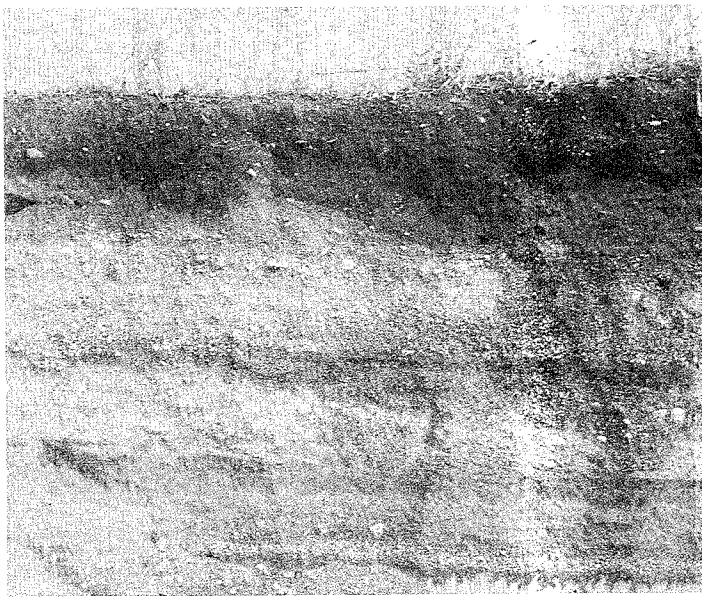
Miscellaneous Report 172 — 1980

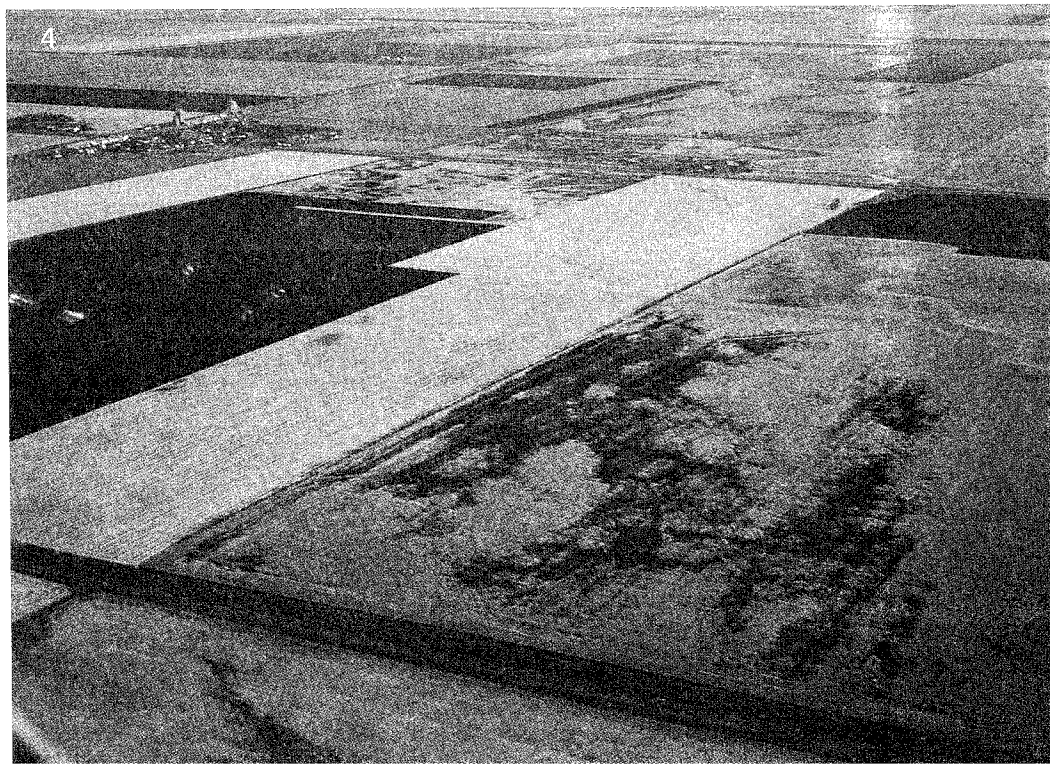
MINNESOTA SOIL ATLAS

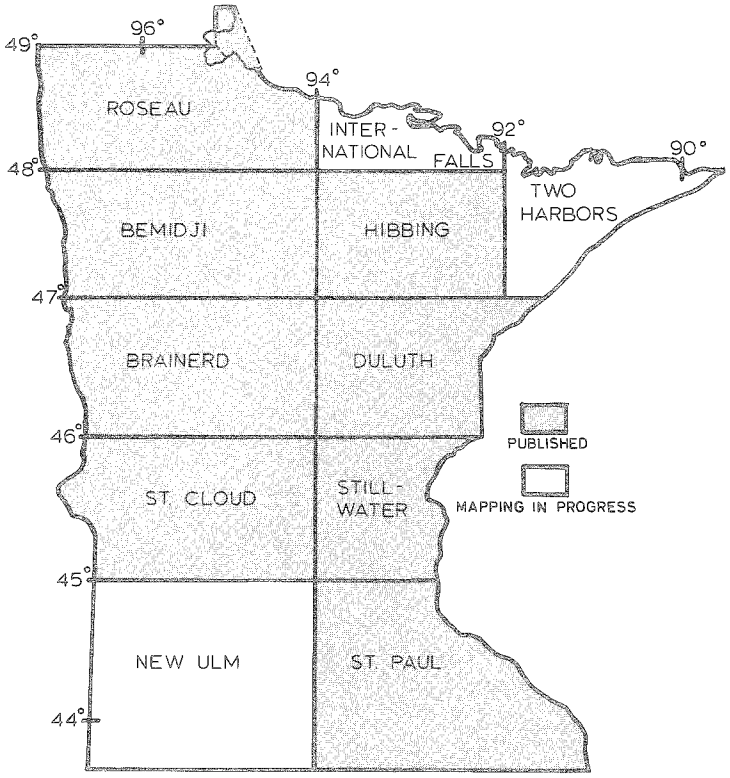
roseau sheet

Agricultural Experiment Station
University of Minnesota



1. Barley did not make it on a saline soil in unit CCPD in the Red River Valley Area (1). 2. Combining barley in soil landscape unit CCPD in the Red River Valley Area (1). 3. Semi-dwarf wheat in soil landscape unit LLWD in the Red River Valley Area (1). 4. Crop damage caused by soil salinity is easily seen in this aerial photo taken in Kittson County. 5. A cut through a beach line in the Inter-Beach Area (1C) showing stratification of sand and gravel.





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Acknowledgment

The Department of Soil Science, University of Minnesota in cooperation with the U.S. Department of Agriculture-Soil Conservation Service (USDA-SCS), and the Minnesota Geological Survey prepared this Minnesota Soil Atlas-Roseau Sheet, eighth in a series of eleven covering the entire state. Published are the Brainerd Sheet, Miscellaneous Report 90 (1969); Hibbing Sheet, Miscellaneous Report 110 (1971); St. Paul Sheet, Miscellaneous Report 120 (1973); Duluth Sheet, Miscellaneous Report 148 (1978); St. Cloud Sheet, Miscellaneous Report 159 (1979); Stillwater Sheet, Miscellaneous Report 171 (1979); and Bemidji Sheet, Miscellaneous Report 168 (1980).

R.A. Erickson, A.S. Robertson, D.D. Barron, G.F. Harms, R.L. Skarie, and R.H. Rust did the Roseau Sheet field work, map, and report.

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Fargo and Bearden soils in unit CLPD near the town of Robbin. The lighter areas are Bearden soils which have an excess of lime in the surface horizon. (Photo courtesy of USDA-Soil Conservation Service)

Introduction

Information is lacking on the soils and landscape characteristics of large areas of Minnesota. Many planning agencies simply have to go without information needed for their work. Detailed soil surveys published on a scale of 1:20,000 or 1:15,840 are being made by the USDA-SCS in cooperation with the Minnesota Agricultural Experiment Station to fill this need. Because they cannot be supplied rapidly enough for broad planning, the Soil Atlas is being developed. It is not intended to replace detailed soil survey reports, which are essential for planning the use of smaller pieces of land.

Until detailed soil surveys are available for all Minnesota counties, broad planning can be facilitated by the eleven sheets to be published in the Minnesota Soil Atlas series (see inside cover). The atlas map series is being published with explanatory texts for each sheet of the state. For uniformity the Atlas Sheets are being published on the same scale as the U.S. Geological Survey topographic maps and other maps prepared by the Minnesota Geological Survey.

The Roseau Sheet encompasses approximately 6,200,000 acres in northwestern Minnesota: from 48 to 49 north latitude and from 94 west longitude to the Red River including all or parts of nine counties. Appendix B indicates the extent of modern detailed soil surveys in this area.

Use of the Soil Atlas

The Minnesota Soil Atlas provides essential information for broad planning. Some of the uses that can be developed from this map follow:

1. To determine areas suitable for various crops such as potatoes, sugar beets, and canning crops to enable processors to locate plants within areas of greatest potential.
2. To determine potential for various types of farming, forestry, or recreation.
3. To determine areas that would benefit from drainage or irrigation.
4. To locate sources of sand and gravel.
5. To prepare wildlife density maps.
6. To locate pulp and lumber mills within areas of greatest potential supply.
7. To locate feasible routes for utility lines and highways.
8. To serve as a reference for science teachers in junior high, high school, and college courses.

For specific planning of individual farms, cities, towns, recreation areas, tax equalization, and road building purposes, more detailed surveys are necessary. However, this map may point to priority areas where detailed surveys will be most useful.

How the Map was Prepared

The base map was prepared from the Roseau, Thief River Falls, and Kenora quadrangles of the U.S. Geological Survey, Department of Interior. The scale of 1:250,000, or about 1/4 inch to 1 mile, makes it possible to show areas as small as 1 square mile. .

Soil landscape delineations were developed from detailed soil surveys made by the USDA-SCS where available. Field work was necessary where no detailed soil survey existed.

Attempting to provide a generalized map for the user with a minimum soils knowledge, soils are grouped into soil landscape units based on the following factors:

1. Texture of soil material below 5 feet: sandy (S); loamy or silty (L); clayey (C); mixed sandy and loamy (X); mixed silty and clayey (Y); and bedrock (R).
2. Texture of material less than 5 feet deep, or a significant part of it: sandy (S); loamy or silty (L); and clayey (C).
3. Drainage: moderately well, well, excessively drained soils designated (W); poorly drained soils designated (P). Units with (W) designation will generally have water tables below rooting zone and units with (P), water tables commonly within rooting zone.
4. Color of surface soil: dark color designated (D); and light color designated (L).

Thus, the Fargo series would appear on the map as CCPD and would be interpreted from the map as a dark-colored, poorly drained clayey soil over clayey material.

Some areas on the map do not have a four-letter symbol. These are soil landscapes such as SP for shallow peat over sandy, LP for shallow peat over loamy, NP for non-acid deep peat, AP for acid deep peat, BP for raised bogs, A for alluvial soils, and M for marsh.

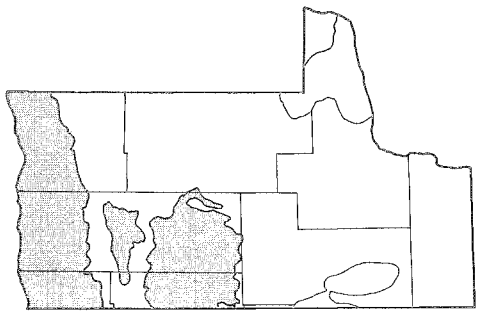
Six geomorphic areas are delineated to illustrate broad physiographic features and to provide some identification of parent materials on which the soils have developed.

