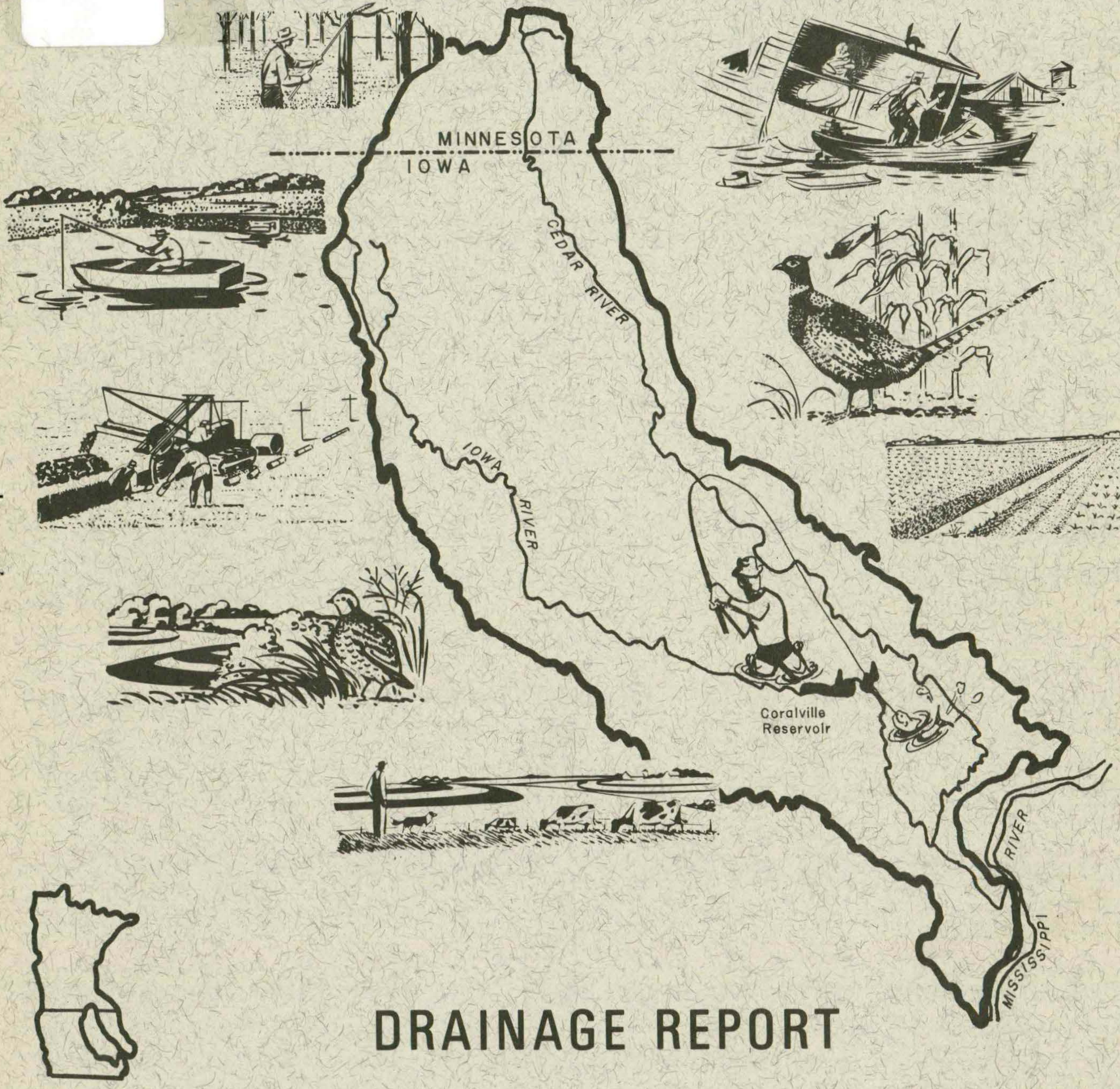
IOWA-CEDAR

RIVERS BASIN STUDY



DRAINAGE REPORT

1975

U.S. DEPARTMENT OF AGRICULTURE

Soil Conservation Service
Economic Research Service
Forest Service

340

IOWA-CEDAR RIVERS BASIN STUDY

Iowa and Minnesota

DRAINAGE REPORT OF THE IOWA-CEDAR RIVERS BASIN

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Conservation Service
Economic Research Service

1975

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DRAINAGE REPORT OF THE IOWA-CEDAR RIVERS BASIN

INTRODUCTION

Definition of Agricultural Drainage

Agricultural drainage may be defined as the removal and disposal of excess water from agricultural land.

The sources of excess water may be precipitation, snowmelt, irrigation water, overland flow or underground seepage from adjacent areas, artesian flow from deep aquifers, floodwater from channels, or water applied for such special purposes as leaching salts from the soil or for temperature control. In this basin the drainage needs are largely due to excess water from precipitation, snowmelt, and underground seepage from adjacent areas, and floodwater from channels.

Drainage systems are needed to supplement natural drainage in many areas. The amount of water to be removed by such systems depends, therefore, upon the relative effectiveness of the natural and constructed drainage.

Agricultural drainage is divided into two broad classes: surface and subsurface. Many installations in the Iowa-Cedar Rivers Basin serve the dual purpose of surface and subsurface drainage.

Agriculturally, excess water becomes a problem when it interferes with tillage, plant growth, and harvest operations. These problems contribute to reduced crop production, increased production costs, delays in planting, and reduced quality of products produced.

History of the Development of Legal Drainage Districts in the Iowa-Cedar Rivers Basin

Iowa agricultural landowners have been actively draining their lands since the enactment of the first drainage law in 1906. Legal drainage districts were organized in large numbers soon after enactment of this law, especially in the northern and western parts of the Basin.

The "Report of the Iowa State Drainage, Waterways and Conservation Commission" written in 1910, stated, "Farmers who have set about underdraining their farms are so encouraged by the results, that all lines of drainage work are being carried forward with great vigor. The facilities for doing this work, such as excavation machinery, drain tile factories, skilled labor, and engineers, have been taxed in many cases beyond their ability to render good service." This 1910 report further stated, "It has been found that County Commissioners frequently exercise their authority by

ordering the engineers whom they have employed to change the plans and estimates which they have made for the district against their best judgment. Instances had been found where the efficiency of the drainage system had been materially lessened by miscellaneous and ill-considered changes in plans ordered by Boards of Commissioners."

It was also admitted that not infrequently the engineering was faulty. Design criteria used for most tile mains for these early organized legal drainage districts required a capacity for removing one-fourth inch depth of water from the drainage area in 24 hours. This report indicated that some tile mains which proved to be too small were checked and the capacity was usually less than one-fourth inch and sometimes as small as one-eighth inch in 24 hours. The report also indicated quality problems with both clay and "cement" drain tiles with many failures, particularly those with greater than eight inches in diameter. It was stated too that construction was not always first class with engineers not always employed for layout and inspection.

Minnesota also passed a Drainage and Conservancy Districts Law, but the few districts organized under this law nearly fifty years ago have either been abandoned or reorganized as watershed districts under the Watershed District Statute 112.34. There is also a Minnesota Statute Chapter 106 that governs county and joint county drainage systems. This statute permits county boards to authorize and maintain public drainage systems.

DRAINAGE REPORT OF THE IOWA-CEDAR RIVERS BASIN

A report on drainage needs was made at the request of the sponsors of the Iowa-Cedar Rivers Basin Study. It includes an inventory of the legal drainage districts. Legal drainage districts that are drained only by ditches were not included in the inventory due to the extensive field work required to determine the adequacy of drainage ditches.

Special Drainage Study for the Basin by the Economic Research Service of the United States Department of Agriculture

The ERS (Economic Research Service) made an analysis of the cropland recorded in the 1967 CNI (Conservation Needs Inventory) that showed a need for drainage improvement. The 1967 CNI shows that over 1.2 million acres of cropland soils need drainage improvement. This represents over fifteen percent of the cropland soils of the Basin. Segments of nearly half of the farms have some drainage needs.

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[illegible]

DRAINAGE [illegible] RIVER BASIN

A [illegible] drainage [illegible] made [illegible] River [illegible] Study. [illegible] of the [illegible] drainage [illegible] only [illegible] in [illegible] due to the extensive [illegible] work required [illegible].

[illegible] Study for the [illegible] by the [illegible] Research [illegible] of the United States Department of Agriculture

The [illegible] Economic Research Service [illegible] the problem [illegible] the [illegible] shows [illegible] for drainage [illegible] and [illegible] improvements [illegible] for the [illegible].

Typical drainage problems in the LRA 103 portion of the Basin. Impaired drainage results in lost work days, increased production costs, reduced crop yields, and lower income for farmers.

Typical drainage problems in the 12A 102 portion of the Basin. Impaired drainage results in lost work days, increased production costs, reduced crop yields and lower income for farmers.

The ERS evaluated the impact of drainage on crop production for the Basin for the year 2000 assuming all drainage needs were satisfied. Table 1 shows a summary of the potential increased yields and value changes totaling nearly $81 million annually. In calculating increased values, Agriculture Price Standards for Water and Related Land Resource Planning published by the U.S. Water Resources Council, Washington, D.C., February 1974, were used. Table 2 shows these values along with calculations that were made.

The ERA evaluations included only land that is presently cultivated. No evaluation was made of crop production that could be achieved from draining existing "wetlands" 1/. Total construction cost of installing needed drainage improvements to achieve the $81 million increase in annual crop production would be approximately $300 million. Engineering, administration, right-of-way, and construction costs amortized at an interest rate of 7 percent for a 50-year period provide an annual cost of $30 million. Annual maintenance costs would approach $1 million. Economic benefits from increased crop production would exceed these costs by a ratio of 2.6 to 1.

Additional benefits not calculated would result from reduced production costs and improved quality of harvested crops. The unevaluated reduced production costs include such items as reduced labor, seed, machinery maintenance, and fuel.

Secondary benefits would occur from such items as providing additional employment for installation of drainage improvement that would require a minimum of 20,000 man-years.

It may be noted in Table 3 that the greatest crop value increase potential is from the major upland soils; SRG's 10, 20, 21, and 22. (See Appendix B for SRG descriptions). A compilation of cropland reveals that nearly 80 percent of cropland soils needing drainage in the Basin are upland soils with nearly 75 percent of these in the northern portion (see figure 1). The major bottomland soil resource group is SRG 18. Seventy-five percent of soils needing additional drainage in SRG 18 are in the southern portion.

Legal Drainage District Inventory

As part of the Iowa-Cedar Rivers Basin study, the Soil Conservation Service inventoried the legal drainage districts using tile mains as

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1/ See Appendix C for a brief description of "wetlands".
A detailed description is included in "Wetlands of the United States" (Circular 39) published by the United States Department of the Interior, Fish and Wildlife Service.

The FWS evaluated the impact of drainage on crop production for the basin for the year 2000, assuming all drainage needs were satisfied. Table 2 shows a summary of the potential increased yields and value changes totalling nearly $88 million annually. In calculating increased values, April 1974 Price Standards for Water and Related Land Resource Planning published by the U.S. Water Resources Council, Washington, D.C., February 1974, were used. Table 2 shows these figures along with calculations that are made.

The FWS evaluation included only land that is presently cultivated. It estimated the total crop production that could be achieved from draining existing "wetlands" [illegible]. Total construction cost of installing needed drainage improvements to achieve the foregoing increase in total crop production would be approximately $[illegible] million. Engineering, administration, right-of-way, and construction costs amortized at an interest rate of 7 percent for a 50-year period provide an annual cost of $[illegible] million. Annual maintenance costs would approach $1 million. Economic benefits from increased crop production would exceed these costs by a ratio of [illegible] to 1.

