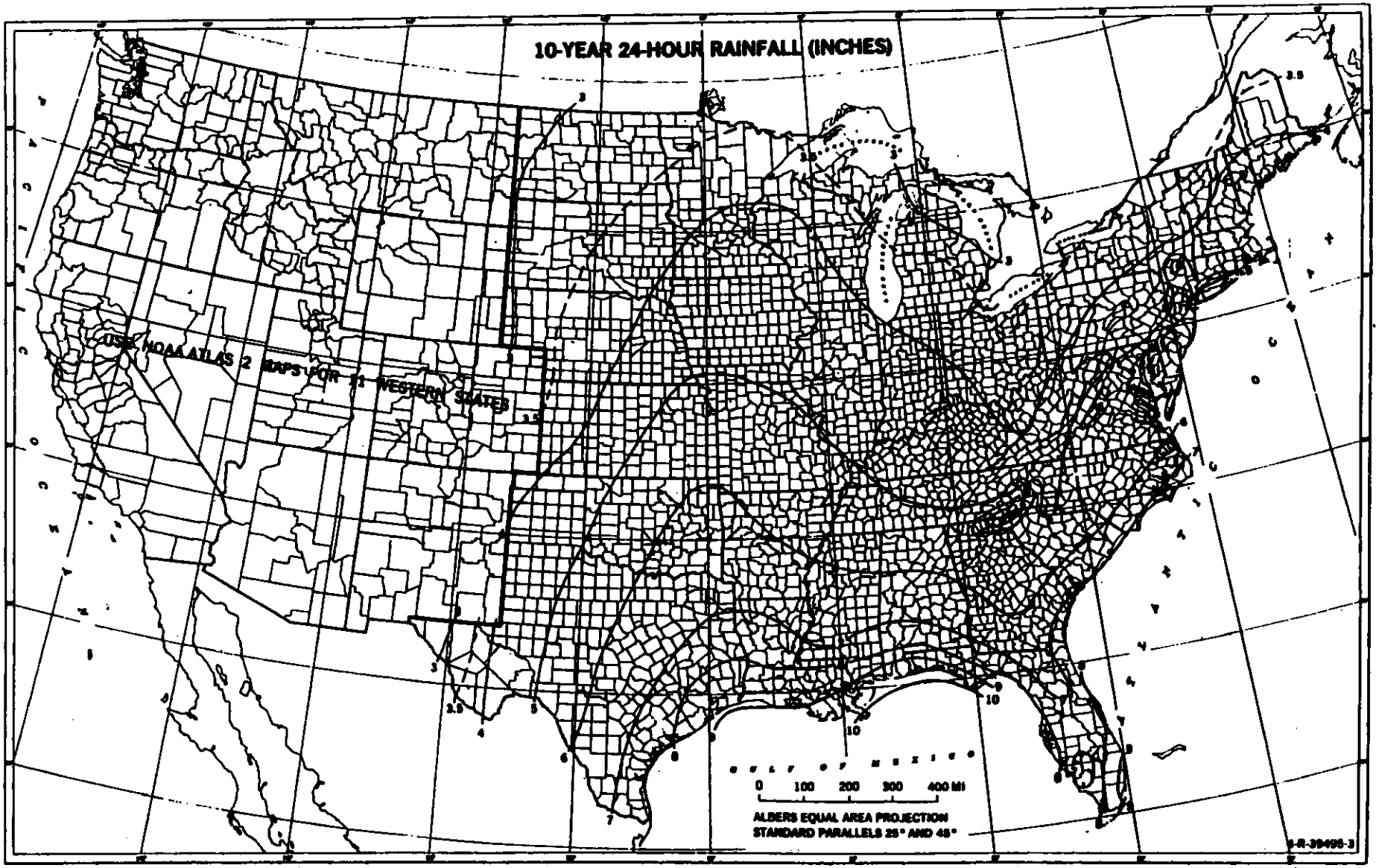
