
651.1070 Appendix 10C—Runoff From Feedlots and Evaporation

(a) Runoff

Runoff must be handled if feedlots or other components of the livestock production unit are exposed to the weather. Contaminated runoff should be collected in settling basins and storage ponds.

A paved or surfaced feedlot typically has a runoff curve number (RCN) of about 97; an RCN of 90 is representative of an unpaved or unsurfaced feedlot. Based on these RCN's, the amount of runoff from feedlots can be estimated as a percentage of the precipitation that is expected over a period of time.

Figures 10C-1 and 10C-2 describe for the continental United States the percentage of annual precipitation that will occur as runoff from unsurfaced and surfaced feedlots, respectively. Figures 10C-3 through 10C-14 describe the percentage of monthly precipitation that will occur as runoff from unsurfaced feedlots. Figures 10C-15 through 10C-26 describe the percentage of monthly precipitation that will occur as runoff from surfaced feedlots.

Other available sources give the annual or monthly precipitation data to which the runoff percentages are applied. One such source is "Climatography of the United States No. 81 (by state) Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1941-70," prepared by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service. Another source available in many counties is the local soil survey, which contains a section on climatic data.

The runoff percentage from figures 10C-1 through 10C-26 is multiplied by the precipitation from the corresponding time period to determine the amount of runoff. This is the runoff volume (ROV) value used in several of the worksheets in chapter 10.

Design example 10C-1—Runoff from a concrete feedlot

Determine the annual runoff from a concrete feedlot near Portland, Oregon. From the reference cited, the mean annual precipitation is 37.6 inches. From figure 10C-2, the annual runoff is 49 percent of the precipitation. Therefore, the annual ROV = (37.6 in. x 0.49) = 18.4 inches.

Design example 10C-2—Runoff from an earth feedlot

Determine the runoff to be expected from an earth feedlot near Dallas, Texas, for the period October to March.

Month	Precip. (inches)	Runoff %	Runoff (inches)
Oct.	3.18	36	1.14
Nov.	2.60	27	0.70
Dec.	2.34	24	0.56
Jan.	1.96	20	0.39
Feb.	2.57	20	0.51
Mar.	3.04	22	0.67
Total			3.97

(b) Evaporation

Storage and treatment facilities require an allowance for precipitation less evaporation for the most critical design period. For example, for a 90-day storage period, an allowance for storage is planned using the three successive months that result in the greatest sum of precipitation less evaporation that is critical.

Some ponds or structures, especially those containing dairy manure and straw bedding, develop a crust on the surface, and evaporation may be limited. This will vary among areas and individual farms. For a conservative design when crusting is anticipated, the allowance evaporation in the pond sizing can be omitted.

Local records are almost always available for the average monthly precipitation for each month of the year. Local records may also be available for average monthly evaporation. If evaporation data are not readily available, however, the annual free water surface evaporation (shallow lake evaporation) may be determined using figure 10C-27. Monthly free water surface evaporation may be determined using table 10C-1, which gives the approximate mean monthly percent of the annual evaporation for selected stations in the continental United States.

Table 10C-1 was developed for use in obtaining monthly evaporation for selected stations from annual Class A pan evaporation maps. This table is to be used

on free water surface maps. Although the information in this table is not completely correct, the monthly percentages are adequate for estimating free water surface evaporation. Several other factors prevent an exact correlation between evaporation from waste storage ponds and lagoon surfaces and Class A pan evaporation. Factors causing differences include effects of salinity, coloration, and floating surface material, such as bedding, on evaporation rates.

Worksheet 10A-6 can be used to determine the monthly precipitation less evaporation value for each month.

Design example 10C-3

Mr. Austin Peabody of Rocky Mount, North Carolina, has selected an alternative for an agricultural waste management system that includes a waste storage pond. Designing the depth of the pond requires that an allowance for containing the precipitation evaporation minus evaporation for the storage period be determined. Using worksheet 10A-6, determine the precipitation less evaporation value to use for a 180-day storage period.

- The annual FWS evaporation (FWS) is selected from figure 10C-27.
- The monthly precipitation (MP) values are selected from local data.
- The monthly portion of annual evaporation (MPAE) is determined using the appropriate station in table 10C-1.
- The monthly evaporation (ME) is computed by the equation:

$$ME = FWS \times MPAE$$

- The monthly precipitation less evaporation (MPLE) is determined by the equation:

$$MPLE = MP - ME$$

- The 180-day storage period is about 6 months; therefore, the successive 6 months that are critical are determined by inspection. For this example, the storage period is September through February.

- The total precipitation less evaporation depth that must be accommodated in the waste storage pond is the sum of monthly values for September through February.

Completed worksheet for design example 10C-3**Worksheet 10A-6 – Monthly precipitation minus evaporation**

Decisionmaker: Austin Peabody			Date:	
Site:				
Annual FWS Evaporation (FWS)= <u>39</u> inches				
Month	Monthly precipitation MP (inches)	Monthly portion of annual evaporation MPAE (percent)	Monthly evaporation ME (inches)*	Monthly precipitation less evaporation MPLE (inches)
January	<u>3.53</u>	<u>3</u>	<u>1.17</u>	<u>2.36</u>
February	<u>3.71</u>	<u>5</u>	<u>1.95</u>	<u>1.76</u>
March	<u>3.49</u>	<u>8</u>	<u>3.12</u>	<u>0.37</u>
April	<u>3.50</u>	<u>10</u>	<u>3.90</u>	<u>-0.40</u>
May	<u>3.61</u>	<u>12</u>	<u>4.68</u>	<u>-1.07</u>
June	<u>4.47</u>	<u>13</u>	<u>5.07</u>	<u>-0.60</u>
July	<u>5.58</u>	<u>13</u>	<u>5.07</u>	<u>0.51</u>
August	<u>4.45</u>	<u>12</u>	<u>4.68</u>	<u>-0.23</u>
September	<u>3.95</u>	<u>9</u>	<u>3.15</u>	<u>0.44</u>
October	<u>2.79</u>	<u>7</u>	<u>2.73</u>	<u>0.06</u>
November	<u>2.24</u>	<u>5</u>	<u>1.95</u>	<u>0.29</u>
December	<u>3.49</u>	<u>3</u>	<u>1.17</u>	<u>2.32</u>
*ME = FWS x MPAE				
Storage or treatment period, days (D) = <u>180</u>				
months = <u>6</u>				
Critical successive months				
Month	Monthly precipitation less evaporation MPLE (inches)	Month	Monthly precipitation less evaporation MPLE (inches)	
<u>SEPT</u>	<u>0.44</u>	<u> </u>	<u> </u>	
<u>Oct</u>	<u>0.06</u>	<u> </u>	<u> </u>	
<u>NOV</u>	<u>0.29</u>	<u> </u>	<u> </u>	
<u>DEC</u>	<u>2.32</u>	<u> </u>	<u> </u>	
<u>JAN</u>	<u>2.36</u>	<u> </u>	<u> </u>	
<u>FEB</u>	<u>1.76</u>	<u> </u>	<u> </u>	
Total			<u>7.2 inches</u>	

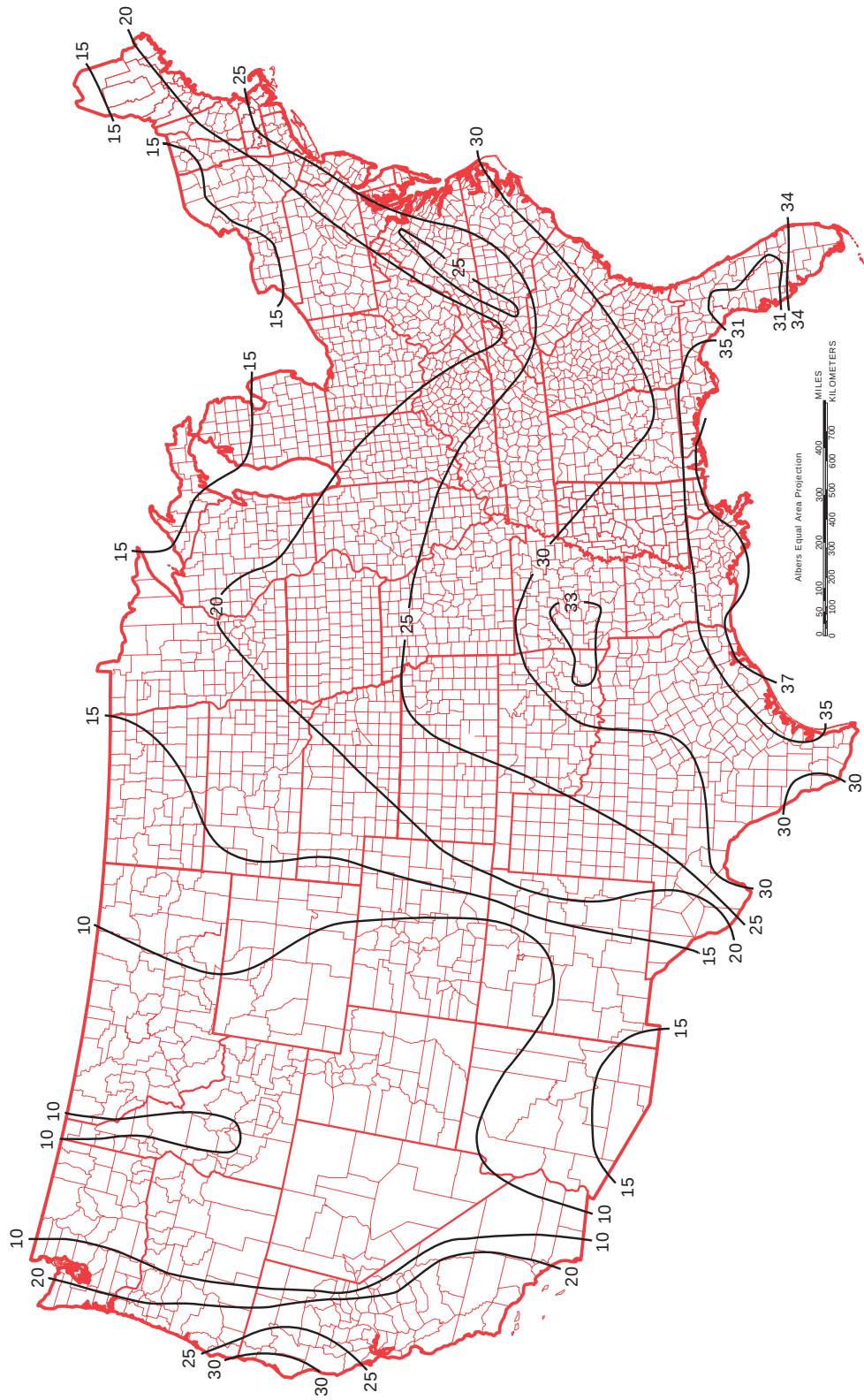
Table 10C-1 Adjusted approximate mean monthly free water surface evaporation for selected stations

Station name	Lat. Long -		Percent of annual													

	----- May Nov															
	thru	thru	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Oct	Apr
Fairhope, AL	30°32'	87°55'	4	5	7	10	12	13	12	11	9	8	5	4	65	35
Bartlett Darn, AZ	33°49'	111°38'	3	4	6	9	12	14	14	11	10	8	5	4	69	31
Bacus Ranch, CA	34°57'	118°11'	3	3	7	9	11	14	15	15	10	7	3	3	72	28
Sacramento, CA			2	3	6	8	12	15	16	15	11	7	3	2	76	24
Wagon Wheel Gap, CO	37°48'	106°58'						14	16	14	12	11	7		74	26
Hartford, CT			3	3	6	10	13	14	15	14	9	6	4	3	71	29
Tantiami Trail, FL	25°45'	80°50'	5	6	9	10	11	10	11	10	9	8	6	5	59	41
Experiment, GA	33°16'	84°17'	4	5	7	10	12	13	13	11	9	7	5	4	65	35
Moscow, U of 1, ID	46°44'	116°58'				7	12	14	19	18	12	6			81	19
Pocatello, ID			2	2	6	8	12	15	19	14	11	6	3	2	77	23
Ames, IA	42°00'	98°39'				10	15	16	15	13	9	8	3		76	24
Toronto Darn, KS	37°45'	95°56'	2	3	7	10	13	13	15	14	9	8	4	2	72	28
Tribune, KS	38°28'	101°46'				9	12	14	16	14	10	7			73	27
Madisonville, KY	37°19'	87°29'				11	13	14	14	13	10	8			72	28
Urbana, IL	40°06'	88°14'				9	13	15	15	14	10	7	4		75	25
Woodworth S. F., LA	31°08'	92°28'	3	4	7	9	12	13	13	13	9	8	5	4	68	32
Caribou, ME	46°52'	68°01'	2	3	5	8	15	16	16	14	9	7	3	2	77	23
Rochester, MA	41°47'	70°55'				8	13	15	15	13	9	5			70	30
E.Lansing Hort Fin, MI	42°43'	84°28'				9	14	15	16	14	10	6	2		75	25
Scott, MS	33°36'	91°05'	3	4	7	10	13	14	13	12	9	7	5	3	68	32
Weldon Spr. Fin, MO	38°42'	90°44'				10	12	14	14	13	11	8	4		72	28
Bozeman Agr. C., MT	45°40'	111°09'				8	12	14	19	17	10	6			78	22
Medicine Ck Darn, NE	40°23'	100°13'				10	12	14	15	14	11	8			74	26
Boulder City, NV	35°59'	114°51'	3	4	6	9	12	14	15	13	10	7	4	3	71	29
Topaz Lake, NV	38°41'	119°02'				8	12	14	16	14	11	7	3		74	26
Elephant Bte Dam, NM	33°09'	107°11'	3	4	8	11	14	15	12	11	8	7	4	3	67	33
El Vado Dam, NM	36°36'	106°44'			10	10	15	14	15	12	9	6			71	29
Aurora Res Fin, NY	42°44'	76°39'					13	15	17	14	10	7			76	24
Chapel Hill, NC	25°55'	79°06'	3	5	8	10	12	13	13	12	9	7	5	3	66	34
Wooster Exp Sta, OH	40°47'	81°36'				9	13	15	15	14	10	7			74	26
Canton Dam, OK	36°05'	98°36'	3	4	7	10	11	13	14	14	9	7	5	3	68	32
Detroit Pwr. Hse, OR	44°43'	122°15'	1	2	4	7	12	15	22	18	11	5	2	1	83	17
Redfield, SD	44°53'	98°23'				10	13	15	17	16	11	7			79	21
Neptune, TN	36°19'	87°11'	2	4	7	11	12	14	14	13	9	7	4	3	69	31
Grapevine, TX	32°58'	97°03'	3	4	7	9	10	12	15	14	10	7	5	4	68	32
Welasco, TX	26°09'	97°48'	4	5	7	9	11	11	13	13	10	7	6	4	65	35
Utah Lake, UT	40°22'	111°54'			6	9	13	15	18	15	11	7			79	21
Templeau Darn, WI	44°00'	91°26'					14	16	16	14	10	8			78	22
Heart Mountain, WY	44°41'	108°57'				7	13	14	16	15	10	6			74	26