Table 1. Acreage estimates of geomorphic areas within the Roseau Sheet

No.	Name	Acres	Percent of sheet
1	Agassiz Lacustrine Plain, Red River Valley	1,580,000	25
1B	Agassiz Lacustrine Plain, Big Fork Valley	280,000	5
1C	Agassiz Lacustrine Plain, Inter-Beach Area	670,000	11
1D	Agassiz Lacustrine Plain, Red Lake Area	420,000	7
1E	Agassiz Lacustrine Plain, Beltrami Island Area	1,200,000[1]	19
1F	Agassiz Peatlands	2,060,000[2]	33
		6,210,000	100

[1] About 300,000 acres of Lake of the Woods included.
[2] About 150,000 acres of Upper Red Lake included.

Agassiz Lacustrine Plain, Red River Valley Area (1)



This region encompasses approximately 1,580,000 acres or about 25 percent of the Roseau Sheet.

The region consists of a low, nearly level plain having a gradual slope to the west and north. The Red River, which forms the state's western boundary, is a slow moving, winding stream, with about 5 inches fall per mile. The flood plain is too narrow in most places to delineate. The Agassiz National Wildlife Refuge is an intermittent marshy lake of about 100,000 acres.

The area located generally west of the Inter-Beach area (IC), formed in glacial times under about 300 feet of water. Consequently, lake laid sediments are thickest in this part of the Roseau Sheet area, ranging from 5 to over 100 feet thick. Clays and silty clays are most common, although fine silts occur northeast of East Grand Forks. Soils in the area generally are poorly drained. Runoff is slow to very slow and the permeability is slow. The water-holding capacity is high.

The water tables are normally deeper than 10 feet. A perched water table may develop during extended wet periods especially in areas of shallow sandy or silty sediments over clayey materials.

The remainder of this geomorphic area formed under much shallower water resulting in thinner deposits of lacustrine sediments. In places, wave action removed the lake sediments and partially eroded the exposed glacial till surface. Most of the soils are poorly or very poorly drained. Most of the shallow peat which originally covered the area has been removed by burning. Depth to the water table generally ranges from 5 to over 10 feet. Runoff is slow to very slow, the permeability is slow and the water-holding capacity in most of the soils is high.

Original vegetation in most of the region consisted of tall prairie grass. A narrow strip along the Red River consisted of bottomland hardwoods. Eastern Marshall and Pennington counties were wet meadows, and a wide border west of the meadows was dominantly brush prairie. Present crops are wheat, barley, soybeans, sunflowers, sugarbeets, and potatoes. An estimated 5 to 11 percent is wooded, mainly along the Red River. Another 15 to 25 percent is grass and brush occurring in small areas used mainly for pasture. Nearly all the land in soil landscape units CCPD, CLWD, and LLWD west of the beaches is under cultivation.

Fifteen soil landscape units are mapped in this region, CCPD, LLPD, LSPD, CLPD, LP, CLWD, LSWD, LLWD, A, LLPL, CCWD, SLWD, SSPD, SSWD, and M. Table 2 gives selected features of the units. Additional information follows:

CCPD — Some soils of the unit have excessive salts which occur in small scattered areas and which may retard crop growth. Soils having a silty or very fine sandy surface layer, 2 to 3 feet thick, and better drainage occupy 10 to 15 percent of the unit. (Vertic Haplaquolls)

LLPD — Moderately well-drained soils occur in 5 to 10 percent of the unit. Another 10 percent have sandy material over the loamy or silty sediments. Shallow peat occupies about 10 percent of the unit. (Typic Haplaquolls)

LSPD — The loamy underlying sediments are mainly glacial till. The soils are alkaline or calcareous throughout. Well-drained soils occupy 20 to 25 percent of the area, and another 5 percent have loamy rather than sandy surface horizons. (Typic Haplaquolls)

CLPD — This unit consists largely of intermixed areas of loamy and clayey soils and of shallow (2 to 3 feet thick) loamy soils over clay. Sixty to 70 percent of the soils are either alkaline or calcareous throughout. (Typic Calciaquolls)

LP — Peat overlying sandy material occupies 10 to 15 percent of the unit, and islands of mineral soils occur in another 5 percent. (Terric Borosaprists)

CLWD — These soils are generally calcareous throughout. Some soils have excessive amounts of salts which retard crop production. These salty areas are small and scattered. A perched high water table may develop in these soils during wet periods. Poorly drained soils occupy about 15 percent of the unit. (Aeric Calciaquolls)

LSWD — Frequently a thin layer of gravelly material occurs in the lower portion of the sandy sediments. During extended wet periods a perched water table may develop in these soils. Poorly drained soils occupy about 25 percent of this unit. Deep sandy soils occur in about 5 percent, and another 5 to 10 percent have a clayey rather than loamy substratum. (Aeric Calciaquolls)

LLWD — Loamy soils are underlain by lacustrine clay below 3 to 4 feet in 5 to 10 percent of the unit. Another 5 to 10 percent has very fine sand below 2 to 3 feet. Most of the soils in the unit are alkaline. Gypsum crystals are quite common below 2 to 3 feet. (Aeric Calciaquolls)

A — These stream bottoms are subject to frequent overflow. (unclassified)

LLPL — Shallow peat occurs in 5 to 15 percent of the unit. Another 5 to 10 percent of the unit contains well-drained soils. (Typic Ochraqualfs)

CCWD — About 10 percent of the unit has poorly drained soils. (Udertic Haploborolls)

SLWD — Inclusions in this unit follow: 5 to 10 percent, poorly drained; 10 to 15 percent, having underlying silty material; 5 to 10 percent, sandy substratum. These soils are calcareous throughout. (Aeric Calciaquolls)

SSPD — Soils in 10 to 15 percent of the unit are well drained. Another 10 to 15 percent is loamy below 36 inches. (Typic Calciaquolls)

SSWD — Soils on beach lines are underlain by sand and gravel. About 10 percent is poorly drained, and another 10 percent is loamy in the upper 24 inches. (Aeric Calciaquolls)

M — Most of the units are peatlands that have been flooded artificially to develop marsh conditions for wildlife. (unclassified)

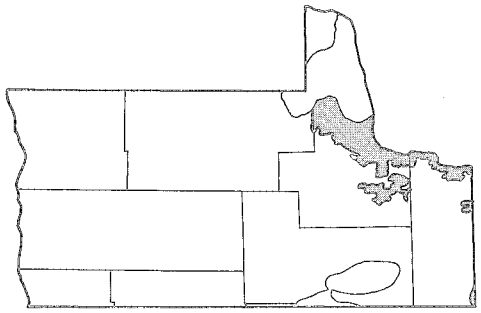
Table 2. Selected features of soil landscape units within the Agassiz Lacustrine Plain, Red River Valley Area (1) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
CCPD	32	level and nearly level lake plain	silty clay and clay (3)	clay (3-20+)	8-12	poorly drained	7.8-8.0	med.	high	Fargo Hegne Borosaprists
LLPD	36	nearly level to shallow depressions on lake plain	silt loam, loam and clay loam (3)	silt loam silty clay loam and clay loam (3-20+)	8-12	poorly drained	7.0-8.0	low	med.	Roliss Colvin Rockwell
LSPD	4	flats or shallow depressions on lake plain	fine sandy loam and loamy fine sand (3)	clay loam and loam (3-20+)	4-8	poorly drained	7.8-8.5	med.	med.	Aranka Rockwell Gorgie
CLPD	5	level lake plain	silt loam (3)	clay and silty clay (3-20+)	8-12	poorly drained	7.8-8.0	low	med.	Unnamed Grimstad
LP	4	shallow depressions on lake plain	muck and peat (1-4)	loam and sandy loam (4-20+)	8+	very poorly drained	6.1-7.8	low	low	Cathro Haug
CLWD	4	nearly level lake plain	very fine sandy loam (3)	silty clay and clay (3-20+)	8-12	moderately well drained	7.5-8.1	low	med.	Wheatville Unnamed
LSWD	3	nearly level lake plain	loamy fine sand and fine sand (3)	loam and clay loam (3-20+)	4-8	moderately well drained	7.8-8.0	low	med.	Grimstad Foldahl
LLWD	3	level lake plain	silt loam and loam (3)	silt loam and loam (3-4+)	8-12	moderately well drained	7.5-8.1	low	high	Bearden
A	<1	nearly level stream bottoms	sandy loam to clay (3)	sandy loam to clay (3+)	4-12	poorly drained	6.6-7.3	med.	high	Alluvial land, undifferentiated
LLPL	1	slightly concave slopes on lake plain	silt loam very fine sandy loam, and loam (3)	silt loam and loam (3-4+)	8-12	somewhat poorly and poorly drained	6.0-7.0	high	med.	Chilgren Spooner
CSWD	<1	level to gently sloping stream terrace	clay (3)	clay (3-20+)	8-12	somewhat poorly to moderately well drained	6.6-7.3	med.	high	Wahpeton

Table 2 (continued). Selected features of soil landscape units within the Agassiz Lacustrine Plain, Red River Valley Area (1) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
SLWD	<1	level lake plain	very fine sandy loam (3)	very fine sand (3-4+)	4-8	moderately well to somewhat poorly drained	7.8-8.1	low	high	Glyndon
SSPD	<1	nearly level lake plain	loamy sand and sandy loam (1-2)	fine sand (2-4+)	<4	somewhat poorly and poorly drained	6.0-7.0	low	low	Poppleton
SSWD	<1	gently undulating lake plain	loamy fine sand (3)	fine sand (3-4+)	<4	somewhat poorly to moderately well drained	7.8-8.5	low	low	Ulen
M	<1	depressions in lake plain	peat (1-3)	peat or mineral (3-4+)	8+	marshy				

Sugarbeets are an important crop in unit CCPD of the Red River Valley Area (1). (Photo courtesy of USDA-Soil Conservation Service)



Agassiz Lacustrine Plain, Big Fork Valley Area (1B)

This region has approximately 280,000 acres or about 5 percent of the Roseau Sheet.

The Big Fork area is a nearly level region located along the Rainy River and Big Traverse Bay of Lake of the Woods. Numerous beach ridges are located in this region. They are narrow, therefore identified on the map by symbols. Bedrock (indicated by symbols on the map) outcrops in a few areas.

About 50 percent of the soils in the area are medium textured, 25 percent are sandy, 15 percent are organic, and the rest are clayey. Most of the soils are poorly drained. Surface drainage is slow to very slow. The water-holding capacity of most soils is moderate to high. Normally the water tables in the peat bogs and very poorly drained soils are from 0 to about 6 feet deep, and 6 to over 10 feet deep in other areas.

The original vegetation was mainly white pine. An estimated 45 to 55 percent remains forested, principally with aspen species, 20 to 30 percent is pasture and another 20 to 30 percent is cropland. Oats, alfalfa, brome, and red clover are the main crops.

