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Soil and Climatic Limitations for Sprinkler Irrigated Potato Production in Five Southeastern South Dakota Counties

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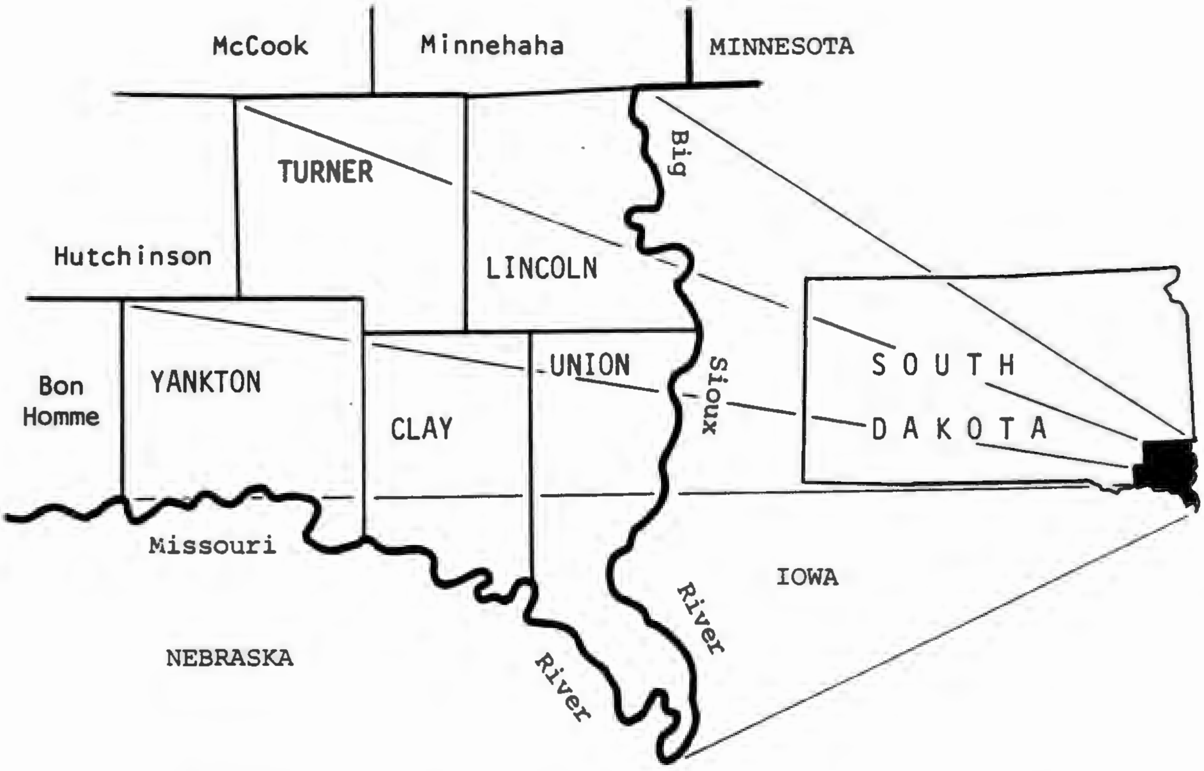
SOIL and CLIMATIC LIMITATIONS for SPRINKLER IRRIGATED POTATO PRODUCTION in FIVE SOUTHEASTERN SOUTH DAKOTA COUNTIES



AGRICULTURAL EXPERIMENT STATION
PLANT SCIENCE DEPARTMENT
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CONTENTS

List of Figures

List of Tables

Acknowledgement

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Soil and Climatic Limitations for Sprinkler Irrigated Potato Production in Five Southeastern South Dakota Counties[1]

by

D. D. Malo and G. D. Lemme[2]

INTRODUCTION

The soils of Southeastern South Dakota are an important and vital agricultural resource. Recently, questions about expanding irrigated potato production into the five counties of Clay, Lincoln, Turner, Union, and Yankton Counties have been asked by state government officials and business leaders. Soils vary greatly in their suitability for sprinkler irrigated potato production. As a result of this concern a study was initiated to identify soil limitations and suitability for sprinkler irrigated potato production. The soils in Clay and Union Counties were evaluated for both dryland and sprinkler irrigated potato production earlier (1983).

The objectives of this study were to:

1. describe the climate of the study area;
2. prepare and develop soil limitation ratings for sprinkler irrigated potato production for Clay, Lincoln, Turner, Union, and Yankton County soils; and
3. prepare soil limitation maps for each county using the soil association map located in the published soil survey for each county.

This bulletin is meant to point out potential areas and not provide detailed site information. It is designed to serve as a guide for county, state, and business officials as they explore the potential for irrigated potato production in Southeast South Dakota.

STUDY LIMITATIONS

The maps and data contained in this document are for planning purposes and are not meant to replace "on-site" investigation for potato development. Before any specific parcel of land can be evaluated for its suitability for potato development an on-site investigation by trained professionals is required.

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1 Contribution from the Plant Science Department and the Agricultural Experiment Station, South Dakota State University, Brookings, 57007. Projects 287470 and 287548.

2 Associate Professors of Pedology, Plant Science Department, South Dakota State University, Brookings, 57007.

This publication is intended to make the general public aware of the soils present in the five counties and their limitations for sprinkler irrigated potato production. With proper irrigation design, tillage, and water application management many of the limitations can be overcome. However, the costs will vary considerably with the limitation present.

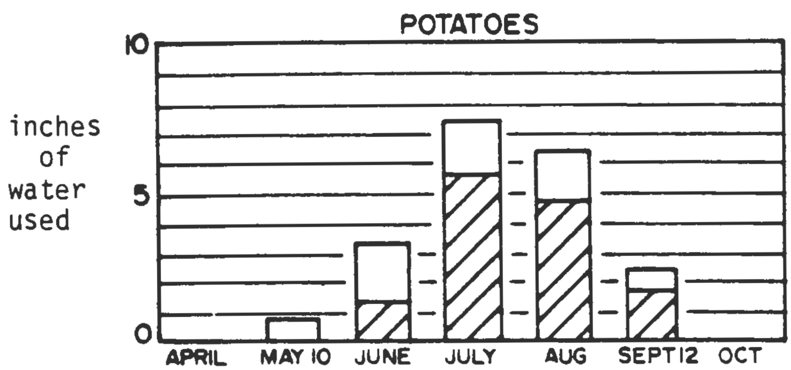
CLIMATE OF STUDY AREA

The climate of this area is continental with warm to hot summers and cold winters. Temperatures can fluctuate rapidly because there are no large bodies of water or mountains to modify temperature changes.

This climatic summary was based on weather records from Centerville (1904-1983), Vermillion (1891-1983), Sioux City, Iowa (1888-1983), Marion (1900-1983), Canton (1895-1983), and Yankton (1872-1983). Soil temperature data was based on weather records from the Southeast South Dakota Experiment Farm near Centerville (1975-1983), the Castana Experiment Farm near Sioux City, Iowa (1971-1983). The Castana Farm operated by Iowa State University is located on soils similar to those found in the study area. Total evaporation and wind information was based on weather records from Sioux Falls (1964-1983) and Castana Experiment Farm (1953-1983).

Figure 1 illustrates the water demands for potato production in the study area. Note the large demand for water in the months of July and August. Consequently, a soil that is suited for potato production needs to store adequate amounts of plant available moisture until supplemental irrigation can supply the needed water.

Figure 1. Estimated seasonal and monthly consumptive use of water for potatoes in southeastern South Dakota.



		TOTAL CONS. USE	NET IRRIG.
Spring Date	May 10	0.8"	0.0"
	June	3.4"	1.4"
	July	7.5"	5.6"
	Aug.	6.4"	4.7"
Fall Date	Sept. 12	2.4"	1.7"
Seasonal Use		20.5"	13.4"

The total bar height (both light and dark portions) represents the total consumptive water use for the month. The light portion represents the portion of the total consumptive use which can be expected to be received from effective rainfall. The dark portion of the bar represents the portion of the total consumptive use required from irrigation.

Table 1. Average Air Temperature for Study Area

Month	Location: Centerville	Vermillion	Sioux City, Iowa	Marion	Canton	Yankton	Average
January	14.6°F	17.0°F	16.2°F	13.4°F	14.2°F	14.8°F	15.0°F
February	21.5	23.9	23.3	20.4	21.2	21.2	21.9
March	32.1	34.3	33.8	31.0	32.2	31.1	32.4
April	48.6	50.2	49.7	47.4	48.3	47.1	48.6
May	60.3	61.3	61.5	59.6	60.4	59.1	60.4
June	70.2	71.1	70.9	71.1	71.1	69.1	70.6
July	74.9	75.7	75.6	74.4	74.9	74.6	75.0
August	72.8	73.4	73.3	72.3	72.7	72.3	72.8
September	62.9	64.0	64.5	62.3	62.7	62.1	63.1
October	51.6	52.7	52.5	50.5	51.2	50.8	51.6
November	35.2	36.7	36.4	33.9	34.5	34.9	35.3
December	21.7	23.8	23.3	20.5	21.3	22.2	22.1
Annual Avg.	47.2	48.7	48.4	46.2	47.0	46.6	47.4

Source: National Oceanic and Atmospheric Administration Climatological Data for South Dakota and Iowa.

Table 2. Average Precipitation for Study Area

Month	Location: Centerville	Vermillion	Sioux City, Iowa	Marion	Canton	Yankton	Average
January	0.50 in	0.47 in	0.65 in	0.47 in	0.61 in	0.32 in	0.50 in
February	1.18	0.85	0.94	0.91	0.86	0.69	0.91
March	1.37	1.17	1.45	1.62	1.40	1.26	1.38
April	2.42	2.24	2.19	2.44	2.33	2.16	2.30
May	3.48	3.77	3.54	3.23	3.23	3.63	3.48
June	4.70	4.28	4.59	3.85	4.31	4.13	4.30
July	3.11	3.39	3.30	2.96	2.80	3.14	3.12
August	3.04	3.19	2.95	2.67	3.21	3.06	3.02
September	2.68	2.55	2.84	2.71	2.74	2.50	2.67
October	1.65	1.57	1.63	1.45	1.40	1.31	1.50
November	0.94	0.84	0.91	0.96	1.00	0.94	0.93
December	0.62	0.71	0.75	0.81	0.73	0.55	0.70
Annual Avg.	25.69	25.03	25.74	24.08	24.62	23.69	24.81

Source: National Oceanic and Atmospheric Administration Climatological Data for South Dakota and Iowa.

Tables 1 and 2 show the average annual temperature and precipitation data respectively, for the study area. The annual temperature averages 47.4°F with monthly averages of 75°F in July and 15°F in January. The annual precipitation averages 24.8 inches of which 18.9 inches, or 76 percent, falls during the growing season (April through September).

The probability dates of temperatures near freezing or below are shown in Table 3. Growing season lengths as influenced by selected temperatures and various probabilities are presented in Table 4.

Both air and soil temperatures have a significant influence on the growth and development of potatoes. Optimum soil temperature for tuber production is in the range of 60 to 75°F. Warm days and cool nights are most desirable for potato production since it is a cool season crop.

Potatoes can do very well at high temperatures however, when adequate water supplies are present to meet evapotranspiration demands. The critical factor is a supply of water at soil moisture tensions low enough to keep the stomata open during the heat of the day so yield is not reduced.