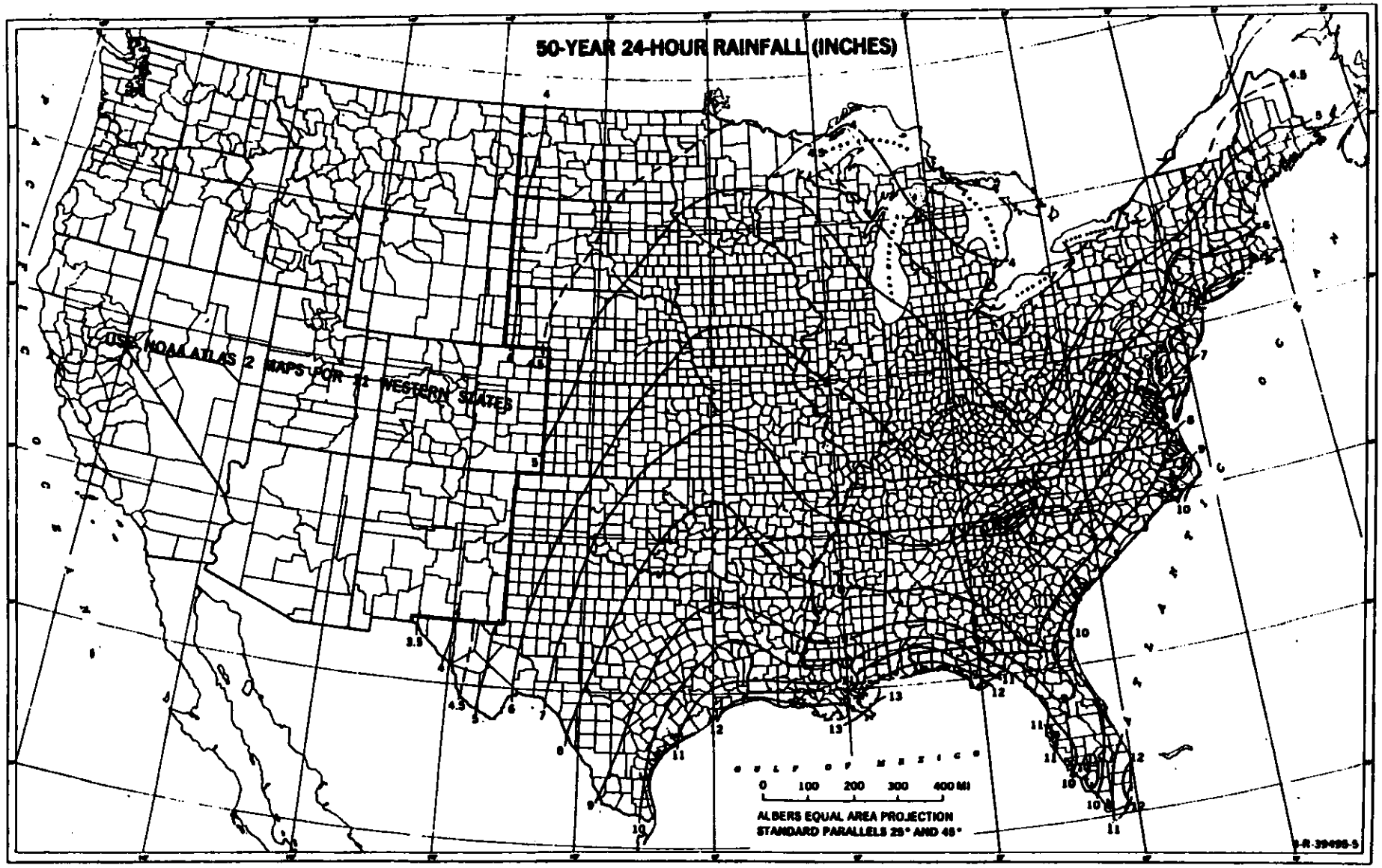