Fifteen soil landscape units are mapped in this region: LLPL, CCPD, LP, LLWL, CCPL, NP, LSWL, LSPD, M, CCWL, SSWL, LLPD, SSPD, SP and BP. Table 3 gives selected features of the units. Additional information follows:

LLPL — Shallow peat occurs in 5 to 10 percent of the unit, and well-drained soils in another 5 to 10 percent. (Typic Ochraqualfs)

CCPD — Inclusions are as follows: 10 to 20 percent of soils with a shallow peat cover; about 5 to 10 percent with loamy till underlying the lacustrine clay. (Mollic Ochraqualfs)

LP — The following inclusions occur in this unit: deep peat, 5 to 15 percent; shallow peat over sand, 10 to 15 percent; poorly drained mineral soils, 5 to 10 percent. (Terric Borosaprists)

LLWL — Some gravel ridges occur in this unit. About 15 percent of the soils are poorly drained. (Aquic Eutroboralfs)

CCPL — Inclusions occurring in the unit are: 5 to 10 percent of well-drained soils and 5 to 10 percent of soils with shallow peat over clay. (Typic Ochraqualfs)

NP — The following inclusions occur in this unit: 10 to 15 percent of acid peat soils and 5 to 15 percent of soils with shallow peat over loamy material. (Typic Borosaprists)

LSWL — Poorly drained soils occur in 10 to 20 percent of the unit. Small areas of gravelly material over till occupy the area. (Aquic Udorthents)

LSPD — This unit includes 15 to 20 percent of soils formed in deep sands; 15 to 20 percent which consist of shallow peat over loamy material; and about 5 percent well-drained soils. (Mollic Haplaquents)

M — These marshes occur largely along Lake of the Woods. (unclassified)

CCWL — Loamy soils occupy about 25 percent of the unit. Another 10 to 15 percent are poorly drained. (Aquic Eutroboralfs)

SSWL — Approximately 15 percent of the soild are underlain by silty or loamy material. Another 15 to 20 percent are poorly drained soils or have shallow peat over sandy material. (Spodic Udipsamments)

LLPD — This unit includes about 5 percent shallow peat soils; about 5 percent of light-colored soils and about 5 percent of well-drained soils. (Mollic Haplaquents)

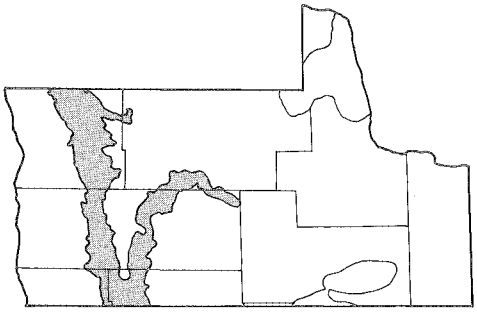
SSPD — This unit includes a few areas of gravelly ridges. (Mollic Psammaquents)

SP — The unit includes some deep peats and mineral soils (Histic Humaquepts)

BP — About 10 percent of the soils developed in acid peats are included. (Typic Sphagnofibrists)

Table 3. Selected features of soil landscape units within the Agassiz Lacustrine Plain, Big Fork Valley Area (1B) geographic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
LLPL	44	nearly level lake plain	silt loam (2-3)	silt loam and silty clay loam (3-4+)	8-12	somewhat poorly and poorly drained	6.4-7.0	high	med.	Spooner Baudette
CCPD	21	shallow depressions in lake plain	silty clay and clay (2-3)	clay (3-4+)	8-12	very poorly drained	6.3-6.9	low	high	Wildwood
LP	14	shallow depressions in lake plain	peat and muck (1-4)	loam and sandy loam (4-20+)	8+	very poorly drained	6.1-7.5	low	low	Haug Cathro Unnamed
LLWL	5	nearly level lake plain	very fine sandy loam, silt loam and silty clay loam (4)	silt loam (4+)	8-12	moderately well drained	6.4-7.0	med.	med.	Baudette Garnes
CCPL	5	nearly level lake plain	silty clay and clay (2-3)	clay (3-4+)	8-12	somewhat poorly to poorly drained	5.4-6.2	med.	high	Indus
NP	3	shallow depressions in lake plain	peat and muck (2)	peat (2-4+)	12+	very poorly drained	5.5-7.0	low	low	Seelyeville
LSWL	1	nearly level to undulating lake plain	loamy fine sand and fine sand (2-3)	clay loam and loam (3-20+)	4-8	moderately well to somewhat poorly drained	5.7-6.0	high	low	Enstrom
LSPD	2	level to depressional lake plain	loamy fine sand and fine sand (2-4)	clay loam and loam (4-20+)	4-8	poorly and very poorly drained	6.0-7.0	med.	low	Grygla
M	1	depressions in lake plain	peat (1-3)	peat or mineral (3-20+)	12+	marshy				
CCWL	1	nearly level to undulating lake plain	silty clay and clay (3)	clay (3-4+)	8-12	moderately well drained	6.9	low	med.	Taylor
SSWL	1	undulating lake plain	loamy fine sand and fine sand (1-3)	fine sand (3-4+)	<4	moderately well to somewhat poorly drained	5.2-6.5	high	low	Hiwood Redby
LLPD	1	level to depressional lake plain	very fine sandy loam, loam and loamy fine sand (2-3)	loam (3-4+)	4-12	poorly and somewhat poorly drained	6.0-7.0	med.	low	Unnamed Grygla
SSPD	1	level to depressional lake plain	loamy fine sand and fine sand (1-3)	fine sand (3-4+)	<4	somewhat poorly to poorly drained	5.6-6.5	med.	low	Cormant Unnamed Redby
SP	<1	level to depressional lake plain	peat and muck (1-4)	loamy sand and sand (4+)	8+	very poorly drained	7.4-7.8	low	low	Deerwood Unnamed
BP	<1	raised bogs on lake plain	peat (1-3)	peat (3-4+)	12+	very poorly drained	3.5-4.5	low	low	Washkish



Agassiz Lacustrine Plain, Inter-Beach Area (1C)

This region contains an area of approximately 670,000 acres or about 11 percent of the Roseau Sheet.

The Inter-Beach area consists of a linear network of beach ridges and low, poorly drained areas. Most of the beaches are discontinuous ridges, which are too narrow to delineate so are indicated on the map by symbols. Normally the water table occurs at depths of 10 feet or more on the beaches and from 0 to 6 feet deep in the poorly drained areas.

About half the soils are sandy, 10 percent are organic, and the rest are loamy. Beach ridges and other excessively drained sandy soils occupy 25 to 30 percent of the region. Many beaches are a good source of gravel. Surface drainage between beaches is slow to very slow, and the water-holding capacity is moderate to high. Soils on the ridges have a low water-holding capacity and are droughty. No lakes are located in this region.

Originally the region was mostly prairie. In a few locations, mainly in northern Kittson County, the original cover was jack and red pine and some brushland.

The percent of cropland varies considerably in the region but overall it is estimated to be 15 to 20 percent. Oats, timothy, and brome are the main crops. The remainder is largely brush and aspen with occasional areas of intermixed hardwoods, conifers, and grasslands. Some areas are pastured.

Thirteen soil landscape units are mapped in the region: LLPD, LSPD, SSWD, SSWL, SSPD, LP, LSWD, SLPD, SP, M, NP, LLWD, and A. Table 4 lists selected characteristics of the units. Additional information follows:

LLPD — The soils in this unit have developed in a thin layer of loamy sediments (1 to 3 feet thick) overlying calcareous glacial till. The soils are alkaline. Frequently a layer of gravel and sand, 4 to 12 inches thick, occurs between the loamy sediments and glacial till. Some gravelly beach ridges are included in the unit. Shallow peat soils occupy 5 to 10 percent of the area. (Typic Haplaquolls)

LSPD — In places the sandy sediments contain a high percent of gravel. Peat soils occupy 20 to 30 percent of the unit. Five to 10 percent has deep sands or gravelly soils, and another 5 percent has poorly drained light-colored sandy soils. (Typic Haplaquolls)

SSWD — The gravelly and coarse sandy soils occupy the beach ridges, and the fine sandy soils occur on glacio-lacustrine and delta plains. Poorly drained mineral soils and shallow peat make up 20 to 30 percent of the unit. (Udorthentic Haploborolls)

SSWL — The gravelly and coarse sandy soils in this unit also occupy beach ridges. Some of the soils are moderately dark colored. Poorly drained mineral soils and shallow peat occupy elongated depressions or swales which make up 20 to 30 percent of the unit. (Psammentic Eutroboralfs)

SSPD — The following inclusions occur in this unit: loamy surfaces, 5 to 15 percent; loamy substrata, 10 to 15 percent; narrow elongated areas of peat, less than 5 percent; and a few gravelly and sandy ridges, less than 5 percent. (Mollic Psammaquents)

LP — Beach ridges occupy about 20 percent of the area. (Terric Borosaprists)

LSWD — The lower portions of the sandy horizons frequently contain some gravelly material. During extended wet periods a perched water table may develop. Inclusions are as follows: poorly drained soils, 20 to 30 percent; deep sandy soils, about 5 percent; clayey substratum, 5 to 10 percent. (Aquic Haploborolls)

SLPD — Beach ridges make up 10 to 15 percent of the unit, and shallow peat soils occur in some swales between beach ridges. (Typic Calciaquolls)

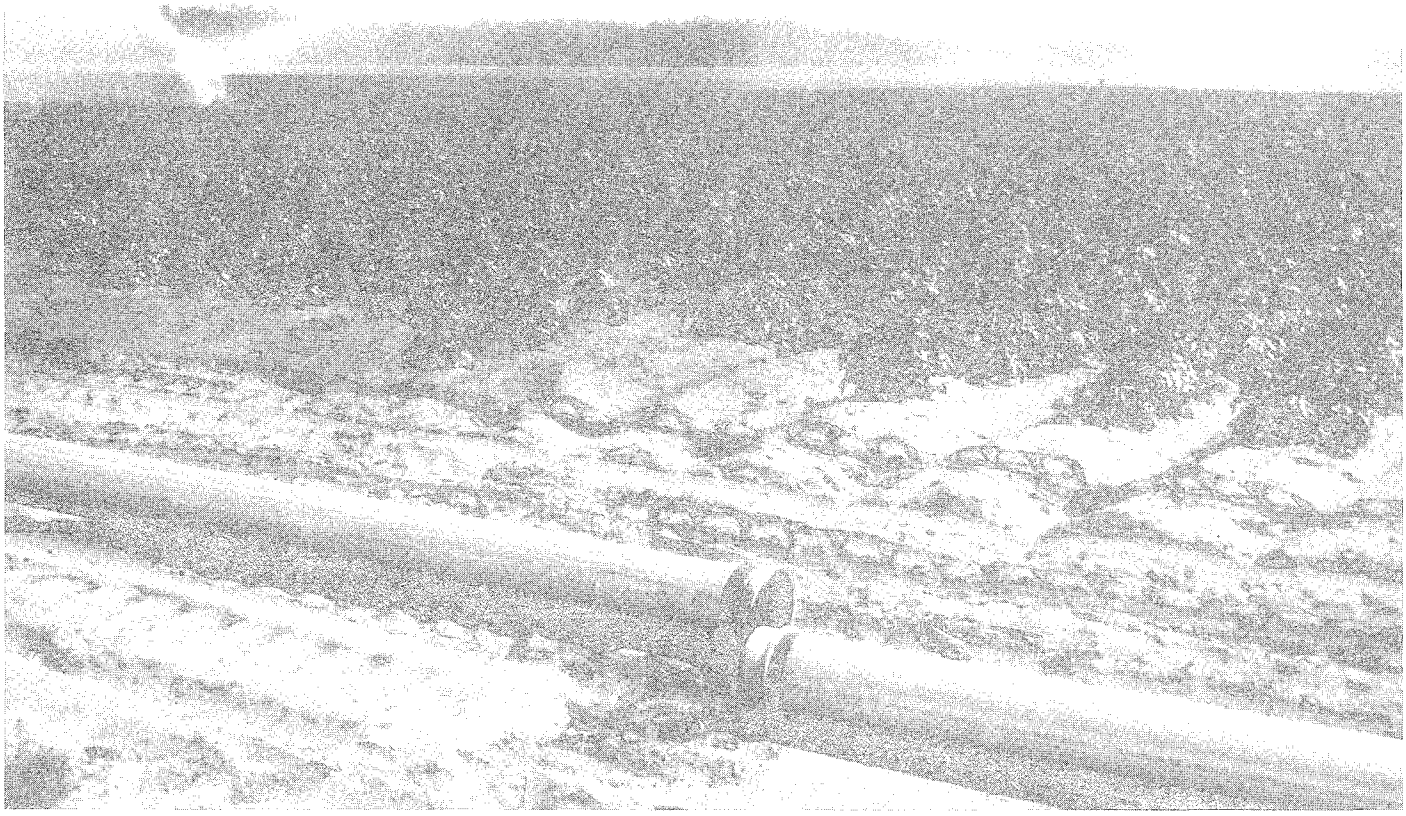
SP — Beach ridges occupy about 20 percent of the unit. (Histic Humaquepts)