Additional benefits not calculated would result from reduced production costs and improved quality of harvested crops. The unevaluated reduced production costs include such items as reduced labor, seed, machinery maintenance, and fuel.

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[illegible]

The [illegible] of the Iowa-Cedar [illegible] and [illegible]

1/ See appendix [illegible] for a brief description of "wetlands". A more detailed description is included in "Wetlands of the United States" (Circular 39) published by the United States Department of the Interior, Fish and Wildlife Service.

TABLE 1

IMPACT OF COMPLETING DRAINAGE NEEDS 1/
IN THE IOWA-CEDAR RIVERS BASIN IN YEAR 2000

Item	Acres	Annual Increased Production	2/ Price/ Unit	Value Change
Corn	554,146	31,758,020 bu.	$1.35	$42,873,330
Silage	16,771	144,790 ton	9.00	1,303,080
Oats	26,115	841,770 bu.	0.81	681,860
Soybeans	445,239	8,094,090 bu.	3.74	30,271,900
Cropland Pasture	77,131	6,111,484 AD 3/	0.35	2,150,810
Alfalfa Hay	82,623	145,210 ton	25.30	3,673,760
Other Hay	4,871	3,780 ton	25.30	95,580
TOTALS	1,206,896 acres 4/			$81,050,300 5/

1/ From CNI Inventory-1967

2/ Prices established in Guideline 2 - Agriculture Price Standards for Water and Related Land Resources Planning published by the U.S. Water Resources Council, Washington, D.C., February 1974.

3/ AD = Animal Day of Grazing

4/ This includes 168,742 acres in the portion that is in Minnesota.

5/ Annual value change of crop production in Minnesota area is $12.7 million.

TABLE 2

EFFECT OF DRAINAGE ON VALUE OF PRODUCTION in Year 2000

Iowa Cedar-Rivers Basin

SRG[1/]	Acreage PD Acres[2/]	ND Acres[3/]	Value Change Total	Per Acre
1	-	7,597	$ 360,036	$ 47.39
2	105,537	105,537	7,930,677	37.57
3	-	3,399	134,549	39.58
4	-	200	7,992	39.96
5	-	3,852	68,593	17.81
10	-	66,580	4,881,383	73.32
13	4,531	-	32,176	7.10
14	10,503	-	153,028	14.57
15	1,636	-	20,231	12.37
16	2,154	-	20,523	9.53
18	60,230	60,230	8,089,715	67.16
19	5,584	5,584	464,672	41.61
20	346,907	346,907	54,014,650	77.85
21	-	29,592	2,119,403	71.62
22	30,213	-	2,248,942	74.44
23	10,123	-	503,740	49.76
Total	577,418	629,478	$81,050,310	$ 67.16[4/]

Source: Appendix A.

1/ Soil Resource Group - For description see Appendix B.

2/ Partly drained soils.

3/ Soils with no subsurface drainage.

4/ Weighted average.

TABLE 3

INVENTORY OF LEGAL DRAINAGE DISTRICTS
Iowa-Cedar Rivers Basin

	SUBBASIN				
	Iowa Upper Portion	Cedar Upper Portion	West Fork	Shell Rock	Total
Acres in Subbasin	879,551	1,064,138	551,879	1,124,174	3,619,742
Number of Drainage Districts	275	30	74	149	528
Acres in Drainage Districts	323,100	32,577	94,334	161,279	611,290
% of Acres in Drainage Districts	36.7	3.1	17.1	14.4	16.9
Less than 1/4" Coefficient 1/					
Number of D.D.'s	128	11	37	81	257
% of D.D's	46.9	36.7	50.0	54.4	48.8
Acres in D.D.'s	210,483	16,034	57,727	107,855	392,099
% of Acres in DD's	65.1	49.2	61.2	66.9	64.1
1/4" to 3/8" Coefficient					
Number of D.D.'s	87	7	18	43	155
% of D.D.'s	31.9	23.3	24.3	28.8	29.5
Acres in D.D.'s	71,387	3,478	22,122	39,837	136,824
% of Acres in D.D.'s	22.1	10.7	23.5	24.7	22.4
3/8" to 1/2" Coefficient					
Number of D.D.'s	32	7	13	14	66
% of D.D.'s	11.0	23.3	17.6	9.4	12.5
Acres in D.D.'s	21,547	8,960	11,058	8,275	49,840
% of Acres in D.D.'s	6.7	27.5	11.7	5.1	8.1
Over 1/2" Coefficient					
Number of D.D.'s	28	5	6	11	50
% of D.D.'s	10.2	16.7	8.1	7.4	9.5
Acres in D.D.'s	19,683	4,105	3,427	5,312	32,527
% of Acres in D.D.'s	6.1	12.6	3.6	3.3	5.3

1/ Refers to capacity of tile mains. Tile mains do not have the capacity to remove one-fourth inch of water from the drainage area of the drainage district during a 24-hour period.

UNITED STATES DEPARTMENT OF AGRICULTURE

IOWA-CEDAR RIVERS BASIN

IOWA AND MINNESOTA

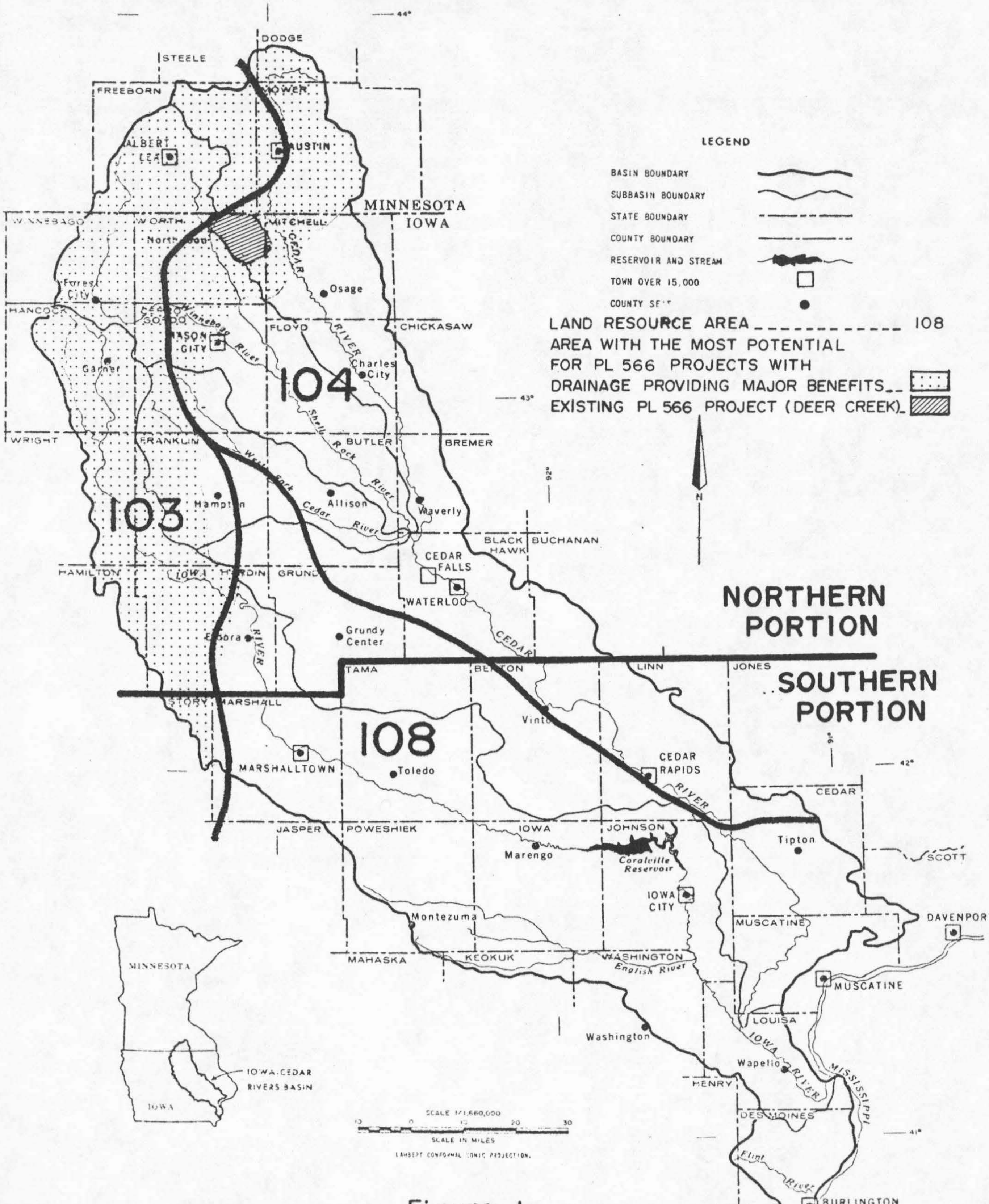


Figure I

SOURCE:
U.S.G.S. 1:500,000 BASE MAPS (IOWA AND MINNESOTA).
U.S.C.&G.S. 1:500,000 AERONAUTICAL CHARTS (DES MOINES AND DUBUQUE).

USDA-SCS-LINCOLN, NEBR. 1-70

5-30-70
5,0-28,270

major outlets. Only the upper areas of the Iowa and Cedar Rivers subbasins and all the area of the Shell Rock River and the West Fork Cedar River subbasins (Figures 2, 3, 4 and 5) were reviewed. Very few legal drainage districts utilizing tile mains exist in the remainder of the Basin.

There were 528 legal districts with a total area of 611,290 acres inventoried. These range in size from 80 to 6,600 acres with an average size of 1,160 acres. The maximum tile main size was 48 inches in diameter with many from 30 to 48 inches. Most of these systems inventoried were installed between 1906 and 1920.