The bare soil temperatures for the study area are shown in Table 5. The soil temperatures at the four and eight inch depths were selected for this study since they correspond to planting depth and the area of tuber production. In order to achieve high yields, potatoes should be planted in mid-April when soil temperatures reach 50°F at the eight inch soil depth. The average soil temperatures in bare soil may exceed optimum conditions in July and August. A good crop canopy early in the season and proper irrigation management should minimize any potential for hot (>80°F) soil temperatures.

Table 3. Probabilities of Stated Temperatures After Specified Dates in Spring and Before Specified Dates in Fall for Study Area.

Probability	24°F or lower*	28°F or lower*	32°F or lower*
After specified date in Spring			
50 percent	April 14	April 24	May 6
30 percent	April 26	May 7	May 16
10 percent	May 1	May 13	May 22
Before specified date in Fall			
10 percent	Oct 7	Sept 27	Sept 15
30 percent	Oct 15	Oct 5	Sept 22
50 percent	Oct 25	Oct 12	Oct 2

*Average of climatic data from Canton, Vermillion, Sioux City (Iowa), Marion, and Yankton.

Table 4. Number of Consecutive Days with Greater than Stated Spring and Fall Temperatures for Study Area.

	24°F Spring Probability*			28°F Spring Probability*			32°F Spring Probability*		
	50%	30%	10%	50%	30%	10%	50%	30%	10%
24°F Fall Probability		days			days			days	
10%	176	164	159	166	153	147	154	144	138
30%	184	172	167	174	161	155	162	152	146
50%	194	182	177	184	171	165	172	162	156
28°F Fall Probability									
10%	166	154	149	156	143	137	144	134	128
30%	174	162	157	164	151	145	152	142	136
50%	181	169	164	171	158	152	159	149	143
32°F Fall Probability									
10%	154	142	137	144	131	125	132	122	116
30%	161	149	144	151	138	132	139	129	123
50%	171	159	154	161	148	142	149	139	133

* Average of climatic data from Canton, Vermillion, Sioux City (Iowa), Marion, and Yankton.

Table 5. Average Bare Soil Temperatures for Study Area. (Data from Centerville and Castana Experiment Farms)

Soil Depth	J	F	M	A	M	J	J	A	S	O	N	D	Avg.
4 in.	21.4	25.1	34.2	49.1	63.9	76.9	84.4	79.0	68.7	53.2	37.1	26.9	51.7°F
8 in.	21.5	23.2	30.3	44.5	58.0	70.5	76.6	72.6	64.1	50.5	37.4	27.5	48.1°F

RATING SOIL USE FOR SPRINKLER IRRIGATED POTATO PRODUCTION

Soils were rated based on the most restrictive features for sprinkler irrigated potato production. Thus, a soil rated severe gives only the soil property (ies) that caused the soil to be rated severe. This soil may have other restrictive features for sprinkler irrigated potato production. Soils were rated under natural conditions. No unusual modification of soil materials or site characteristics was considered.

Soil limitations are indicated by the ratings slight, moderate, severe, and not suited. Slight means that soil properties are favorable and the limitations are minor or easily corrected. No major problem in producing potatoes under sprinkler irrigation is expected.

Moderate means some soil and/or topographic properties are unfavorable but can be modified or corrected with management techniques and irrigation design such as tillage, artificial drainage, flood control, irrigation scheduling, and water application rates. During at least part of each year the use of these soils for sprinkler irrigated potato production is less favorable than for soils with slight limitations.

Severe means soil and/or topographic properties are unfavorable for use and are difficult and expensive to correct. These limitations require major soil reclamation, special irrigation equipment design or intensive management. In some instances the soil can be improved by reducing or removing the soil property limiting its use. Usually this practice is very difficult and costly.

Not suited means soil and/or topographic properties make the soil unsuited for sprinkler irrigated potato production based on criteria developed by USDA Soil Conservation Service (1978). Soils with steep slopes (>17%), clay textured, frequently flooded for long periods, and sodic soils are some examples of soils not suited for sprinkler irrigated potato production.

Many soils with moderate or severe limitations can be modified and/or managed to achieve satisfactory performance. It is important to remember that in rating soils for agricultural use, one can modify soil properties, site features, or can adjust system designs and management to compensate for most limitations. The key question, however, is cost. Such considerations were not considered in this publication. Soils were considered in their natural, unaltered state.

CRITERIA USED

The criteria used in this study to rank soils based on limitations for sprinkler irrigated potato production are presented in Table 6. They were modified from an earlier study (Malo and Lemme, 1983) using the best possible management information available.

The rationale used for the limitation criteria presented in Table 6 are as follows:

1. Flooding - Potatoes like most crop can not tolerate extended periods of flooding (>1-2 days).

TABLE 6 . SOIL LIMITATIONS CRITERIA FOR CENTER PIVOT SPRINKLER IRRIGATED POTATO PRODUCTION (Modified from Table 12 in Plant Science Pamphlet 82).

Property	Degree of Limitations			Limitations
	Slight	Moderate	Severe	
1. Flooding (during growing season)	None	Rare, occasionally (with very brief duration and HWT >24 in. deep)	Common, Occasionally (with longer than very brief duration), Frequently	Floods
2. Depth to High Water Table (HWT)	>36 in.	24 to 36 in.	<24 in.	HWT
3. Surface Texture	Silt loam, Sandy loam, Loam, Fine sandy loam, Very fine sandy loam, Loamy fine sand, Loamy very fine sand	Silty clay loam, Clay loam, Sandy clay loam (unfavorable air/water relationships)	Clay, Silty clay, Sandy clay	Surface texture
		Very fine sand, Fine sand, Loamy, Coarse sandy loam, Coarse sand, Loamy sand (wind erosion)	Coarse sand, Sand	
4. Drainage Class	Well drained, Moderately well drained, Somewhat excessively drained	Excessively drained, Somewhat poorly drained (HWT >24 in.)	Somewhat poorly drained Poorly drained,(HWT <24 in) Very poorly drained	Poor drainage or excessive drainage
5. Soil Intake Family*	≥0.5	0.3	<0.1	Slow intake
6. Slope (percent)	0-3	4-6	>6	Slope
7. Surface pH	5.6-6.5	6.6-7.4	>7.4	pH
8. Surface Salinity (mmhos/cm)	0-2.0	2.1-4.0	>4.0	Excess salinity
9. Sodicity	---	---	natric horizon present	Excess sodium
10. Available Water Holding Capacity (in/24 in. soil)	>2.5 in.	1.6-2.5 in.	<1.6 in.	Droughty
11. Permeability	Moderate, Moderately rapid	Moderately slow, Rapid, Very rapid	Very slow, Slow	Percs slowly or percs rapidly
12. Soil Profile Thickness	---	---	<24 in.	Rooting depth
13. Stoniness (>3 in. in diameter)	---	---	>15% by Vol. (top 24 inches	Excess stones
14. Accessibility for machinery and irrigation equipment	---	---	Channelled phase of map unit	Inaccessible

* Irrigation Guide for South Dakota. 1978

2. Depth to High Water Table - Potatoes need soils with a water table greater than 24 inches and preferably at 36 inches. A water table shallower than 24 inches prevents root growth, aeration, nutrient uptake, and thus causes a yield reduction.

3. Surface Texture - The physical characteristics of medium textured soils provides good air/moisture relationships, friable consistence for tuber expansion, and easy tuber cleaning after harvest. Fine textured soils cling to tubers at harvest, limit tuber growth, and prevent rapid infiltration of air and water to the potato tuber and roots. Very coarse textured soils are susceptible to wind erosion and need to be protected to prevent this problem. Potatoes are vulnerable to wind erosion.

4. Drainage Class - The early planting of potato fields can be limited by excess spring moisture in somewhat poorly, poorly, and very poorly drained soils. Excessively drained soils often can have a limitation for droughty conditions because of a low water holding capacity. Potatoes need a well aerated soil which holds adequate moisture to meet evapotranspiration demands.

5. Soil Intake Family - Soil intake families of 0.3 or less are limited for sprinkler irrigated potato use due to the slow rate of water infiltration allowed by these soils. Definitions and descriptions of the soil intake families can be found in the <u>Irrigation Guide for South Dakota</u> (USDA-Soil Conservation Service, 1978).

6. Slope - Potato fields are exceptionally erosive because of the open canopy, low residue cover, and soil loosening affect of the potato tuber.

7. Surface pH - Alkaline soil pH (>7.4) favors the pathogen responsible for potato scab. In addition, the availability of soil phosphorus is greatly reduced in moderately alkaline soils.

8. Surface Salinity - Potatoes are sensitive to high salinity levels. Electrical conductivity values of 4 mmhos/cm will cause a yield reduction of at least 25 percent.

9. Sodicity - The presence of a natric horizon and its associated characteristics (high pH, slow to very slow permeability, and high bulk density values) cause a soil to have a severe limitation for potato production.

10. Available Water Holding Capacity - Potatoes require approximately 20 inches of water per year. Soils with low and very low available water holding capacity will be highly dependent upon frequent small quantity irrigation to supply the potato crop with needed moisture. Potato scab is favored by hot dry soil conditions. Thus, neutral and alkaline soils should be irrigated in a manner so that they are at or near field capacity most of the time.

11. Permeability - Potatoes need a soil which has a moderate permeability rate to allow for adequate air and water movement.

12. Soil Profile Thickness - Soils with less than 24 inches of good soil material do not have adequate rooting depth for the potato crop. Nutrient storage and water holding capacity are limitations associated with thin soils.

13. Stoniness - Soils containing a significant percentage of stones (>15% by volume) have severe limitations for potato production due to harvesting and cultivational problems.

14. Accessibility - Channeled phases of soil mapping units have fields which are small in size and often inaccessible for irrigation equipment and cultivational activities.

RANKING OF SOILS

Using the criteria developed in the previous section and listed in Table 6, the soils of the study area were categorized according to their limitations for sprinkler irrigated potato production (see Tables 7 through 11). Detailed soils information was obtained from the published soil surveys for each county (Buntley, et al., 1953; Driessen, 1976, 1978; Ensz, 1979; Kunze, 1982) and from detailed soil series information sheets available from the USDA-National Cooperative Soil Survey.