M — Mainly peatlands between beach ridges. (unclassified)

NP — Inclusions are as follows: shallow peat soils about 15 percent; loamy and sandy mineral soils about 5 percent. (Typic Borosaprists)

LLWD — Some poorly drained soils occur in this unit. (Aquic Haplobzorolls)

A — These stream bottoms are subjected to frequent flooding. (unclassified)



Irrigation helps to increase yields of potatoes grown on sandy soils of the Inter-Beach Area (1C). (Photo courtesy of USDA-Soil Conservation Service)

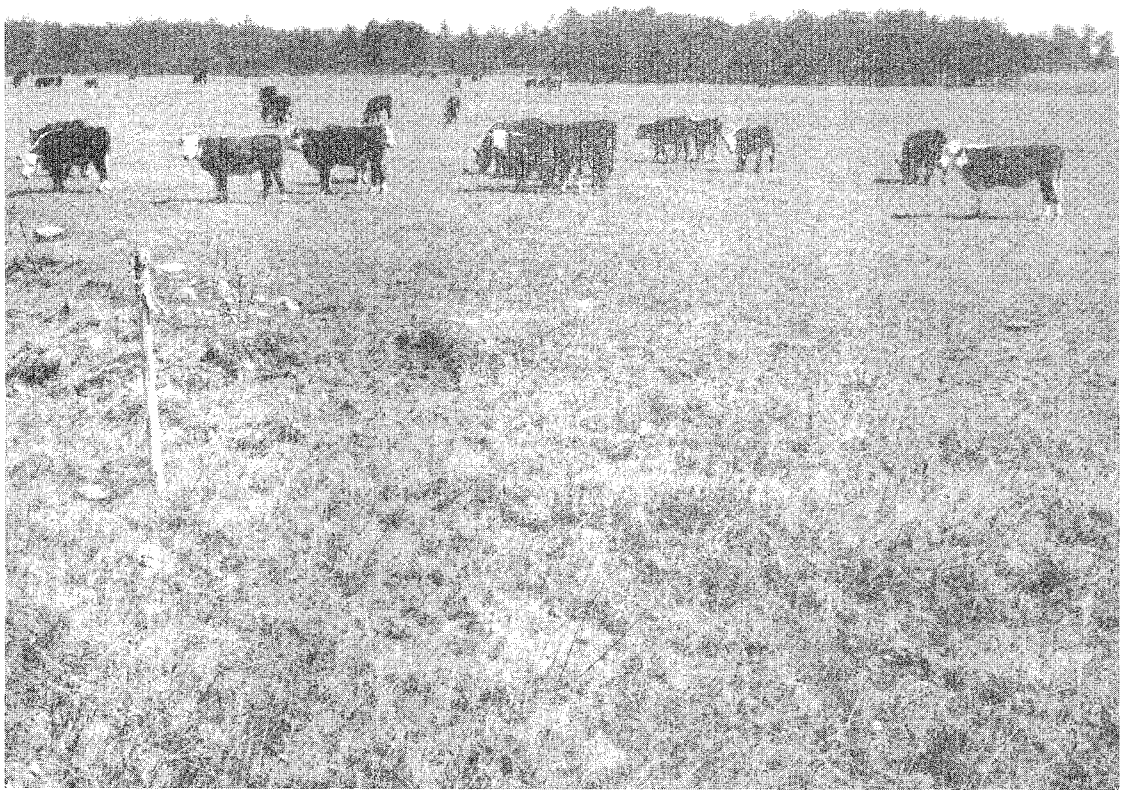
Table 4. Selected features of soil landscape units within the Agassiz Lacustrine Plain, Inter-Beach Area (1C) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
LLPD	15	depressional lake plain	loam and clay loam (2-3)	loam and clay loam (3-20+)	8-12	poorly and very poorly drained	7.0-8.0	low	med.	Rolfs Mavie Percy
LSPD	13	depressional lake plain	loamy sand and sand (2-3)	loam and clay loam (3-20+)	4-8	poorly and very poorly drained	6.5-7.5	low	low	Kratka Grygla
SSWD	12	elongated beach ridges and nearly level lake plain	loam, gravelly loamy sand and loamy fine sand (1-2)	gravelly sand coarse sand and sand (2-4+)	<4	excessively drained	7.0-8.0	low	low	Sioux Maddock Lohnes
SSWL	12	elongated beach ridges and nearly level lake plain	loamy sand and gravelly sandy loam (1-2)	very gravelly sand and sand (2-4+)	<4	somewhat excessively drained	6.0-7.0	med.	low	Marquette Menagha
SSPD	11	gentle rises and swales in beach area	loamy fine sand and fine sand (3)	fine sand and sand (3-4+)	<4	somewhat poorly to very poorly drained	6.0-7.0	high	med.	Cormant Poppleton
LP	11	shallow depressions between beach ridges	muck and peat (1-4)	loam and sandy loam (4-20+)	8+	very poorly drained	6.1-7.5	low	low	Cathro Haug

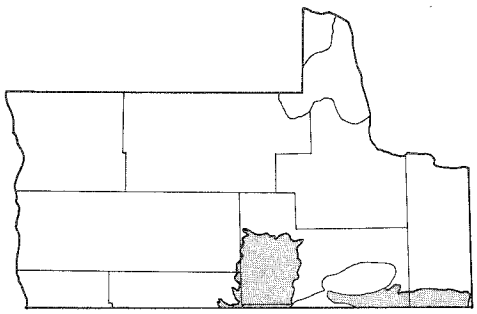
Table 4 (continued). Selected features of soil landscape units within the Agassiz Lacustrine Plain, Inter-Beach Area (1C) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
LSWD	10	convex slopes on lake plain	sandy loam loamy sand and sand (2-3)	loam and clay loam (3-20+)	4-8	moderately well drained	6.6-7.3	med.	med.	Foldahl Grimstad
SLPD	8	low swales between beach ridges	very fine sandy loam and sandy clay loam (2-3)	loamy very fine sand and fine sand	4-8	poorly and very poorly drained	7.4-8.2	low	low	Borup Arveson
SP	4	shallow depressions in lake plain	muck and peat (1-4)	loamy fine sand gravelly sand and sand (4+)	4-12	very poorly drained	7.4-7.8	low	low	Deerwood Unnamed
M	<1	depressions in lake plain	peat (1-3)	peat or mineral (3-4+)	1 to 4 feet of water on surface	marshy				
NP	<1	shallow depressions in lake plain	peat and muck (2)	peat (2-4+)	12+	very poorly drained	5.6-7.3	low	low	Seelyeville
LLWD	<1	nearly level lake plain	loam (4)	loam (4-20+)	8-12	moderately well drained	6.6-7.3	med.	high	Roliss Nereson
A	<1	nearly level stream bottoms	variable loam to loamy sand (2-3)	variable loam to loamy sand (3-4+)	4-12	poorly drained	6.6-7.3	med.	high	Alluvial lands, undifferentiated

Pasturing beef cattle is common on soils of the Inter-Beach Area (1C) that are not suitable for cropland. (Photo courtesy of USDA-Soil Conservation Service)



Agassiz Lacustrine Plain, Red Lake Area (1D)



The region encompasses approximately 420,000 acres or about 7 percent of the Roseau Sheet.

The region is a low, nearly level to slightly depressional lake plain, much of it originally covered by shallow and deep peat. Large areas of shallow peat have since been burned exposing the mineral soils. About 40 percent of the land surface currently has a peat cover. The water tables are normally from 0 to 6 feet deep on the organic and very poorly drained mineral soils, and 6 to 10 feet deep on most of the remaining soils. The region borders on Upper and Lower Red Lakes.

The mineral soils are commonly poorly drained sands underlain by glacial till 2 to 4 feet below the surface. Surface runoff is slow to very slow. The water-holding capacity on the sandy soils is low and on the medium-textured soils, moderate to high.

The original vegetation was wet meadow except for an area of northern hardwoods south of Upper Red Lake. Most of the region consists of wet meadow, brush, and aspen. Some of it is pastured. Less than 10 percent is cropped to oats and timothy.

Sixteen soil landscape units are mapped in the region: LP, LSPD, LLPD, NP, SSWL, LSPL, AP, SSPL, M, LLPL, SSPD, LSWL, LLWL, SP, BP, and A. Table 5 lists selected characteristics of the units. Additional information follows:

LP — The unit includes about 10 percent poorly drained loamy mineral soils, and an estimated 10 percent with 4 feet or more of peat. The mineral material underlying the peat includes some clayey sediments. (Terric Borosaprists)

LSPD — An estimated 20 percent of the unit consists of deep sandy soils. Shallow peat occurs in 15 to 25 percent of the unit. (Mollic Haplaquents)

LLPD — Some areas of light-colored soils are included in western Beltrami County. In cultivated areas the unit includes about 10 percent shallow peat. In the Beltrami Island State Forest and the Red Lake Reservation the unit includes 20 to 30 percent of soils developed in shallow peat. (Typic Haplaquolls)

NP — There is a wide variation of the amount of woody material in the upper 24 inches. Some areas of peat less than four feet thick are included. (Typic Borosaprists)

SSWL — Approximately 20 percent of the unit is occupied by poorly drained mineral soils and shallow peat. The unit includes some gravelly soils. (Spodic Udipsamments)

LSPL — The unit includes about 20 percent shallow peat, and another 5 to 15 percent well-drained soils. (Typic Haplaquents)

AP — Approximately 10 percent of the unit consists of shallow peat. It also includes some areas of peat with a pH of more than 5.5. Inclusions of small areas of mineral soils occur. (Typic Borohemists)

SSPL — The unit includes about 15 percent shallow peat and about 10 percent well-drained soils. Approximately 15 percent of the unit is underlain by loamy materials at less than 40 inches below the surface. (Aquic Udipsamments)

M — This unit consists mainly of peat lands that have been flooded by artificial means. (unclassified)

LLPL — Five to 15 percent of the unit is shallow peat, another 5 to 15 percent consists of well-drained soils. (Typic Ochraqualfs)

SSPD — Approximately 10 percent of the unit consists of well-drained soils. Another 10 to 15 percent is shallow peat. Inclusions of sand over till also occur in the unit. (Mollic Psammaquents)

LSWL — Inclusions of 10 to 20 percent poorly drained soils occur in this unit. Some gravelly soils over loamy materials also occur. (Aquic Udorthents)

LLWL — The unit includes 20 to 0 percent poorly drained soils and small areas of gravelly soils. (Aquic Eutroboralfs)

SP — In places the substratum contains inclusions of a loamy material. About 10 percent of the unit has mineral soils. (Histic Humaquepts)

BP — Areas of peat less than 4 feet thick are included. (Typic Borosaprists)

A — The flood plain occurs along the Red Lake River and is subject to frequent flooding. (unclassified)

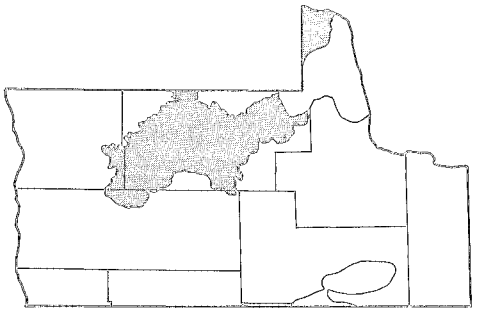
Grass and sedge vegetation are typical of peatlands in the Red Lake Area (1D).