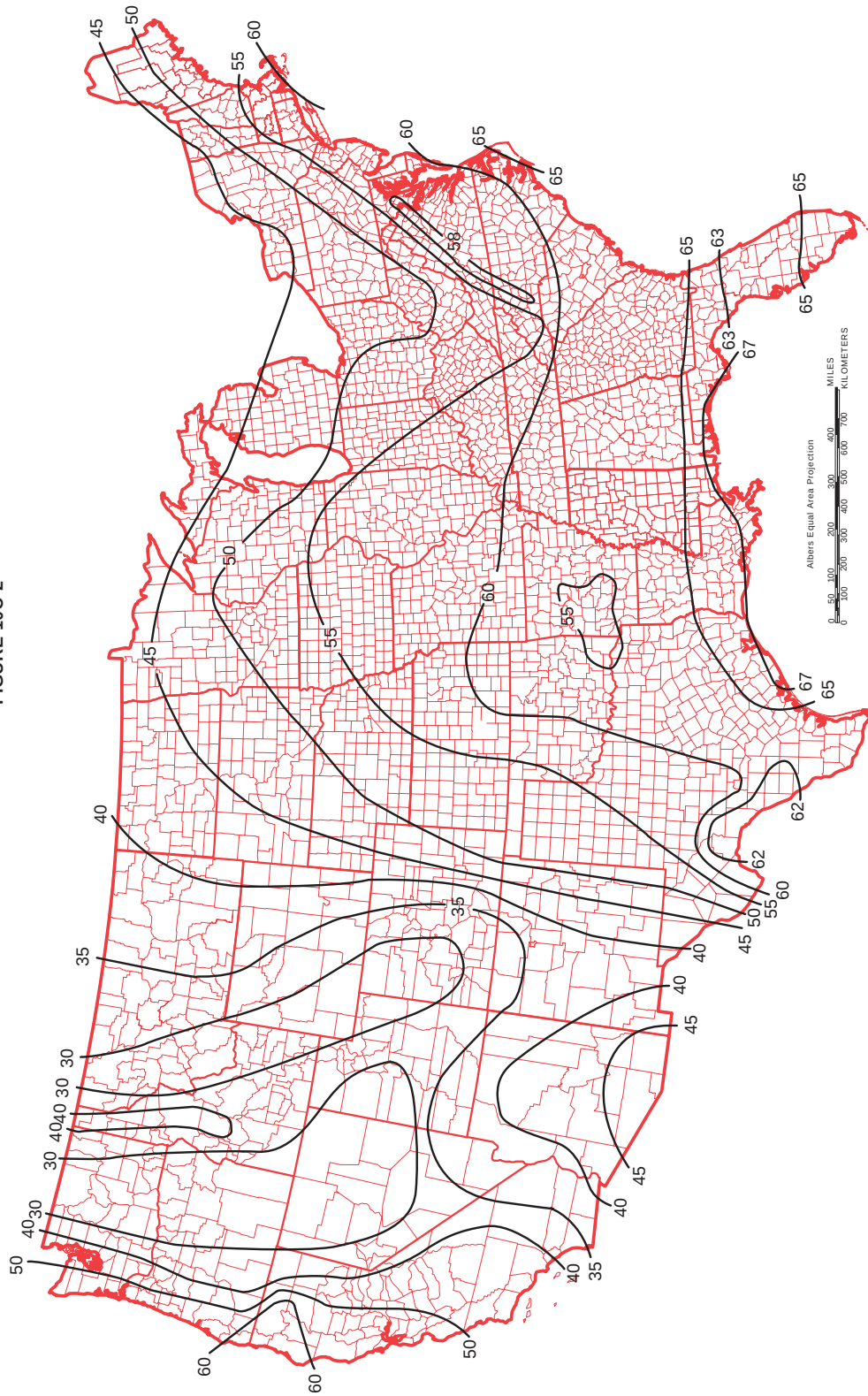
Source: Adapted from Evaporation Atlas for the Contiguous 48 United States, NOAA Technical Report NWS 33, Table 3-Adjusted mean monthly Class A pan evaporation for selected stations, 1956-70.

ANNUAL RUNOFF FROM UNSURFACED FEEDLOTS (CN-90) AS PERCENT OF MEAN ANNUAL PRECIPITATION FIGURE 10C-1



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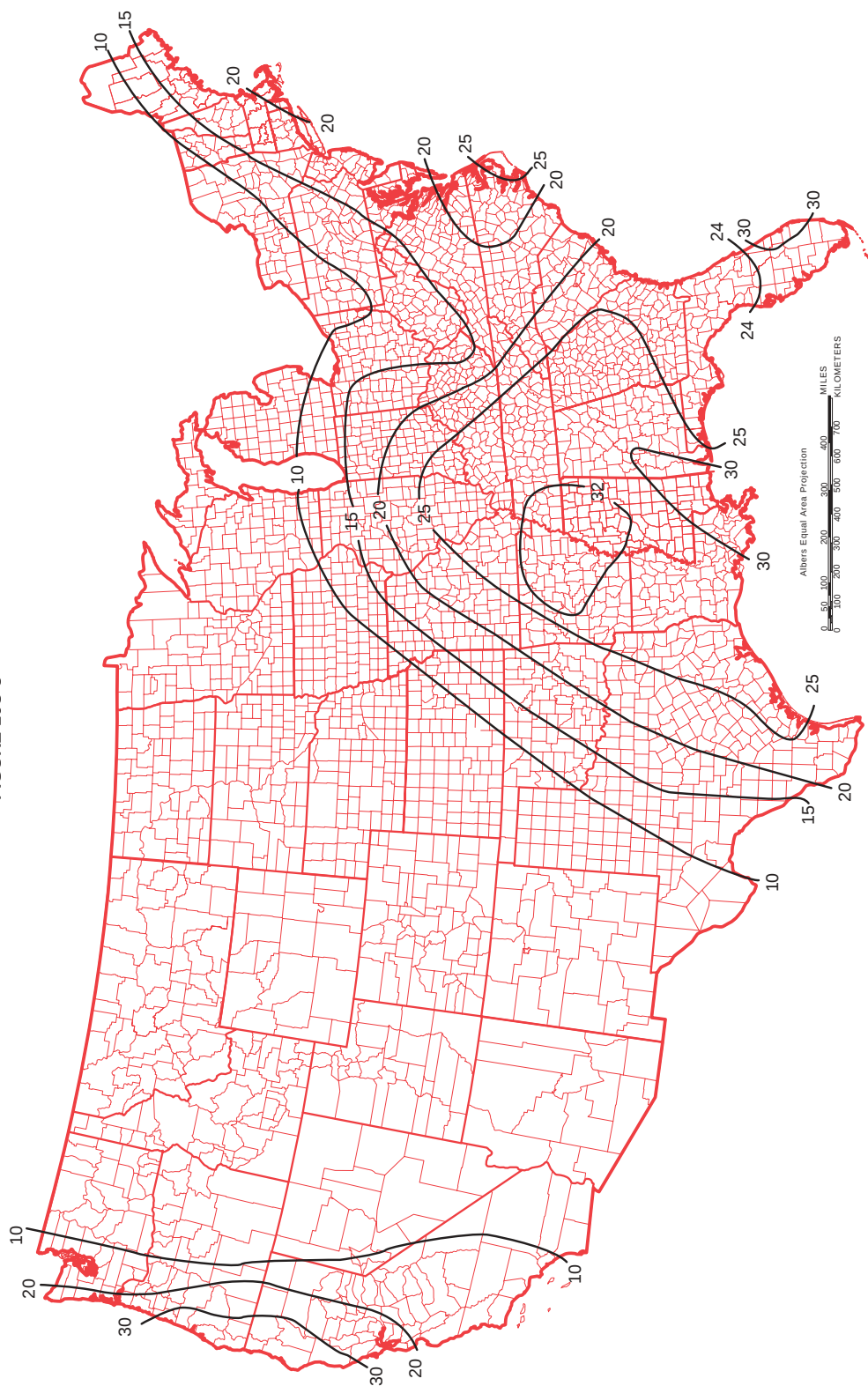
**ANNUAL RUNOFF
FROM CONCRETE FEEDLOTS (CN-97) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-2



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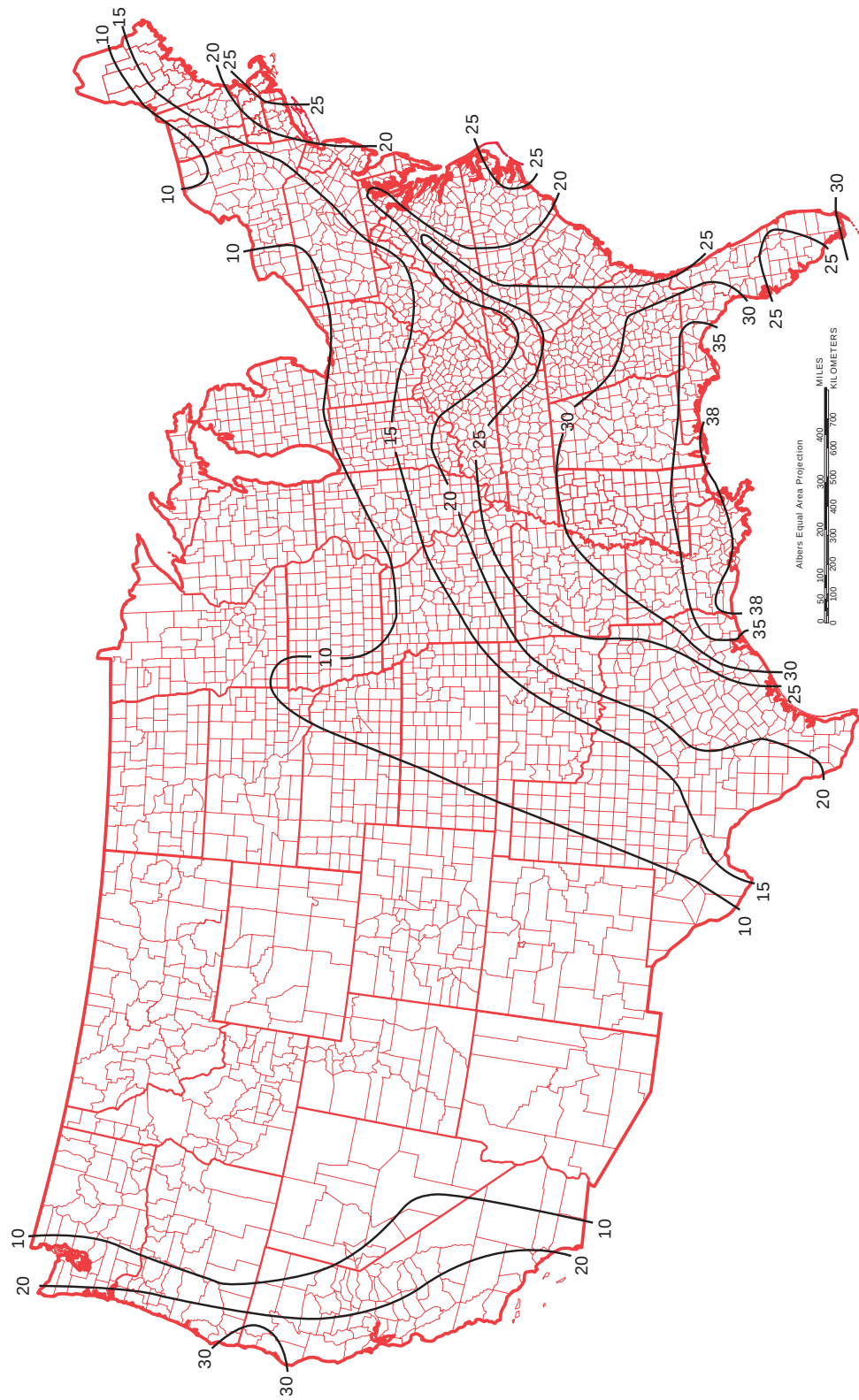
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**JANUARY RUNOFF
FROM UNSURFACED FEEDLOTS (CN-90) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-3



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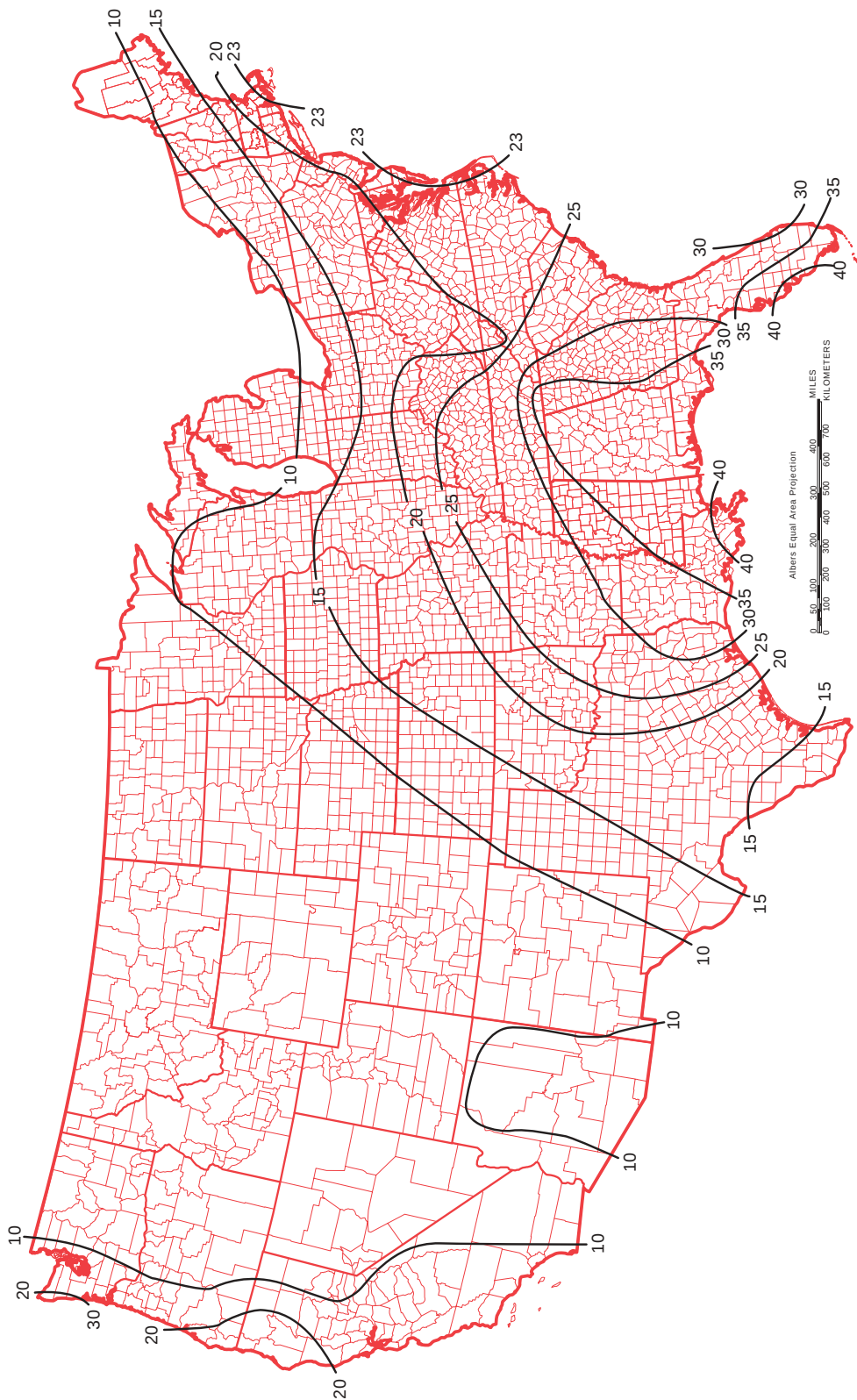
**FEBRUARY RUNOFF
FROM UNSURFACED FEEDLOTS (CN-90) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-4