TABLE 7. DEGREE OF LIMITATION FOR SPRINKLER IRRIGATED POTATO PRODUCTION IN CLAY COUNTY, SOUTH DAKOTA

Symbol	Name	Degree of Limitation	Limitations	Acres
AH-HH	Albaton-Haynie			19,674
	Albaton	Not Suited	Surface texture, Poor drainage, HWT, Percs slowly, Slow intake	
	Haynie	Moderate	Floods, Ph	
CY-EU	Clarno-Ethan			5,324
	Clarno	Moderate	Slope, Slow intake	
	Ethan	Moderate	Slope	
DX	Dempster	Moderate	Surface texture	2,662
FF-WF-CY	Egan-Wentworth-Clarno			23,376
	Egan	Moderate	Surface texture, Slope, Slow intake	
	Wentworth	Moderate	Surface texture, Slope	
	Clarno	Moderate	Surface texture, Slope, Slow intake	
EF-WF-VH	Egan-Wentworth-Viborg			98,981
	Egan	Moderate	Surface texture, Slope, Slow intake	
	Wentworth	Moderate	Surface texture, Slope	
	Viborg	Moderate	Surface texture	
EU-CY-B3	Ethan-Clarno-Betts			29,656
	Ethan	Moderate	Slope, pH	
	Clarno	Moderate	Slope, Slow intake	
	Betts	Severe	Slope, pH	
HH-SD	Haynie-Sarpy			7,604
	Haynie	Moderate	pH, Floods	
	Sarpy	Severe	pH, Floods	
LC	Lamo	Severe	HWT, Floods, pH, Poor drainage	5,324
LU	Luton	Not Suited	Surface texture, Poor drainage, HWT, Percs slowly, Slow intake	35,854
NA	Napa	Not Suited	Poor drainage, HWT, Percs slowly, Slow intake	3,328
34	Fluvaquents	Severe	Poor drainage, HWT, Floods	3,993
TP-MU	Trent-Moody			19,840
	Trent	Moderate	Surface texture, pH, Floods	
	Moody	Moderate	Surface texture	
TP-WK	Trent-Wakonda			2,840
	Trent	Moderate	Surface texture, pH, Floods	
	Wakonda	Severe	pH	

TABLE 8 . DEGREE OF LIMITATION FOR SPRINKLER IRRIGATED POTATO PRODUCTION IN LINCOLN COUNTY, SOUTH DAKOTA

Symbol	Name	Degree of Limitation	Limitations	Acres
AcA	Alcester Silty clay loam, 0 to 2% slopes	Moderate	Floods, pH	3,900
AcB	Alcester Silty clay loam, 2 to 6% slopes	Moderate	Slope, pH	3,500
Af	Alcester Silty clay loam, channeled, 0 to 2% slopes	Severe	Inaccessible	3,000
Ah	Alcester and Lamo Silty clay loams, 0 to 2% slopes			3,200
	Alcester (50%)	Moderate	Floods, pH	
	Lamo (50%)	Severe	Floods, HWT, pH	
Bo	Bon soils, frequently flooded, 0 to 2% slopes	Severe	Floods, pH	2,300
Ca	Chancellor-Tetonka Silty clay loams, 0 to 2% slopes			25,500
	Chancellor (65%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
	Tetonka (25%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
Cd	Chancellor-Viborg Silty clay loams, 0 to 2% slopes			13,200
	Chancellor (55%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
	Viborg (45%)	Moderate	Surface texture	
Ch	Chancellor-Wakonda-Tetonka complex, 0 to 2% slopes			17,400
	Chancellor	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
	Wakonda (35%)	Severe	HWT, pH	
	Tetonka	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
Co	Clamo Silty clay loams, 0 to 1% slopes, eroded	Not Suited	Floods, Percs slowly, Poor drainage, HWT	2,300
CpD2	Crofton-Nora Silt loams, 9 to 17% slopes, eroded			9,200
	Crofton (50%)	Severe	Slope, pH	
	Nora (50%)	Severe	Slope	
Da	Davis Loam, 0 to 2% slopes	Moderate	Floods	1,500
DeA	Delmont Loam, 0 to 2% slopes	Moderate	pH	456
DeB	Delmont Loam, 2 to 6% slopes	Moderate	Slope, pH	1,050

TABLE 8. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
DgB	Delmont-Graceville complex, 2 to 6% slopes			2,150
	Delmont (45%)	Moderate	Slope, pH	
	Graceville (35%)	Moderate	Slope, Surface texture	
DkB	Delmont-Talmo soils, 2 to 9% slopes			1,500
	Delmont (50%)	Moderate	Slope, pH	
	Talmo (50%)	Severe	Slope, Rooting depth, pH	
DmA	Dempster Silt loam, 0 to 2% slopes	Slight		2,000
DmB	Dempster Silt loam, 2 to 6% slopes	Moderate	Slope	830
EaB	Egan Silty clay loam, 3 to 6% slopes	Moderate	Slope, Surface texture, Slow intake	29,500
EcB	Egan-Chancellor Silty clay loams, 2 to 4% slopes			13,700
	Egan (70%)	Moderate	Slope, Surface texture, Slow intake	
	Chancellor (30%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
EsB	Egan-Shindler complex, 2 to 6% slopes			11,600
	Egan (55%)	Moderate	Slope, Surface texture, Slow intake	
	Shindler (45%)	Moderate	Slope, pH, Slow intake, Surface texture	
EsC	Egan-Shindler complex, 6 to 9% slopes			7,800
	Egan (50%)	Severe	Slope	
	Shindler (50%)	Severe	Slope	
EwB	Egan-Worthing complex, 2 to 6% slopes			4,400
	Egan (70%)	Moderate	Slope, Surface texture, Slow intake	
	Worthing (30%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage, Surface texture	
Gr	Graceville Silty clay loam, 0 to 2% slopes	Moderate	Floods, Surface texture	4,250
HuA	Huntimer Silty clay loam, 0 to 2% slopes	Not Suited	Percs slowly, Slow intake	3,050
La	Lamo Silty clay loam, 0 to 1% slopes	Severe	Floods, pH, HWT	7,300

TABLE 8. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
Lu	Luton Silty clay, 0 to 1% slopes	Not Suited	Floods, HWT, Percs slowly, Poor drainage, Slow intake	480
Mh	March, 0 to 1% slopes	Not Suited	Floods	1,100
MoA	Moody Silty clay loam, 0 to 2% slopes	Moderate	Surface texture	1,450
MoB	Moody Silty clay loam, 2 to 6% slopes	Moderate	Surface texture	12,200
MpB	Moody-Nora Silty clay loams, 2 to 6% slopes			2,450
	Moody (60%)	Moderate	Slope, Surface texture	
	Nora (40%)	Moderate	Slope, Surface texture, pH	
MpC2	Moody-Nora Silty clay loams, 6 to 10% slopes, eroded			18,400
	Moody (55%)	Severe	Slope	
	Nora (45%)	Severe	Slope, pH	
Sa	Salmo Silty clay loam, very wet, 0 to 1% slopes	Not Suited	Floods, HWT, Excess salt, pH, Poor drainage	2,050
ShD	Shindler clay loam, 9 to 15% slopes	Severe	Slope	700
ShF	Shindler Clay loam, 25 to 40% slopes	Not Suited	Slope	1,900
SkD2	Shindler-Egan complex, 9 to 15% slopes, eroded			3,100
	Shindler (55%)	Severe	Slope	
	Egan (45%)	Severe	Slope	
SmF	Shindler-Renner complex, 15 to 40% slopes			2,300
	Shindler (55%)	Not Suited	Slope	
	Renner (45%)	Not Suited	Slope	
StD	Shindler-Talmo soils, 6 to 30% slopes			530
	Shindler (50%)	Severe	Slope	
	Talmo (50%)	Severe	Slope, pH, Rooting depth	
SuF	Steinauer-Shindler Clay loams, 24 to 40% slopes			2,900
	Steinauer (50%)	Not Suited	Slope, pH	
	Shindler (50%)	Not Suited	Slope	

TABLE 8. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
Te	Tetonka Silty clay loam, 0 to 1% slopes	Not Suited	Floods, HWT, Percs slowly, Poor drainage	5,100
ThB	Thurman Fine sandy loam, 2 to 6% slopes	Moderate	Slope	1,350
ThC	Thurman Fine sandy loam, 6 to 9% slopes	Severe	Slope	219
WeA	Wentworth Silty clay loam, 0 to 2% slopes	Moderate	Surface texture	20,800
WhA	Wentworth-Chancellor Silty clay loams, 0 to 2% slopes			106,300
	Wentworth (75%)	Moderate	Surface texture	
	Chancellor (25%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
Ws	Worthing Silty clay, 0 to 1% slopes	Not Suited	Floods, HWT, Percs slowly, Poor drainage	8,600

TABLE 9. DEGREE OF LIMITATION FOR SPRINKLER IRRIGATED POTATO PRODUCTION IN TURNER COUNTY, SOUTH DAKOTA

Symbol	Name	Degree of Limitation	Limitations	Acres
Ac	Alcester Silt loam	Moderate	Floods, pH	2,100
Ar	Arlo Clay loam	Not Suited	HWT, Floods, pH, Poor drainage	520
Ba	Baltic Silty clay loam	Not Suited	Floods, HWT, Percs slowly, Ph, Poor drainage	4,940
Bb	Baltic Silty clay loam, ponded	Not Suited	Floods, HWT, Percs slowly, pH, Poor drainage	1,990
BeE	Betts-Ethan loams, 15 to 40% slopes			1,780
	Betts (70%)	Not Suited	Slope, pH	
	Ethan (30%)	Not Suited	Slope	
BhE	Betts-Talmo complex, 12 to 40% slopes			1,660
	Betts (75%)	Not Suited	Slope, pH	
	Talmo (25%)	Not Suited	Slope, pH, Rooting depth	
BkA	Blendon Fine sandy loam, 0 to 2% slopes	Slight		900
BmB	Blendon-Henkin Fine sandy loams, 2 to 6% slopes			780
	Blendon (65%)	Moderate	Slope	
	Henkin (35%)	Moderate	Slope	
Ca	Chancellor Silty clay loam	Not Suited	Floods, HWT, Percs slowly, Poor drainage	5,990
Cc	Chaska Loam, channeled	Not Suited	Floods, HWT, Inaccessible, Poor drainage	5,560
Cd	Clamo Silty clay	Not Suited	Floods, Percs slowly, HWT, Poor drainage, Surface texture	6,530
Ce	Clamo Clay, gravelly substratum	Not Suited	Floods, Percs slowly, HWT, Poor drainage, Surface texture	2,090
ChA	Clarno-Bonilla loams, 0 to 2% slopes			21,520
	Clarno (70%)	Moderate	Slow intake	
	Bonilla (30%)	Moderate	Floods, HWT	
ChB	Clarno-Bonilla loams, 1 to 6% slopes			18,980
	Clarno (75%)	Moderate	Slope, Slow intake	
	Bonilla (25%)	Moderate	Floods, HWT	

Table 9. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
CkA	Clarno-Crossplain-Davison complex, 0 to 3% slopes			39,850
	Clarno (60%)	Moderate	Slow intake	
	Crossplain (25%)	Not Suited	Floods, Slow intake, HWT, Percs slowly, Poor drainge	
	Davison (15%)	Severe	HWT, pH	
CmB	Clarno-Davison loams, 2 to 5% slopes			1,610
	Clarno (65%)	Moderate	Slope, Slow intake	
	Davison (35%)	Severe	Slope, HWT, pH	
CoB	Clarno-Ethan loams, 2 to 6% slopes			20,770
	Clarno (60%)	Moderate	Slope, Slow intake	
	Ethan (40%)	Moderate	Slope, pH	
CoC	Clarno-Ethan loams, 5 to 9% slopes			7,150
	Clarno (50%)	Severe	Slope	
	Ethan (50%)	Severe	Slope	
Cr	Crossplain Clay loam	Not Suited	Floods, HWT, Percs slowly, Slow intake	4,620
DaA	Davis Loam, 0 to 2% slopes	Moderate	Floods	2,910
DbA	Davis Loam, 2 to 6% slopes	Moderate	Slope	880
DbB	Davis Loam, Sandy substratum, 0 to 2% slopes	Moderate	Floods	920
DeA	Delmont-Enet Loams, 0 to 2% slopes			12,470
	Delmont (65%)	Moderate	pH	
	Enet (35%)	Slight		
DeB	Delmont-Enet Loams, 2 to 6% slopes			5,300
	Delmont (60%)	Moderate	Slope, pH	
	Enet (40%)	Moderate	Slope	
DgB	Dempster-Graceville Silty clay loams, 1 to 5% slopes			1,270
	Dempster (70%)	Moderate	Surface texture, Slope	
	Graceville (30%)	Moderate	Surface texture, Slope	