Relating the plan of records maintained by county auditors to present day criteria, it can be reasonably assumed that over 50 percent of these drainage districts studied have inadequate tile main systems. Present day criteria for a high majority of the drainage systems in LRA 103 calls for a drainage coefficient of one-half inch. 1/

The present criteria for tile main capacity listed in the "Iowa Drainage Guide"2/ is as follows:

Drainage Coefficients of New Systems for General Field Crops

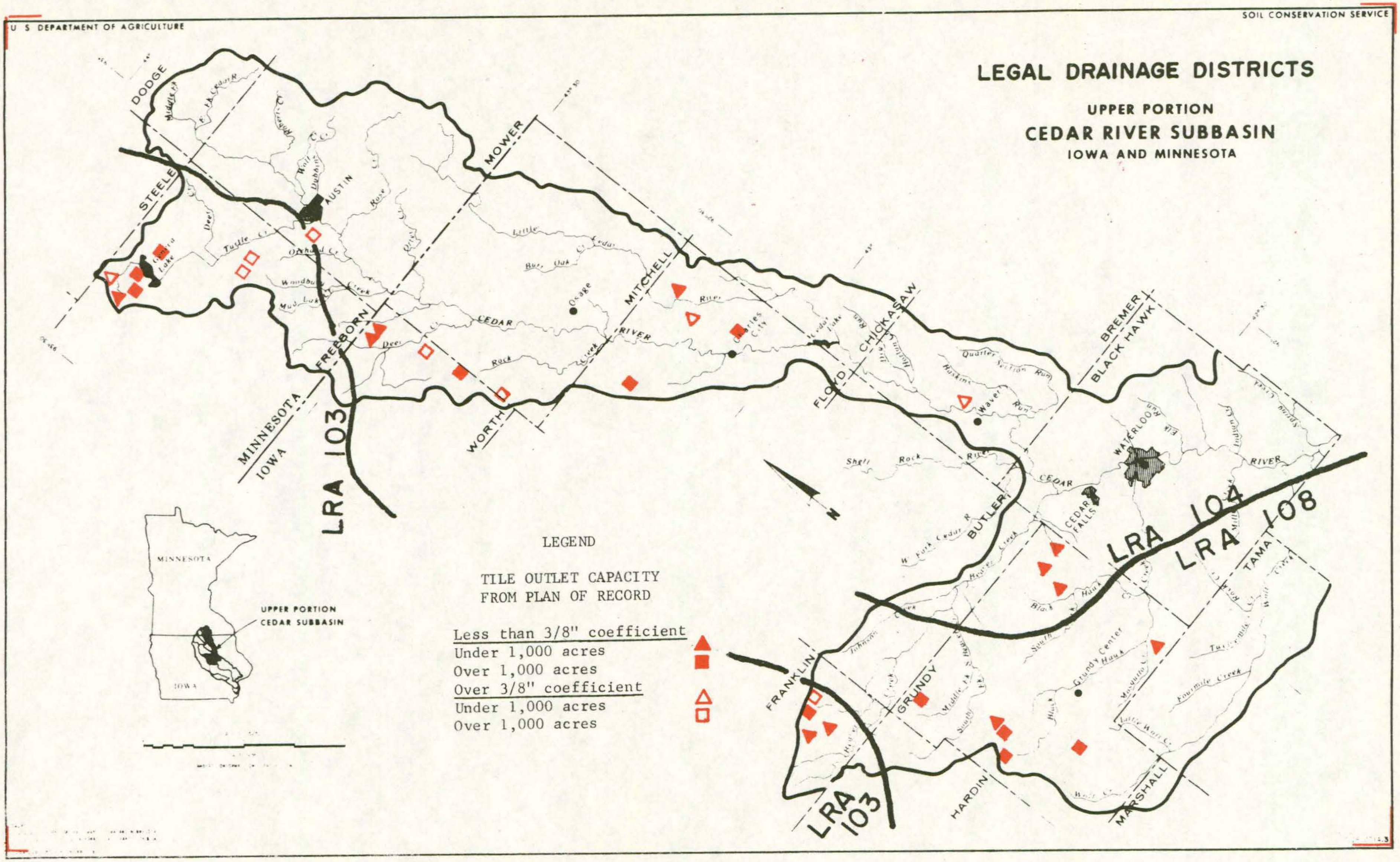
The drainage coefficient for new mains and laterals is selected according to the degree of existing surface drainage.

1. If surface inlets must be used to drain potholes when adequate surface drainage does not exist, the tile should have a capacity to remove runoff from the entire watershed area which drains toward the inlet, at the rate of one-half inch in 24 hours. This capacity should be provided whether or not the surface inlets are initially installed. An exception may be made for small potholes when surveys are available so that the volume of the potholes can be determined accurately. In this case, a tile capacity to remove three-eighths inch per 24 hours from the land area which needs tile drainage plus the capacity to remove the volume of the pothole in 24 hours is sufficient.

2. If adequate surface drainage exists naturally or has been constructed to drain depressed areas, the tile should have a capacity to remove tile drainage water from only the area within the watershed which needs tile drainage at the rate of three-eighths inch per 24 hours.

1/ A drainage system designed with a drainage coefficient of one-half inch has capacity to remove one-half inch of water from the entire drainage area during a 24-hour period.

2/ "Iowa Drainage Guide", Special Report #13 (Rev.) Iowa State University, Ames, Iowa - December 1962.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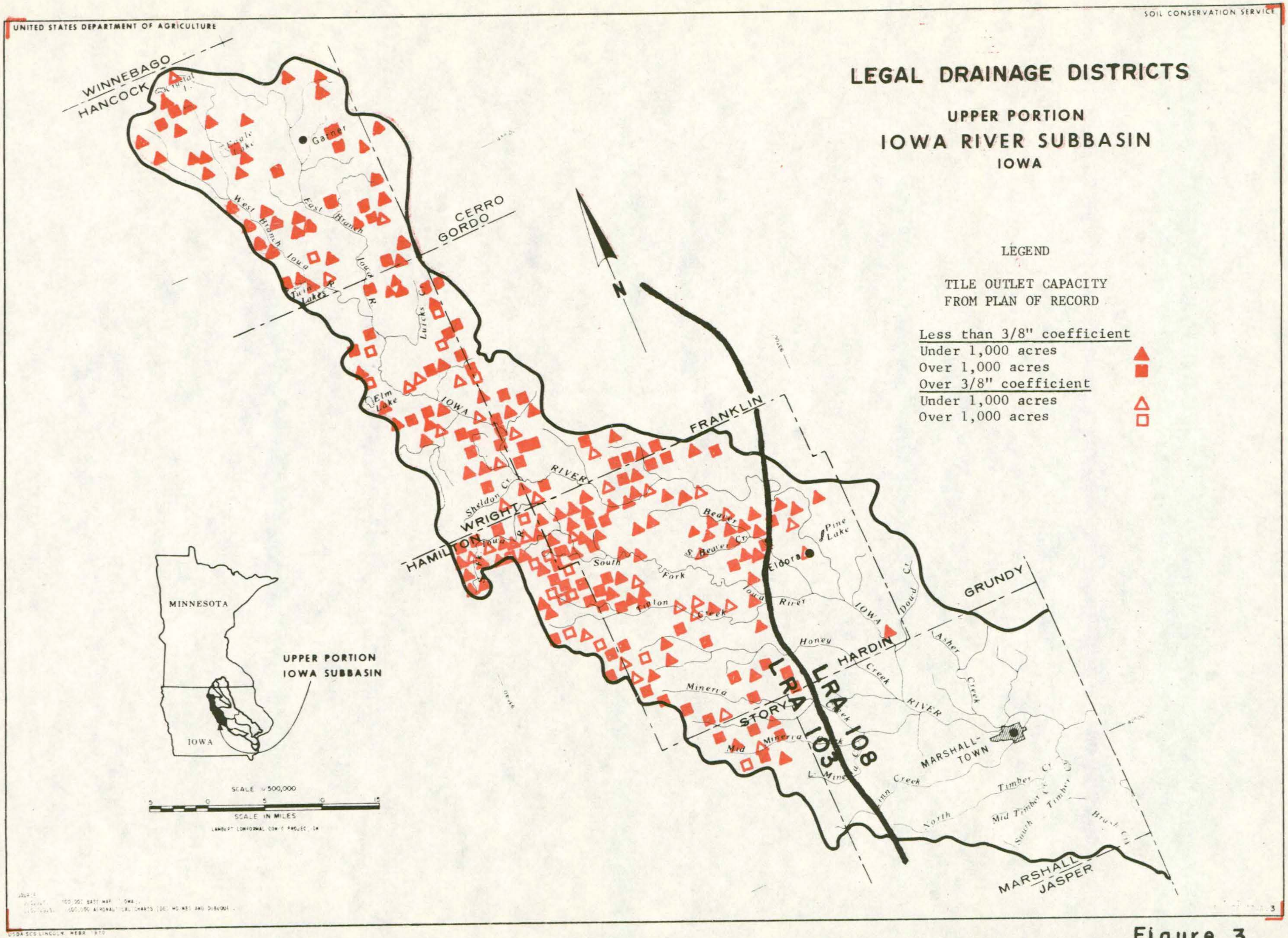
SOIL CONSERVATION SERVICE
LEGAL DRAINAGE DISTRICTS
UPPER PORTION
CEDAR RIVER SUBBASIN
IOWA AND MINNESOTA
LEGEND
TILE OUTLET CAPACITY
FROM PLAN OF RECORD
Less than 3/8" coefficient
Under 1,000 acres
Over 1,000 acres
Over 3/8" coefficient
Under 1,000 acres
Over 1,000 acres
MINNESOTA
IOWA
UPPER PORTION
CEDAR SUBBASIN
DODGE
STEELE
MOWER
FREEBORN
MITCHELL
WORTH
FLOYD
CHICKASAW
BREMER
BLACK HAWK
BUTLER
FRANKLIN
GRUNDY
HARDIN
TAMA
MARSHALL
AUSTIN
WATERLOO
CEDAR FALLS
LRA 103
LRA 104
LRA 108
CEDAR
RIVER
Shell Rock River
N

Figure 2


UNITED STATES DEPARTMENT OF AGRICULTURE
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LEGAL DRAINAGE DISTRICTS
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Over 1,000 acres
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Under 1,000 acres
Over 1,000 acres
WINNEBAGO
HANCOCK
CERRO GORDO
FRANKLIN
WRIGHT
HAMILTON
GRUNDY
HARDIN
STORY
MARSHALL
JASPER
Garner
Eldora
MARSHALL-TOWN
LRA 108
LRA 103
N
MINNESOTA
IOWA
UPPER PORTION
IOWA SUBBASIN
SCALE IN MILES

Figure 3

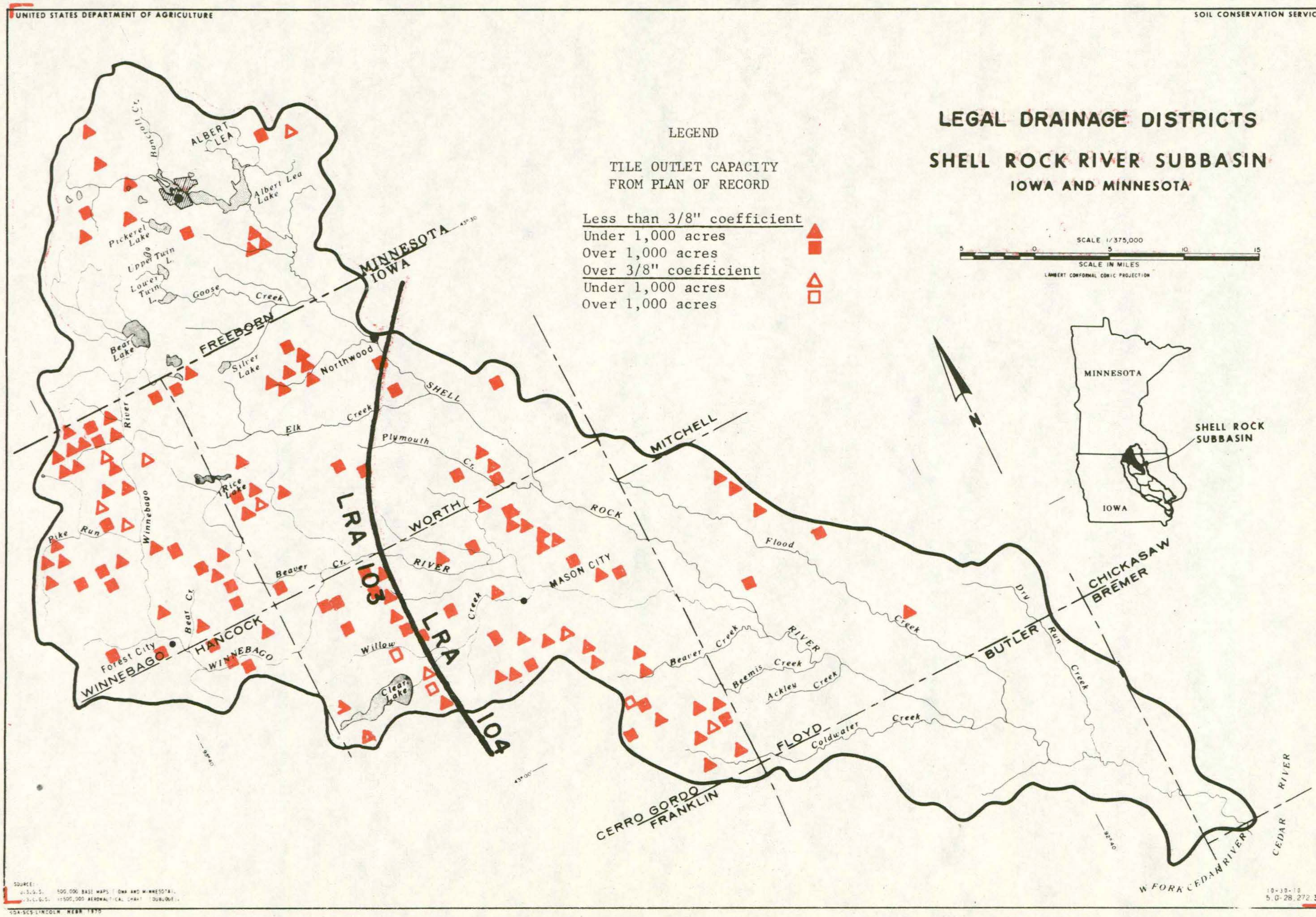
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LEGAL DRAINAGE DISTRICTS
SHELL ROCK RIVER SUBBASIN
IOWA AND MINNESOTA
SCALE 1/375,000
SCALE IN MILES
LEGEND
TILE OUTLET CAPACITY
FROM PLAN OF RECORD
Less than 3/8" coefficient
Under 1,000 acres
Over 1,000 acres
Over 3/8" coefficient
Under 1,000 acres
Over 1,000 acres
MINNESOTA
IOWA
SHELL ROCK SUBBASIN
ALBERT LEA
Albert Lea Lake
Pickerel Lake
Upper Twin L.
Lower Twin L.
Goose Creek
Bear Lake
Silver Lake
FREEBORN
Northwood
SHELL
ROCK
RIVER
Elk Creek
Plymouth Cr.
MITCHELL
WORTH
Rice Lake
Winnebago
Pike Run
Beaver Cr.
LRA 103
LRA 104
MASON CITY
Flood Creek
Willow Creek
Clear Lake
Forest City
HANCOCK
WINNEBAGO
Beaver Creek
Beemis Creek
Ackley Creek
Coldwater Creek
FLOYD
CERRO GORDO
FRANKLIN
BUTLER
Dry Run Creek
CHICKASAW
BREMER
CEDAR RIVER
W FORK CEDAR RIVER