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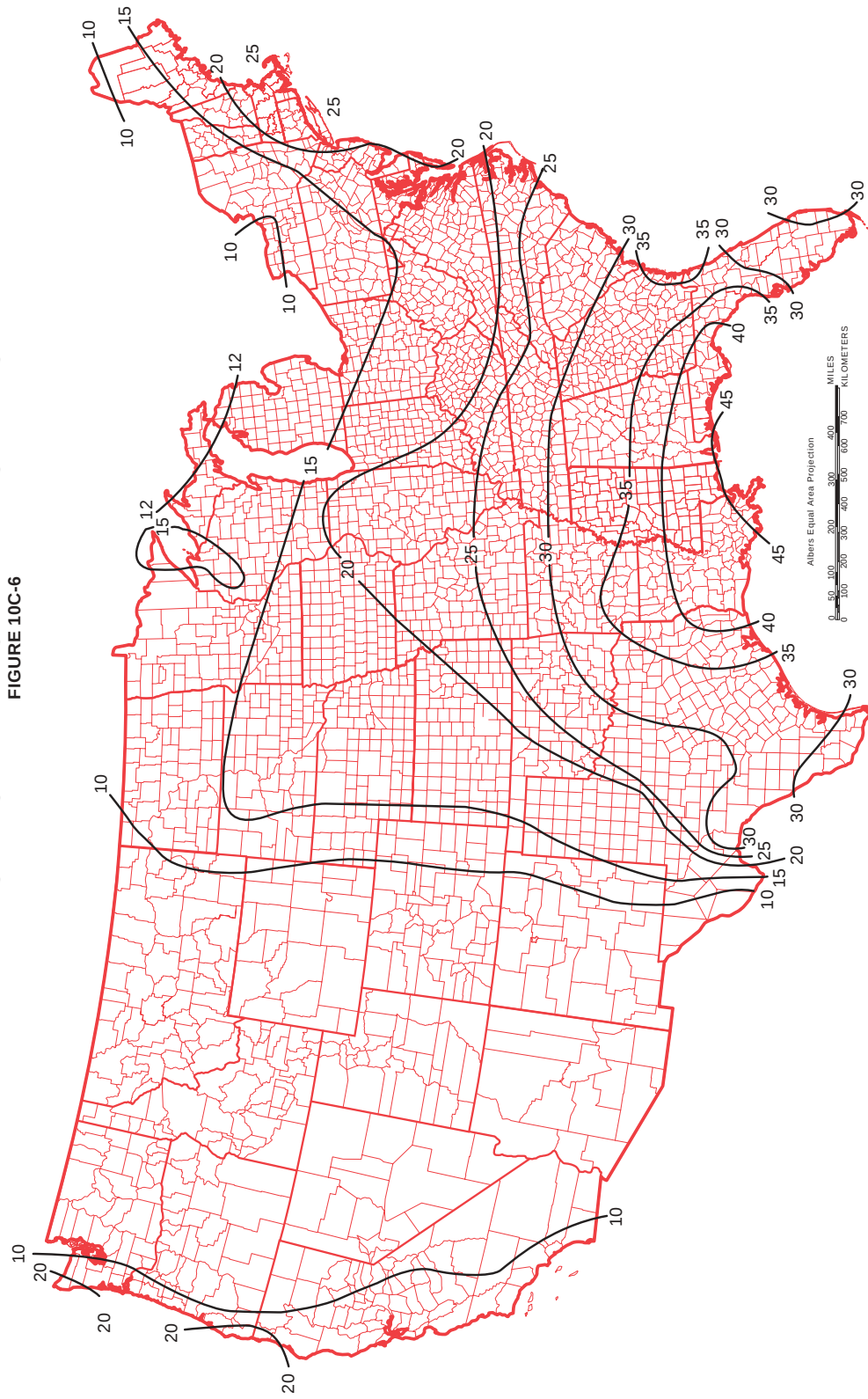
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**MARCH RUNOFF
FROM UNSURFACED FEEDLOTS (CN-90) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-5



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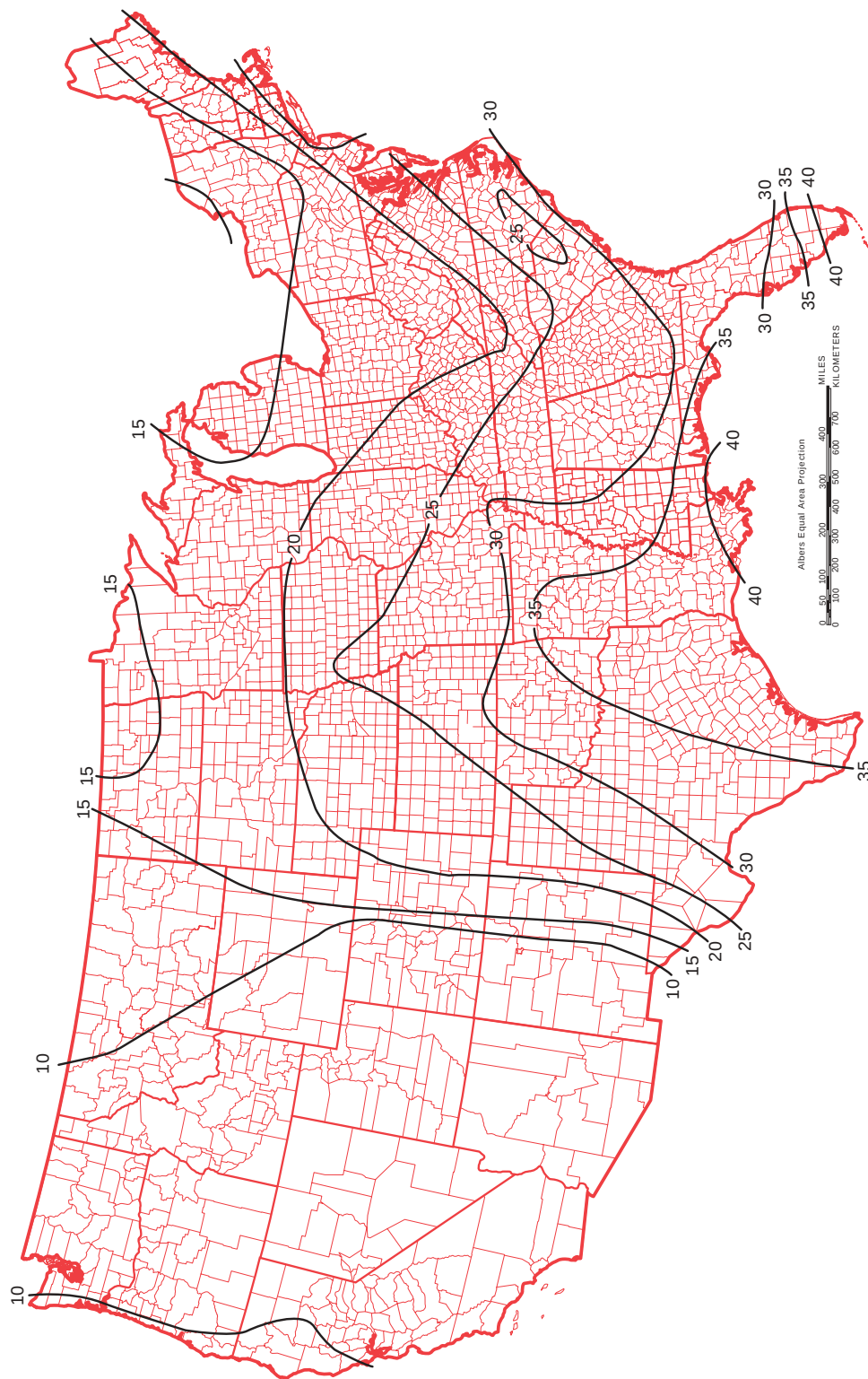
APRIL RUNOFF **FROM UNSURFACED FEEDLOTS (CN-90) AS** **PERCENT OF MEAN MONTHLY PRECIPITATION** FIGURE 10C-6



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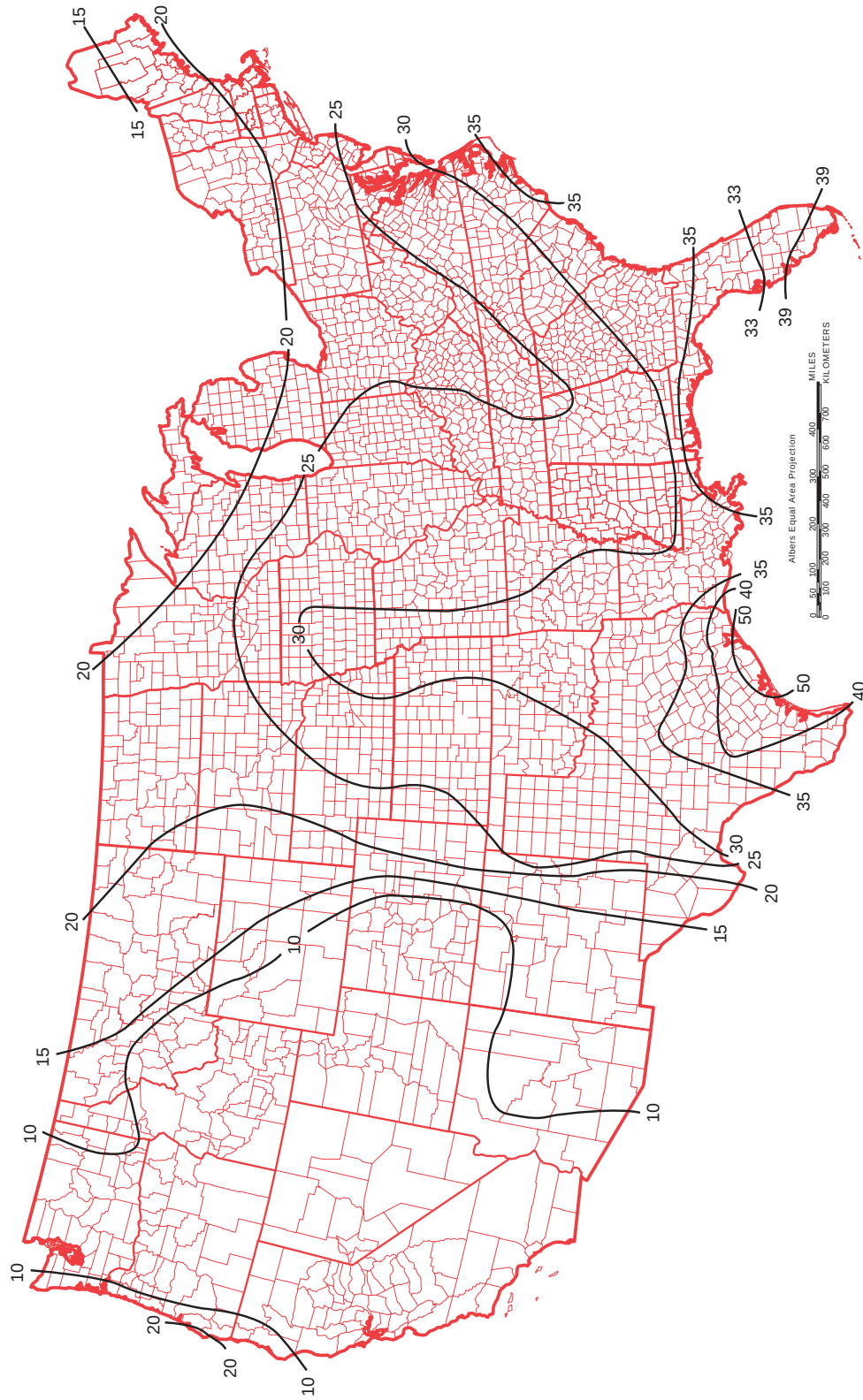
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**APRIL RUNOFF
FROM UNSURFACED FEEDLOTS (CN-90) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-7



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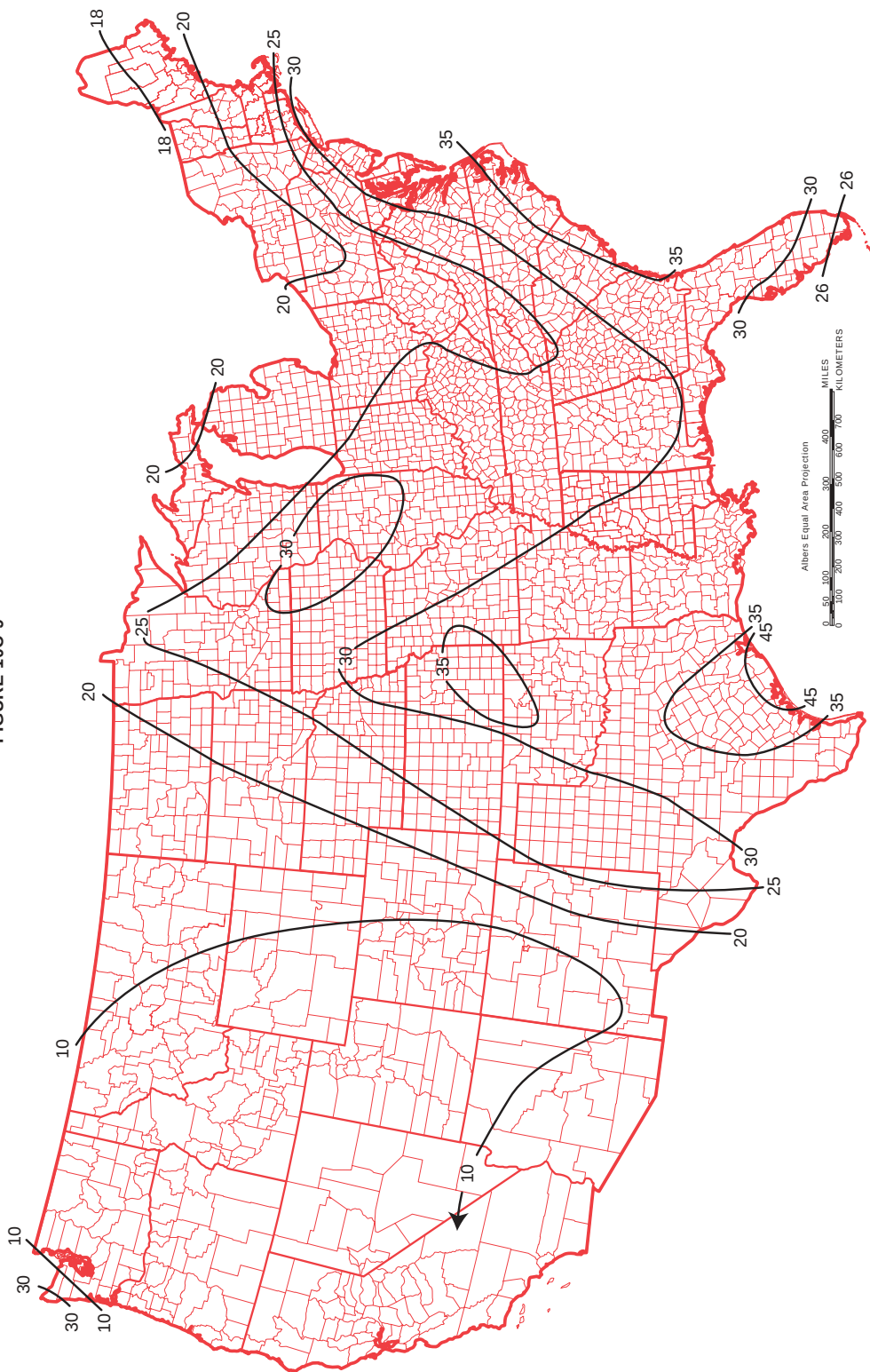
JUNE RUNOFF FROM UNSURFACED FEEDLOTS (CN-90) AS PERCENT OF MEAN MONTHLY PRECIPITATION FIGURE 10C-8