Table 5. Selected features of soil landscape units within the Agassiz Lacustrine Plain, Red Lake Area (1D) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
LP	21	shallow depressions in lake plain	peat and muck (1-4)	loam and sandy loam (4-20+)	8+	very poorly drained	6.1-6.5	low	low	Cathro Unnamed
LSPD	19	level to depressional lake plain	loamy fine sand and fine sand (2-4)	loam, clay loam and sandy loam (4-20+)	4-8	poorly and very poorly drained	6.6-7.3	low	low	Grygla Kratka
LLPD	18	nearly level to shallow depressional lake plain	loam and clay loam (2-3)	loam and clay loam (3-20+)	8-12	poorly drained	6.6-7.3	med.	high	Roliss
NP	17	shallow depressions in lake plain	peat and muck (2)	peat (2-4+)	12+	very poorly drained	5.5-7.0	low	low	Seelyeville
SSWL	6	undulating lake plain	loamy fine sand and fine sand (1-3)	fine sand (3-4+)	<4	moderately well to somewhat poorly drained	6.1-6.5	med.	low	Hiwood Redby
LSPL	5	level to depressional lake plain	fine sandy loam and loamy fine sand (1-3)	sandy clay loam (3-20+)	4-8	poorly to very poorly drained	6.6-7.3	low	low	Unnamed Grygla
AP	4	shallow depressions in lake plain	peat (1-3)	peat (3-4+)	12+	very poorly drained	<5.5	low	low	Mooselake

Table 5 (continued). Selected features of soil landscape units within the Agassiz Lacustrine Plain, Red Lake Area (1D) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
SSPL	3	level to depressional lake plain	loamy fine sand and fine sand (1-3)	fine sand (3-20+)	4-8	poorly to somewhat poorly drained	6.6-7.3	low	low	Redby Poppleton
M	2	depressional lake plain	peat or mineral	peat or mineral	1 to 4 feet of water on surface					
LLPL	1	level to slightly depressional lake plain	silt loam, loam and silty clay loam (1-3)	silt loam, clay loam and loam (3-20+)	8-12	poorly to somewhat poorly drained	6.1-7.3	med.	high	Chilgren Spooner
SSPD	1	level to depressional lake plain	loamy fine sand and fine sand (1-3)	fine sand (3-4+)	<4	poorly drained	6.1-7.3	low	low	Cormant
LSWL	1	nearly level to undulating lake plain	loamy fine sand and fine sand (2-3)	clay loam and loam (3-20+)	4-8	moderately well to somewhat poorly drained	6.1-7.3	low	low	Enstrom
LLWL	1	nearly level lake plain	loam, silt loam and sandy clay loam (2-3)	loam, fine sandy loam and silt loam (3-4+)	8-12	moderately well drained	6.1-7.3	med.	med.	Garnes Baudette
SP	<1	level to depressional lake plain	peat and muck (1-4)	loamy sand and sand (4+)	8+	very poorly drained	7.4-8.2	low	low	Deerwood Unnamed
BP	<1	raised bogs on lake plain	peat (1-3)	peat (3-4+)	12+	very poorly drained	3.5-4.5	low	low	Washkish
A	<1	nearly level stream bottoms	variable loam to loamy sand (2-3)	variable loam to loamy sand (3-4+)	4-12	poorly drained	6.1-7.5	med.	med.	Alluvial lands, undifferentiated



Agassiz Lacustrine Plain, Beltrami Island Area (1E)

The region encompasses approximately 1,200,000 acres or about 19 percent of the Roseau Sheet. About 300,000 acres of the Lake of the Woods are included.

The region consists of a nearly level to slightly depressional lake plain. A long beach ridge (Campbell beach) in Roseau County extends into the region from the Inter-Beach area near the town of Pelan. From there it extends through Greenbush, Badger, and Fox. These towns, the railroad, highway, and many farmsteads are located on the ridge to take advantage of well-drained soils. Several other beaches occur in this region. Most of them are discontinuous and too narrow to delineate as a soil landscape unit. They are identified on the map by symbols.

Roseau Lake, a dry lake, located 4 to 5 miles northwest of Roseau is another conspicuous feature of the landscape. On an earlier Roseau County soil survey, the lake bed was mapped shallow peat and alluvial soils. It existed as a lake long enough to form a beach along the west side.

Normally the water tables are more than 6 feet deep on mineral soils and from 0 to 6 feet deep on the peat soils. The surface drainage generally is slow to very slow. The water-holding capacity is moderate to high in the medium-textured soils and low in the sandy soils.

Most of the soils are loamy and poorly drained. The region includes some shallow sands over loamy till, and some areas of clayey soils. The underlying loamy till in most of this region has a high content of carbonate, often more than 30 percent. Soils on the beaches are sandy and gravelly, and droughty. Approximately 15 percent of the land area is organic soil. Originally the acreage of peat in the region was considerably higher. The practice of burning has reduced the area of organic soil considerably.

The original vegetation was brush prairie, conifers (jack pine and upland spruce and fir), oak openings, and prairie. An estimated 15 to 20 percent of the region is cropped to oats and timothy. The remainder is mainly aspen, brush, and some hardwoods with prairie openings. Some of it is pastured.

Twenty soil landscape units are mapped in this region: LLPD, LP, LLWD, LSPD, CCPD, NP, SSWL, SSWD, LSWL, LSWD, LLPL, CLWL, M, SSPD, BP, LLWL, A, SP, CCWL, SLPD. Table 6 lists selected features of each unit. Additional information follows:

LLPD — Moderately well-drained soils occupy 5 to 10 percent of the unit. Another 10 percent has sandy material over the loamy sediments. In eastern Roseau County 5 percent of the soils have a clayey substratum. Small areas of sandy and gravelly soils and shallow peat have been included in the unit. (Typic Haplaquolls)

LP — The peat overlies sandy material in 10 to 15 percent of the unit. Another 5 percent has mineral soils, generally sandy over loamy. (Terric Borosaprists)

LLWD — These soils are alkaline throughout. Poorly drained soils occupy about 30 percent of this unit. In the vicinity of Roseau, soils of this unit developed in 6 to 20 feet or more of calcareous silty sediments. These sediments frequently have thin layers or varves of fine sandy loam, very fine sand, and silty clay or clay. The soils are alkaline throughout. The topography is level and smooth. Poorly drained soils occupy about 15 percent of the area. Another 5 percent has a clayey substratum at 3 to 4 feet. (Aquic Haploborolls)

LSPD — In eastern Roseau County the soils in this unit were originally covered by 1 to 2 feet of peat. Most of the peat has been removed by fire or mechanical means. Small scattered areas of peat remain. Drainage is poorer in these areas. Elsewhere dark-colored, well-drained soils occupy 15 to 20 percent of the unit. (Typic Haplaquolls)

CCPD — Shallow peat occurs in about 10 percent of the unit. (Mollic Ochraqualfs)

NP — The average depth of the peat is estimated to be 5 to 6 feet. Peat less than 4 feet thick occupies an estimated 15 percent of the unit. Another 5 percent is occupied by small tracts of mineral soils. (Typic Borosaprists)

SSWL — Poorly drained sandy soils and peat occur in approximately 20 percent of the unit. (Spodic Udipsamments)

SSWD — The beach ridges are elongated and vary in width from 300 feet to one half mile. The unit includes sandy soils that occur on the lake-modified till plain. Poorly drained soils occupy about 30 percent of the unit. Small areas of shallow peat are also included. (Udorthentic Haploborolls)

LSWL — Approximately 15 percent of the soils have sandy or loamy textures underlain by clayey sediments. Another 10 to 15 percent is dark-colored poorly drained soils. (Aquic Udorthents)

LSWD — Approximately 15 percent of the soils are underlain by clayey material. Poorly drained soils occur in another 10 to 15 percent of the unit. (Aquic Haploborolls)

LLPL — Five to 15 percent of the unit is shallow peat, another 5 to 15 percent consists of well-drained soils. (Typic Ochraqualfs)

CLWL — Approximately 25 percent of the unit consists of deep loamy soils. The underlying sediments in some areas are silts. Another 10 to 15 percent is poorly drained soils. (Aquic Eutroboralfs)

M — Mainly peatlands bordering lakes. (unclassified)

SSPD — Approximately 10 percent of the unit consists of the well-drained soils. Shallow peat occurs in 10 to 15 percent of the unit. Inclusions of sand underlain by till also occur. (Mollic Psammaquents)

BP — This unit consists of sphagnum peat. (Typic Sphagnofibrists)

LLWL — The unit includes some silty soils. Approximately 10 percent of the unit consists of poorly drained soils. Some gravelly ridges are also included. (Aquic Eutroboralfs)

A — This unit occurs along the Roseau River. (unclassified)

SP — Peat overlying loamy materials occupies 5 to 10 percent of the unit and often occurs as islands in mineral soils. Small areas of peat over 4 feet deep also are included. (Histic Humaquepts)

CCWL — The unit includes some areas underlain by silty or loamy sediments. Loamy soils occur in 10 to 20 percent of the unit. Another 10 to 15 percent are poorly drained soils. (Aquic Eutroboralfs)

SLPD — Moderately well-drained soils are included in about 10 percent of the unit. Sandy soils occupy an additional 5 percent of the unit and another 5 to 10 percent are shallow peat soils. (Typic Calciaquolls)

Boulders cover the surface where fine particles have been removed by waves and currents of glacial Lake Agassiz. This pasture is located in the Beltrami Island Area (1E) near the town of Caribou. (Photo courtesy of USDA-Soil Conservation Service)