Table 9. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
Do	Dimo Clay loam	Severe	Floods, HWT, Surface texture	2,390
EeA	Egan-Ethan complex, 0 to 2% slopes			910
	Egan (75%)	Moderate	Surface texture, Slow intake	
	Ethan (25%)	Moderate	pH	
EeB	Egan-Ethan complex, 2 to 6% slopes			52,260
	Egan (60%)	Moderate	Slope, Surface texture, Slow intake	
	Ethan (40%)	Moderate	Slope, pH	
EfA	Egan-Trent Silty clay loam, 0 to 2% slopes			49,020
	Egan (75%)	Moderate	Surface texture, Slow intake	
	Trent (25%)	Moderate	Floods, Surface texture	
EgB	Egan-Wentworth Silty clay loams, 2 to 6% slopes			27,800
	Egan (60%)	Moderate	Slope, Surface texture, Slow intake	
	Wentworth (40%)	Moderate	Slope, Surface texture	
EnA	Enet Loam, 0 to 2% slopes	Slight		740
EsD	Ethan-Betts Loams, 6 to 15% slopes			6,770
	Ethan (60%)	Severe	Slope	
	Betts (40%)	Severe	Slope, pH	
EtB	Ethan-Egan complex, 2 to 6% slopes			2,960
	Ethan (60%)	Moderate	Slope	
	Egan (40%)	Moderate	Slope, Surface texture, Slow intake	
EtC	Ethan-Egan complex, 5 to 9% slopes			10,280
	Ethan (60%)	Severe	Slope	
	Egan (40%)	Severe	Slope	
HuA	Huntimer Silty clay loam, 0 to 2% slopes	Not Suited	Percs slowly, Slow intake	880
La	Lamo Silty clay loam	Severe	Floods, HWT, pH	6,870
Or	Orthents-Aquents complex	Severe	Rooting depth, HWT, Inaccessible	840
Ro	Roxbury Silt loam	Severe	Floods, pH	7,050
Rv	Roxbury Variant Silt loam	Severe	Floods, pH	1,710
Sa	Salmo Silty clay loam	Not Suited	Floods, HWT, Excess salt, pH, Poor drainage	3,510
Te	Tetonka Silt loam	Not Suited	Floods, Percs slowly, HWT, Poor drainage	8,850

Table 9. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
WaA	Wakonda-Wentworth-Chancellor			1,450
	Silty clay loams,			
	0 to 3% slopes			
	Wakonda (45%)	Severe	pH	
	Wentworth (35%)	Moderate	Surface texture	
	Chancellor (20%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
WeA	Wentworth-Chancellor-Wakonda			28,850
	Silty clay loams,			
	0 to 2% slopes			
	Wentworth (60%)	Moderate	Surface texture	
	Chancellor (25%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
	Wakonda (15%)	Severe	pH	
Wo	Worthing Silty clay loam	Not Suited	Floods, HWT, Percs slowly, Poor drainage	4,990

TABLE 10. DEGREE OF LIMITATION FOR SPRINKLER IRRIGATED POTATO PRODUCTION IN UNION COUNTY, SOUTH DAKOTA

Symbol	Name	Degree of Limitation	Limitations	Acres
Ab	Albaton Silt loam, overwash	Not Suited	Poor drainage, pH, HWT, Surface texture, Percs slowly	930
Ac	Albaton Silty clay	Not Suited	Poor drainage, pH, HWT, Surface texture, Percs slowly	7,800
Ad	Albaton Silty clay, depressional	Not Suited	Poor drainage, pH, HWT, Surface texture, Percs slowly	1,450
Ae	Alcester Silt loam, 2 to 6% slopes	Moderate	Slope, pH	27,490
Bd	Benclare Silty clay loam, Somewhat poorly drained	Severe	Floods	4,150
Be	Benclare soils, overwash	Severe	Floods	1,320
Bf	Blencoe Silty clay	Not Suited		2,500
Bg	Blyburg Silt loam	Moderate	pH, Floods	4,150
Ca	Calco Silty clay loam, wet	Not Suited	Poor drainage, pH, HWT, Percs slowly	9,710
CbE2	Crofton Silt loam, 12 to 17% slopes, eroded	Severe	Slope, pH	11,320
CbF	Crofton Silt loam, 17 to 30% slopes	Not Suited	Slope	2,400
CnB	Crofton-Nora Silt loams, 2 to 6% slopes			1,500
	Crofton (65%)	Severe	pH	
	Nora (35%)	Moderate	Slope	
CnD2	Crofton-Nora Silt loams, 6 to 12% slopes, eroded			37,190
	Crofton (55%)	Severe	pH, Slope	
	Nora (25%)	Severe	Slope	
Da	Davis Loam	Moderate	Floods	1,500
De	Dempster Silty clay loam	Moderate	Surface texture	1,960
EaB	Egan-Shindler complex, 2 to 6% slopes			4,200
	Egan (55%)	Moderate	Slow intake, Surface texture, Slope	
	Shindler (45%)	Moderate	Surface texture, Slope, Slow intake, pH	

Table 10. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
EaC	Egan-Shindler complex, 6 to 9% slopes			1,300
	Egan (50%)	Severe	Slope	
	Shindler (50%)	Severe	Slope	
EmA	Enet Loam, 0 to 2% slopes	Slight		700
EnB	Enet & Dempster soils, 2 to 6% slopes	Moderate	Slope	480
Fa	Fluvaquents	Not Suited	Floods, HWT	2,600
Fb	Fluvaquents, wet	Not Suited	Floods, HWT	3,450
Fc	Forney Silty clay	Not Suited	Poor drainage, HWT, Surface texture, Slow intake, Percs slowly	15,730
Fe	Forney soils, overwash	Not Suited	Poor drainage, HWT, Surface texture, Slow intake, Percs slowly	1,260
Ga	Grable Silt loam	Severe	pH, Floods	3,150
Gb	Graceville Silt clay loam	Moderate	Surface texture, Floods	2,160
Ha	Haynie Silt loam	Moderate	Floods, pH	7,250
Hb	Haynie Silty clay loam	Moderate	Floods, pH, Surface texture	2,300
Ja	James Silty clay	Not Suited	Floods, HWT, Poor drainage, Percs slowly, High salt	420
Ka	Kennebec Silty clay loam	Severe	Floods	12,220
La	Lakeport Silty clay loam	Moderate	Floods, Surface texture, Poor drainage, Slow intake	2,300
Lb	Lamo Silty clay loam	Severe	Floods, HWT, pH	2,900
Ld	Luton Silty clay	Not Suited	Floods, HWT, Percs slowly, Poor drainage, Slow intake	9,510
Ma	McPaul Silt loam	Severe	pH	8,500
Mb	Modale Silt loam	Severe	pH	5,600
McA	Moody Silty clay loam, 0 to 2% slopes	Moderate	Surface texture	200
McB	Moody Silty clay loam, 2 to 6% slopes	Moderate	Surface texture, Slope	11,020
MdC	Moody-Nora Silty clay loams, 6 to 10% slopes			14,320
	Moody (65%)	Severe	Slope	
	Nora (35%)	Severe	Slope, pH	
NeF	Nora-Crofton Silt loams, 20 to 50% slopes			610
	Nora (50%)	Not Suited	Slope	
	Crofton (50%)	Not Suited	Slope, pH	

Table 1[illegible]. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
Oa	Oamdi Silt loam	Moderate	pH	3,450
Ob	Onawa Silty clay	Not Suited	Floods, Percs slowly, Slow intake, Surface texture, pH	6,500
Pa	Percival Silty clay	Not Suited	Floods, Percs slowly, Slow intake, Surface texture, pH	1,400
Sa	Salix Silty clay loam	Moderate	Surface texture, pH, Floods	3,200
Sb	Salmo Silty clay loam, Somewhat poorly drained	Severe	Drainage	780
ScB	Sarpy Loamy find sand, 3 to 9% slopes	Severe	pH, Slope, Floods	2,800
SdA	Sarpy Silty clay overwash, 0 to 1% slopes	Severe	pH, Surface texture, Floods	720
SeA	Sarpy soils, 0 to 3% slopes	Severe	pH, Floods	2,900
ShD	Shindler Clay loam, 9 to 15% slopes	Severe	Slope	1,330
ShE	Shindler Clay loam, 15 to 30% slopes	Not Suited	Slope	1,000
St	Storla Loam	Severe	pH	720
TaB	Thurman Fine sandy loam, 3 to 9% slopes	Moderate	Slope	670
Wa	Wakonda-Worthing-Chancellor complex,			11,820
	Wakonda (50%)	Severe	pH	
	Worthing (30%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
	Chancellor (20%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
WbA	Wentworth Silty clay loam, 0 to 2% slopes	Moderate	Surface texture	8,950
WbA	Wentworth Silty clay, 2 to 6% slopes	Moderate	Slope, Surface texture	4,150
Wc	Wentworth-Worthing Silty clay loams			4,300
	Wentworth (40%)	Moderate	Surface texture	
	Worthing (60%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
Wh	Whitewood Silty clay loam	Not Suited	Floods, HWT, Percs slowly, Poor drainage	1,230
Wo	Worthing Silty clay loam	Not Suited	Floods, HWT, Percs slowly, Poor drainage	1,000
Ws	Worthing-Chancellor Silty clay loams			2,950
	Worthing (55%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
	Chancellor (45%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	

TABLE 11. DEGREE OF LIMITATION FOR SPRINKLER IRRIGATED POTATO PRODUCTION IN YANKTON COUNTY, SOUTH DAKOTA

Symbol	Name	Degree of Limitation	Limitations	Acres
Ba	Baltic Clay loam	Not Suited	Percs slowly, Floods, HWT, Slow intake, Poor drainage	945
Bb	Baltic Silty clay	Not Suited	Percs slowly, Floods, HWT, Slow intake, Poor drainage, Surface texture	3,625
Bc	Baltic Silty clay, depressional	Not Suited	Percs slowly, Floods, HWT, Slow intake, Poor drainage, Surface texture	1,015
BdE	Betts-Gavins complex, 15 to 40% slopes			875
	Betts (45-55%)	Not Suited	Slope, Surface texture, pH	
	Gavins (25-35%)	Not Suited	Slope, Rooting depth,	
Be	Blake Silty clay loam	Severe	pH	3,155
Bf	Blencoe Silty clay	Not Suited	HWT, Slow intake, Surface texture, Percs slowly, Poor drainage	420
Bg	Blencoe-Gayville complex,			415
	Blencoe (45-55%)	Not Suited	HWT, Slow intake, Surface texture, Percs slowly, Poor drainage	
	Gayville (25-35%)	Not Suited	Floods, Percs slowly, Excess sodium	
BhB	Blendon-Thurman complex, 0 to 6% slopes			1,185
	Blendon (40-50%)	Moderate	Slope	
	Thurman (25-35%)	Moderate	Slope, Percs rapidly, Surface texture	
Bk	Blyburg Silt loam	Moderate	pH, Floods	2,245
Bm	Bon Loam	Severe	Floods, pH	2,805
BnA	Bonilla-Crossplain complex, 0 to 2% slopes			1,050
	Bonilla (45-55%)	Severe	Floods	
	Crossplain (30-40%)	Not Suited	Floods, HWT, Percs slowly, Surface texture, pH	
BoE	Boyd-Ethan association, 15 to 40% slopes			1,425
	Boyd (45-55%)	Not Suited	Slope, Slow intake, Percs slowly, Surface texture, pH	
	Ethan (30-40%)	Not Suited	Slope, pH	
Ca	Chancellor Silty clay loam	Not Suited	Floods, HWT, Percs slowly, Poor drainage	3,230
Cb	Clamo Silty clay loam	Not Suited	Floods, HWT, Percs slowly, Poor drainage	5,600
Cc	Clamo Variant Silty clay loam	Not Suited	Floods, HWT, Percs slowly, Poor drainage	1,030