Figure 4

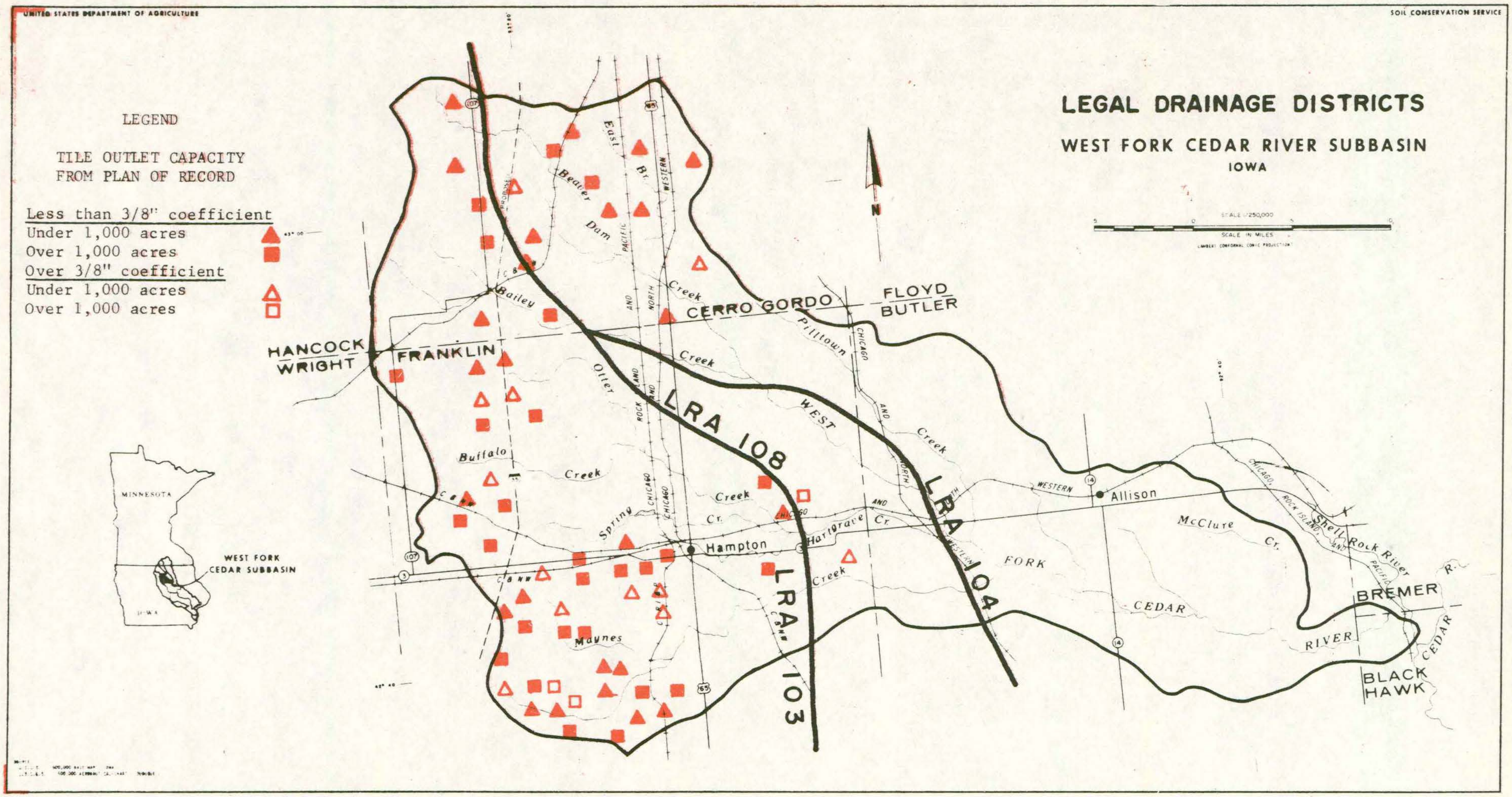
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LEGAL DRAINAGE DISTRICTS
WEST FORK CEDAR RIVER SUBBASIN
IOWA
LEGEND
TILE OUTLET CAPACITY
FROM PLAN OF RECORD
Less than 3/8" coefficient
Under 1,000 acres
Over 1,000 acres
Over 3/8" coefficient
Under 1,000 acres
Over 1,000 acres
HANCOCK
WRIGHT
FRANKLIN
CERRO GORDO
FLOYD
BUTLER
BREMER
BLACK HAWK
LRA 108
LRA 104
LRA 103
Hampton
Allison
Maynes
Beaver Dam Creek
East Br.
Bailey
Otter
Pilltown
Creek
WEST
Buffalo
Creek
Spring
Creek
Cr.
Hartgrave Cr.
Creek
McClure Cr.
Shell Rock River
FORK
CEDAR
RIVER
CEDAR
R.
N
MINNESOTA
IOWA
WEST FORK CEDAR SUBBASIN
SCALE IN MILES

Figure 5

3. For areas where <u>no ponding exists but surface drainage is limited</u>, capacity should be provided for the area needing tile drainage at the rate of one-half inch per 24 hours.

About 82 percent (434) of the legal drainage districts inventoried are located in LRA (Land Resource Area) 103. Item 1 listed above is applicable for a majority of the drainage districts located in LRA 103 which includes the Webster-Nicollet-Clarion-Harps Soil Association. 1/ Table 3 indicates less than ten percent of the drainage districts inventoried have capacity for one-half inch drainage coefficient. About 13 percent of the districts studied are in LRA 104 and about five percent in LRA 108. Design criteria listed in item 2 would apply to nearly all the systems in LRA 108 and many in 104. For the broad flat upland areas of LRA 104 the design criteria for capacity should meet that listed under item 3. A capacity of from one-eighth to three-sixteenths inch for the entire watershed is adequate for most drainage systems in LRA's 104 and 108. Many of the drainage districts studied in these LRA's have adequate capacity.

The time required to analyze the adequacy of these drainage systems was beyond the scope of this study. Important factors not analyzed that materially affect the adequacy of a system are as follows:

1. Condition of the tile. Many tile have been found crushed in systems as old as many of these. It is also common to find tile lines blocked or partially blocked by sand, rodents, or tree roots.

2. Actual size of the tile mains. Soil Conservation Service technicians have found that the size of tile in the ground does not always agree with the plan of record, and if not they are generally smaller.

3. Poor alignment of tile and tile not laid on design grade.

4. Adequacy of the outlets. Many do not allow free flow of water from tile mains.

5. Adequacy of the depth of the tile mains. Tile mains may be laid too shallow to provide adequate drainage for some areas.

1/ The reverse side of Figure 6 lists a brief description of these Soil Associations.

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

SOIL ASSOCIATION MAP
IOWA-CEDAR RIVERS BASIN
IOWA AND MINNESOTA

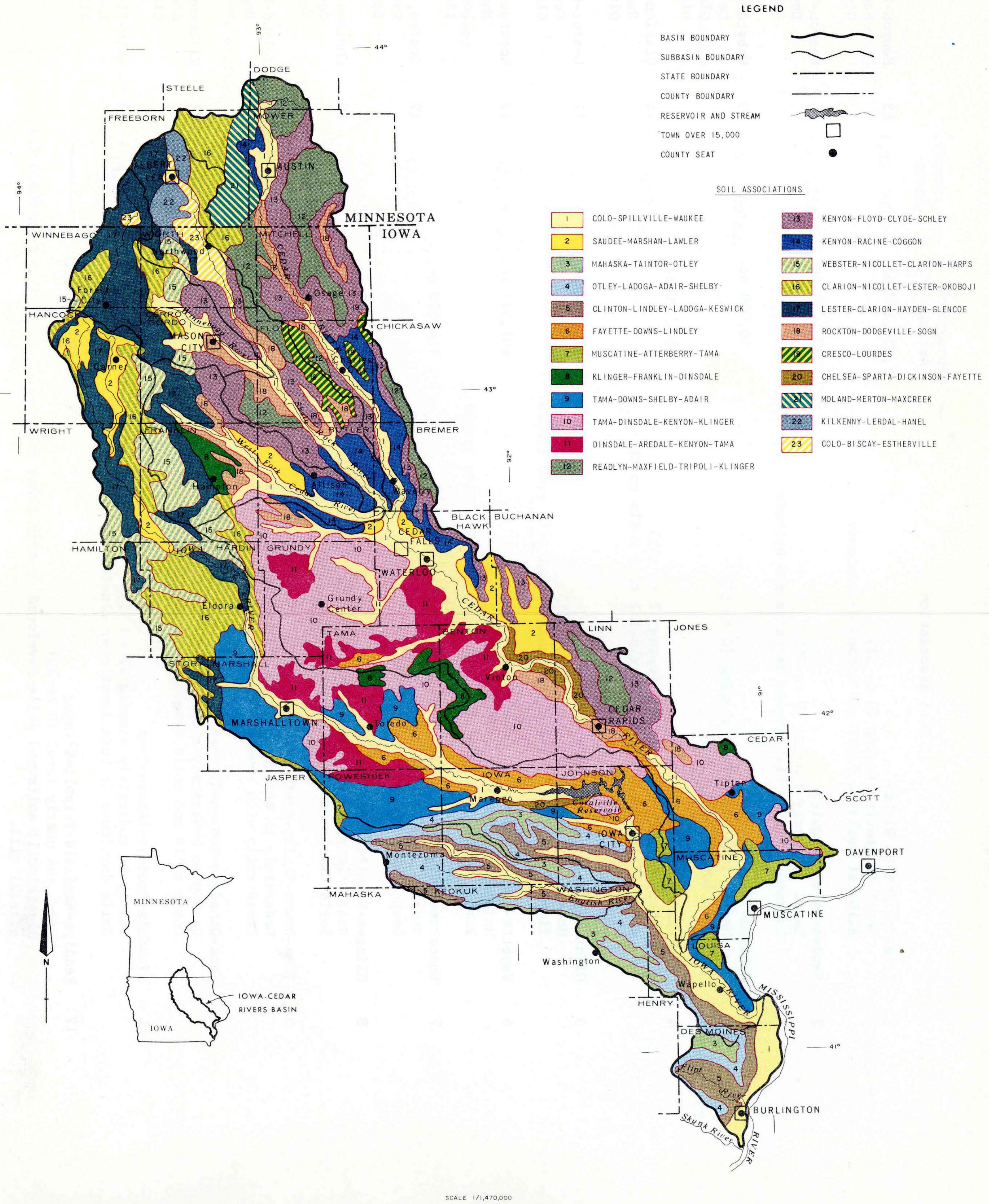

Figure 6

SOURCE:
SCS DRAWING 5,0-28270 AND INFORMATION FROM FIELD TECHNICIANS.