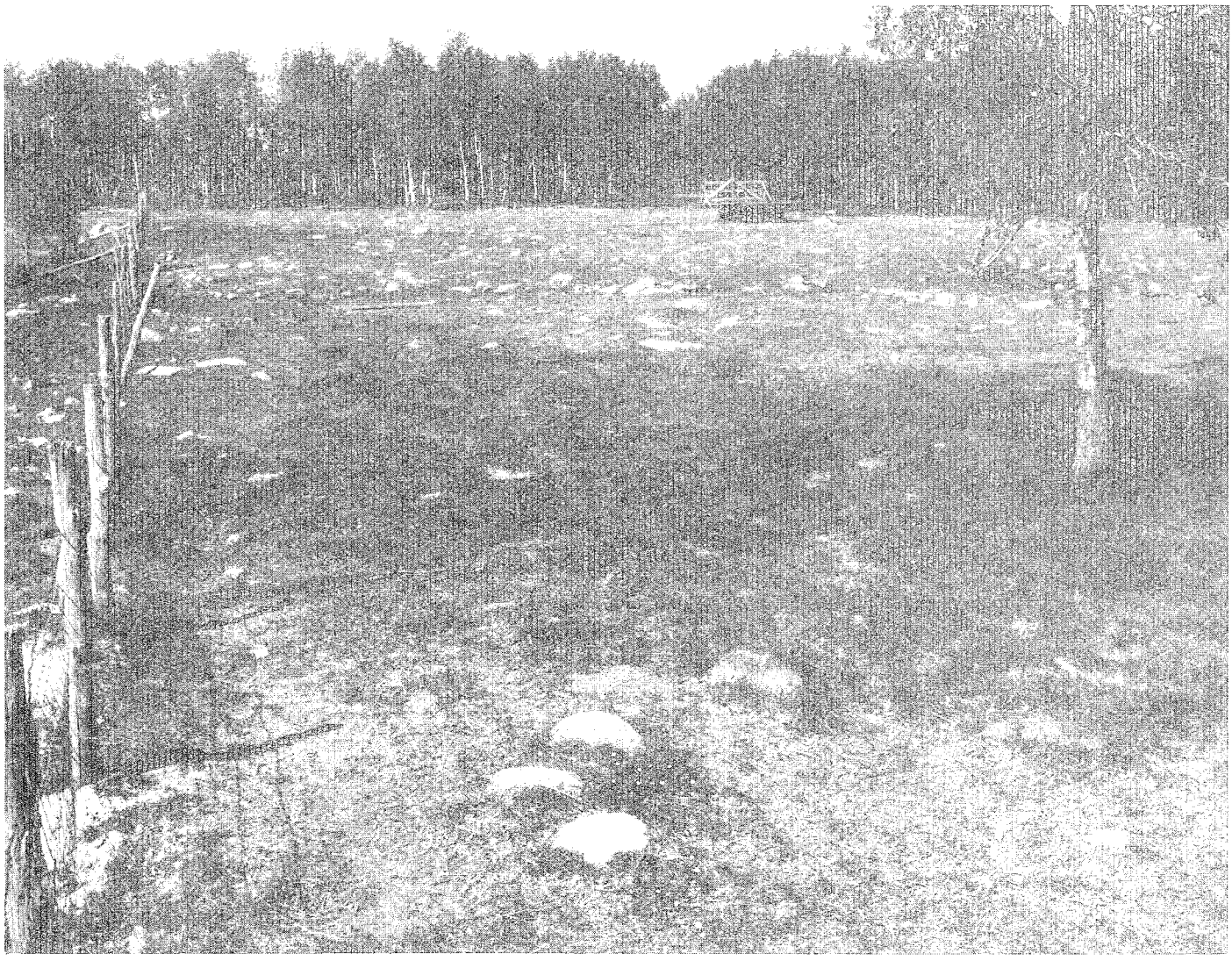
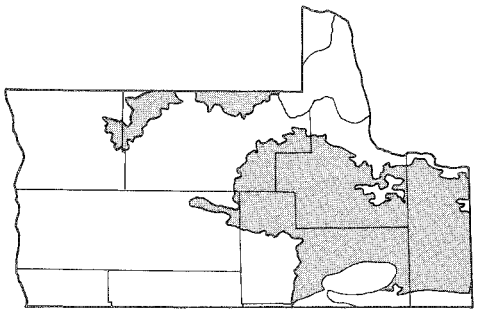


Table 6. Selected features of soil landscape units within the Agassiz Lacustrine Plain, Beltrami Island Area (1E) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
LLPD	70	level to gently undulating lake plain	loam and sandy clay loam (2-3)	loam and clay loam (3-20+)	8-12	poorly drained	7.0-8.0	low	med.	Roliss Percy
LP	5	shallow depressional lake plain	peat and muck (1-4)	loam and sandy loam (4-20+)	8+	very poorly drained	6.1-7.5	low	low	Cathro Haug
LLWD	4	nearly level to gently undulating lake plain	sandy loam, loamy sand and sand (2-3)	loam and fine sandy loam (3-20+)	8-12	moderately well to somewhat poorly drained	7.0-8.2	low	high	Kittson Nereson Grimstad
LSPD	4	nearly level lake plain	sandy clay loam, fine sandy loam and fine sand (2-3)	loam and sandy loam (3-20+)	8-12	poorly drained	7.4-7.8	low	med.	Kratka Rockwell Grygla
CCPD	4	shallow depressions in lake plain	peat and clay (2-3)	clay (3-4+)	8-12	very poorly and poorly drained	6.3-6.9	med.	high	Wildwood Indus
NP	3	level to depressional lake plain	peat and muck (2)	peat (2-5+)	12+	very poorly drained	5.5-7.0	low	low	Seelyeville Markey
SSWL	3	level to undulating lake plain	loamy fine sand and fine sand (1-3)	fine sand (3-4+)	<4	moderately well to somewhat poorly drained	6.1-6.5	low	low	Hiwood Menagha Redby
SSWD	2	beach ridges and sandy lake plain	loam, gravelly loam and loamy sand (1)	gravelly sand and fine sand (1-4+)	<4	excessive to somewhat poorly drained	5.6-6.0	low	low	Sioux Poppleton
LSWL	2	nearly level to gently undulating lake plain	loamy fine sand and fine sand (2-3)	loam and clay loam (3-20+)	4-8	somewhat poorly to moderately well drained	6.1-7.3	low	low	Enstrom Kratka Grygla
LSWD	1	nearly level lake plain	sandy loam, loamy sand, and sand (2-3)	loam and clay loam (3-20+)	4-8	moderately well drained	6.1-7.3	med.	med.	Foldahl Enstrom
LLPL	1	level to slightly depressional lake plain	loam, silt loam and silty clay loam (1-3)	silt loam, loam and clay loam (3-20+)	8-12	poorly to somewhat poorly drained	6.1-7.3	med.	high	Chilgren Spooner
CLWL	<1	nearly level to gently undulating	loam and silty clay (1-2)	clay (2-4+)	8-12	moderately well drained	5.6-6.0	med.	high	Unnamed
M	<1	depressional lake plain	peat or mineral	peat or mineral	1 to 4 feet of water on surface	marshy				
SSPD	<1	level to depressional lake plain	loamy fine sand and fine sand (3)	fine sand (3-4+)	<4	poorly drained	5.6-6.5	med.	low	Cormant
BP	<1	raised bogs in lake plain	peat (1-3)	peat (3-4+)	12+	very poorly drained	3.5-4.5	low	low	Washkish
LLWL	<1	nearly level lake plain	loam and sandy clay loam (2-3)	loam and fine sandy loam (3-20+)	8-12	moderately well drained	6.1-7.3	med.	med.	Garnes

Table 6 (continued). Selected features of soil landscape units within the Agassiz Lacustrine Plain, Beltrami Island Area (1E) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
A	<1	nearly level stream bottom	variable loam to loamy sand (2-3)	variable loam to loamy sand (3-4+)	4-12	poorly drained	6.1-7.5	med.	med.	Alluvial lands, undifferentiated
SP	<1	level to depressional lake plain	peat and muck (1-4)	loamy sand and sand (4+)	8+	very poorly drained	7.4-8.2	low	low	Deerwood
CCWL	<1	nearly level to gently undulating lake plain	silty clay and loam (1-2)	clay (2-4+)	8-12	moderately well drained	5.6-6.0	med.	high	Taylor
SLPD	<1	level to depressional lake plain	very fine sandy loam, loam, and sandy clay loam (2-3)	loamy very fine sand and fine sand (3-4+)	4-8	poorly drained	7.4-8.2	low	low	Borup



Agassiz Peatlands (1F)

This region has approximately 2,060,000 acres or about 33 percent of the Roseau Sheet.

The peatlands are a low, very poorly drained lake plain. About 75 percent consists of organic soils generally from 7 to 8 feet deep. The mineral soils are dominantly sandy and poorly drained, occurring mainly in the northern part of the region. Two lakes totaling about 10,000 acres are located in the region which is partially bounded on the south by the Red Lakes. Normally the water tables are from 0 to 3 feet deep on the organic soils and 6 to 10 feet deep on the mineral soils.

Most of the sandy soils are 2 to 4 feet thick over loamy glacial till. Small areas of loamy and clayey soils are delineated. The organic soils are mostly non-acid (pH 5.5 or more). The water-holding capacity is very high on the peat soils and low on the sandy soils.

The original vegetation was swamp conifers, and the present is much the same. Less than 10 percent is cropland. Principal crops are oats, timothy, and alfalfa mixtures.

Eighteen soil landscape units are mapped in this region: NP, AP, LP, SSWL, SP, LSPD, BP, SSPD, SSPL, LLPL, CCPL, A, LLPD, LSWL, M, LSPL, SSWD, and CCPD. Table 7 lists selected features of each unit. Additional information follows:

NP — Peat is less than 4 feet thick on an estimated 15 percent of the unit. Another 5 to 10 percent of the unit consists of mineral soils. (Typic Borosaprists)

AP — Inclusions of shallow peat occur in about 5 percent of the unit. Approximately 15 percent of the peat in the unit has a pH of more than 5.5. (Typic Borohemists)

LP — The underlying material in some areas is clayey. Approximately 15 percent of the unit is mineral soils. (Terric Borosaprists)

SSWL — About 20 percent of the soils in this unit are poorly drained. Some shallow peat and gravelly soils are included. (Spodic Udipsamments)

SP — Peat overlying loamy materials occupies 5 to 10 percent of the unit and another 5 percent occur as mineral soils. (Histic Humaquepts)

LSPD — An estimated 15 percent of the unit is occupied by deep sandy soils. Another 10 to 20 percent of the unit consists of soils developed in shallow peat. (Mollic Haplaquents)

BP — About 10 percent of the unit consists of acid non-sphagnum peat. (Typic Sphagnofibrists)

SSPD — Light-colored soils occur in about 10 percent of the unit. Another 10 to 15 percent of the soils consist of shallow peat over sandy material. Some inclusions of poorly drained sands over loam till are included. (Mollic Psammaquents)

SSPL — About 15 percent of the unit is underlain by loamy material at 2 to 4 feet. Soils in shallow peat over sandy material occur in 10 to 15 percent of the unit. (Typic Psammaquents)

LLPL — Shallow peat occupies 5 to 15 percent of the unit. Well-drained soils occur in another 5 to 10 percent of the unit. (Typic Ochraqualfs)

CCPL — Well-drained soils occur in about 10 percent of the unit. Another 10 to 15 percent of the soils are very poorly drained and dark colored. (Typic Ochraqualfs)

A — The alluvial soils are subject to frequent flooding. (unclassified)

LLPD — Shallow peat occupies about 15 percent of the unit. Another 5 to 10 percent of the soils are well drained. (Typic Haplaquolls)

LSWL — Ten to 20 percent of the unit consists of poorly drained soils. Some areas have considerable amounts of gravel over the loamy till. (Aquic Udorthents)