Table 11. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
CdA	Clarno Loam, 0 to 2% slopes	Moderate	Slow intake	13,550
CeB	Clarno-Bonilla Loams, 1 to 6% slopes			47,230
	Clarno (55-65%)	Moderate	Slope, Slow intake	
	Bonilla (15-25%)	Moderate	Floods, HWT	
ChA	Clarno-Crossplain-Stickney complex,			2,880
	Clarno (65%)	Moderate	Slow intake	
	Crossplain (35%)	Not Suited	Floods, Slow intake, HWT, Percs slowly, Poor drainage	
	Stickney (15%)	Not Suited	Percs slowly, Excess sodium	
CkA	Clarno-Crossplain-Tetonka complex			49,692
	Clarno (60%)	Moderate	Slow intake	
	Crossplain (30%)	Not Suited	Floods, Slow intake, Percs slowly, HWT, Poor drainage	
	Tetonka (10%)	Not Suited	Floods, Percs slowly, HWT, Poor drainage	
CoE	Crofton-Boyd association, 15 to 40% slopes			1,655
	Crofton (55%)	Not Suited	Slope, pH	
	Boyd (45%)	Not Suited	Slope, Percs slowly, Slow intake pH	
CmE	Crofton-Nora Silt loams, 9 to 25% slopes			1,270
	Crofton (45-55%)	Severe	Slope, pH	
	Nora (30-40%)	Severe	Slope	
DaB	Davis Silt loam, 2 to 9% slopes	Moderate	Slope	5,055
DbB	Davis Variant Loam, 0 to 6% slopes	Severe	Floods, pH	855
EaB	Egan-Chancellor Silty clay loams, 1 to 6% slopes			4,340
	Egan (45-55%)	Moderate	Surface texture, Slow intake, Slope	
	Chancellor (20-30%)	Not Suited	Floods, HWT, Percs slowly, Poor drainage	
EbB	Egan-Ethan-Trent complex, 1 to 6% slopes			29,075
	Egan (45-55%)	Moderate	Surface texture, Slow intake, Slope	
	Ethan (20%)	Moderate	pH, Slope	
	Trent (20%)	Moderate	Floods, Surface texture	

Table 11. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
EbC	Egan-Ethan-Trent complex, 2 to 9% slopes			12,870
	Egan (35-45%)	Moderate	Slope, Surface texture, Slow intake	
	Ethan (25-35%)	Moderate	Slope, pH	
	Trent (15%)	Moderate	Floods, Surface texture	
EcA	Egan-Wentowrth Silty clay loams, 0 to 2% slopes			6,040
	Egan (45-55%)	Moderate	Surface texture, Slow intake	
	Wentworth (30-40%)	Moderate	Surface texture	
EcB	Egan-Wentworth Silty clay loams, 2 to 6% slopes			8,415
	Egan (45-55%)	Moderate	Slope, Surface texture, Slow intake	
	Wentworth (35-45%)	Moderate	Slope, Surface texture	
EdA	Egan-Whitewood Silty clay loams, 0 to 3% slopes			6,055
	Egan (65%)	Moderate	Slope, Surface texture, Slow intake	
	Whitewood (35%)	Not Suited	Floods, HWT, Slow intake, Poor drainage	
EhA	Enet-Delmont Loams, 0 to 2% slopes			1,145
	Enet (45-55%)	Slight		
	Delmont (30-40%)	Moderate	pH	
EhB	Enet-Delmont Loams 2 to 6% slopes			880
	Enet (40-50%)	Moderate	Slope	
	Delmont (35-45%)	Moderate	Slope, pH	
EkD	Ethan Stony loam, 3 to 25% slopes	Severe	Excess stones, Slope	810
EmE	Ethan-Betts Loams, 15 to 40% slopes			22,890
	Ethan (45-55%)	Severe	Slope	
	Betts (25-35%)	Severe	Slope, pH	
EnC	Ethan-Bonilla Loams, 3 to 9% slopes			13,080
	Ethan (65%)	Moderate	Slope, pH	
	Bonilla (35%)	Severe	Floods	
EoD	Ethan-Davis Loams, 9 to 15% slopes			10,890
	Ethan (60%)	Severe	Slope, pH	
	Davis (40%)	Severe	Slope	

Table 11. Continued.

Symbol	Name	Degree of Limitation	Limitations	Acres
EpD	Ethan-Talmo Loams, 9 to 15% slopes			740
	Ethan (40-50%)	Severe	Slope, pH	
	Talmo (30-40%)	Severe	Slope, Rooting depth, pH	
Fa	Farney Silty clay loam	Severe	HWT, Poor drainage, Percs slowly, Slow intake	7,565
Ga	Grable Silt loam	Severe	Floods, pH	1,250
Gb	Graceville Silty clay loam	Moderate	Surface texture, rare	460
Ha	Haynie Silt loam	Moderate	Floods, pH	6,080
Hb	Haynie Silty clay loam, overwash	Moderate	Floods, pH, Surface texture	2,365
Ja	James Silty clay loam	Not Suited	Floods, HWT, Poor drainage, Percs slowly, Excess salt	1,305
La	Lakeport Silty clay loam	Moderate	Floods, Poor drainage, Surface texture, Slow intake	1,915
Lb	Lamo Silty clay loam	Severe	Floods, HWT, pH	2,015
Lc	Luton Silty clay	Not Suited	Floods, HWT, Percs slowly, Poor drainage, Slow intake	2,750
Ld	Luton Silty clay loam, depressional	Not Suited	Floods, HWT, Percs slowly, Poor drainage, Slow intake	945
Oa	Onawa Silty clay	Not Suited	Floods, Percs slowly, Slow intake, Surface texture, pH	1,525
Ob	Owega Silty clay loam	Not Suited	Floods, Percs slowly, Slow intake	2,025
Pa	Pits, gravel	Not Suited	Rooting depth, Inaccessible	345
Ra	Redstoe Variant Silt loam, 6 to 15% slopes	Severe	Slope, pH	485
Rb	Roxbury Loam, channeled	Severe	Floods, pH, inaccessible	1,910
Rc	Roxbury Silt loam	Severe	Floods, pH	4,195
Sa	Salix Silty clay loam	Moderate	Floods, Surface texture, pH	500
Sb	Salmo Silty clay loam	Not Suited	Floods, HWT, pH	2,115
SdA	Sarpy Loamy fine sand, 0 to 3% slopes	Severe	Floods, pH	1,710
SeA	Sarpy-Grable complex, 0 to 4% slopes			2,955
	Sarpy (45-55%)	Severe	Floods, Surface texture, pH	
	Grable (30-40%)	Severe	Floods, pH	
TaE	Talmo-Thurman complex, 15 to 40% slopes			1,865
	Talmo (50-60%)	Not Suited	Slope, Rooting depth, pH	
	Thurman (25-35%)	Not Suited	Slope	
Tb	Tetonka Silt loam	Not Suited	Floods, HWT, Percs slowly, Poor drainage	4,925

Table 11. Continued.

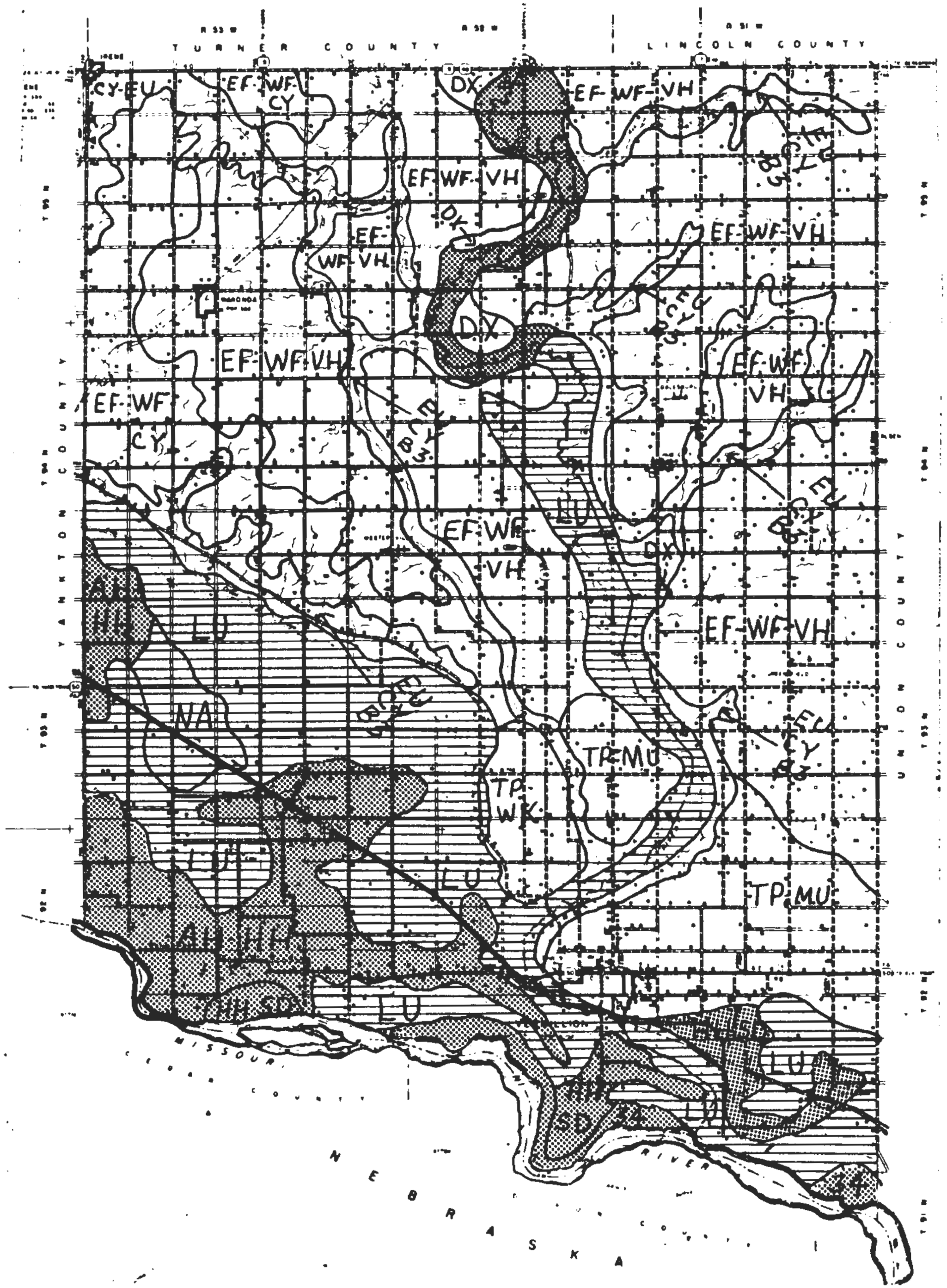
Symbol	Name	Degree of Limitation	Limitations	Acres
TcC	Thurmam-Ethan complex, 2 to 9% slopes			1,250
	Thurman (40%)	Moderate	Slope	
	Ethan (35%)	Moderate	Slope, pH	
TdA	Trent Silty clay loam, 0 to 2% slopes	Moderate	Floods, Surface texture	975
Wa	Waubonsie Very fine sandy loam	Severe	Floods, HWT, pH	1,090
WbA	Wentworth Silty clay loam, 0 to 2% slopes	Moderate	Surface texture	3,065
WcB	Wentworth-Trent Silty clay loams, 2 to 6% slopes			2,515
	Wentworth (55-65%)	Moderate	Slope, Surface texture	
	Trent (20-30%)	Moderate	Floods, Surface texture	
Wd	Worthing Silty clay loam	Not Suited	Floods, HWT, Percs slowly, Poor drainage	2,270
We	Worthing Silty clay loam, ponded	Not Suited	Floods, HWT, Percs slowly, Poor drainage	1,225