LAMBERT CONFORMAL CONIC PROJECTION

USDA-SCS-LINCOLN, NEBR. 1971

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U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

SOIL ASSOCIATION MAP

IOWA-CEDAR RIVERS BASIN

IOWA AND MINNESOTA

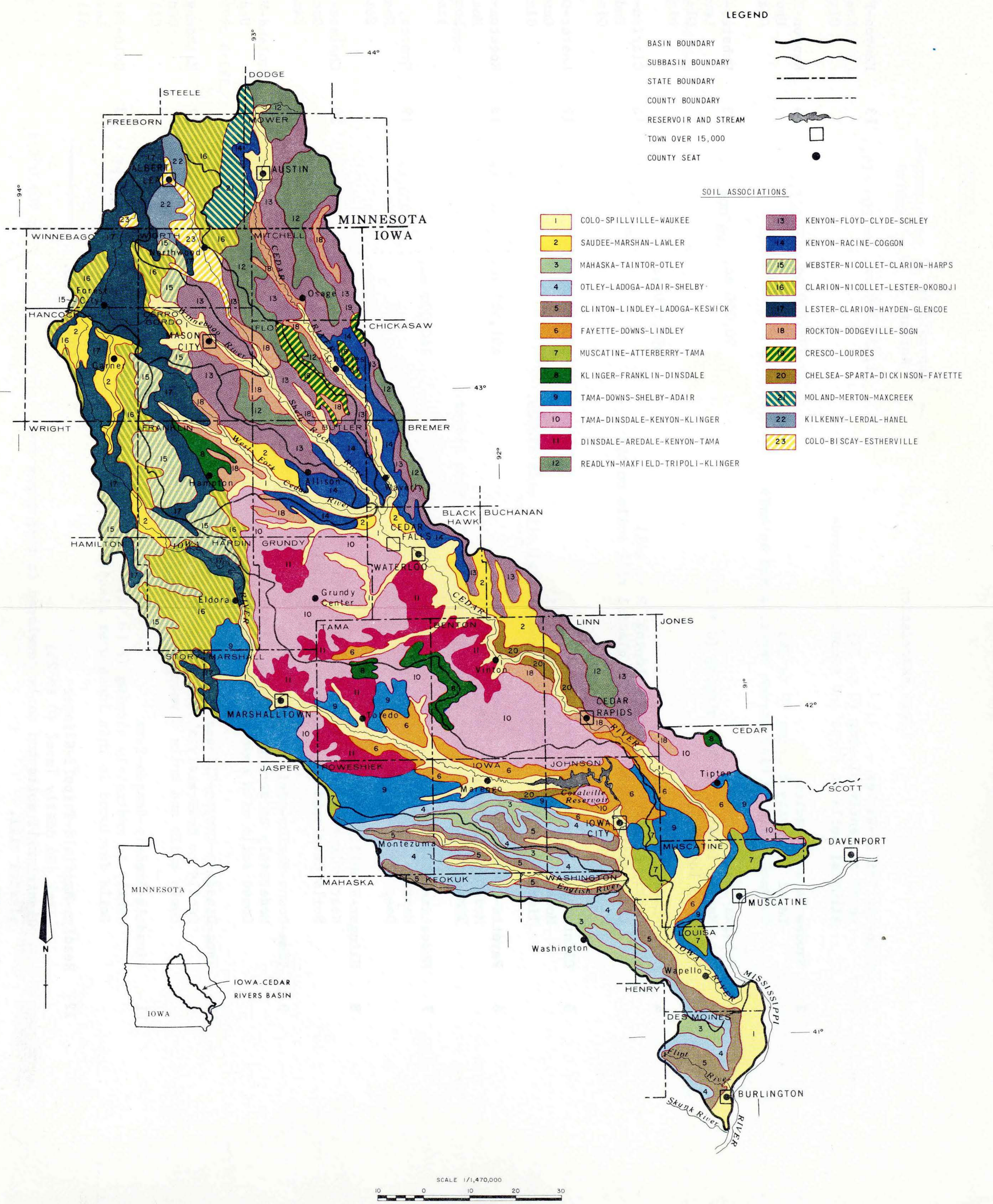

Figure 6

SOURCE:
SCS DRAWING 5,0-28270 AND INFORMATION FROM FIELD TECHNICIANS.

LAMBERT CONFORMAL CONIC PROJECTION

USDA-SCS-LINCOLN, NEBR. 1971

7-8-71
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6. Drainage coefficient required for individual drainage districts to provide adequate capacity. The land in each district must be checked in detail to determine percent of soils needing drainage and the degree of surface drainage that is available.

To provide adequate drainage for soils that have tile mains of inadequate capacity, one or more of the following steps may need to be taken:

1. Improve the outlet channel of the tile mains to allow for more free flow of water from the tile.

2. Add new tile mains and continue utilizing the existing mains.

3. Abandon existing mains and install completely new main systems.

4. Substitute open ditches for tile mains to provide adequate outlet capacity. Construction costs for open ditches are generally lower than large capacity subsurface conduits (over 30 inches in diameter). However, right-of-way and annual maintenance costs are normally much higher for ditches and may more than offset the increased construction costs of subsurface conduits or tile mains.

P.L. 566 is a tool available to provide cost sharing for updating these legal drainage districts and other watersheds with major drainage problems. Progress has been made in rehabilitating one of these drainage districts in Deer Creek Watershed in Worth County with the use of P.L. 566 watershed assistance. Applications have been made for similar assistance for West Branch Watershed in Hancock County; Morlee Watershed in Franklin County; and Honeycomb Watershed in Hardin County. Economic benefits for this type of watershed are generally high. Those that have been analyzed have had benefit-to-cost ratios greater than three to one. Figure 1 shows the area with the most potential for P.L. 566 projects.

Inadequate Drainage Prevents Utilization of Soil Erosion Control Practices

Many soils in the Kenyon-Floyd-Clyde-Schley Soil Association Area (see Figure 6) have a need for drainage for increased economic returns as well as a need for installation of conservation practices such as terracing and contouring. Without subsurface drainage these conservation practices are not recommended on some soils in this association

d. Enlarge [illegible] required for individual [illegible] ditches to provide adequate capacity. The field [illegible] should be checked in detail to determine current [illegible] drainage and the degree of surface [illegible] advantage that is available.

To provide adequate drainage for soils that have slow rates of water movement, one or more of the following steps may need to be taken:

1. Improve the outlet [illegible] of the [illegible] to allow it to carry flow of water from the tile.

2. Add new field drains and continue utilizing the existing drains.

3. Abandon existing drains and install completely new main systems.

4. [illegible] drains for [illegible] to provide adequate outlet capacity. [illegible] are generally [illegible] than [illegible] (drains in [illegible]). However, [illegible] and [illegible] more offset the increased construction costs of [illegible] of tile drains.

[illegible] to provide cost sharing for updating these local drainage districts and other watersheds with major drainage problems. [illegible] has been made [illegible] in one of these drainage districts [illegible] watershed in [illegible] County with the [illegible] watershed [illegible]. Applications have been made for similar assistance [illegible] in [illegible] County, North [illegible] and [illegible] County. Economic benefits for this type of watershed are generally high. [illegible] have been analyzed have [illegible] benefit-cost ratios greater than one. Figure [illegible] shows the area with the [illegible] projects.

[illegible]

[illegible]

because they slow surface water runoff. Slowing the water allows more to infiltrate which can add to the existing drainage problems.

There is a need for many small group drainage projects throughout this soil association that would be too small to fit into the P.L. 566 program.

Problems Reported that Deter Installation or Improvement of Drainage Systems

Relating the high economic potential, nuisance elimination, and work days gained by providing good drainage with the slow progress in upgrading drainage systems during the past fifty years, it is obvious that many problems exist in achieving good drainage.

Some of these problems reported by landowners are as follows:

1. High capital outlay.

2. Lack of agreement among landowners on the proportioning or sharing of costs. This isn't a problem for existing legal drainage districts as costs have already been proportioned.

3. Inability to obtain right-of-way. Legal drainage districts do have the power of condemnation for right-of-way not available for small informal groups.

4. Opposition to open drainage ditches where outlet capacity needed is more than is practical to provide with tile or other subsurface conduits. Many times the location for the required outlet ditch is on land that has adequate drainage.

5. Indifference of landowners.

6. In Land Resource Area 103 portion of Basin in Iowa, 31 percent of farm operators are tenants compared to 24 percent for the state of Iowa. Many of these landowners live out of the area, making it difficult for them to participate in organizing drainage projects.

7. Long standing neighborhood feuds that originated in the early 1900's that exist into the third and fourth generations have been reported.

because they slow surface water runoff. Clearing the watersheds adds to difficulties which can add to the existing drainage problems.

There is a need for many small watershed projects throughout this soil association that would be too small to fit into the P.L. 566 program.

<u>Problems Encountered in Either Initiation or Improvement of Drainage Systems</u>

Relating the high economic potential, existing organization, and work done already in providing good drainage with the slow progress in completing drainage systems during the past fifty years, it is obvious that many problems exist in achieving good drainage.

Some of these problems encountered by landowners are as follows:

1. High cost of drainage.

2. Lack of agreement among landowners on the apportioning or sharing of costs. This is also a problem for existing legal drainage districts where costs have already been apportioned.

3. Inability to obtain right-of-way. Legal drainage districts do have the power of condemnation for right-of-way not available for small informal groups.

4. Opposition to open drainage ditches where outlet capacity needed is more than is practical to provide with tile or other subsurface drainage. Many times the location for the required outlet ditch is on land that has adequate drainage.

5. Indifference of landowners.

6. In some townships about [illegible] percent of land is owned by [illegible] compared to [illegible] percent for the state of Iowa. Many of these landowners live out of the area, making it difficult for them to participate in organizing drainage projects.

7. Long standing neighborhood feuds that originated in the early 1900's that exist into the third and fourth generations, have been perpetuated.