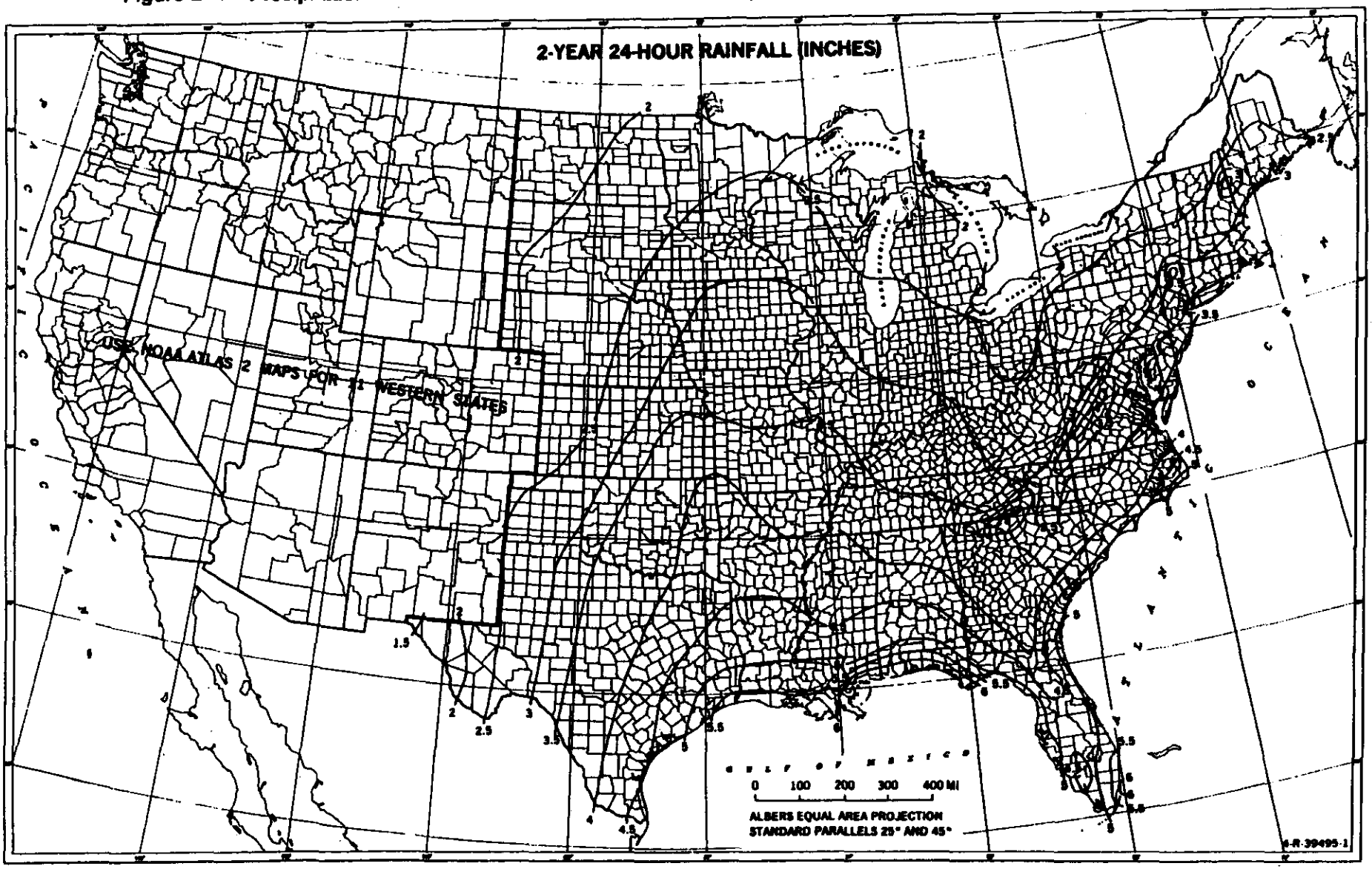