SOIL LIMITATION MAPS

General soil association soil map sheets from each of the published county soil surveys were selected to use as base maps for this study. The limitation categories for sprinkler irrigated potato production were overprinted onto each soil map using the criteria developed in previous sections. The coded maps appear as Figures 2 through 6. Legends for the limitation categories are shown on each map.

The dominant soil was considered when preparing these maps. Thus, there may be soils with widely different limitation ratings occurring in the same mapping unit. These maps are for planning purposes only and are meant to illustrate potential areas for in-depth on-site inspection by trained professionals to determine suitability for sprinkler irrigated potato production.

Figure 2. Soil Limitation Map for Clay County.



CLAY COUNTY
General Soil Map

Symbol	Name
AH-HH	Albaton-Haynie
CY-EU	Clarno-Ethan
DX	Dempster
EF-WF-CY	Egan-Wentworth-Clarno
EF-WF-VH	Egan-Wentworth-Viborg
EU-CY-B3	Ethan-Clarno-Betts
HH-SD	Haynie-Sarpy
LC	Lamo
LU	Luton
NA	Napa
34	Riverwash
TP-MU	Trent-Moody
TP-WK	Trent-Wakonda

Soil Conservation Service, U.S.D.A., and S. Dak. Agr. Expt. Station Cooperating. DLB, FCW & JD 6/70

Soil Limitations for Sprinkler Irrigated Potato Production

Slight
Severe
Moderate
Not Suited

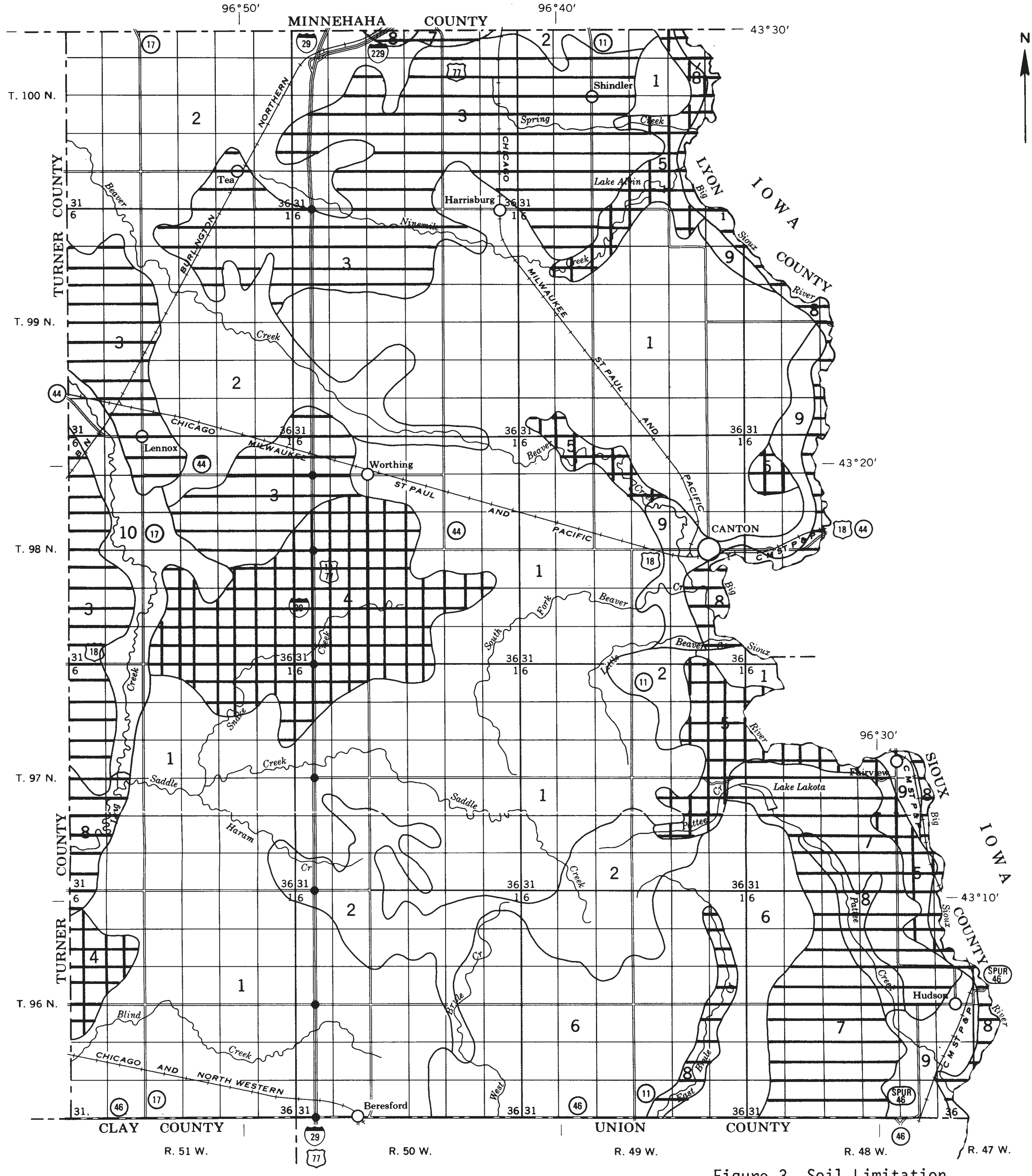


Figure 3. Soil Limitation Map for Lincoln County.

Scale 1:190,080

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

LINCOLN COUNTY, SOUTH DAKOTA

Scale 1:190,080
1 0 1 2 3 4 Miles

SOIL ASSOCIATIONS*

SOILS FORMED IN GLACIAL DRIFT AND GLACIAL TILL; ON UPLANDS

- 1 — Wentworth-Chancellor association: Deep, well drained and somewhat poorly drained, nearly level, silty soils
- 2 — Egan-Shindler-Worthing association: Deep, well-drained, gently sloping to rolling, silty and loamy soils; and poorly drained, level, clayey soils
- 3 — Egan-Chancellor association: Deep, well drained and somewhat poorly drained, mainly gently undulating or gently sloping, silty soils
- 4 — Chancellor-Wakonda-Tetonka association: Deep, moderately well drained to poorly drained, nearly level and level, silty soils
- 5 — Shindler-Steinauer-Renner association: Deep, well-drained, hilly to steep, loamy soils

SOILS FORMED IN LOESS; ON UPLANDS

- 6 — Moody-Nora-Alcester association: Deep, well drained and moderately well drained, nearly level to sloping, silty soils
- 7 — Nora-Moody-Crofton association: Deep, well-drained, gently sloping to strongly sloping, silty soils

SOILS FORMED IN ALLUVIUM; ON BOTTOM LANDS

- 8 — Lamo-Bon-Clamo association: Deep, moderately well drained to poorly drained, level and nearly level, silty and loamy soils

SOILS UNDERLAIN BY SAND AND GRAVEL; ON HIGH TERRACES

- 9 — Graceville-Dempster association: Moderately well drained and well drained, nearly level to gently sloping, silty soils that are deep and moderately deep over sand and gravel
- 10 — Delmont-Graceville-Talmo association: Moderately well drained to excessively drained, nearly level to undulating, loamy and silty soils that are deep to very shallow over sand and gravel

* Terms for texture refer to the surface layer of the major soils in each association unless otherwise indicated.

Compiled 1974

Soil Limitations for Sprinkler Irrigated Potato Production

- Slight
- Moderate
- Severe
- Not Suited

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

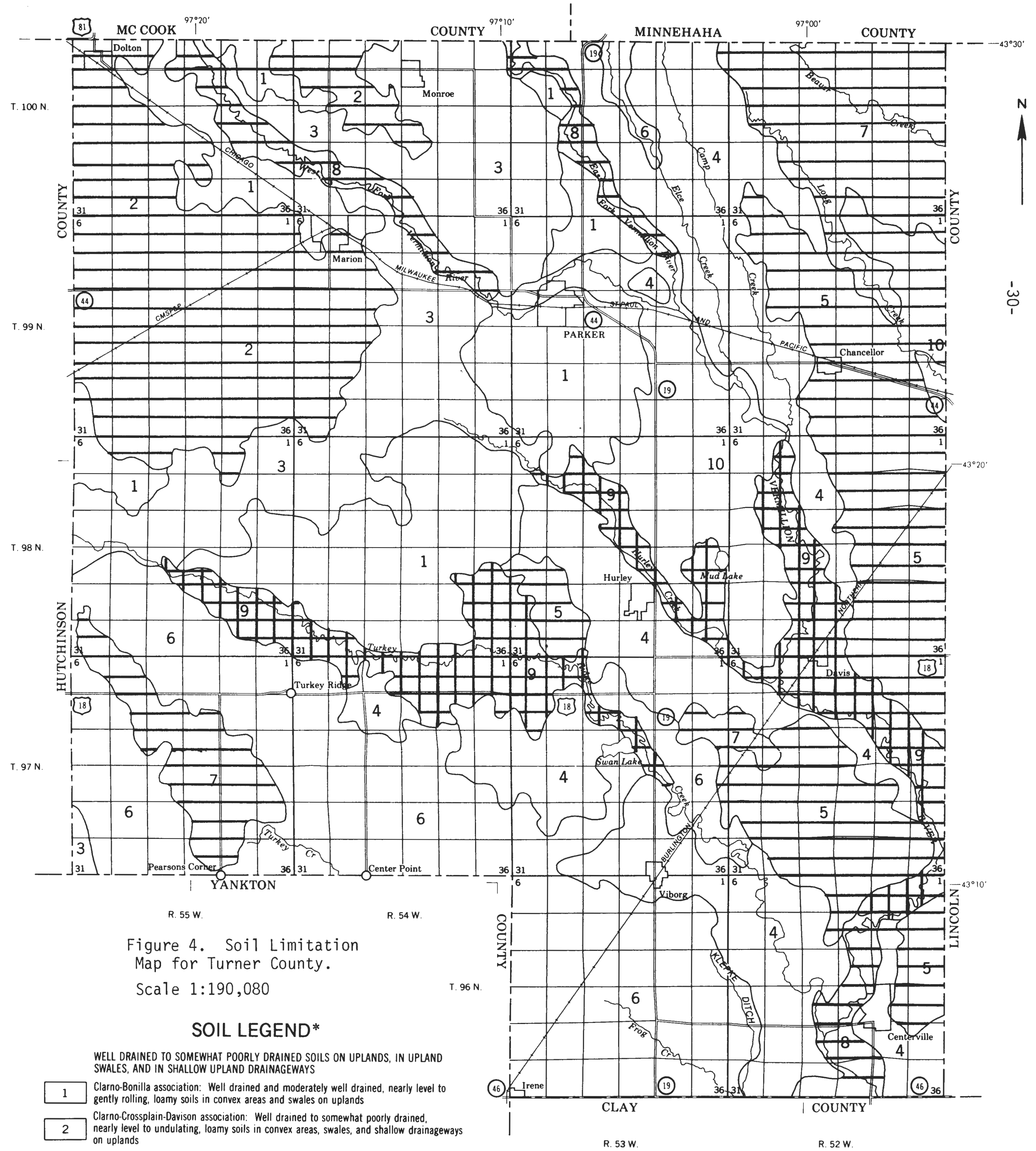


Figure 4. Soil Limitation Map for Turner County.