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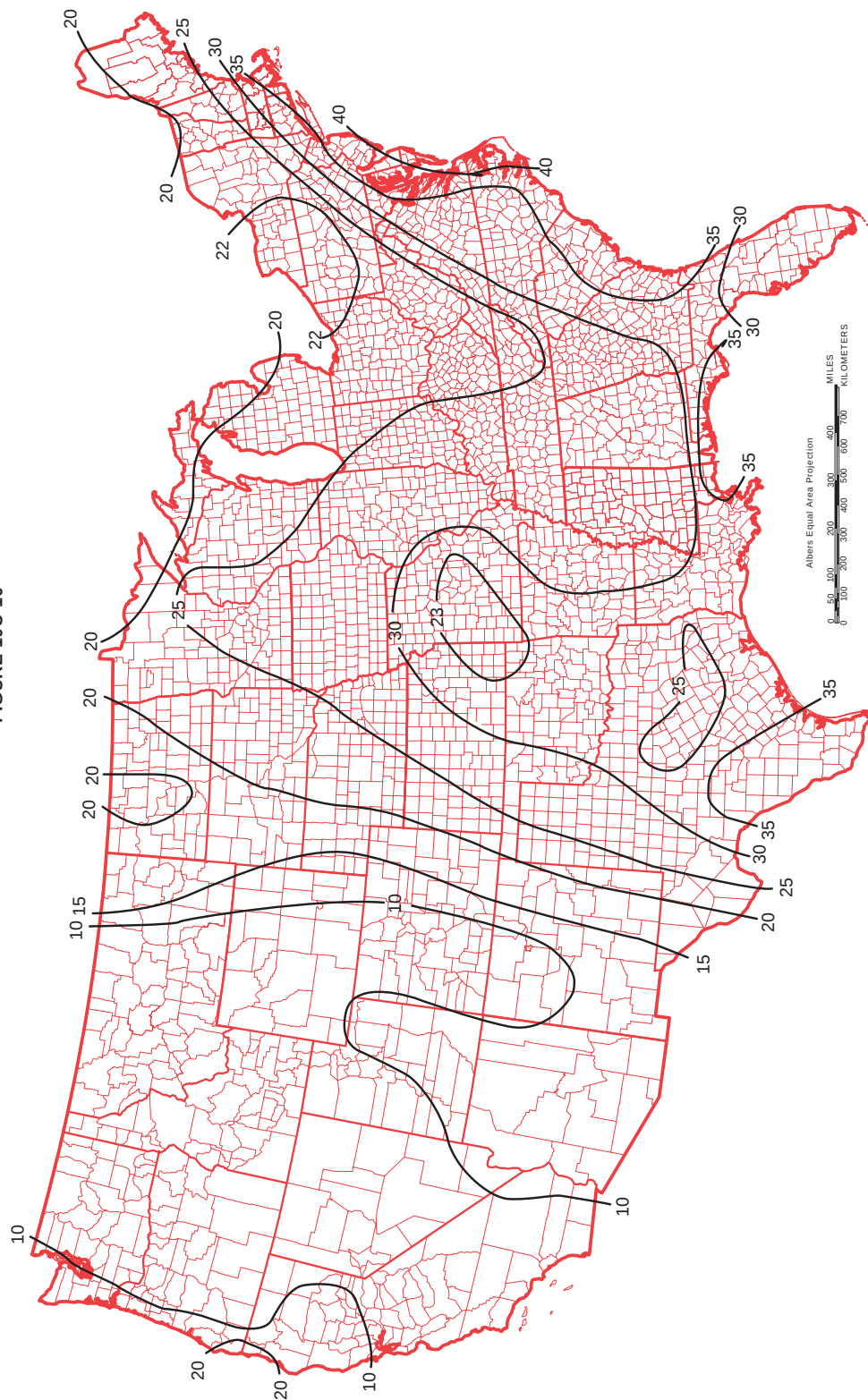
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**JULY RUNOFF
FROM UNSURFACED FEEDLOTS (CN-90) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-9



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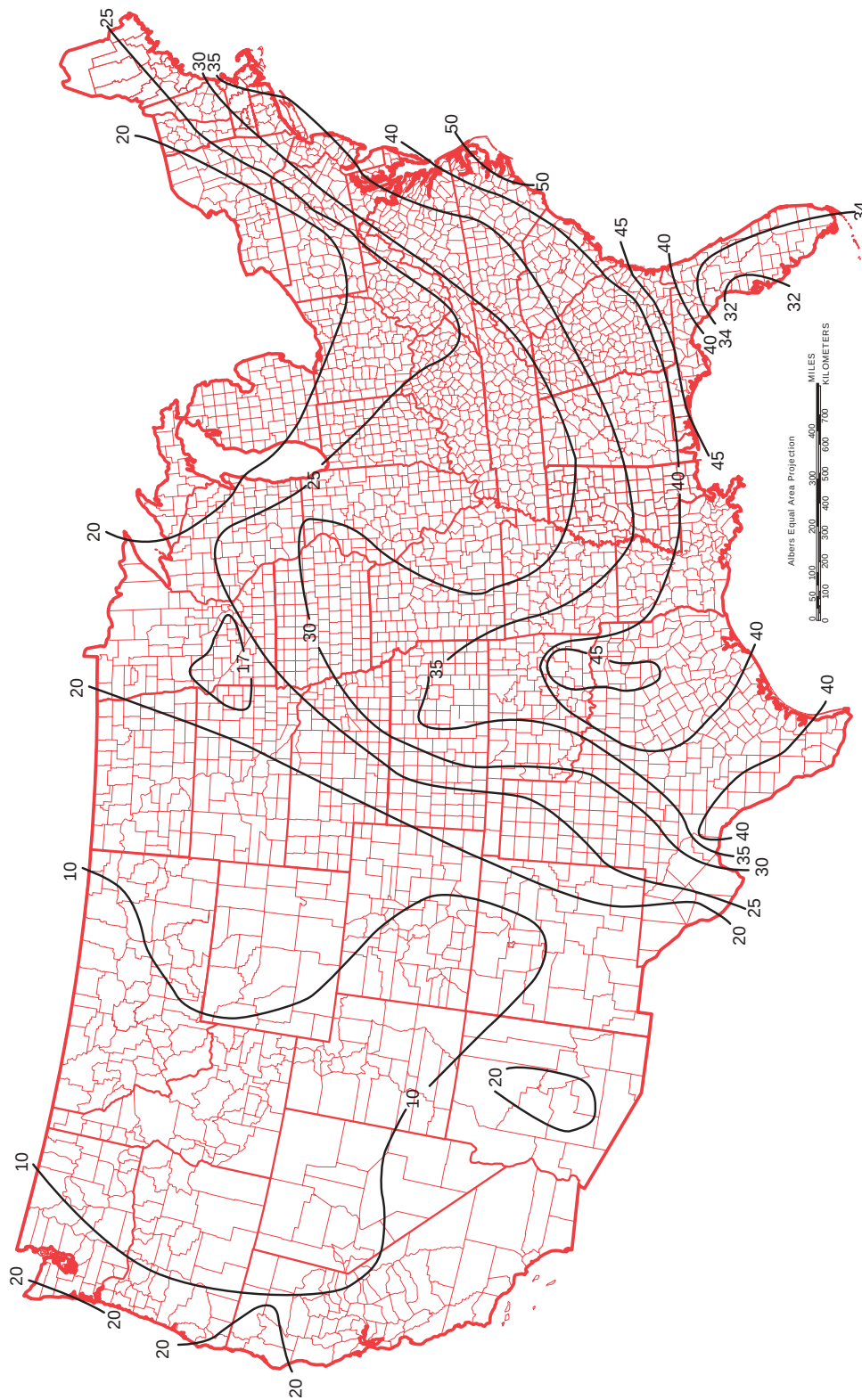
**AUGUST RUNOFF
FROM UNSURFACED FEEDLOTS (CN-90) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-10



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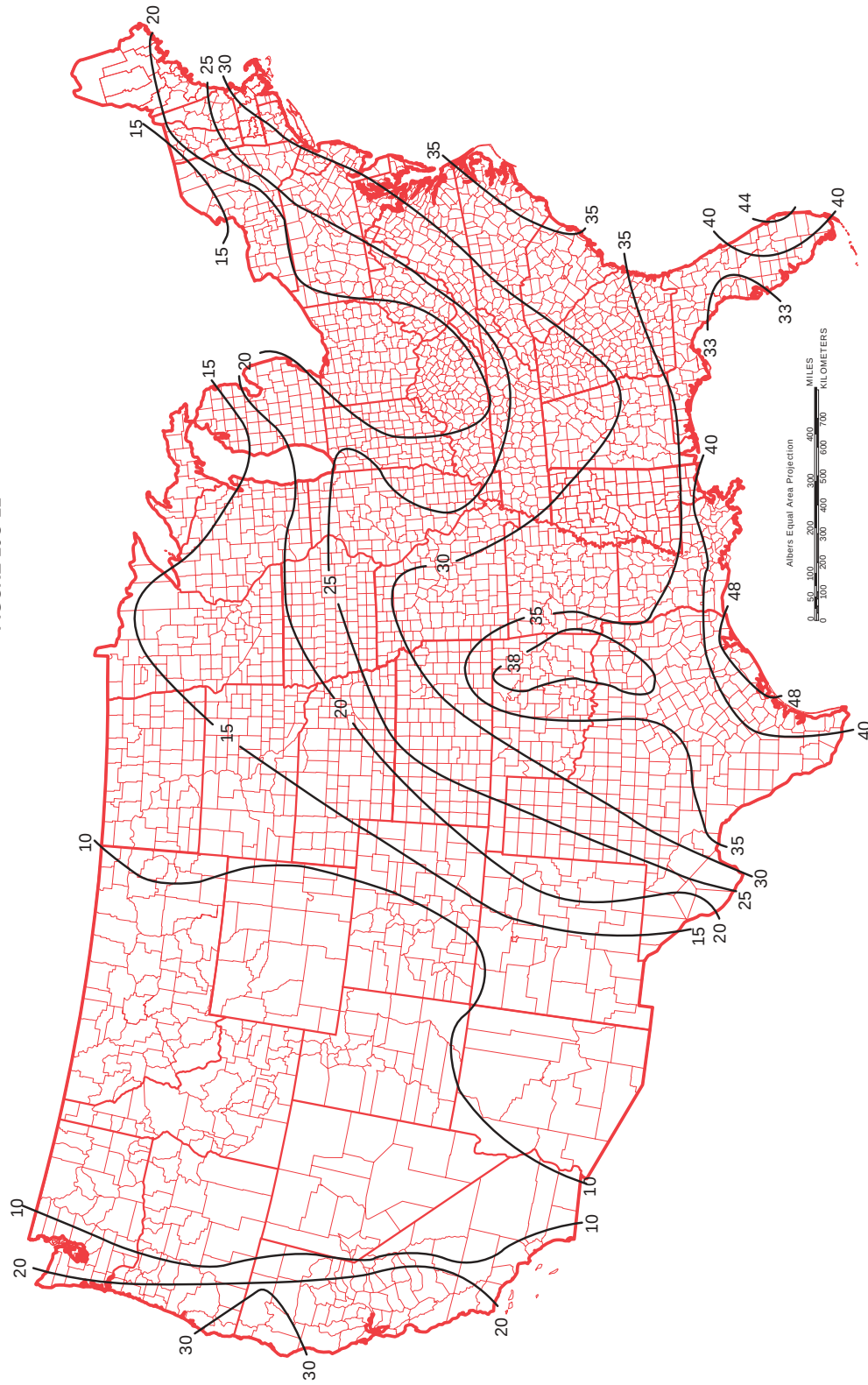
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SEPTEMBER RUNOFF FROM UNSURFACED FEEDLOTS (CN-90) AS PERCENT OF MEAN MONTHLY PRECIPITATION FIGURE 10C-11