Figure 2-6.—**Precipitation values for the Eastern United States—50-year 24-hour rainfall (inches)**



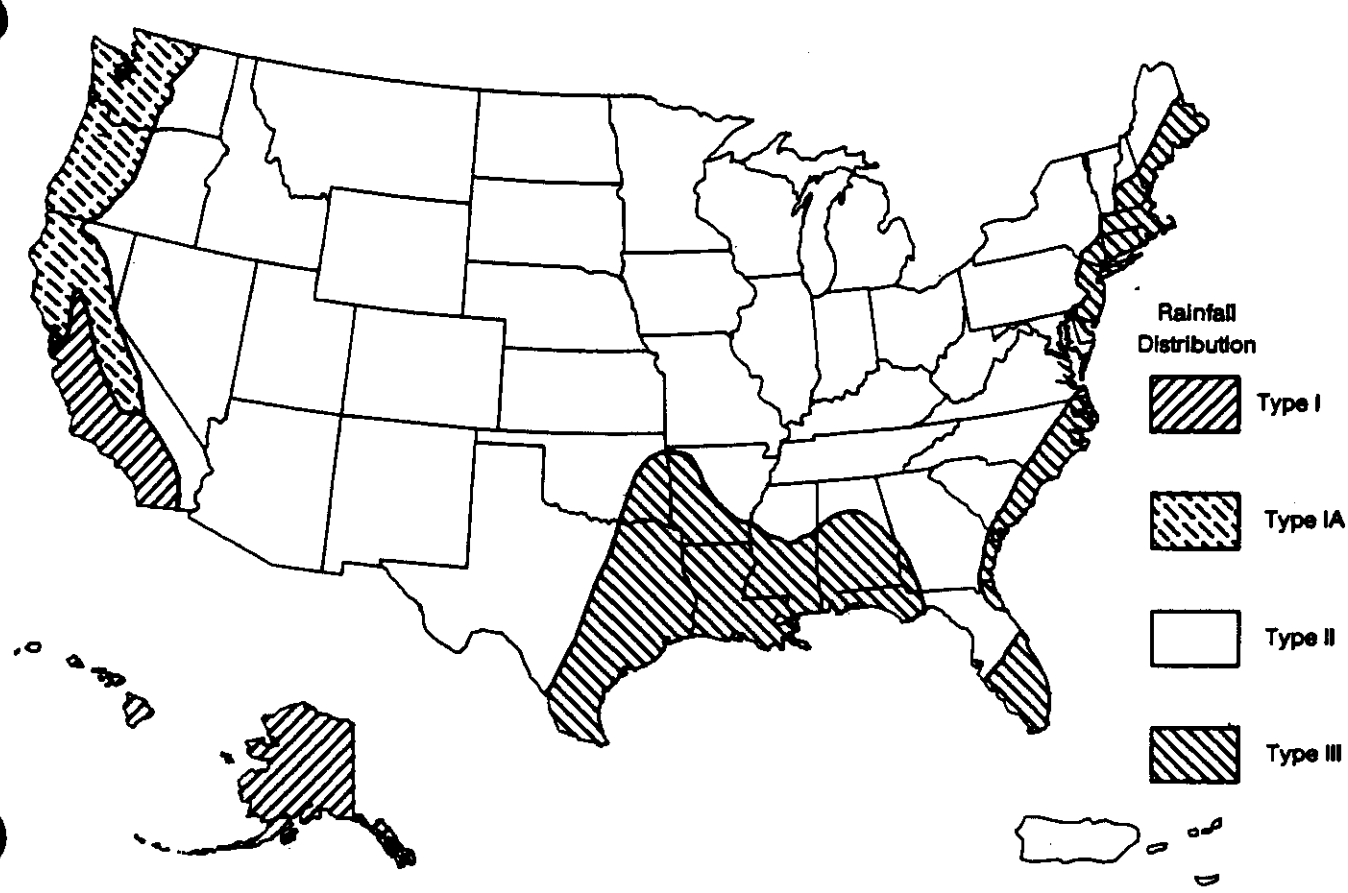
Prepared by U.S. Weather Bureau

Figure 2-2 —**Precipitation values for the Eastern United States—2-year 24-hour rainfall (inches)**