Scale 1:190,080

SOIL LEGEND*

WELL DRAINED TO SOMEWHAT POORLY DRAINED SOILS ON UPLANDS, IN UPLAND SWALES, AND IN SHALLOW UPLAND DRAINAGEWAYS

1	Clarno-Bonilla association: Well drained and moderately well drained, nearly level to gently rolling, loamy soils in convex areas and swales on uplands
2	Clarno-Crossplain-Davison association: Well drained to somewhat poorly drained, nearly level to undulating, loamy soils in convex areas, swales, and shallow drainageways on uplands
3	Clarno-Ethan association: Well drained, nearly level to moderately steep, loamy soils on uplands

WELL DRAINED, MODERATELY WELL DRAINED, SOMEWHAT POORLY DRAINED, AND VERY POORLY DRAINED SOILS ON UPLANDS AND IN SWALES, SHALLOW DRAINAGEWAYS, AND DEPRESSIONS IN THE UPLANDS

4	Egan-Trent association: Well drained and moderately well drained, nearly level to undulating, silty soils on uplands and in upland swales
5	Wentworth-Chancellor-Wakonda association: Well drained to somewhat poorly drained, nearly level to undulating, silty soils in convex areas, swales, and shallow drainageways on uplands
6	Egan-Ethan association: Well drained, nearly level to moderately steep, silty and loamy soils on uplands
7	Egan-Worthing association: Well drained and very poorly drained, level to gently rolling, silty soils on uplands and in upland depressions

WELL DRAINED, SOMEWHAT POORLY DRAINED, AND POORLY DRAINED SOILS ON FLOOD PLAINS

8	Roxbury-Davis-Chaska association: Well drained and somewhat poorly drained, nearly level and gently sloping, silty and loamy soils on flood plains
9	Clamo-Lamo association: Poorly drained and somewhat poorly drained, level and nearly level, clayey and silty soils on flood plains

SOMEWHAT EXCESSIVELY DRAINED AND WELL DRAINED SOILS ON TERRACES

10	Delmont-Enet association: Somewhat excessively drained and well drained, nearly level to undulating, loamy soils on terraces

*The texture terms in the descriptive headings refer to the surface layer of the major soils in each association.

Compiled 1981

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

TURNER COUNTY, SOUTH DAKOTA

Scale 1:190,080

1 0 1 2 3 4 Miles
1 0 1 2 3 4 5 6 Kilometers

Soil Limitations for Sprinkler Irrigated Potato Production

Slight

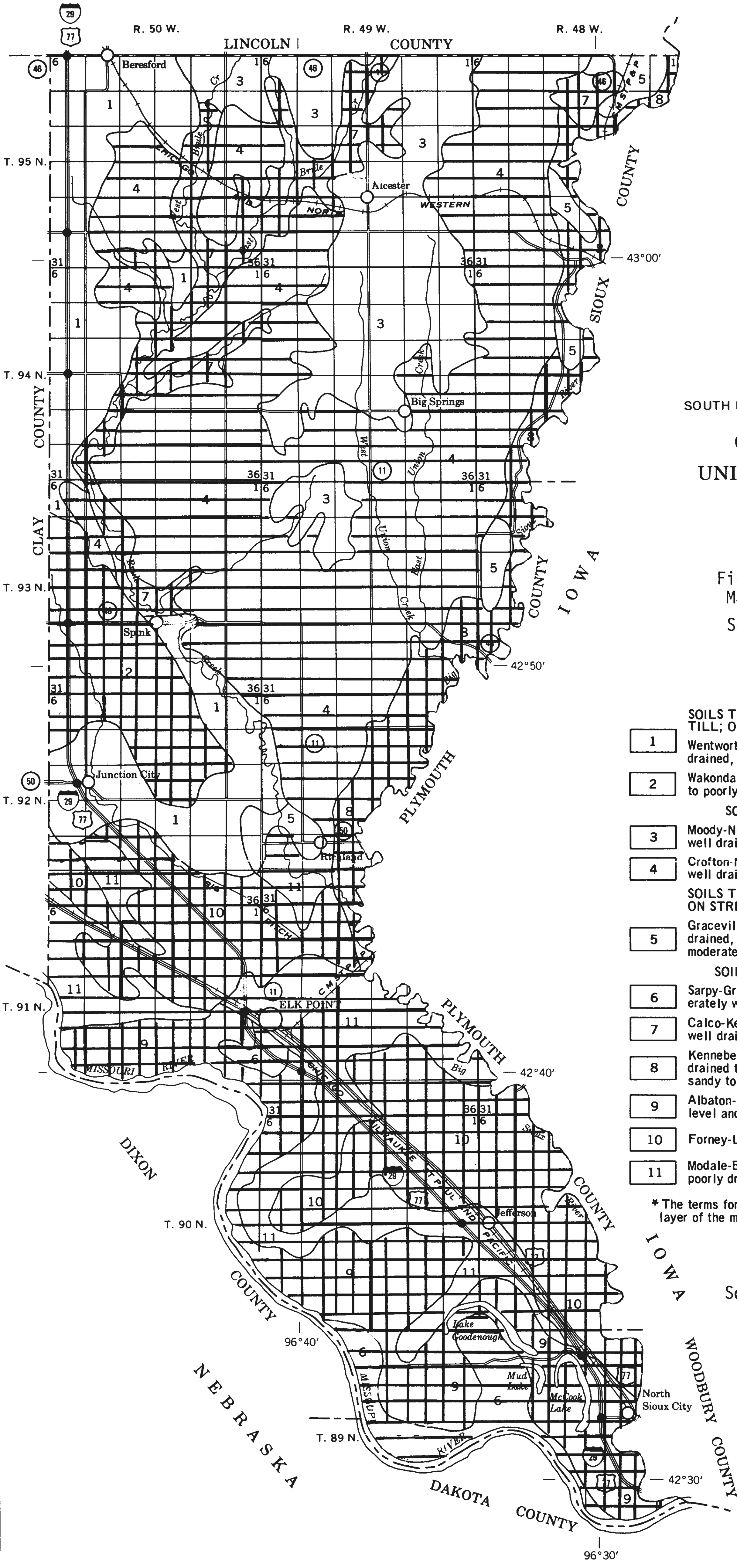
Moderate

Severe

Not Suited

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

UNION COUNTY, SOUTH DAKOTA

Scale 1:190,080

1 0 1 2 3 4 Miles

Figure 5. Soil Limitation Map for Union County.
Scale 1:190,080

SOIL ASSOCIATIONS*

SOILS THAT FORMED MOSTLY IN GLACIAL DRIFT AND GLACIAL TILL; ON UPLANDS

1 Wentworth-Shindler-Worthing association: Deep, well drained and poorly drained, level to steep, silty and loamy soils

2 Wakonda-Worthing-Chancellor association: Deep, moderately well drained to poorly drained, nearly level and level, silty soils

SOILS THAT FORMED MOSTLY IN LOESS; ON UPLANDS

3 Moody-Nora-Alcester association: Deep, well drained and moderately well drained, nearly level to sloping, silty soils

4 Crofton-Nora-Alcester association: Deep, well drained and moderately well drained, gently sloping to very steep, silty soils

SOILS THAT FORMED IN ALLUVIUM OVERLYING GRAVELLY SAND; ON STREAM TERRACES

5 Graceville-Dempster association: Moderately well drained and well drained, nearly level to gently sloping, silty soils that are deep and moderately deep over gravelly sand

SOILS THAT FORMED IN ALLUVIUM; ON BOTTOM LANDS

6 Sarpy-Grable-Haynie association: Deep, excessively drained to moderately well drained, level to undulating, sandy and silty soils

7 Calco-Kennebec association: Deep, poorly drained and moderately well drained, level and nearly level, silty soils

8 Kennebec-Fluvaquents-Benclare association: Deep, moderately well drained to very poorly drained, level and nearly level, silty and mixed sandy to clayey soils

9 Albaton-Haynie-Onawa association: Deep, poorly drained to well drained, level and nearly level, clayey and silty soils

10 Forney-Luton association: Deep, poorly drained, level, clayey soils

11 Modale-Blyburg-Benclare association: Deep, well drained to somewhat poorly drained, nearly level and level, silty soils

*The terms for texture used in the descriptive headings apply to the surface layer of the major soils in each association.