8. Opposition to projects from individuals and groups because of unwarranted fear of increased flooding due to improvements. (See Appendix D.)

Legal drainage districts provide the means of solving the problems listed in items 2 and 3.

Opposition to projects from individuals and groups because of [illegible] fear of increased flooding due to improvements. (See Appendix B.)

[illegible] districts provide the means of solving the problems cited in items 2 and 3.

APPENDIX A

CALCULATIONS FOR DETERMINING IMPACT OF DRAINAGE ON CROP PRODUCTION - YEAR 2000

APPENDIX A

CALCULATIONS FOR DETERMINING IMPACT OF DRAINAGE ON CROP PRODUCTION - Year 2000
Iowa-Cedar Rivers Basin

SRG [1]	Crop	Acreage PD [2]	Acreage ND [3]	Yields DR [4]	Yields PD	Yields ND	Yields Change DR-PD	Yields Change DR-ND	Change in Production PD-DR	Change in Production ND-DR	Change in Production Total Change	Price [5]	Total Value Change	Average Change Per Acre Drained
1	Corn		3,666	163.3		122.5		40.8		149,573	149,573	$1.35	$201,924	$55.08
	Silage		78	26.9		20.2		6.7		523	523	9.00	4,707	60.30
	Oats		130	66.0		49.5		16.5		2,145	2,145	.81	1,737	13.36
	Soybeans		2,439	50.5		37.9		12.6		30,731	30,731	3.74	114,934	47.12
	Crop Pasture		600	249.7		187.3		62.4		37,440	37,440	.35	13,104	21.84
	Alfalfa Hay		645	5.5		4.1		1.4		903	903	25.30	22,846	35.42
	Other Hay		39	3.1		2.3		.8		31	31	25.30	784	20.24
	Total		7,597										$360,036	$47.39
2	Corn	56,380	56,380	179.0	156.5	134.2	22.5	44.8	1,268,550	2,525,824	3,794,374	$1.35	$5,122,405	$45.43
	Silage	1,394	1,394	29.2	26.3	21.9	2.9	7.3	4,043	10,176	14,219	9.00	127,969	45.90
	Oats	2,428	2,428	101.4	91.3	76.0	10.1	25.4	24,523	61,671	86,194	0.81	69,817	14.38
	Soybeans	30,060	30,060	50.5	45.4	37.9	5.1	12.6	153,306	378,756	532,062	3.74	1,989,912	33.10
	Crop Pasture	7,151	7,151	249.7	224.7	187.3	25.0	62.4	178,775	446,222	624,997	.35	218,749	15.30
	Alfalfa Hay	7,667	7,667	5.5	4.9	4.1	0.6	1.4	4,600	10,734	15,334	25.30	387,950	25.30
	Other Hay	457	457	3.4	3.1	2.5	0.3	0.9	137	411	548	25.30	13,875	15.18
	Total	105,537	105,537										$7,930,677	$37.57

Appendix A (continued)

SRG[1/]	Crop	Acreage PD[2/]	Acreage ND[3/]	Yields DR[4/]	Yields PD	Yields ND	Yields Change DR-PD	Yields Change DR-ND	Change in Production PD-DR	Change in Production ND-DR	Total Change	Price[5/]	Total Value Change	Average Change Per Acre Drained
3	Corn		1,260	147.6		110.7		36.9		46,494	46,494	$1.35	$62,767	$49.82
	Silage		41	24.6		18.4		6.2		254	254	9.00	2,288	55.80
	Oats		230	93.4		70.0		23.4		5,382	5,382	0.81	4,359	18.95
	Soybeans		893	46.9		35.2		11.7		10,448	10,448	3.74	39,076	43.76
	Crop Pasture		455	236.2		177.1		59.1		26,890	26,890	0.35	9,412	20.68
	Alfalfa Hay		490	5.3		4.0		1.3		637	637	25.30	16,116	32.89
	Other Hay		30	2.8		2.1		0.7		21	21	25.30	531	17.71
	Total		3,399										$134,549	$39.58
4	Corn		200	114.6		85.0		29.6		5,920	5,920	$1.35	$7,992	$39.96
	Silage											9.00		
	Oats											0.81		
	Soybeans											3.74		
	Crop Pasture											0.35		
	Alfalfa Hay											25.30		
	Other Hay											25.30		
	Total		200										$7,992	$39.96

Appendix A (continued)

SRG[1/]	Crop	Acreage PD[2/]	Acreage ND[3/]	Yields DR[4/]	Yields PD	Yields ND	Yields Change DR-PD	Yields Change DR-ND	Change in Production PD-DR	Change in Production ND-DR	Change in Production Total Change	Price[5/]	Total Value Change	Average Change Per Acre Drained
5	Corn		2,000	153.9		138.5		15.4		30,800	30,800	$1.35	$41,580	$20.79
	Silage											9.00		
	Oats											.81		
	Soybeans		1,852	38.8		34.9		3.9		7,223	7,223	3.74	27,013	14.59
	Crop Pasture											.35		
	Alfalfa Hay											25.30		
	Other Hay											25.30		
	Total		3,852										$68,593	$17.81
10	Corn		29,157	138.2		70.6		67.6		1,971,013	1,240,325	1.35	2,660,868	91.26
	Silage		947	22.3		16.4		5.9		5,587	3,516	9.00	50,283	53.10
	Oats		1,394	59.6		30.6		29.0		40,426	40,426	.81	32,745	23.49
	Soybeans		27,108	43.3		22.3		21.0		569,268	358,239	3.74	2,129,062	78.54
	Crop Pasture		3,733	189.0		189.0		0		0	0	.35	0	0
	Alfalfa Hay		4,003	4.2		4.2		0		0	0	25.30	0	0
	Other Hay		238	2.7		1.3		1.4		333	210	25.30	8,425	35.40
	Total		66,580										4,881,383	73.32

Appendix A (continued)

SRG[1/]	Crop	Acreage PD[2/]	Acreage ND[3/]	Yields DR[4/]	Yields PD	Yields ND	Yields Change DR-PD	Yields Change DR-ND	Change in Production PD-DR	Change in Production ND-DR	Total Change	Price[5/]	Total Value Change	Average Change Per Acre Drained
13	Corn	2,508		64.4	58.0		6.4		16,051		16,051	$1.35	$21,669	$8.64
	Silage	81		10.5	9.4		1.1		89		89	9.00	802	9.90
	Oats	66		33.8	30.4		3.4		224		224	.81	182	2.75
	Soybeans	878		20.0	18.0		2.0		1,756		1,756	3.74	6,567	7.48
	Crop Pasture	941		81.0	72.9		8.1		7,622		7,622	.35	2,668	2.84
	Alfalfa Hay	57		1.8	1.6		0.2		11		11	25.30	288	5.06
	Other Hay	-		1.2	1.1		-		-		-	25.30	-	-
	Total	4,531											$32,176	$7.10
14	Corn	4,095		122.5	110.2		12.3		50,368		50,368	$1.35	$67,997	$16.60
	Silage	133		19.8	17.8		2.0		266		266	9.00	2,394	18.00
	Oats	664		85.3	76.8		8.5		5,644		5,644	.81	4,572	6.88
	Soybeans	3,846		42.2	38.0		4.2		16,153		16,153	3.74	60,413	15.71
	Crop Pasture	826		209.2	188.3		20.9		17,263		17,263	.35	6,042	7.32
	Alfalfa Hay	886		4.6	4.1		0.5		443		443	25.30	11,208	12.65
	Other Hay	53		3.0	2.7		0.3		16		16	25.30	402	7.59
	Total	10,503											$153,028	$14.57

Appendix A (continued)

		Acreage		Yields					Change in Production					
							Change						Total Value	Average Change Per Acre
SRG 1/	Crop	PD 2/	ND 3/	DR 4/	PD	ND	DR-PD	DR-ND	PD-DR	ND-DR	Total Change	Price 5/	Change	Drained
15	Corn	660		106.8	96.1		10.7		7,062		7,062	$ 1.35	$9,534	$ 14.44
	Silage	21		17.5	15.7		1.8		38		38	9.00	340	16.20
	Oats	27		77.3	69.6		7.7		208		208	.81	168	6.24
	Soybeans	383		38.8	34.9		3.9		1,494		1,494	3.74	5,586	14.59
	Crop Pasture	255		195.7	176.1		19.6		4,998		4,998	.35	1,749	6.86
	Alfalfa Hay	274		4.3	3.9		0.4		110		110	25.30	2,773	10.12
	Other Hay	16		2.1	1.9		0.2		3		3	25.30	81	5.06
	Total	1,636											$ 20,231	$ 12.37
16	Corn	812		103.6	93.2		10.4		8,445		8,445	$1.35	$11,400	$14.04
	Silage	26		17.5	15.7		1.8		47		47	9.00	421	16.20
	Oats	31		45.1	40.6		4.5		140		140	.81	113	3.64
	Soybeans	691		23.5	31.1		2.4		1,658		1,658	3.74	6,202	8.98
	Crop Pasture	278		81.0	72.9		8.1		2,252		2,252	.35	788	2.84
	Alfalfa Hay	298		1.8	1.6		0.2		60		60	25.30	1,508	5.06
	Other Hay	18		1.9	1.7		0.2		4		4	25.30	91	5.06
	Total	2,154											$20,523	$9.53

Appendix A (continued)

SRG[1/]	Crop	Acreage PD[2/]	Acreage ND[3/]	Yields DR[4/]	Yields PD	Yields ND	Yields Change DR-PD	Yields Change DR-ND	Change in Production PD-DR	Change in Production ND-DR	Total Change	Price[5/]	Total Value Change	Average Change Per Acre Drained
18	Corn	28,496	28,689	149.1	111.5	73.8	37.6	75.3	1,071,450	2,160,282	3,231,731	$1.35	$4,362,838	$76.29
	Silage	1,322	932	26.5	24.6	14.1	1.9	12.4	2,512	11,557	14,069	9.00	126,617	56.17
	Oats	1,387	1,387	86.9	66.0	43.5	20.9	43.4	28,988	60,196	89,184	.81	72,239	26.04
	Soybeans	18,502	18,628	46.9	35.2	23.5	11.7	23.4	216,473	435,895	652,369	3.74	2,439,859	65.71
	Crop Pasture	4,927	4,960	222.7	135.0	81.0	87.7	141.7	432,098	702,832	1,134,930	.35	397,225	40.18
	Alfalfa Hay	5,282	5,318	4.9	3.0	1.8	1.9	3.1	10,036	16,486	26,522	25.30	670,996	63.60
	Other Hay	314	316	3.4	2.5	1.8	0.9	1.6	283	506	788	25.30	19,941	31.65
	Total	60,230	60,230										$8,089,715	$67.16
19	Corn	2,017	2,042	111.1	92.6	53.4	18.5	57.7	37,314	117,823	155,138	$1.35	$209,436	$51.60
	Silage	66	-	23.8	19.8	-	4.0	-	264	-	264	9.00	2,376	36.00
	Oats	180	180	46.3	38.6	22.5	7.7	23.8	1,386	4,284	5,670	.81	4,593	12.76
	Soybeans	1,878	1,901	35.2	29.3	16.4	5.9	18.8	11,080	35,739	46,819	3.74	175,103	46.34
	Crop Pasture	675	683	162.0	135.0	81.0	27.0	81.0	18,225	55,323	73,548	.35	25,742	18.96
	Alfalfa Hay	725	734	3.6	3.0	1.8	0.6	1.8	435	1,321	1,756	25.30	44,432	30.46
	Other	43	44	3.7	3.1	1.6	0.6	2.1	26	92	118	25.30	2,990	34.37
	Total	5,584	5,584										$464,672	$41.61