Prepared by U.S. Weather Bureau

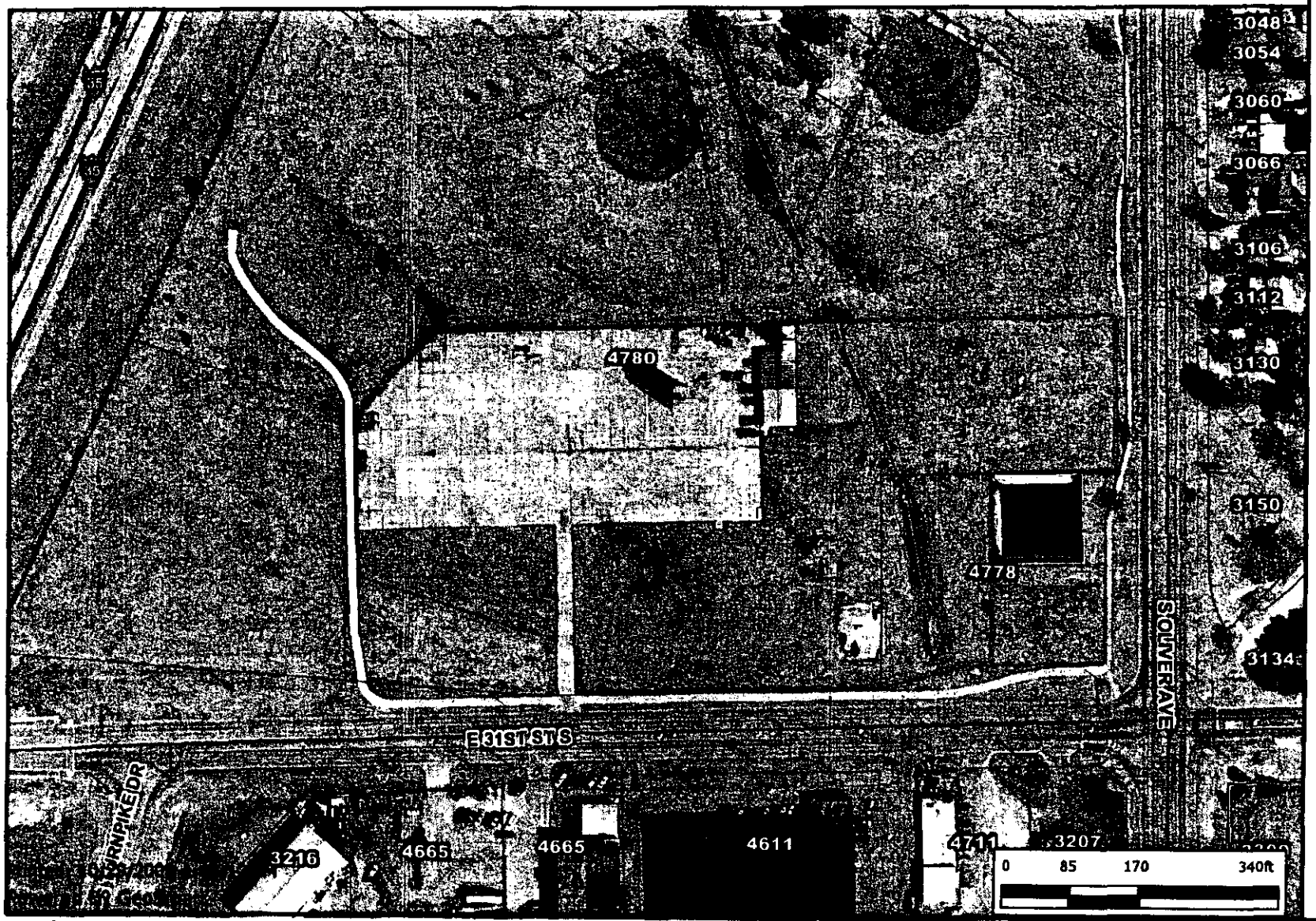
Figure 2-1 —**Approximate geographic boundaries for SCS rainfall distributions**