Compiled 1977

Soil Limitations for Sprinkler Irrigated Potato Production

Slight

Moderate

Severe

Not Suited

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

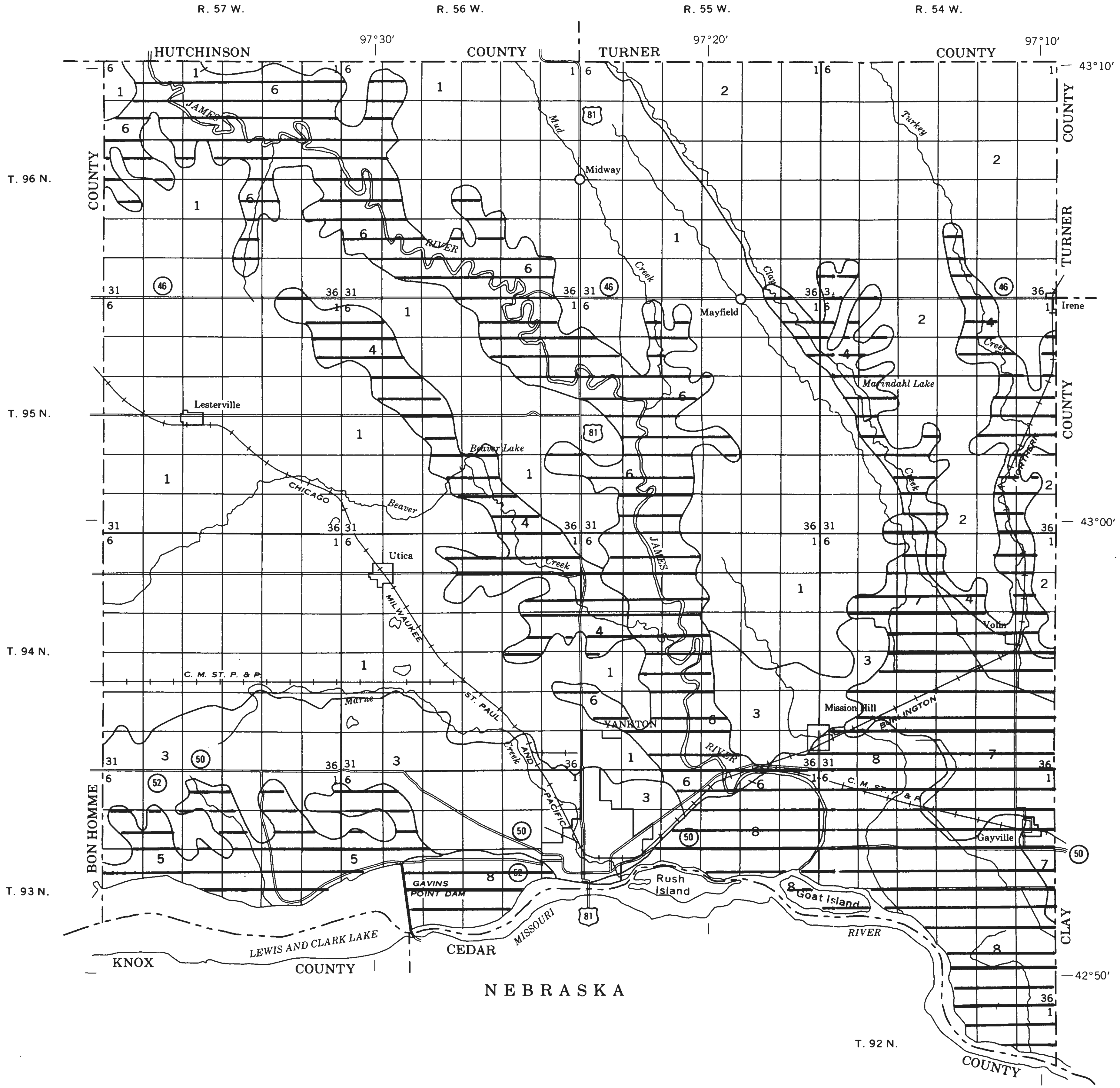
GENERAL SOIL MAP

YANKTON COUNTY, SOUTH DAKOTA

Scale 1: 190,080

Figure 6. Soil Limitation Map for Yankton County.

Scale 1:190,080



SOIL LEGEND*

1	Clamo—Bonilla—Tetonka: Deep, nearly level to undulating, well drained, moderately well drained, and poorly drained loamy and silty soils on uplands
2	Egan—Ethan—Trent: Deep, nearly level to gently rolling, well drained and moderately well drained silty and loamy soils on uplands
3	Egan—Wentworth: Deep, nearly level and gently sloping, well drained silty soils on uplands
4	Ethan—Betts: Deep, moderately steep and steep, well drained and excessively drained loamy soils on uplands
5	Crofton—Boyd—Ethan: Deep and moderately deep, strongly sloping to steep, well drained silty, clayey, and loamy soils on uplands
6	Ethan—Clamo—Davis: Deep, nearly level to moderately steep, well drained and poorly drained loamy and silty soils on uplands and flood plains
7	Baltic—Roxbury—Lakeport: Deep, nearly level, very poorly drained to moderately well drained loamy, silty, and clayey soils on flood plains
8	Forney—Haynie—Sarpy: Deep, nearly level and gently undulating, poorly drained to excessively drained silty and sandy soils on flood plains

* The texture terms in these descriptive headings refer to the surface layer of the major soils in each map unit.

Compiled 1979

Soil Limitations for Sprinkler Irrigated Potato Production

- Slight
- Moderate
- Severe
- Not Suited

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SUMMARY

The five county area of Southeast South Dakota (Union, Clay, Yankton, Turner, and Lincoln Counties) has been evaluated for its potential as a commercial potato production area. It was assumed that sprinkler irrigation would be used to supplement the natural precipitation of the area. The criteria used to evaluate the soils of the area were obtained from a review of pertinent literature and conversations with Extension Potato Specialists from other states. A table of the criteria used to evaluate soils is found on page 7 of this report.

The acreage within each county with slight, moderate, and severe limitations for potato production plus the acreage of soils not suitable for sprinkler irrigation is given in Table 12.

Table 12. Degree of Limitation of Southeastern South Dakota Soils for Potato Production Under Sprinkler Irrigation.

County	Slight	Moderate	Severe	Not Suited
		Degree of Limitation Acres*		
Clay	0	190,867	16,602	50,986
Lincoln	2,000	197,871	60,989	105,655
Turner	6,004	260,259	54,321	71,375
Union	700	87,675	118,105	80,940
Yankton	687	192,856	71,745	66,742
Total	9,391	929,528	321,762	375,698
% of area	0.6	56.8	19.6	23.0

*Estimated total acres per county based on mapping unit composition information from detailed soil survey reports.

Those soils with moderate and severe limitations can successfully be used for potato production if management measurements are taken to overcome the listed limitations. The indirect and direct costs of production increase as the limitations are overcome. Generally soils with slight and moderate limitations are well enough suited for the given use to be considered potentially suitable acreage. Sound soil management practices can generally reduce the limitations associated with soils with moderate limitations.

The ratings given in Table 12 assume that good quality irrigation water is available. The Water Resource Institute (SDSU) and the South Dakota State Geologic Survey should be consulted as to the availability and quality of ground and surface water in those areas selected for serious planning.

The acreage of soils with various limitations associated with the sprinkler irrigated potato production are shown in Table 13, for those soils not considered unsuitable for irrigation in the Soil Conservation Service's irrigation guide for South Dakota (SCS, 1978). Acreages and limitations are included under all appropriate limitations. For example, Lamo silty clay loam in Yankton County has severe limitations due to flooding, high water table, and pH. Thus, the 2,015 acres of this soil were included in both the slope and pH total for Yankton County.

The most common limitations of irrigated potato production in Southeastern South Dakota are excessive wetness early in the spring due to seasonal high water tables, slope, and alkaline pH values (Table 13). Management alternatives such as residue management and limited tillage can help reduce the erosion hazard on some of the more gently sloping soils. Crop rotation with other crops commonly grown in the area will reduce the hazard of potato pathogens building up on the soil. A two or three year rotation would be necessary to overcome this limitation. The most serious and difficult limitation to overcome continues to be seasonal wetness problems that plague many acres of soil in Southeastern South Dakota. Potatoes should be planted early in the spring. Without the installation of artificial drainage systems in those soils with moderate and severe limitations due to a high water table, early planting of a potato crop would be difficult some years. For example, the years of 1983 and 1984 were too wet to allow timely planting of small grains and corn in Southeastern South Dakota. These conditions could have been a serious problem if potatoes were commercially being produced in the area. The Southeast South Dakota Experiment Station near Beresford should be contacted as to any existing research results that may exist on potatoes for Southeastern South Dakota.

Moderate surface texture, slow intake, and slope were the most common soil limitations in the five county area. This combination of slope and surface texture induced slow intake rates is a serious limitation to sprinkler irrigation development. The inability of the soil to allow water to enter the soil quickly would result in a more serious erosion problem under irrigation than would occur under dryland conditions. Low pressure irrigation systems would result in a more serious erosion hazard than high pressure systems. However, high pressure systems have a higher power requirement and cost than do low pressure systems.

Turner and Yankton counties should be considered the most suitable of the five evaluated counties. They have over 400,000 acres between them that have slight and moderate limitations. The availability of an adequate supply of good quality ground water may be a concern in some of the area. Local shallow aquifers do exist within the outwash plains and in pockets of the glacial tills of the area.

RECOMMENDATIONS FOR FUTURE STUDY

It is our professional opinion that no decisions should be made about the potential of a commercial irrigated potato industry in South Dakota until some other areas are evaluated. The loess and residual sandstone derived soils of South Central South Dakota may provide a generally more acceptable area. Charles Mix and Gregory counties are scheduled to be evaluated within a few weeks. In addition, the loess and silty drift areas of Sully, Hughes, Potter, and Walworth counties should also be considered. There are several hundred thousand acres of soil with slight and moderate limitations in this area. Overcoming these limitations (mostly slope and surface pH) would be less costly to overcome than the seasonal wetness problem in Southeastern South Dakota. The potential for irrigation water from the Missouri River exists in these areas. Irrigation is better accepted and understood as a management technique in this area than in Southeastern South Dakota. Unpublished potato production results from the South Dakota Agricultural Experiment Station Research location in the Gettysburg area indicate that a production potential exists.

TABLE 13. SUMMARY OF SOIL LIMITATIONS FOR SPRINKLER IRRIGATED POTATO PRODUCTION IN SOUTHEASTERN SOUTH DAKOTA

	Flood		HWT		Surface Texture		Drainage		Intake		Slope		pH		Salinity	
County	Moderate	Severe	Moderate	Severe	Moderate	Severe	Moderate	Severe	Moderate	Severe	Moderate	Severe	Moderate	Severe	Moderate	Severe
Clay	18,170	12,359	--	9,317	146,563	--	--	9,317	76,880	--	131,610	5,931	40,868	15,433	--	--
Lincoln	11,250	11,200	--	14,990	101,613	79,725	--	--	53,770	--	65,850	40,699	14,954	32,565	--	--
Turner	30,335	18,020	12,150	16,642	132,939	3,660	--	--	160,631	--	126,353	24,764	34,485	29,861	--	--
Union	22,860	30,160	--	2,900	42,160	720	2,300	780	6,500	--	48,535	68,260	49,730	73,110	--	--
Yankton	38,019	23,941	16,530	10,670	63,095	1,625	1,915	7,565	114,585	7,565	97,718	37,085	32,864	38,988	--	--
Total Acres	120,634	95,680	28,680	54,519	486,370	85,730	4,215	17,662	412,366	7,565	470,066	176,739	172,901	189,957	--	--
% of Area	7.27	5.84	1.75	3.33	29.7	5.24	.257	1.08	25.2	.462	28.7	10.8	10.6	11.6		
	13.2%		5.08%		34.9%		1.34%		25.7%		39.5%		22.2%			

	Sodicity		Available H_2O		Permeability		Depth		Stones		Channel		
County	Moderate	Severe	Moderate	Severe	Moderate	Severe	Moderate	Severe	Moderate	Severe	Moderate	Severe	Unsuited
Clay	--	--	--	--	--	--	--	--	--	--	--	--	50,986
Lincoln	--	--	--	--	--	--	--	1,015	--	--	--	3,000	105,655
Turner	--	--	--	--	--	--	--	840	--	--	--	840	71,375
Union	--	--	--	--	--	--	--	--	--	--	--	--	80,940
Yankton	--	--	--	--	593	7,565	--	370	--	810	--	1,910	66,742
Total Acres	--	--	--	--	593	7,565	--	2,225	--	810	--	5,750	375,698
% of Area					.036	.462	--	.136	--	.049	--	.351	
					.498%		.14%		.05%		.35%		22.0%

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