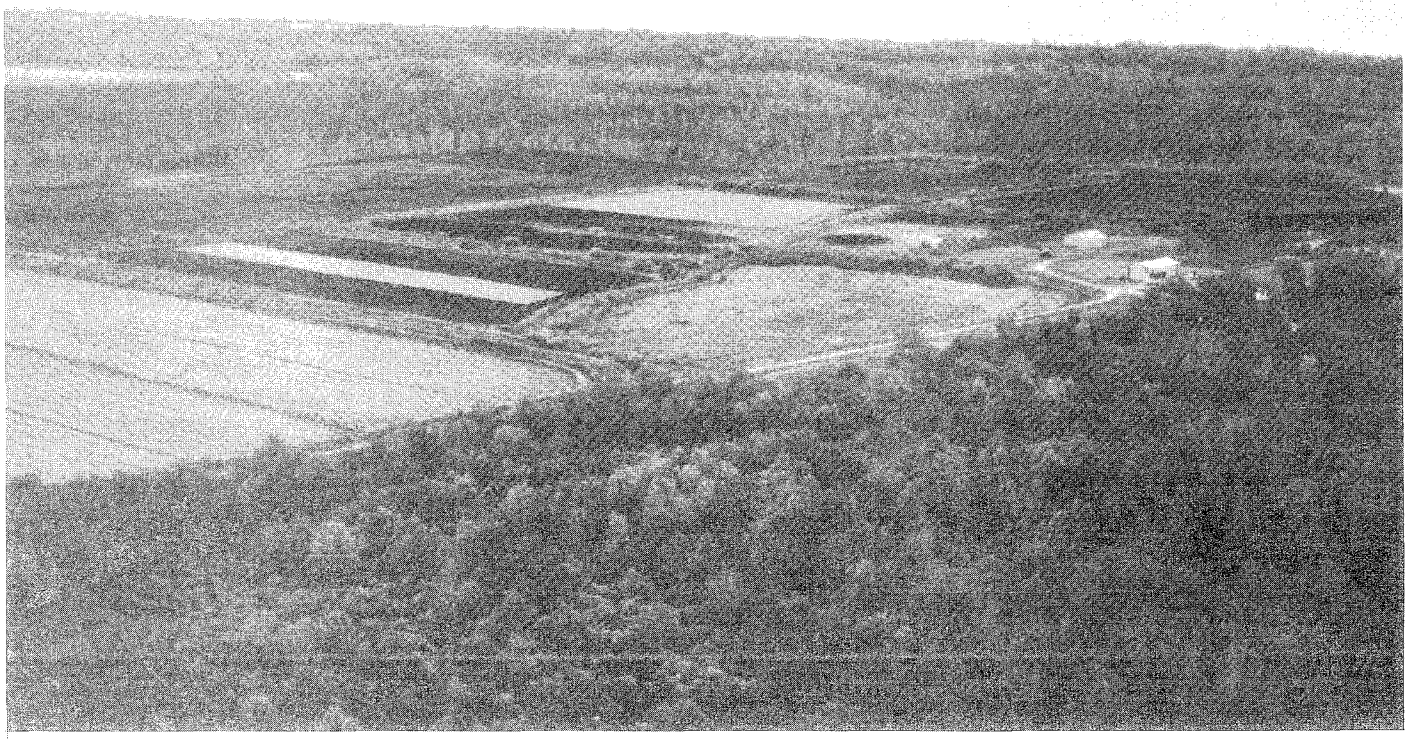
M — These marshy soils are mostly peatlands and occur largely along lake shores. (unclassified)

LSPL — Shallow peat occupies about 20 percent of the unit, and well-drained soils occur in another 5 to 10 percent. (Typic Haplaquents)

SSWD — Poorly drained mineral soils occupy 25 to 30 percent of the unit, and shallow peat occurs in about 5 percent. (Udorthentic Haploborolls)

CCPD — Approximately 10 percent of the unit consists of soils developed in shallow peat. (Mollic Ochraqualfs)

A long auger is used to sample deep organic soils in a black spruce bog of the Agassiz Peatlands (1F).



Commercial wild rice production near Upper Red Lake in the Agassiz Peatlands (1F).

Table 7. Selected features of soil landscape units within the Agassiz Peatlands (1F) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
WP	26	shallow depressions in lake plain	peat and muck (2)	peat (2-4+)	12+	very poorly drained	5.5-7.0	low	low	Seelyeville Markey
AP	23	shallow depressions in lake plain	peat (1-3)	peat (3-4+)	12+	very poorly drained	<5.5	low	low	Mooselake
LP	10	shallow depressions in lake plain	peat and muck (1-4)	loam and sandy loam (4-20+)	8+	very poorly drained	6.1-7.5	low	low	Cathro Haug Unnamed
SSWL	9	level to undulating lake plain	loamy fine sand and fine sand (1-3)	fine sand (3-4+)	<4	moderately well to somewhat poorly drained	6.1-6.5	med.	low	Hiwood Redby
SP	8	level to depressional lake plain	peat and muck (1-4)	loamy sand and sand (4+)	8+	very poorly drained	7.4-8.2	low	low	Deerwood Unnamed
LSPD	8	level to shallow depressions in lake plain	loamy fine sand and sand (2-4)	loam and clay loam (4-20+)	4-8	poorly drained	7.4-7.8	low	med.	Grygla Kratka

Table 7 (continued). Selected features of soil landscape units within the Agassiz Peatlands (1F) geomorphic region

Soil landscape unit	Percent geomorphic region	Landscape position	Most common texture and thickness (feet)		Moisture relationships		Approximate fertility in rooting zone			Representative soil series
			Rooting zone	Substratum	Inches of available water to 5 feet	Drainage class	pH	P	K	
BP	6	raised bogs in lake plain	peat (1-3)	peat (3-4+)	12+	very poorly drained	3.5-4.5	low	low	Washkish
SSPD	4	level to depressional lake plain	loamy fine sand and fine sand (1-3)	fine sand (3-4+)	<4	poorly drained	5.6-6.5	med.	low	Cormant
SSPL	2	nearly level lake plain	loamy fine sand and fine sand (3)	fine sand (3-4+)	<4	somewhat poorly to poorly drained	5.6-6.5	med.	low	Redby Cormant Unnamed
LLPL	2	level to slightly depressional lake plain	silt loam, loam and silty clay loam (1-3)	silt loam, clay loam and loam (3-20+)	8-12	poorly to somewhat poorly drained	6.1-7.3	med.	high	Spooner Chilgren
CCPL	1	nearly level lake plain	silty clay and clay (2-3)	clay (3-4+)	8-12	somewhat poorly to poorly drained	6.0-7.5	med.	high	Indus
A	1	nearly level stream bottoms	variable loam to loamy sand (2-3)	variable loam to loamy sand (3-4+)	4-12	poorly drained	6.1-7.5	med.	med.	Alluvial lands, Undifferentiated
LLPD	<1	level to gently undulating lake plain	loam and sandy clay loam (2-3)	loam and clay loam (3-20+)	8-12	poorly drained	7.0-8.0	low	med.	Roliss Grimstad
LSWL	<1	nearly level to gently undulating lake plain	loamy fine sand and fine sand (2-3)	loam and clay loam (3-20+)	4-8	somewhat poorly to moderately well drained	5.7-6.0	high	low	Enstrom Grygla
M	<1	depressional lake plain	peat or mineral	peat or mineral	1 to 4 feet of water on surface	marshy				
LSPL	<1	nearly level lake plain	loamy sand and sand (1-2)	silty clay loam and loam (2-20+)	4-8	poorly to somewhat poorly drained	6.6-7.3	low	low	Unnamed Grygla
SSWD	<1	elongated beach ridges and glacio-lacustrine plain	sandy loam, gravelly loamy sand, and loamy fine sand (1-2)	sand and gravel (2-4+)	<4	excessively drained	5.6-6.5	low	low	Sioux Maddock
CCPD	<1	shallow depressions in lake plain	silty clay and clay (2-3)	clay (3-4+)	8-12	very poorly to poorly drained	6.3-6.9	med.	high	Wildwood Indus

Development of Landforms[1]

All of the Roseau Sheet area lies within the lacustrine plain of glacial Lake Agassiz. At various times during late Wisconsin glaciation, Lake Agassiz occupied parts of South Dakota, North Dakota, Minnesota, Saskatchewan,

[1] S.R. Moran, et al, "Quaternary Stratigraphy and History of North Dakota, Southern Manitoba and Northwestern Minnesota" is the basis in part, of this section. (See geology references, page 37.)

Manitoba, and Ontario. Sediments from the lake cover about 200,000 square miles, although the lake was probably much smaller than this at any one time.

Lacustrine sediments in the Roseau Sheet area are underlain by glacial till from two ice lobes. About 35,000 years B.P. (before present) the Wadena lobe advanced from the northwest into the Red Lakes lowland. Later, after the Wadena lobe had retreated, the Des Moines lobe advanced southeastward into the area, overriding drift deposited earlier by the Wadena lobe. Glacial till from the Des Moines lobe is exposed at the surface in certain areas where lacustrine sediments are not present.

Glacial ice of the Des Moines lobe occupied the entire Red River Valley until sometime after 14,000 years B.P. As the ice retreated to the north, a drainage divide was eventually exposed near Browns Valley. Meltwater was ponded between the ice and the divide, forming a proglacial lake which drained south through the Minnesota River Valley. This marked the beginning of glacial Lake Agassiz, which existed intermittently for about 5000 years. The actual size and location of the lake at any point during its history was closely related to the position of the ice margin to the north.

Lake Agassiz was the most important factor in the development of the level topography which is characteristic of the Roseau Sheet area. Lacustrine sediments were deposited over much of the area, especially near the Red River, where the mantle may reach a thickness of 150 feet. Where lacustrine deposits are not found, the surface of the glacial till was leveled by currents and wave action. Along the shorelines beach ridges were formed which are fairly conspicuous features of the landscape.

The history of Lake Agassiz has been divided into five phases: Cass (high water phase), Caledonia glacial advance, Lockhart (high water phase), Moorhead (low water phase), and Emerson (high water phase). In relating landform development to the history of Lake Agassiz, the assumption is made that present landscapes are primarily the result of the last period a given area was covered by water.

Cass Phase

As the ice retreated into Canada, water levels of Lake Agassiz were high enough to cover virtually all of the Roseau Sheet area. Most of the landforms of geomorphic areas 1D and 1F probably developed during this phase. A very level landscape resulted as lacustrine sediments were deposited in some areas while in others, glacial till surfaces were eroded by currents and wave action.

Caledonia Advance

During this phase the glacier readvanced southward up the Red River Valley, filling much of the lake bed and eroding many of the sediments deposited previously.

Lockhart Phase

As the ice retreated northward again, Lake Agassiz was enlarged and remained at a stable level long enough to form Herman beach. Herman beach extends in an east-west direction just south of the Roseau Sheet area at an elevation of about 1,160 feet above sea level. Most of the Roseau Sheet area was submerged at this time except for the higher elevations in geomorphic areas 1D and 1F.

As greater volumes of water passed through the outlet near Browns Valley, it eroded deeper until granite bedrock was encountered. The lake stabilized at this lower level and formed Campbell beach along the shore. Campbell beach nearly bisects geomorphic area 1E at an elevation of about 1,070 feet near Greenbush. The Lockhart phase ended when the ice retreated farther into Canada, exposing a lower outlet flowing east into the Lake Superior basin.

Between the Herman and Campbell stages of the lake, probably most of the landscape features were formed in geomorphic areas 1 (eastern portion) 1B, and 1E (southeast of Campbell beach). The glacial till surface was leveled by wave action and a thin mantle of lacustrine sediments were deposited in many areas.

Moorhead Phase

Water was generally well below the Campbell level during the Moorhead phase, and at one point most of the lake bed was exposed. This phase ended when the eastern outlets were blocked by advancing ice and the lake rose again to the Campbell level.

Emerson Phase

Lake Agassiz remained at the Campbell level until the ice gain retreated and the eastern outlets were permanently opened. During this period much of the landform development took place in geomorphic area 1E (northwest of Campbell beach). The main processes involved were the smoothing of the glacial till surfaces by wave action, and the deposition of lacustrine sediments in certain areas.

After the Emerson phase water levels continued to drop until Lake Agassiz had all but disappeared from the Roseau Sheet area. The only remnants are the Red Lakes, Lake of the Woods, and Thief Lake. During this final stage deposition of silts and clays probably continued in the deepest waters. These most recent sediments are the parent materials for the soils of the western portion of geomorphic area 1. A series of beach ridges were formed during this period in the western portion of geomorphic area 1C. Some of these sandy materials, however, may have been deposited at an earlier time. The beaches are usually from 2 to 15 feet high and from 150 to 500 feet wide. In some places the beaches are grouped into a continuous landform up to a half mile wide.