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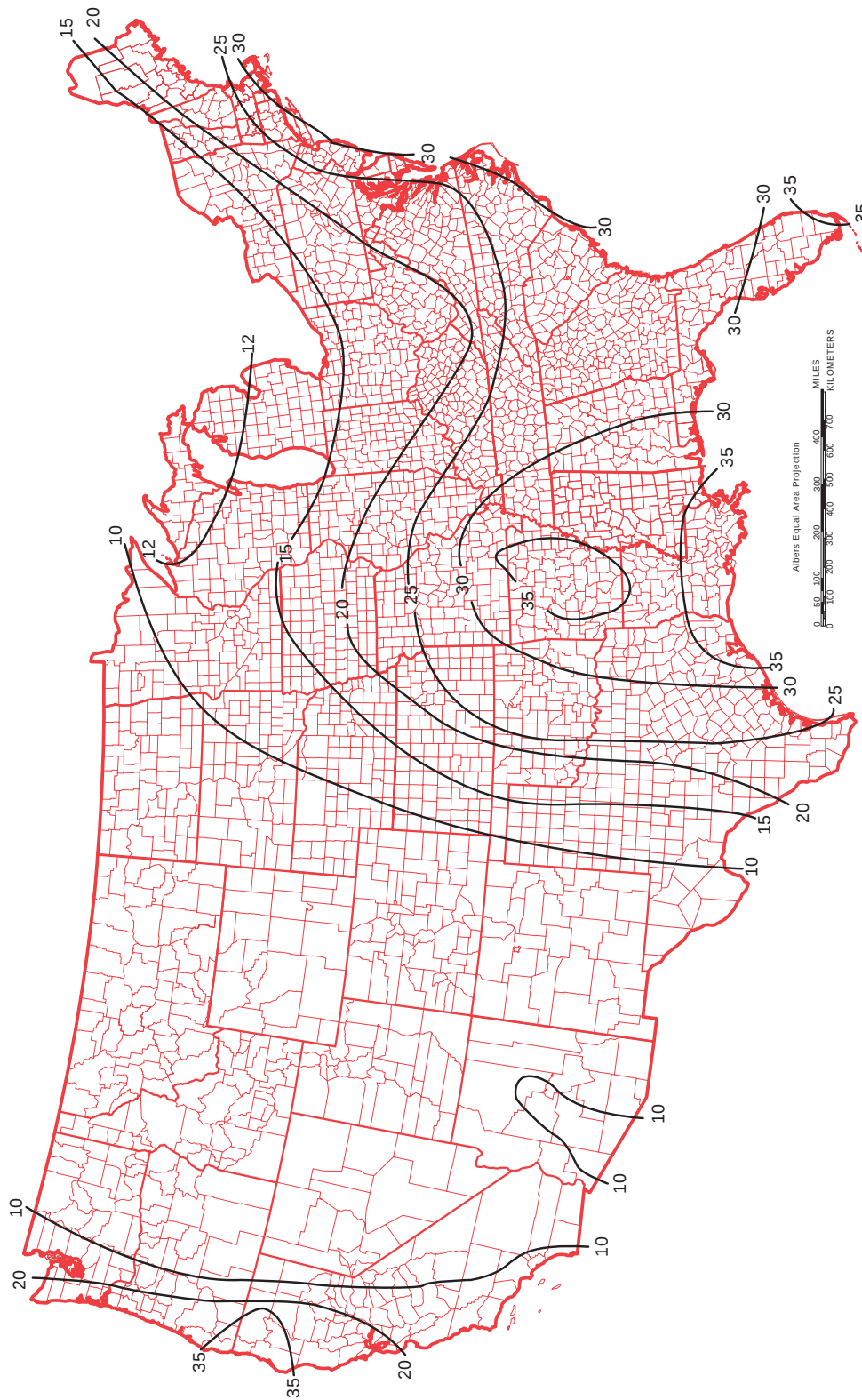
**OCTOBER RUNOFF
FROM UNSURFACED FEEDLOTS (CN-90) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-12



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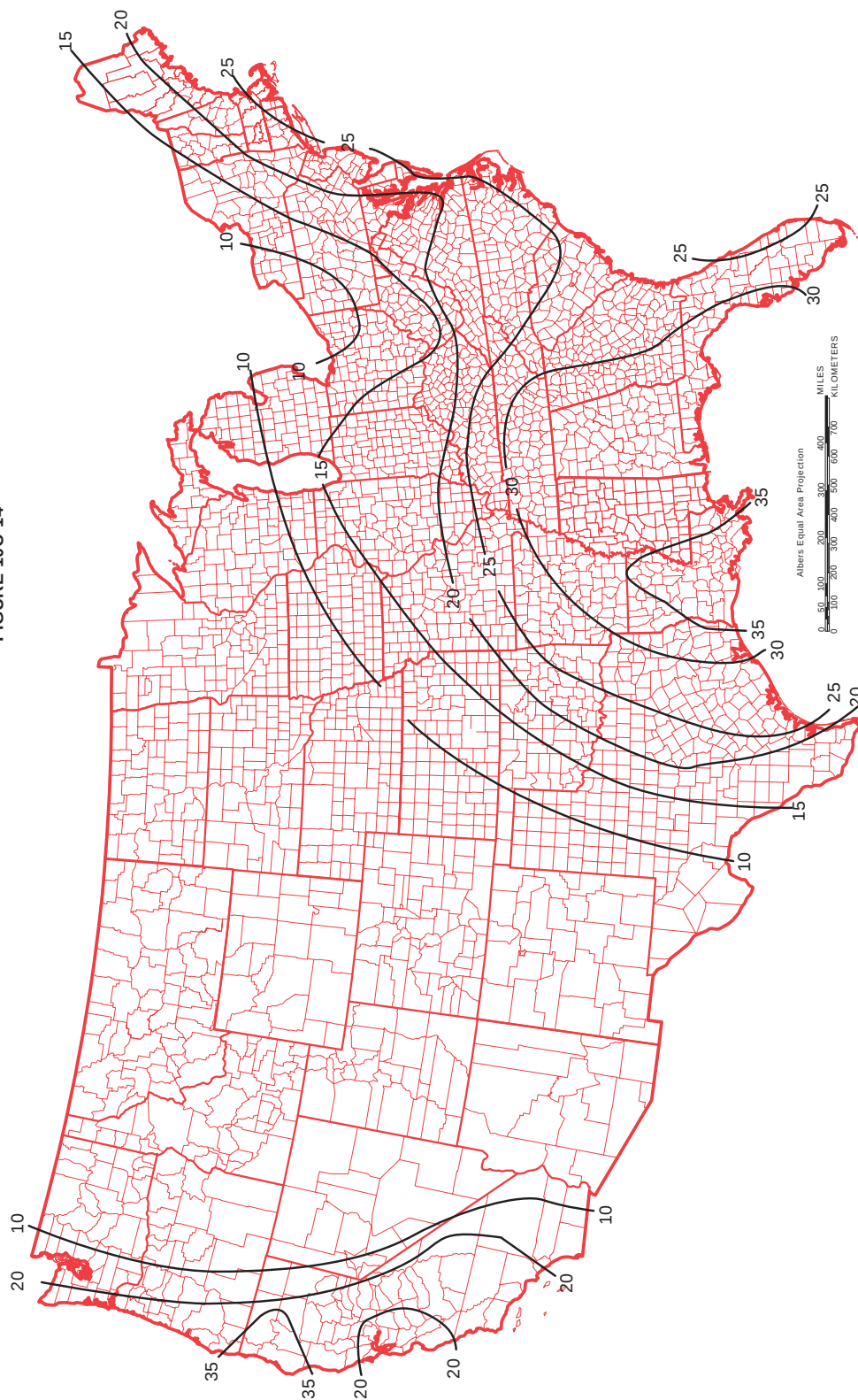
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NOVEMBER RUNOFF FROM UNSURFACED FEEDLOTS (CN-90) AS PERCENT OF MEAN MONTHLY PRECIPITATION FIGURE 10C-13



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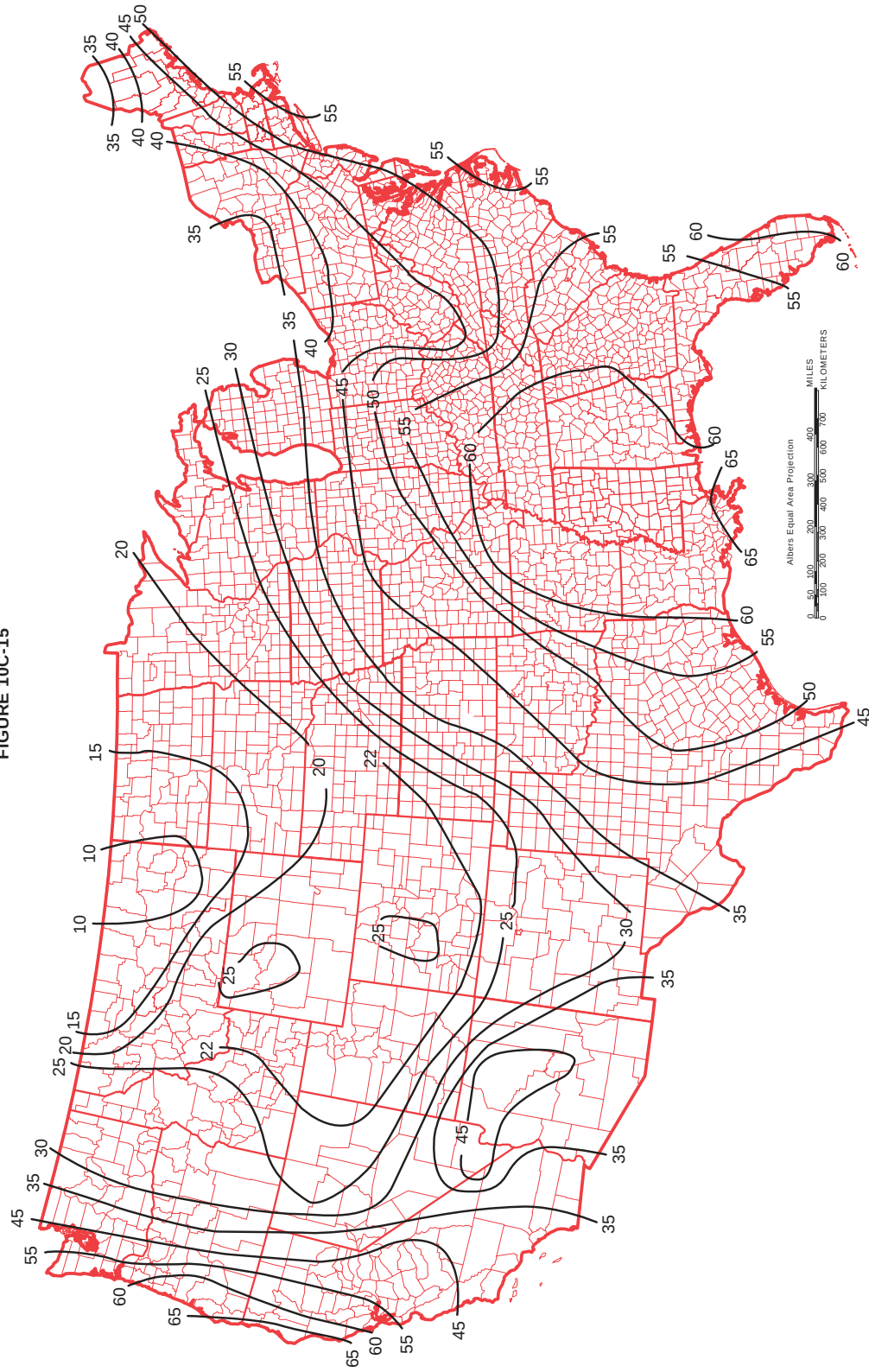
DECEMBER RUNOFF FROM UNSURFACED FEEDLOTS (CN-90) AS PERCENT OF MEAN MONTHLY PRECIPITATION FIGURE 10C-14



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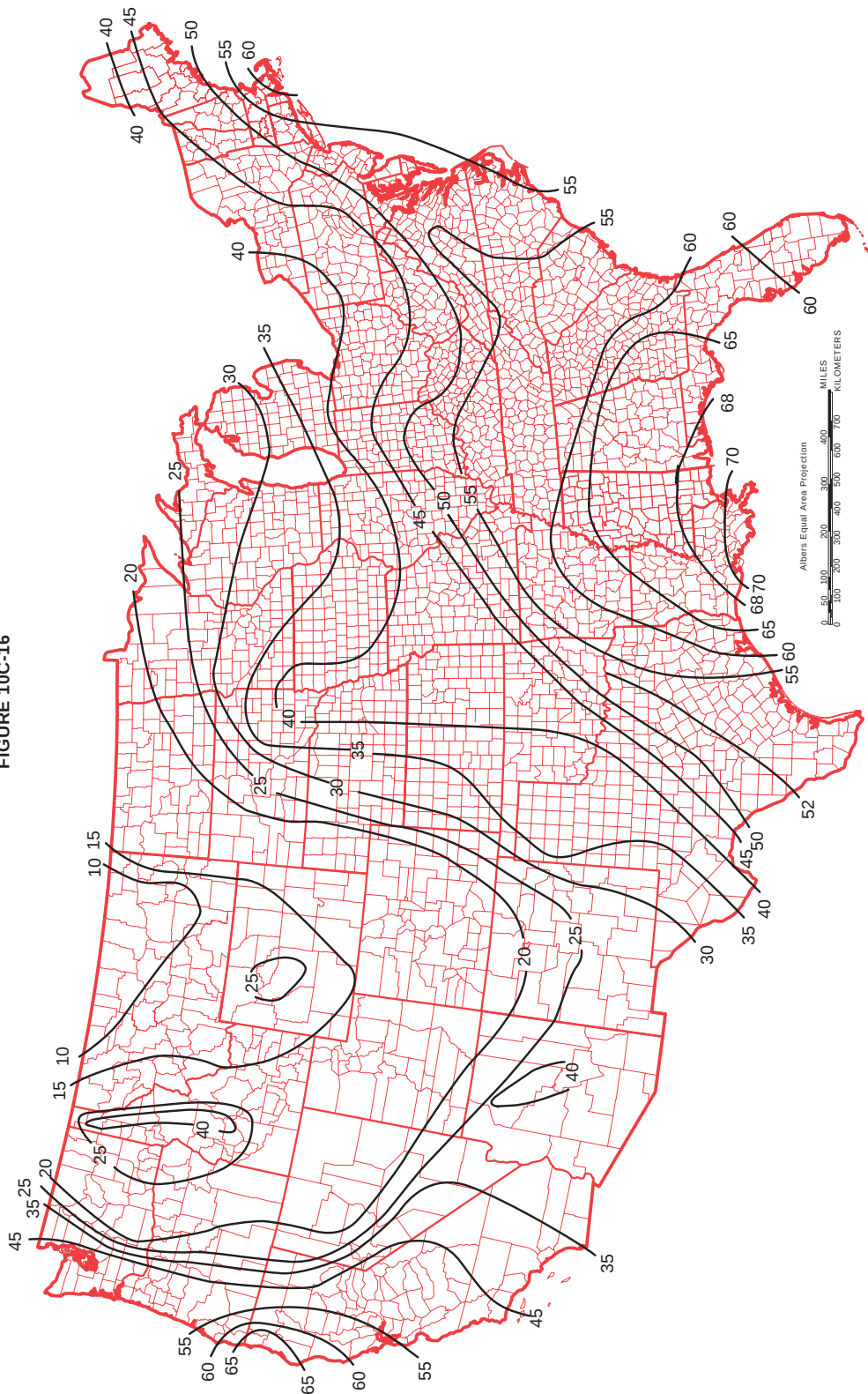
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JANUARY RUNOFF FROM CONCRETE FEEDLOTS (CN-97) AS PERCENT OF MEAN MONTHLY PRECIPITATION **FIGURE 10C-15**