Expected 24–hour Rainfall and Runoff Amounts

County	Rainfall Frequency	Rainfall, Inches	Runoff Curve Number & Corresponding Runoff, in Inches																
			60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92
GREENWOOD	2 year	3.7	0.62	0.71	0.81	0.91	1.02	1.13	1.25	1.38	1.51	1.65	1.80	1.95	2.11	2.28	2.45	2.64	2.83
	5 year	4.7	1.13	1.26	1.39	1.53	1.67	1.82	1.97	2.13	2.29	2.46	2.63	2.81	3.00	3.19	3.38	3.59	3.80
	10 year	5.5	1.60	1.76	1.91	2.08	2.24	2.41	2.59	2.77	2.95	3.14	3.33	3.53	3.73	3.94	4.15	4.36	4.58
	25 year	6.4	2.19	2.37	2.55	2.74	2.93	3.13	3.32	3.52	3.73	3.93	4.14	4.36	4.57	4.79	5.01	5.24	5.46
	50 year	7.2	2.75	2.95	3.15	3.36	3.57	3.79	4.00	4.22	4.44	4.66	4.88	5.10	5.33	5.56	5.79	6.02	6.25
	100 year	8.2	3.48	3.71	3.94	4.17	4.40	4.64	4.87	5.10	5.34	5.58	5.81	6.05	6.29	6.53	6.76	7.00	7.24
	Normal Annual	37.0																	
HAMILTON	2 year	2.3	0.12	0.16	0.20	0.25	0.30	0.36	0.43	0.50	0.58	0.66	0.75	0.85	0.96	1.08	1.21	1.35	1.51
	5 year	3.2	0.41	0.48	0.56	0.64	0.73	0.83	0.93	1.04	1.15	1.27	1.40	1.54	1.68	1.84	2.00	2.17	2.35
	10 year	3.7	0.62	0.71	0.81	0.91	1.02	1.13	1.25	1.38	1.51	1.65	1.80	1.95	2.11	2.28	2.45	2.64	2.83
	25 year	4.4	0.97	1.08	1.21	1.33	1.47	1.60	1.75	1.90	2.05	2.21	2.38	2.55	2.73	2.91	3.10	3.30	3.50
	50 year	5.1	1.36	1.50	1.65	1.80	1.95	2.11	2.28	2.44	2.62	2.80	2.98	3.17	3.36	3.56	3.76	3.97	4.19
	100 year	5.5	1.60	1.76	1.91	2.08	2.24	2.41	2.59	2.77	2.95	3.14	3.33	3.53	3.73	3.94	4.15	4.36	4.58
	Normal Annual	16.9																	
HARPER	2 year	3.3	0.45	0.52	0.61	0.69	0.79	0.89	0.99	1.10	1.22	1.35	1.48	1.62	1.77	1.92	2.09	2.26	2.45
	5 year	4.5	1.02	1.14	1.27	1.40	1.53	1.67	1.82	1.97	2.13	2.29	2.46	2.64	2.82	3.00	3.20	3.40	3.60
	10 year	5.2	1.42	1.56	1.71	1.87	2.02	2.19	2.35	2.52	2.70	2.88	3.07	3.26	3.45	3.65	3.86	4.07	4.28
	25 year	6.1	1.99	2.16	2.33	2.51	2.70	2.88	3.08	3.27	3.47	3.67	3.87	4.08	4.29	4.50	4.72	4.94	5.17
	50 year	7.0	2.60	2.80	3.00	3.20	3.41	3.62	3.83	4.04	4.26	4.47	4.69	4.92	5.14	5.37	5.59	5.82	6.05