Appendix A (continued)

SRG[1]	Crop	Acreage PD[2]	Acreage ND[3]	Yields DR[4]	Yields PD	Yields ND	Yields Change DR-PD	Yields Change DR-ND	Change in Production PD-DR	Change in Production ND-DR	Total Change	Price[5]	Total Value Change	Average Change Per Acre Drained
20	Corn	153,900	154,369	179.0	135.0	89.5	44.0	89,5	6,771,600	13,816,026	20,587,626	$1.35	$27,793,294	$90.16
	Silage	5,000	5,013	29.2	19.8	17.5	9.4	11.7	47,000	58,652	105,652	9.00	950,869	94.96
	Oats	7,449	6,417	104.6	77.3	51.5	27.3	53.1	203,358	340,743	544,100	.81	440,721	31.78
	Soybeans	138,683	139,105	55.1	41.0	28.2	14.1	26.9	1,955,430	3,741,924	5,697,355	3.74	21,308,107	76.71
	Crop Pasture	19,603	19,663	263.2	202.5	135.0	60.7	128.2	1,189,902	2,520,797	3,710,699	.35	1,298,745	33.08
	Alfalfa Hay	21,018	21,082	5.8	4.5	3.0	1.3	2.8	27,323	59,030	86,353	25.30	2,184,731	51.89
	Other Hay	1,254	1,258	3.4	3.3	2.3	0.1	1.1	125	1,384	1,509	25.30	38,183	15.20
	Total	346,907	346,907										$54,014,650	$77.85
21	Corn		9,981	139.7		69.9		69.8		696,674	696,674	$1.35	$940,510	$94.23
	Silage		323	23.5		11.8		11.7		3,779	3,779	9.00	34,012	105.30
	Oats		1,500	77.3		38.7		38.6		57,900	57,900	.81	46,899	31.27
	Soybeans		11,117	38.8		19.4		19.4		215,670	215,670	3.74	806,605	72.56
	Crop Pasture		3,123	195.7		97.9		97.8		305,429	305,429	.35	106,900	34.23
	Alfalfa Hay		3,349	4.3		2.2		2.1		7,033	7,033	25.30	177,932	53.13
	Other Hay		199	2.7		1.4		1.3		259	259	25.30	6,545	32.89
	Total		29,592										$2,119,403	$71.62

Appendix A (continued)

SRG 1/	Crop	Acreage PD 2/	Acreage ND 3/	Acreage DR 4/	Yields PD	Yields ND	Yields Change DR-PD	Yields Change DR-ND	Change in Production PD-DR	Change in Production ND-DR	Total Change	Price 5/	Total Value Change	Average Change Per Acre Drained
22	Corn	13,244		127.2	64.4		62.8		831,723		831,723	$1.35	$1,122,826	$84.78
	Silage	-		25.7	-		-		-		-	9.00	-	-
	Oats	-		78.9	-		-		-		-	.81	-	-
	Soybeans	12,470		39.9	19.9		20.0		249,400		249,400	3.74	932,756	74.80
	Crop Pasture	2,107		182.2	87.7		94.5		199,112		199,112	.35	69,689	33.08
	Alfalfa Hay	2,257		4.0	1.9		2.1		4,740		4,740	25.30	119,914	53.13
	Other Hay	135		2.4	1.3		1.1		148		148	25.30	3,757	27.83
	Total	30,213											$2,248,942	$74.44
23	Corn	4,290		105.2	64.4		40.8		175,032		175,032	$1.35	$236,293	$55.08
	Silage	-		-	-		-		-		-	9.00	-	-
	Oats	217		62.9	41.9		21.0		4,557		4,557	.81	3,691	17.01
	Soybeans	4,745		32.9	19.9		13.0		61,685		61,685	3.74	230,702	48.62
	Crop Pasture	-		-	-		-		-		-	.35	-	-
	Alfalfa Hay	871		4.0	2.5		1.5		1,306		1,306	25.30	33,054	37.95
	Other Hay	-		-	-		-		-		-	25.30	-	-
	Total	10,123											$503,740	$49.76

1/ Soil Resource Group.

2/ Partly drained.

3/ No drainage.

4/ Drained.

5/ Guideline 2 - Agricultural Price Standards for Water and Related Land Resources Planning. United States Water Resources Council. Washington, D.C., February 1974.

APPENDIX B

SRG (SOIL RESOURCE GROUP) DESCRIPTION

APPENDIX B

SRG (SOIL RESOURCE GROUP) DESCRIPTION
Iowa-Cedar Rivers Basin

CODE	DESCRIPTION	IOWA LCU*	IOWA DISTRIBUTION (%)	MINNESOTA LCU*	MINNESOTA DISTRIBUTION (%)	MAJOR SOILS	SLOPE	TEXTURE CLASS	PROBLEMS
1	Deep, well to somewhat poorly drained, medium to moderately fine textured bottomland soils. Moderately to moderately slowly permeable. Fine textured lower Horizons may be encountered throughout the lower portion of the profile.	I a11	58	IIW41	100	Nodaway	Level to gently sloping 0-2%	Silt loam	Minor flooding
		I a12	42						
2	Deep, well and somewhat poorly drained, medium to moderately fine textured, some lacustrine and upland soils. Moderately to moderately slow permeable. Bedrock or gravel may be encountered deep within the profile.	I a41		I-02	26	Tama	Level to gently sloping	Silt loam	Somewhat poorly drained
		I c11		I-03	10	Downs			
		I c13		I-04		Racine			
		I c14		IIE02	16	Kenyon			
		I c15		IIE03	41	Clinton			
		IIEa41		IIE04		Fayette			
		IIEc11	43	IIE29		Dubuque			
		IIEc13				Muscatine			
		IIEc14				Mahaska			
		IIEc15				Nicollet			
		I b11	24			Clarion			
		I b12	5						
		IIWm82	6						
		IIEm82							
		IIEb11							
		IIWL11							
		IIEb12							

*Only LCU's with areas greater than 500 acres are shown.

Appendix B (Continued)

CODE	DESCRIPTION	IOWA LCU	IOWA DISTRIBUTION (%)	MINNESOTA LCU	MINNESOTA DISTRIBUTION (%)	MAJOR SOILS	SLOPE	TEXTURE CLASS	PROBLEMS
3	Deep, moderately well and well	IIIEa41		IIIE03	61	Tama	Gently	Silt	Erosion
	drained, medium and moderately fine	IIIEb12		IIIE04	23	Downs	sloping	loam	
	textured upland soils. Moderate	IIIEc11	82	IIIE02		Racine	5-14%		
	to moderately slowly permeable.	IIIEc13		IIIE10		Ostrander			
	Some areas of calcareous soils are	IIIEc14	16	IIIE29		Dodgeville			
	included.	IIIEc15				Clinton			
		IIIEc16				Fayette			
						Dubuque			
4	Deep, moderately well to drained,	IVEc11	56	IVE03	50	Tama	Modera-	Silt	Erosion
	moderately fine textured upland	IVEc16		IVE04	25	Downs	tely	loam	
	soils. Moderate to moderately	IVEc14	40	IVE10	25	Racine	steep		
	slowly permeable. Some calcareous	IVEd11				Ostrander	14-18%		
	soils are included.					Dodgeville			
						Clinton			
						Fayette			
						Dubuque			
5	Deep, moderately well drained,	IIWd11	12	IIS19	92	Cresco	Level	Loam	Erosion
	moderately fine to fine textured	IIEd11	85	IIE19	8	Lindley	to		
	upland soils. Moderately slowly to	IIEd12					gently		
	slowly permeable soils, with firm						sloping		
	to very firm subsoils.						2-5%		
6	Deep, moderately well drained,	IIEd11	25	IIIE22	50	Cresco	Sloping	Loam	Erosion
	moderately fine to fine textured	IVEd21	75	IIIS19	50	Lindley	5-14%		
	upland soils. Moderately slowly to								
	slowly permeable soils, with firm								
	to very firm subsoils.								

Appendix B (Continued)

CODE	DESCRIPTION	IOWA LCU	IOWA DISTRIBUTION (%)	MINNESOTA LCU	MINNESOTA DISTRIBUTION (%)	MAJOR SOILS	SLOPE	TEXTURE CLASS	PROBLEMS
9	Poorly drained upland soils. Very fine textured soils on side slopes.	IVEf11 IVWf11	33 66			Clarinda	Sloping to moderately steep 5-14%	Silty clay loam	Erosion and wetness
10	Deep, somewhat poorly to poorly drained upland soils with moderately fine to very fine textured subsoils. Level. Some fine textured material over sandy substrata is included. Moderately slowly to very slowly permeable.	IIWm11 IIIWn11 IIIWn12 IIIWn61 IIWm62 IIIWn31 IIIWm11	7 29 52	IIIW10 IIIW12 IIIW20	58 10 32	Adair Keswick	Level 0-2%	Silt loam	Wetness
11	Deep, moderately well to somewhat poorly drained upland soils, with fine textured subsoils. Very slowly to slowly permeable.	IIIEe21	100			Adair Keswick	Gently sloping to sloping 2-9%	Silt loam	Erosion and seepy
12	Deep, moderately well to somewhat poorly drained upland soils with fine textured subsoils. Very slowly permeable.	IVEe21 IVEe22	90 10			Adair Keswick	Moderately steep 9-14%	Silt loam	Erosion and seepy

Appendix B (Continued)

CODE	DESCRIPTION	IOWA LCU	IOWA DISTRIBUTION (%)	MINNESOTA LCU	MINNESOTA DISTRIBUTION (%)	MAJOR SOILS	SLOPE	TEXTURE CLASS	PROBLEMS
13	Well to excessively drained upland soils. Includes soils shallow to bedrock or sand and gravel and deep sandy soils.	IVSh11 IVSk12	 98			Sogn Hagener Chelsea	Level to sloping 0-14%	Sand	Erosion and moderately low moisture holding capacity
14	Well to somewhat poorly drained, moderately deep (24-40") medium to moderately fine textured upland soils overlying sand and gravel or bedrock and deep moderately coarse textured soils.	IISi11 IISi12 IIEi11 IIEi12 IIEj11 IIEi21	44 46 5	IIS24 IIS25 IIE23 IIS23 IIE24 IIIE11	58 8 8 13 	Dickinson	Level to gently sloping 0-5%	Loam	Low moisture holding capacity
15	Well to somewhat poorly drained, moderately deep (24-40"), medium to moderately fine textured upland soils overlying sand and gravel or bedrock. Deep moderately coarse textured soils are included.	IIIEi11 IIIEi12 IIIEi21 IIIEj11 IVEd12 IVEi11 IVEi21 IVEj12	19 5 57 5 6 6	IVE11	100	Dickinson	Sloping to moderately steep 5-14%		Erosion and moderately low moisture holding capacity
16	Deep, moderately coarse to coarse textured upland soils and medium textured soils, shallow to sand and gravel.	IIIEj12 IIISj11 IVSk11 IVEj11 IIISj12	21 64 8 	IIIS34 IIIS36 IIIE34 IIIE36 IIIE37	7 33 20 20 7	Dickinson	Nearly level to sloping 2-4%	Sandy loam	Erosion and low moisture holding capacity

Sheet 4 of 6

Appendix B (Continued)