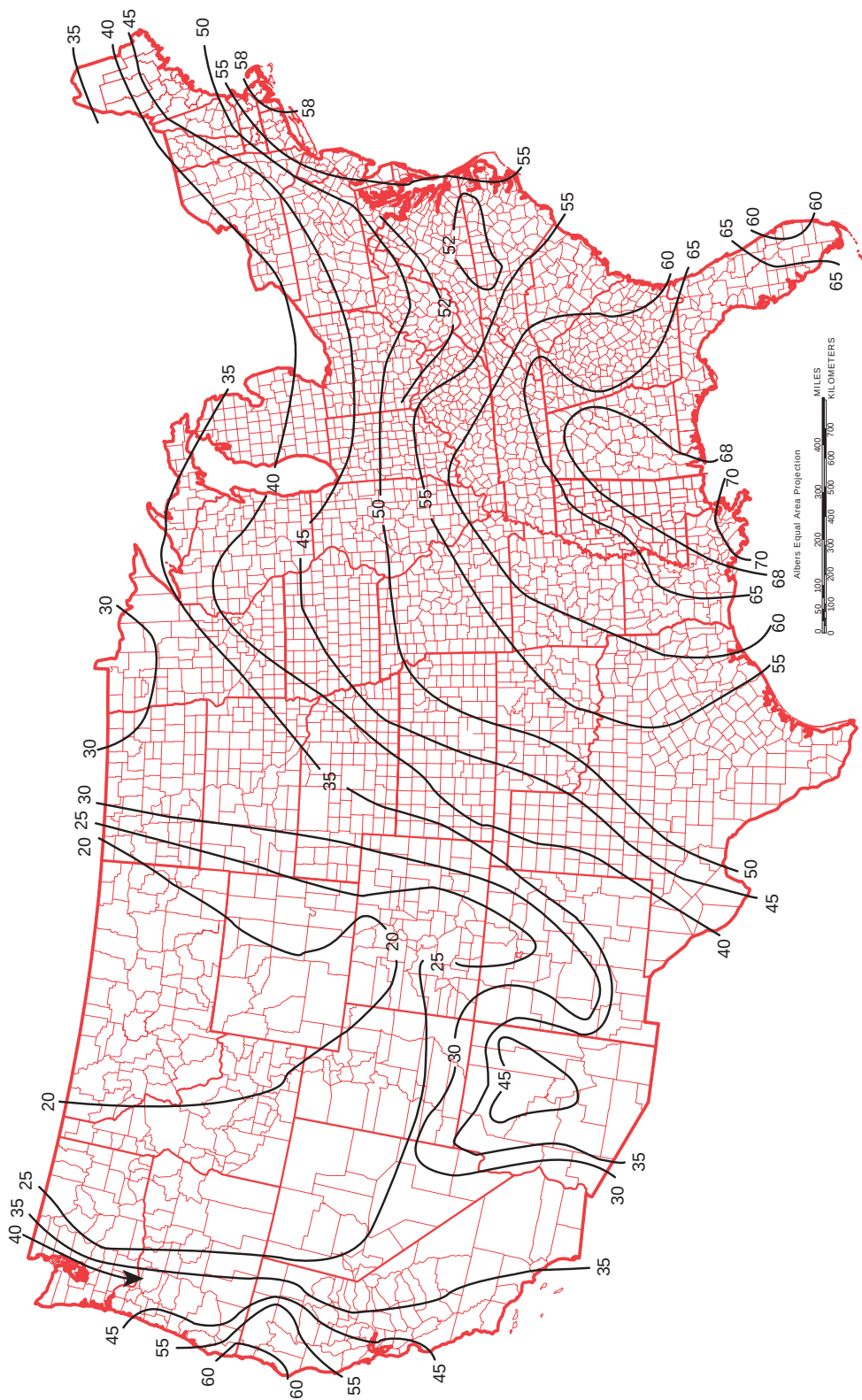
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**FEBRUARY RUNOFF
FROM CONCRETE FEEDLOTS (CN-97)
AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-16



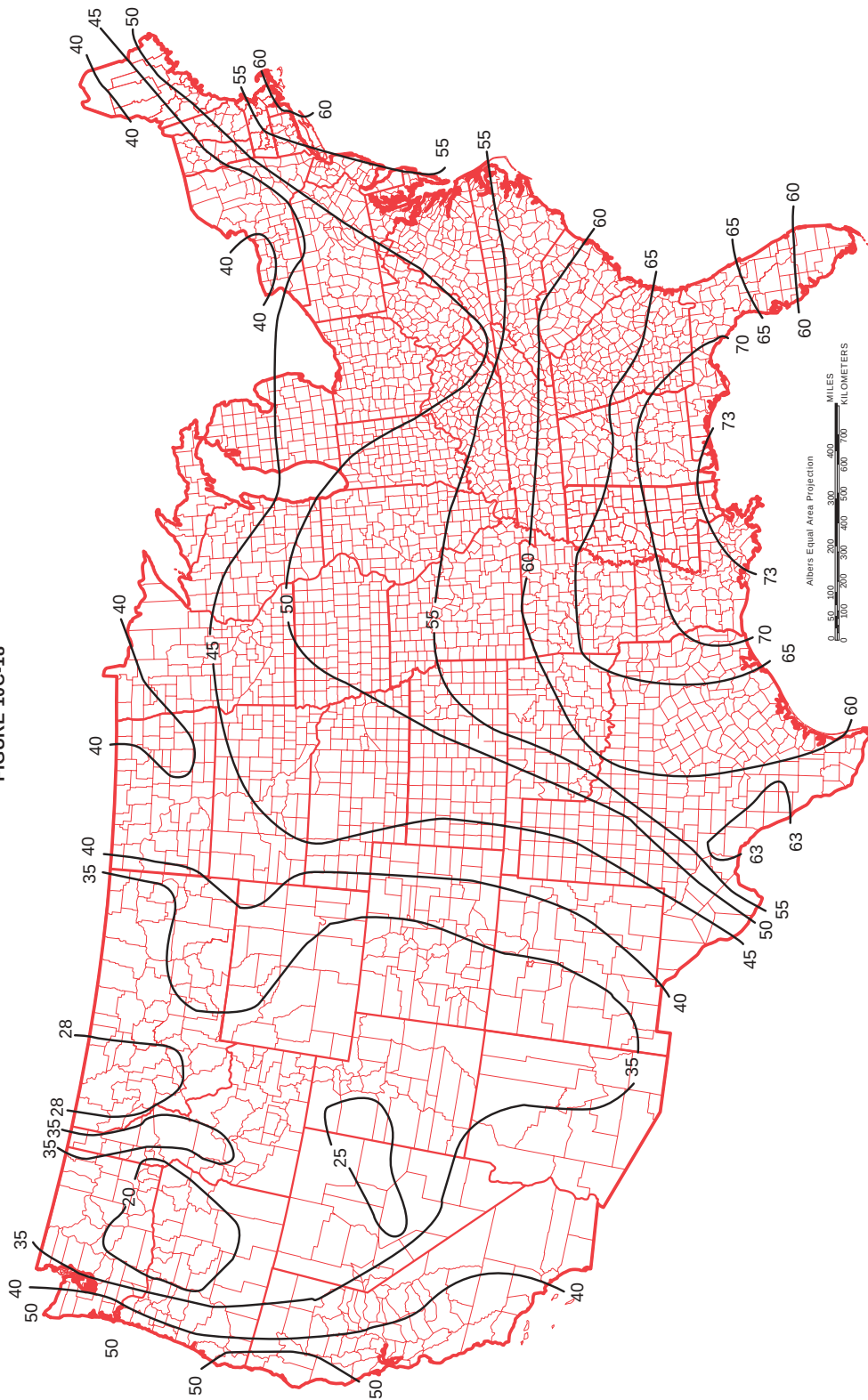
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**MARCH RUNOFF
FROM CONCRETE FEEDLOTS (CN-97) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-17



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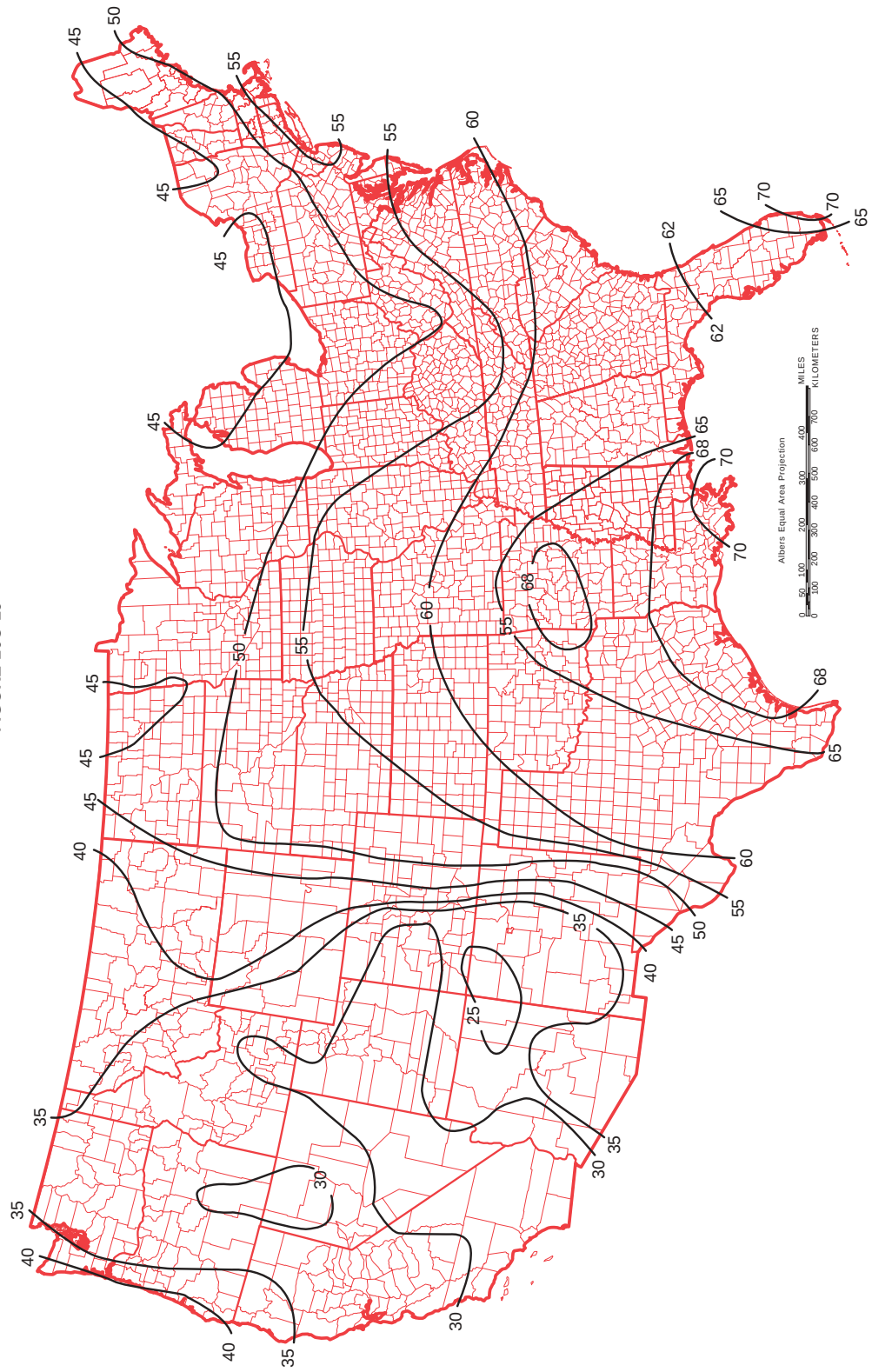
**APRIL RUNOFF
FROM CONCRETE FEEDLOTS (CN-97) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-18



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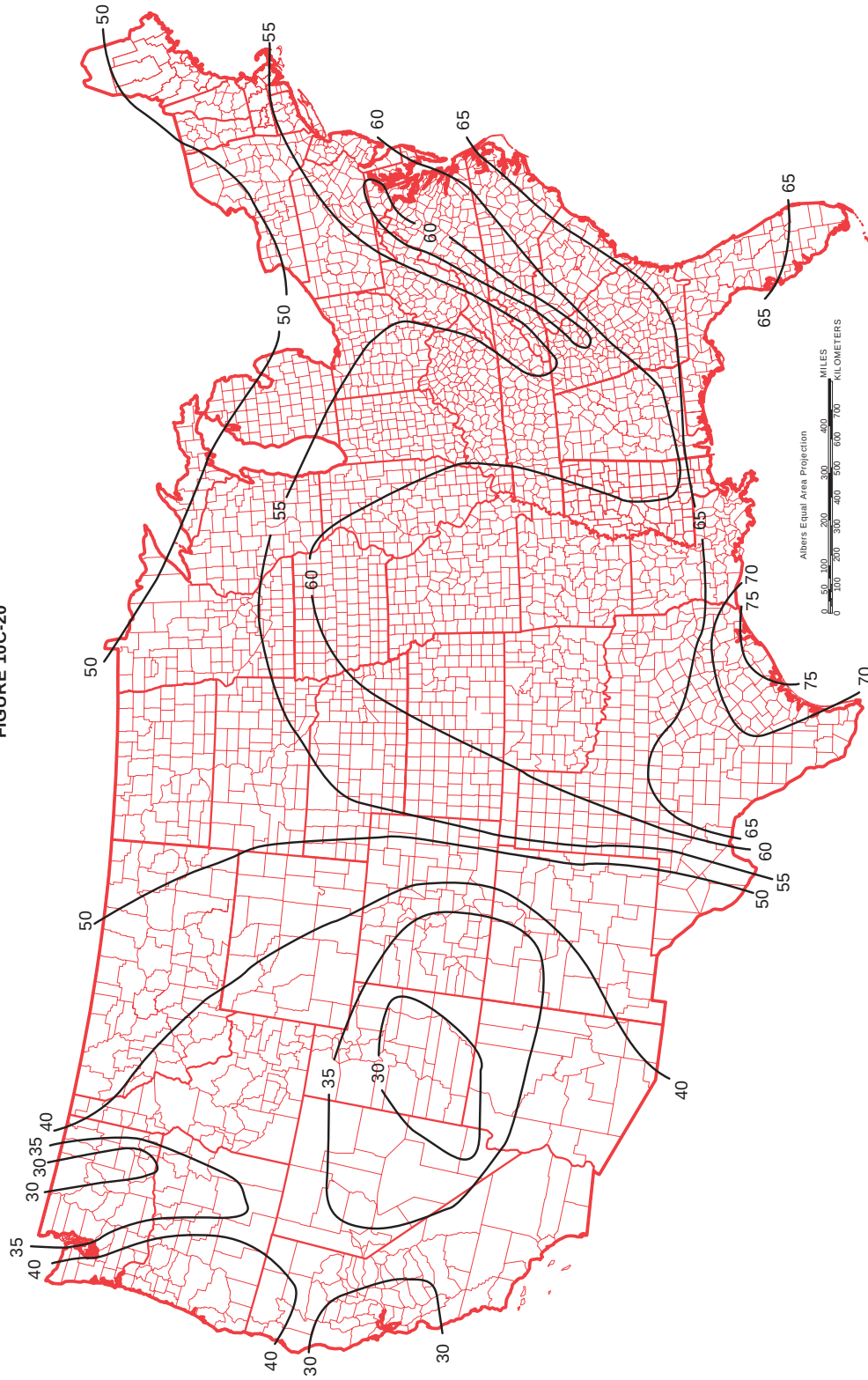
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**MAY RUNOFF
FROM CONCRETE FEEDLOTS (CN-97) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-19