	100 year	7.8	3.18	3.40	3.62	3.84	4.07	4.29	4.52	4.75	4.98	5.21	5.44	5.67	5.90	6.14	6.37	6.61	6.85
	Normal Annual	27.6																	
HARVEY	2 year	3.4	0.49	0.57	0.66	0.75	0.84	0.96	1.06	1.17	1.29	1.42	1.56	1.70	1.85	2.01	2.18	2.35	2.54
	5 year	4.4	0.97	1.08	1.21	1.33	1.47	1.60	1.75	1.90	2.05	2.21	2.38	2.55	2.73	2.91	3.10	3.30	3.50
	10 year	5.2	1.42	1.56	1.71	1.87	2.02	2.19	2.35	2.52	2.70	2.88	3.07	3.26	3.45	3.65	3.86	4.07	4.28
	25 year	6.0	1.92	2.09	2.26	2.44	2.62	2.81	2.99	3.18	3.38	3.58	3.78	3.99	4.20	4.41	4.63	4.85	5.07
	50 year	6.8	2.46	2.65	2.85	3.05	3.25	3.45	3.66	3.87	4.08	4.29	4.51	4.73	4.95	5.17	5.40	5.63	5.86
	100 year	7.7	3.11	3.33	3.54	3.76	3.98	4.21	4.43	4.66	4.89	5.11	5.34	5.58	5.81	6.04	6.28	6.51	6.75
	Normal Annual	31.9																	
HASKELL	2 year	2.5	0.17	0.22	0.27	0.33	0.39	0.46	0.53	0.61	0.69	0.79	0.89	1.00	1.12	1.24	1.38	1.53	1.69
	5 year	3.4	0.49	0.57	0.66	0.75	0.84	0.95	1.06	1.17	1.29	1.42	1.56	1.70	1.85	2.01	2.18	2.35	2.54
	10 year	4.1	0.81	0.92	1.03	1.15	1.27	1.40	1.53	1.67	1.82	1.97	2.12	2.29	2.46	2.64	2.82	3.01	3.21
	25 year	4.7	1.13	1.26	1.39	1.53	1.67	1.82	1.97	2.13	2.29	2.46	2.63	2.81	3.00	3.19	3.38	3.59	3.80
	50 year	5.5	1.60	1.76	1.91	2.08	2.24	2.41	2.59	2.77	2.95	3.14	3.33	3.53	3.73	3.94	4.15	4.36	4.58
	100 year	5.9	1.86	2.02	2.19	2.37	2.54	2.73	2.91	3.10	3.29	3.49	3.69	3.90	4.10	4.31	4.53	4.75	4.97
	Normal Annual	19.5																	
HODGEMAN	2 year	2.8	0.20	0.25	0.31	0.37	0.43	0.50	0.58	0.67	0.76	0.85	0.96	1.07	1.19	1.33	1.47	1.62	1.79
	5 year	3.5	0.53	0.62	0.71	0.80	0.90	1.01	1.12	1.24	1.37	1.50	1.64	1.78	1.94	2.10	2.27	2.45	2.64
	10 year	4.2	0.86	0.97	1.09	1.21	1.33	1.46	1.60	1.74	1.89	2.05	2.21	2.37	2.55	2.73	2.92	3.11	3.31
	25 year	4.9	1.24	1.38	1.52	1.66	1.81	1.96	2.12	2.28	2.45	2.63	2.81	2.99	3.18	3.37	3.57	3.78	3.99
	50 year	5.8	1.79	1.95	2.12	2.29	2.47	2.65	2.83	3.02	3.21	3.40	3.60	3.80	4.01	4.22	4.43	4.65	4.87
	100 year	6.2	2.05	2.23	2.41	2.59	2.78	2.96	3.16	3.35	3.55	3.76	3.96	4.17	4.38	4.60	4.82	5.04	5.27
	Normal Annual	21.5																	