CODE	DESCRIPTION	IOWA LCU	IOWA DISTRIBUTION (%)	MINNESOTA LCU	MINNESOTA DISTRIBUTION (%)	MAJOR SOILS	SLOPE	TEXTURE CLASS	PROBLEMS
18	Poorly drained, medium to moderately fine textured bottomland soils. Moderately to moderately slowly permeable. May be subject to overflow.	IIWm21 IIWm22	94 6			Colo	Level to nearly level 0-2%	Silty clay loam and loam	Poorly drained and overflow
19	Somewhat poorly to poorly drained fine textured soils of the bottom lands. Slowly to very slowly permeable. Subject to occasional overflow.	IIIWn21	100			Zoök Wabash	Level to nearly level 0-2%	Silty clay	Poorly drained and overflow
20	Poorly drained, medium to moderately fine textured soils of uplands or lacustrine plains. Moderately slowly permeable. (Includes moderately deep soils over bedrock and/or gravel). May be seepy. Includes some calcareous soils.	IIWm31 IIWm32 IIWm33 IIWm41 IIIWn41 IIWn31	71 23 5	IIW02 IIW03 IIW08 IIW09 IIIW22	 84 12	Taintor Clyde Tripoli Webster Harps Okoboji	Level to nearly level 0-2%	Loam, clay loam and silty clay loam	Poorly drained
21	Somewhat poorly drained, moderately fine textured upland soils with firm to very firm, slowly permeable subsoils.	IIWm61	100	IIIW14	100		Level to gently sloping 0-3%	Loam	Wetness
22	Organic upland and depression soils. Agricultural soils when drained.	IIIWn51	100	IIIW38 IIIW39	 58 41		Level 0-2%	Muck	Wetness

Appendix B (Continued)

CODE	DESCRIPTION	IOWA LCU	IOWA DISTRIBUTION (%)	MINNESOTA LCU	MINNESOTA DISTRIBUTION (%)	MAJOR SOILS	SLOPE	TEXTURE CLASS	PROBLEMS
23	Alluvial bottomland and organic soils subject to variable frequency of overflow and wetness.	IIIWn61 VWp11	7 92			Colo-Zook	Level 0-2%	Mixed alluvial soils	Wetness overflow

Sheet 6 of 6

APPENDIX C

DEFINITION OF "WETLANDS" OF THE UNITED STATES

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DEFINITION OF "WETLANDS" OF THE UNITED STATES

"Wetlands of the United States" Circular 39 published by United States Department of the Interior, Fish and Wildlife Service, lists 20 types of wetlands. Types 1 through 6 are found in the Iowa-Cedar Rivers Basin.

A brief description of these is as follows:

Type 1 - Seasonability flooded basins or flats. The soil is covered with water, or is waterlogged, during variable seasonal periods but usually is well drained during much of the growing season. Vegetation varies greatly according to the season and the duration of flooding. It includes bottomland hardwoods as well as some herbaceous growths. Where the water has receded early in the growing season, smartweeds, wild millet, fall panicum, tealgrass, chufa, redroot cyperus, and weeds (such as marsh elder, ragweed, and cockleburs) are likely to occur. Shallow basins that are submerged only very temporarily usually develop little or no wetland vegetation.

Type 2 - Inland fresh meadows. The soil is without standing water during most of the growing season but is waterlogged within at least a few inches of its surface. Vegetation includes grasses, sedges, rushes, and various broad-leaved plants. Wild hay is sometimes cut from such areas. Fresh meadows are used somewhat in the North by nesting waterfowl, but in most of the country their value is mainly as supplemental feeding areas.

Type 3 - Inland shallow fresh marshes. The soil is usually waterlogged during the growing season; often it is covered with as much as six inches or more of water. Vegetation includes grasses, bulrushes, spikerushes, and various other marsh plants such as cattails, arrowheads, pickerelweed, and smartweeds. In combination with deep fresh marshes (Type 4) they constitute the principal production areas for waterfowl.

Type 4 - Inland deep fresh marshes. The soil is covered with six inches to three feet or more of water during the growing season. These may border open lakes or fill shallow lake basins. Vegetation includes cattails, reeds, bulrushes, spikerushes, and wildrice. In open areas, pondweeds, naiads, coontail, watermilfoils, waterweeds, duckweeds, waterlilies, or spatterdocks may occur.

Deep fresh marshes constitute the best breeding habitat in the country, and they are also important feeding places.

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Deep fresh marshes constitute the best breeding habitat in the country, and they are also important feeding places.

Type 5 - Inland open fresh water. Shallow ponds and reservoirs are included in this type. Water is usually less than ten feet deep and is fringed by a border of emergent vegetation. Vegetation (mainly at water depths less than six feet) includes pondweeds, naiads, wildcelery, coontail, watermilfoils, muskgrasses, waterlilies, and spatterdocks. These areas are used extensively as brood areas when, in midsummer and late summer, the less permanent marshes begin to dry out.

Type 6 - Shrub swamps. The soil is usually waterlogged during the growing season, and often covered with six inches of water. Vegetation includes alders, willows, buttonbush, dogwoods, and swamp-privet. These occur mostly along sluggish streams and occasionally on flood plains. Used to a limited extent for nesting and feeding in the North.

SOIL CONSERVATION SERVICE POLICY

It is the general policy of the Service to aid in protecting, maintaining, and managing existing wetlands to assure the continuation of their beneficial effects. Assistance also will be given to restore damaged wetlands that are not irrevocably committed to other uses and to create new wetlands, where appropriate.

For further information refer to "Conservation Planning Memorandum" of the SCS regarding wetlands.

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SOIL CONSERVATION SERVICE POLICY

It is the general policy of the Service to aid in preserving, maintaining and managing existing wetlands to assure the continuation of their beneficial effects. Assistance generally will be given to restore drained wetlands that are not irrevocably committed to other uses and to create new wetlands, where appropriate.

For further information refer to Conservation Planning Memorandum [illegible] of the SCS regarding wetlands.

APPENDIX D

IMPACT OF DRAINAGE ON FLOOD DAMAGES

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The following is the Soil Conservation Service's views on drainage given in response to questions from Senator Buckley at Hearings held by the Senate Committee on Public Works on July 27, 1971.

Question. What impact occurs on floods, sediment production, and the productivity of the land when a marsh is drained? Please cite the documentation for your conclusion.

Answer. As indicated in our reply to the previous question, we do not plan the drainage of marshes and, therefore, have little information concerning this. In general we would expect the effects of marsh drainage on floods and sediment production to be similar to these effects for other land discussed below. Concerning the effect of drainage on marsh productivity, we would expect the productivity of water-tolerant vegetation to decrease and of other vegetation to increase as the water table is lowered, provided the soils are suitable. Other forms of life dependent on such vegetation would be affected similarly.

We do have considerable information about the effects of drainage on wet agricultural land. Our conclusions and their basis are as follows:

1. Drainage does not increase the size of floods, especially in large basins.

2. Sediment production is not a significant problem in drained lands.

3. Agricultural productivity usually increases with drainage, the amount depending on adequacy of drainage, type of soil, overall management, and other factors of production.

4. Drainage is best planned on an overall project basis, where a total system can be well planned and designed, rather than on a piecemeal basis. This is done in watershed projects.

There is evidence that farm drainage has no effect on floods in large drainage basins. In small drainage basins peak discharges may increase or decrease depending on the design of the drainage system, soils, time of year, and distribution and timing of the flood-causing precipitation.

The "sponge theory" is often used to support the idea that drainage causes floods. Some people say that wetlands help prevent floods by absorbing flood waters. Actually the opposite is true. A saturated soil or pothole full of water cannot soak up water any more than an already saturated sponge. However, when wetlands are drained, the soil acts as a sponge in soaking up water and letting it out slowly. Some soils can store 6 or more inches of water, depending on type and depth of soils.

Mr. Philip W. Manson of the Department of Agricultural Engineering, in his paper "Water and Agricultural Land", Miscellaneous Journal Series Paper No. 947, August 1957, University of Minnesota Agricultural Experiment Station, states that "farm drainage does not affect major floods." He based this on his studies and on:

1. U.S. Geological Survey records on the Mississippi River at St. Paul which show that from 1867 to 1957, there have been 19 years in which floods occurred; twelve in the first half and 7 in the last half of this period. During this time, there has been extensive drainage in this basin.

2. A paper by Sherman M. Woodward and Floyd B. Nagler "Agriculture Drainage and Flood Runoff", 1929, Paper No. 1709 of the Transactions of the American Society of Civil Engineers. Their study areas included ten million acres in the Des Moines River Basin and two million acres in the Iowa River Basin. The types of drainage in these basins include tile, open ditch, and stream channel straightening. One-third of the total basin areas were drained. In the Des Moines Basin, there was one unit of four million acres which was 67 percent drained. Another unit of two million acres was 100 percent drained. The conclusion of the author included in Mr. Manson's paper: "A critical examination of the records of these two streams shows that there has been no significant change in their behavior which can be attributed to drainage. The total runoff from streams of like precipitation, the maximum rate of discharge, and the rainwater storage conditions within the basin seem to have been unaltered by the extensive drainage operations. It is believed that if any of these factors had been changed to a measurable amount, such fact could easily have been detected by the analysis made in this paper."

Manson goes on to state in his paper, "Each small watershed is a case by itself but normally a well-designed complete drainage system for a

The "sponge theory" is often used to support the idea that drainage causes floods. This reasoning says that wetlands help to prevent floods by absorbing flood waters. In reality, the process is not quite so simple. Soils or potholes will absorb some water if they are not already saturated, but when wetlands are already saturated with water they act only as a pathway. However, when wetlands are drained, the soils are more porous and aerated and therefore tend to absorb more water. Such soils can absorb as much as 4 inches of water, depending on [illegible] and depth of drainage.

Drainage engineers have maintained that increased drainage does not in itself cause more frequent or larger floods. This is borne out by a number of other studies, including those by the Agricultural Research Service of the U.S. Department of Agriculture, the University of Minnesota, and Ohio State University, which found that drainage does not affect flood levels. The reasons why are [illegible].

1. U.S. Geological Survey records on the Mississippi River at [illegible], which show that from 1893 to 1970 there have been 29 years in which floods occurred, 15 during the first half and 14 in the last half of this period. During that time there has been extensive drainage in this area.

2. A paper by Hobart G. Weaver and [illegible] entitled "Agricultural Drainage and Flood Runoff" (1970), Paper No. 7009 of the Transactions of the American Society of Civil Engineers. Their study area included the Blue Earth [illegible] in the Minnesota River Basin and the Le Sueur River in the Blue Earth Basin. The [illegible] data on these basins included [illegible] and [illegible] which represented one-third of the total basin area which was drained. In the [illegible] basin, 54 percent of an area of [illegible] acres was 6 percent drained. Another unit of [illegible] acres was 100 percent drained. One conclusion of the author included in the report's "Statistical Examination of the Records of These Two Basins" was that there has been no significant change in the runoff which can be attributed to the increase in drainage from streams [illegible] like these. Within the [illegible], the [illegible] and [illegible] of these floods during the period seem to have been attributed to the extensive drainage operations. It is believed that [illegible] and [illegible] have had some changes to a considerable extent, and that these studies have been [illegible] in [illegible] in this [illegible].

Marked drainage improvements [illegible] however, [illegible] reduce [illegible] problems [illegible] water and [illegible] which [illegible] a [illegible] force.

small watershed will not increase the peak runoff, although an incomplete or partial system may either slightly increase the peak flow or it may slightly decrease the peak flow. Therefore, it is important to plan drainage systems on a watershed basis and not by piecemeal. The Soil Conservation Service endorses this view. 1/

1/ Statement made in Advisory WS-5 (January 30, 1973) by William B. Davey, Deputy Administrator for Watersheds.

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