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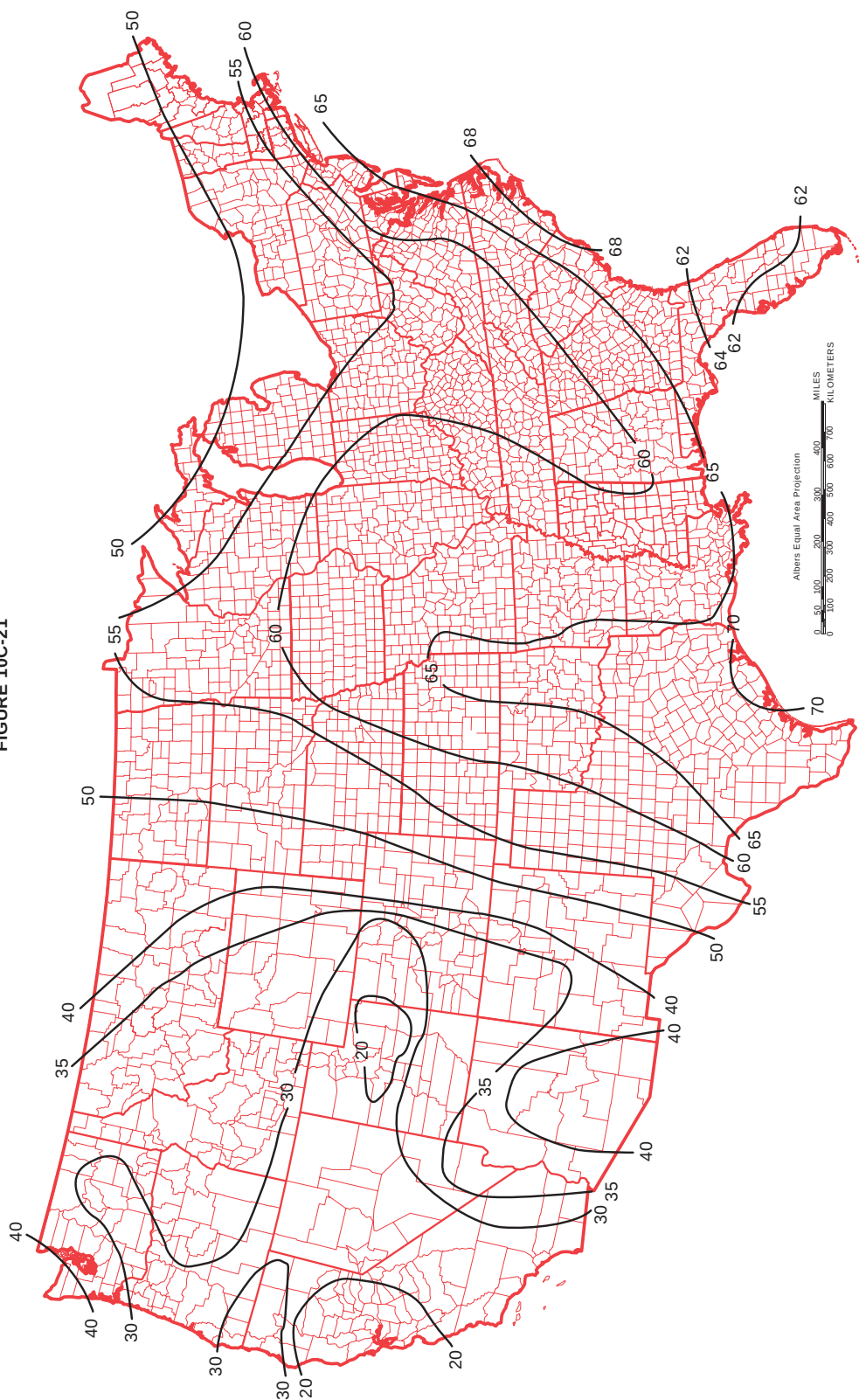
**JUNE RUNOFF
FROM CONCRETE FEEDLOTS (CN-97) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-20



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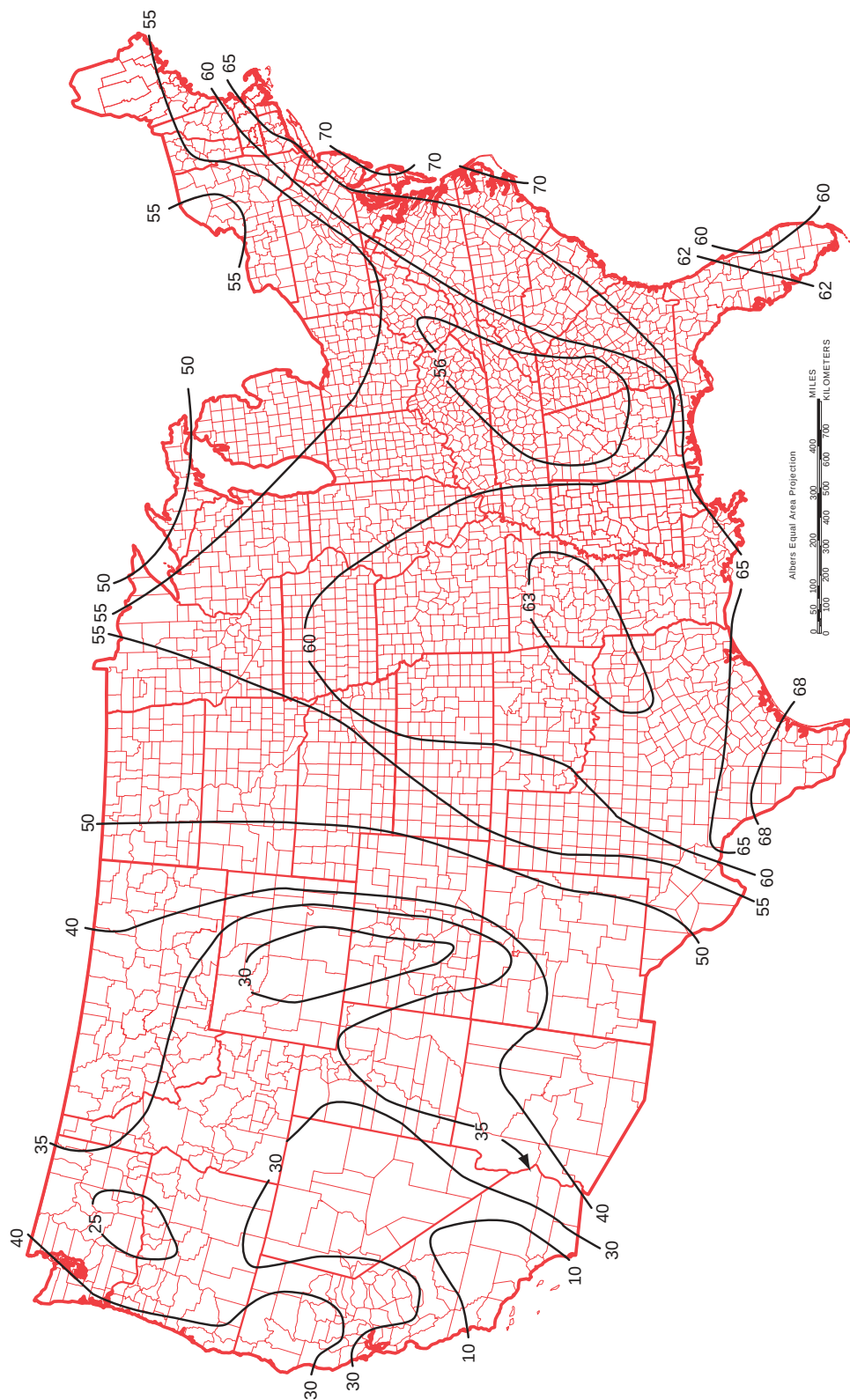
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**JULY RUNOFF
FROM CONCRETE FEEDLOTS (CN-97) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-21



SOURCE:
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AUTOMATED MAP CONSTRUCTION. NATIONAL CARTOGRAPHIC CENTER,
FORT WORTH, TEXAS 1991

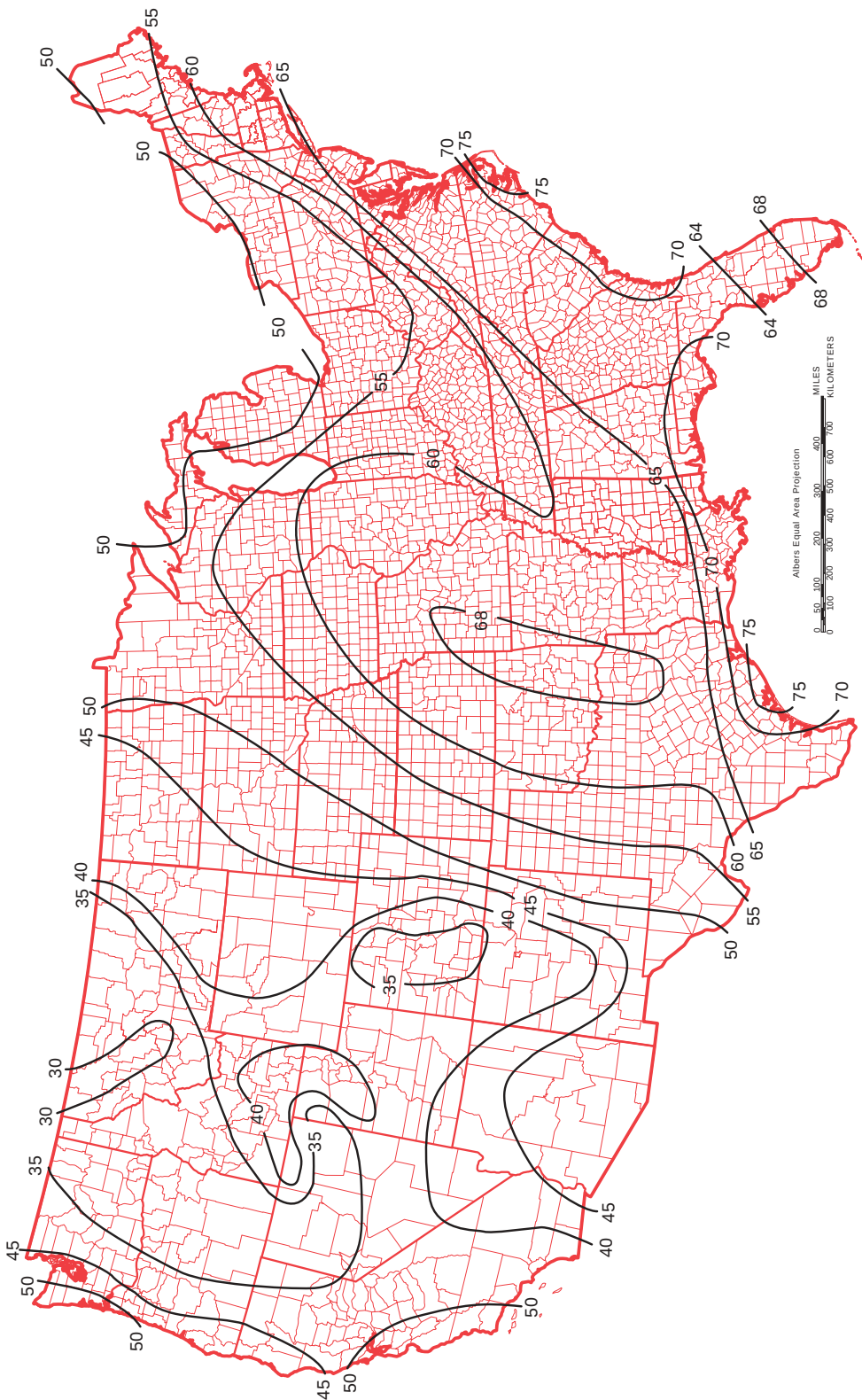
AUGUST RUNOFF FROM CONCRETE FEEDLOTS (CN-97) AS PERCENT OF MEAN MONTHLY PRECIPITATION FIGURE 10C-22



SOURCE:
DATA PROVIDED BY SCS FIELD PERSONNEL. MAP PREPARED USING
AUTOMATED MAP CONSTRUCTION. NATIONAL CARTOGRAPHIC CENTER,
FORT WORTH, TEXAS 1991

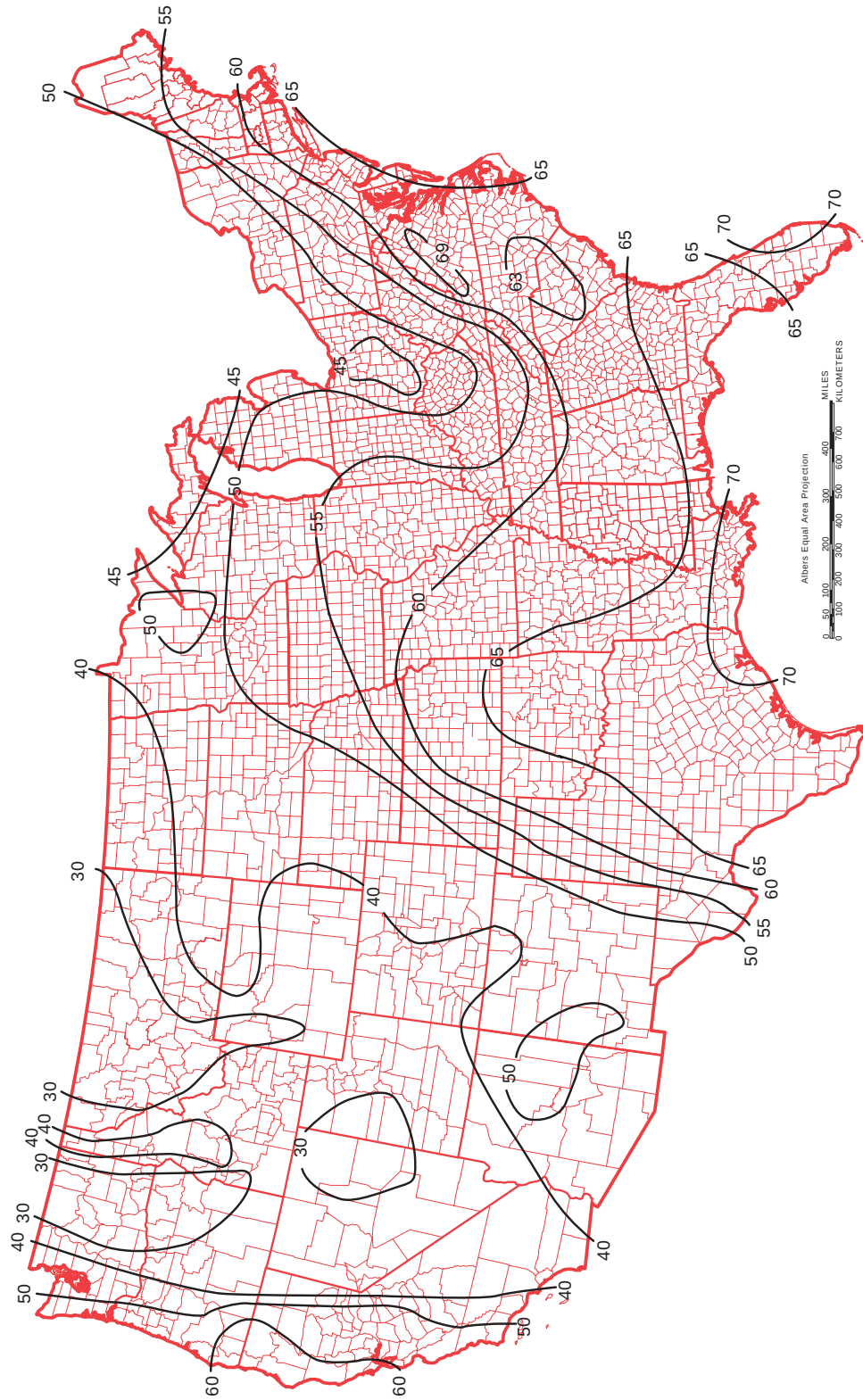
REVISED MARCH 1991 1004848

SEPTEMBER RUNOFF
FROM CONCRETE FEEDLOTS (CN-97) AS
PERCENT OF MEAN MONTHLY PRECIPITATION
FIGURE 10C-23



SOURCE:
DATA PROVIDED BY SCS FIELD PERSONNEL. MAP PREPARED USING
AUTOMATED MAP CONSTRUCTION. NATIONAL CARTOGRAPHIC CENTER,
FORT WORTH, TEXAS 1991