Aerial



Time of Concentration

Time of concentration (Tc) or travel time (Tt)

Project : Wichita Regional Fire Training Addition **By:** ABB **Date:** 1/28/2009
Location : Wichita, Kansas **Checked:** **Date:**

Circle One: [Present] Developed

Circle One: [Tc] Tt through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.
Include map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

		Segment ID		
		AB		
1. Surface description (Table 3-1)		Short Grass		
2. Mannings roughness coeff., n (Table 3-1)		0.06		
3. Flow length, L (total L < 300 ft.)	ft	240		
4. Two-yr 24-hr rainfall, P2	in	3.50		
5. Calculated Land slope, s	ft/ft	0.016		
5a. Land Elevation For Upper End Of Flow Path		1348.0		
5b. Land Elevation For Lower End Of Flow Path		1344.1		
6. Compute Tt	hr	0.16	=	0.16

Sheet flow (Applicable to Tc only)

		Segment ID		
		BC		
1. Surface description (Table 3-1)		Concrete		
2. Mannings roughness coeff., n (Table 3-1)		0.017		
3. Flow length, L (total L < 300 ft.)	ft	320		
4. Two-yr 24-hr rainfall, P2	in	3.50		
5. Calculated Land slope, s	ft/ft	0.022		
5a. Land Elevation For Upper End Of Flow Path		1344.1		
5b. Land Elevation For Lower End Of Flow Path		1337.0		
6. Compute Tt	hr	0.07	=	0.07

Shallow concentrated flow

		Segment ID		
		CD		
7. Surface description (Paved or Unpaved)		Unpaved		
8. Flow length, L	ft	380		
9. Calculated Watercourse slope, s	ft/ft	0.024		
9a. Land Elevation For Upper End Of Flow Path		1337.0		
9b. Land Elevation For Lower End Of Flow Path		1328.0		
10. Average velocity, V (Figure 3-1)	ft/s	2.48		
11. Tt = L/3600V Compute Tt	hr	0.04	=	0.04

Channel Flow

		Segment ID		
12. Cross sectional flow area, a	sf			
13. Wetted perimeter, Pw	ft			
14. Hydraulic radius, r = a/Pw Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17 V = 1.49(r^0.667)(s^0.50)/n Compute V	ft/s			
18. Flow length, L	ft			
19. Tt = L/3600V Compute Tt	hr		=	0.00
20. Watershed or subarea Tc or Tt (add Tt in steps 6,11, and 19)			hr	0.27

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Use Time Of Concentration = 16 Minutes

Time of concentration (Tc) or travel time (Tt)

Project : Wichita Regional Fire Training Addition **By:** ABB **Date:** 1/28/2009
Location : Wichita, Kansas **Checked:** **Date:**

Circle One: [Present] Developed

Circle One: [Tc] Tt through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.
Include map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

		Segment ID		
		AC		
1. Surface description (Table 3-1)		Concrete		
2. Mannings roughness coeff., n (Table 3-1)		0.017		
3. Flow length, L (total L < 300 ft.)	ft	560		
4. Two-yr 24-hr rainfall, P2	in	3.50		
5. Calculated Land slope, s	ft/ft	0.020		
5a. Land Elevation For Upper End Of Flow Path		1348.0		
5b. Land Elevation For Lower End Of Flow Path		1337.0		
6. Compute Tt	hr	0.11	=	0.11

Shallow concentrated flow

		Segment ID		
		CD		
7. Surface description (Paved or Unpaved)		Unpaved		
8. Flow length, L	ft	380		
9. Calculated Watercourse slope, s	ft/ft	0.024		
9a. Land Elevation For Upper End Of Flow Path		1337.0		
9b. Land Elevation For Lower End Of Flow Path		1328.0		
10. Average velocity, V (Figure 3-1)	ft/s	2.48		
11. Tt = L/3600V Compute Tt	hr	0.04	=	0.04

Channel Flow

		Segment ID		
12. Cross sectional flow area, a	sf			
13. Wetted perimeter, Pw	ft			
14. Hydraulic radius, r = a/Pw Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17 V = 1.49(r^0.667)(s^0.50)/n Compute V	ft/s			
18. Flow length, L	ft			
19. Tt = L/3600V Compute Tt	hr		=	0.00
20. Watershed or subarea Tc or Tt (add Tt in steps 6,11, and 19)			hr	0.15

Reference: Urban Hydrology for Small Watersheds
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Use Time Of Concentration = 9 Minutes