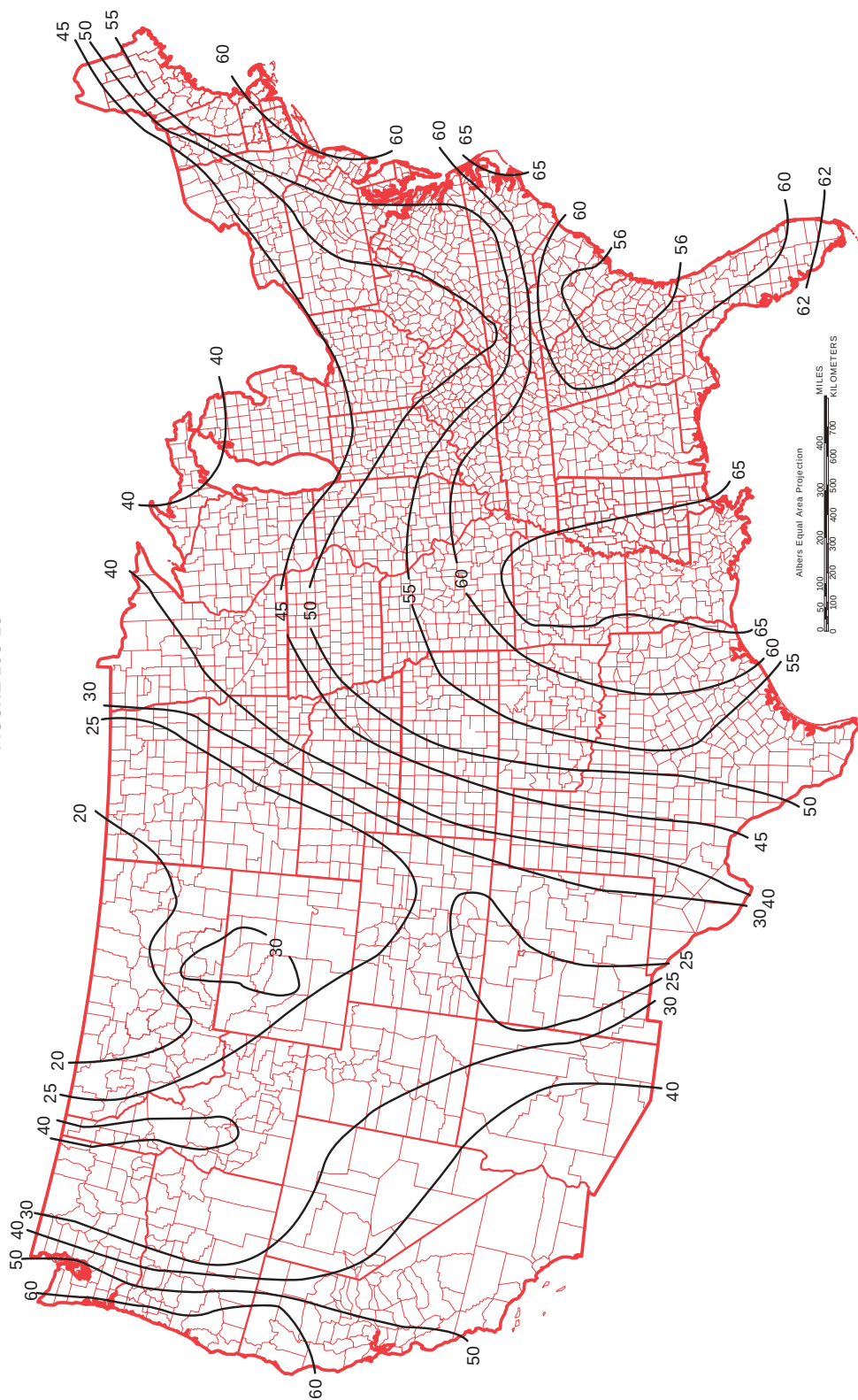
**OCTOBER RUNOFF
FROM CONCRETE FEEDLOTS (CN-97) AS
PERCENT OF MEAN MONTHLY PRECIPITATION**
FIGURE 10C-24



SOURCE:
DATA PROVIDED BY SCS FIELD PERSONNEL. MAP PREPARED USING
AUTOMATED MAP CONSTRUCTION. NATIONAL CARTOGRAPHIC CENTER,
FORT WORTH, TEXAS 1991.

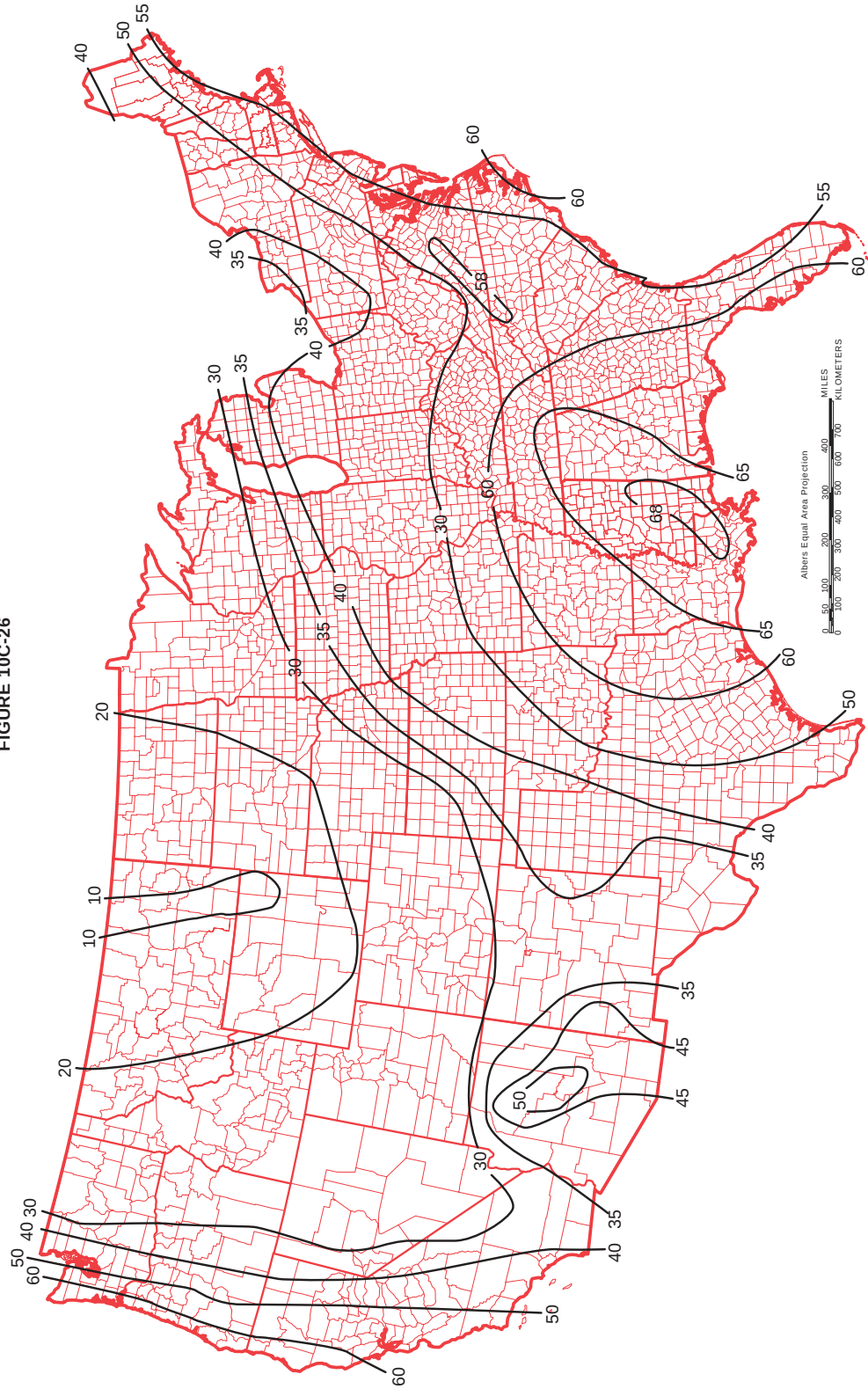
REVISED MARCH 1991 1004850

NOVEMBER RUNOFF
FROM CONCRETE FEEDLOTS (CN-97) AS
PERCENT OF MEAN MONTHLY PRECIPITATION
FIGURE 10C-25



SOURCE:
DATA PROVIDED BY SCS FIELD PERSONNEL. MAP PREPARED USING
AUTOMATED MAP CONSTRUCTION. NATIONAL CARTOGRAPHIC CENTER,
FORT WORTH, TEXAS 1991

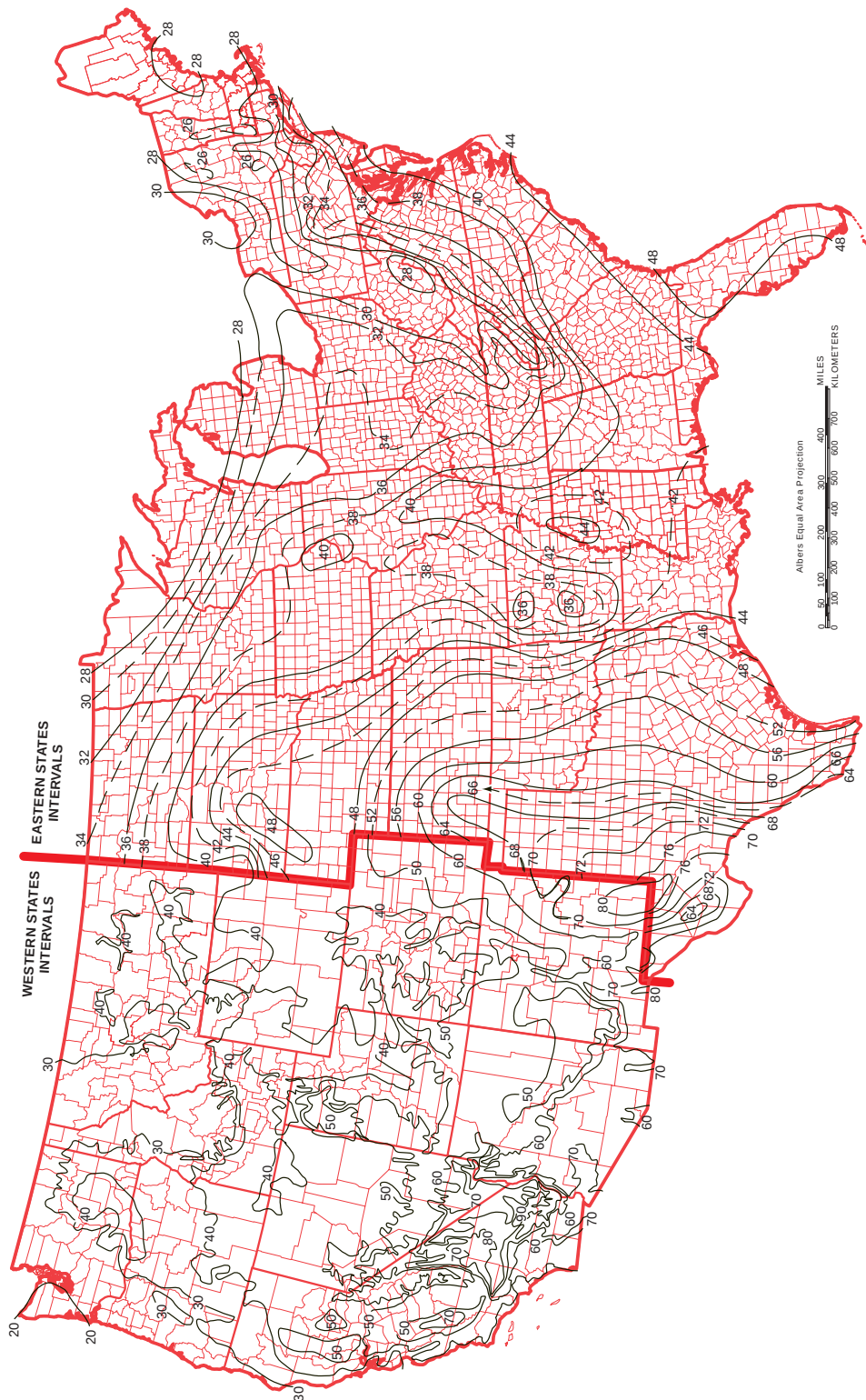
DECEMBER RUNOFF FROM CONCRETE FEEDLOTS (CN-97) AS PERCENT OF MEAN MONTHLY PRECIPITATION FIGURE 10C-26



SOURCE:
DATA PROVIDED BY SCS FIELD PERSONNEL. MAP PREPARED USING
AUTOMATED MAP CONSTRUCTION. NATIONAL CARTOGRAPHIC CENTER,
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ANNUAL FREE WATER SURFACE EVAPORATION FIGURE 10C-27



SOURCE:
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AUTOMATED MAP CONSTRUCTION, NATIONAL CARTOGRAPHIC CENTER,
FORT WORTH, TEXAS 1991.