With few exceptions, the peatlands are the only landforms of the Roseau Sheet area that are not the direct result of glacial Lake Agassiz. Sometime after the lake water receded, peat began to accumulate over much of the area. This occurred because plant growth exceeded the rate of plant decomposition, the latter being slowed by the cold wet environment. The greatest accumulation of organic materials took place in the Agassiz Peatlands (1F), one of the largest continuous peatlands in the world. Within the region are large areas of raised peat bogs, separated by water tracks. The bogs are covered by sphagnum mosses, heath shrubs, tamarack, and black spruce. Because of the accumulation of organic materials these bogs have become slightly higher topographically than the surrounding land. Water from mineral soils flows between the raised bogs, shaping them into ovoid or teardrop shapes. The water tracks are mainly fens covered by sedges which are arranged in a pattern at right angles to direction of water seepage.

Climate

The climate of any land area is an extremely important component of the resources. Climate affects, to some degree, most human activities.

Some of the general climate characteristics of this area are given in the series of nine diagrams. The area has a typical continental climate with wide extremes in temperature from summer to winter. Total annual precipitation ranges from 20 inches per year in the western part to 25 inches in the southeastern portion (figure 1). Nearly half of the precipitation falls during the summer (figure 2).

Snowfall is an important component of annual precipitation and averages 30 to 50 inches (figure 3). Figures 4 and 5 show that this area normally has 70 to 100 days with 6 inches of snow on the ground and 30 to 70 days with over 12 inches.

The average date of the last occurrence of frost ranges from May 22 in the southwestern portion to June 1 on the southeastern border of this area (figure 6). Where soils suited to agriculture occur, wheat, barley, oats, flax, soybeans, sugarbeets, potatoes, sunflowers, early maturing corn, grass seed, alfalfa, and other hay crops are grown successfully. Adapted vegetables and small fruits are also cultivated throughout the area. Fall frost normally occurs September 11 to 21 (figure 7).

Summer weather is typically one of warm days and cool nights. Figures 8 and 9 show that the warmest temperatures in July average from 81° to 83°F, while night air cools to mid 50s. Summer and fall weather is usually very comfortable for outdoor recreational activities.

One of the most important aspects of the climate is the temperature and moisture range which occurs within the soil and within the air zone several feet above ground. The nature of the soil, local topography, direction of slope, and vegetation all interact with the general patterns of air and moisture flow to modify long term temperature averages. For example, the northeastern portion is somewhat affected by the proximity of Lake of the Woods resulting in slightly lower summer temperatures.

The Roseau Sheet area is nearly level; therefore, slope and elevation have minimal effects on temperatures. The numerous areas of peat also produce a micro-climate effect resulting in a somewhat shorter growing season but, because of the large water-holding capacity, often a temperature moderation. The beach soils are sandy and gravelly and have a low water-holding capacity, while soils formed in lacustrine materials are clayey or silty with a high water-holding capacity.

Near lakes surprising differences in temperatures and wind velocities can result from differences in location. Usually lake homes or cabins on the south and east shore of a lake have a cooler, more windy site than one located on the west or north because prevailing winds are from the northwest. Shelter from trees or hills is another important factor.

Additional information about the climate of the area is available from references listed at the end of this publication.

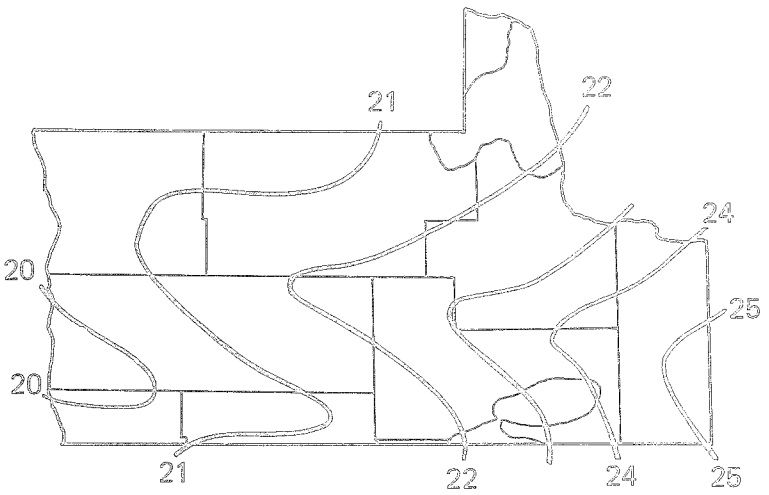


Figure 1. Annual normal precipitation in inches, 1941-1970, Roseau Sheet. (Adapted from Minnesota Technical Bulletin 314, 1978)

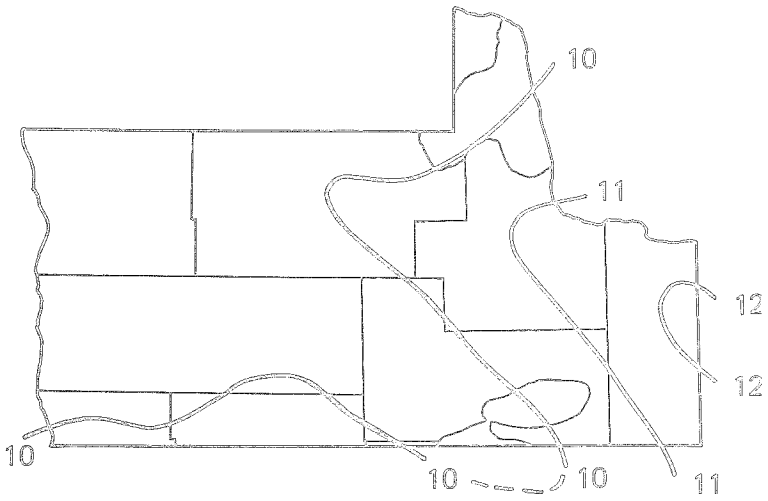


Figure 2. Summer (June, July, August) normal precipitation in inches, 1941-1970, Roseau Sheet. (Adapted from Minnesota Technical Bulletin 314, 1978)

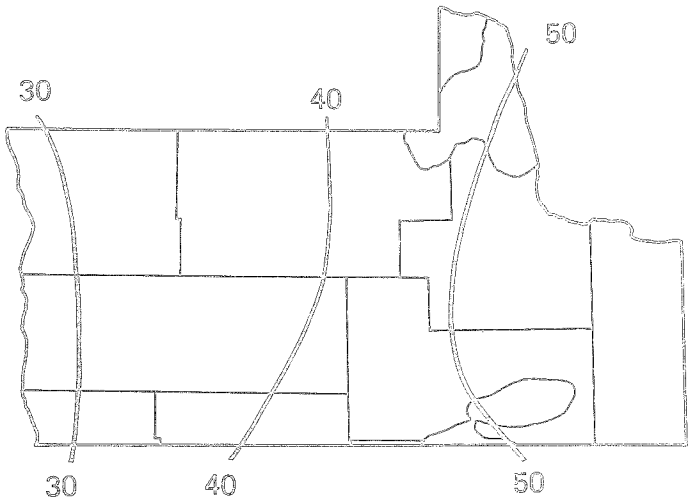


Figure 3. Annual normal snowfall in inches, 1931-1960, Roseau Sheet. (Adapted from Minnesota Technical Bulletin 254, 1967, U.S. Department of Commerce)

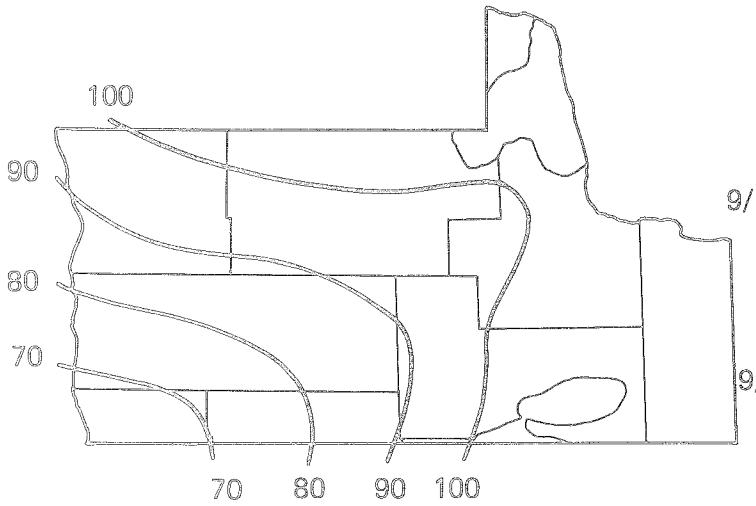


Figure 4. Average number of days per year when snow cover is more than 6 inches, 1959-1979, Roseau Sheet. (Adapted from Minnesota Climatological Data, U.S. Department of Commerce)

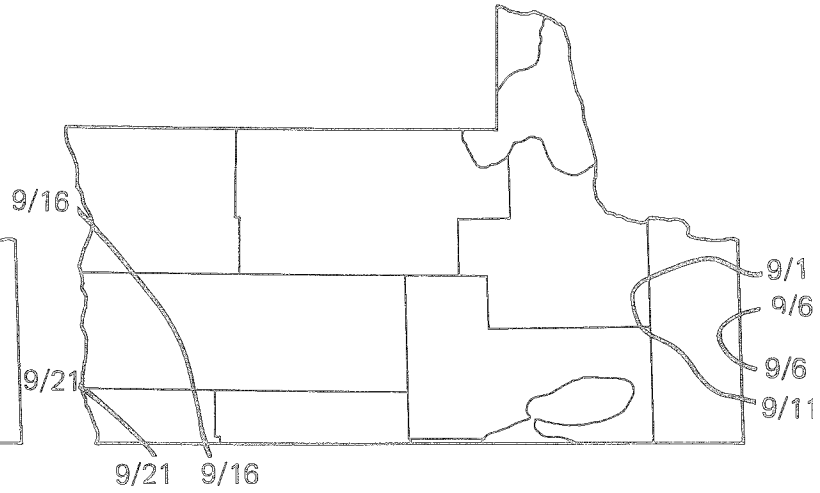


Figure 7. Average date of first occurrence of 32°F or lower in the fall, Roseau Sheet. (Adapted from Minnesota Technical Bulletin 243, 1963)

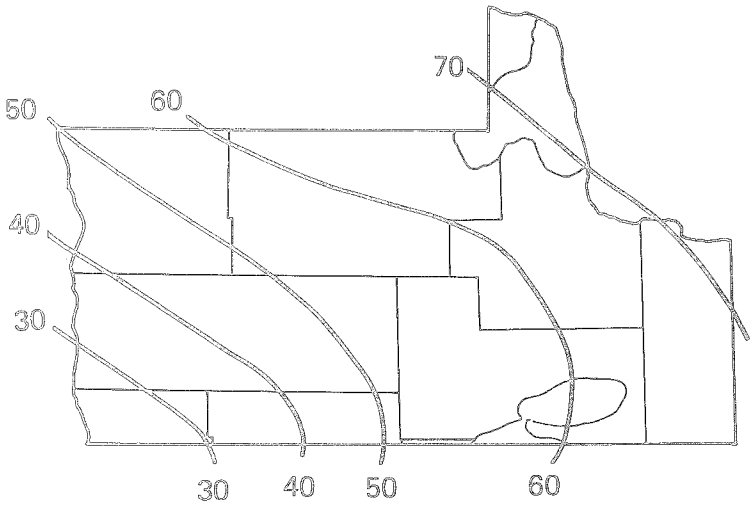


Figure 5. Average number of days per year when snow cover is more than 12 inches, 1959-1979, Roseau Sheet. (Adapted from Minnesota Climatological Data, U.S. Department of Commerce)

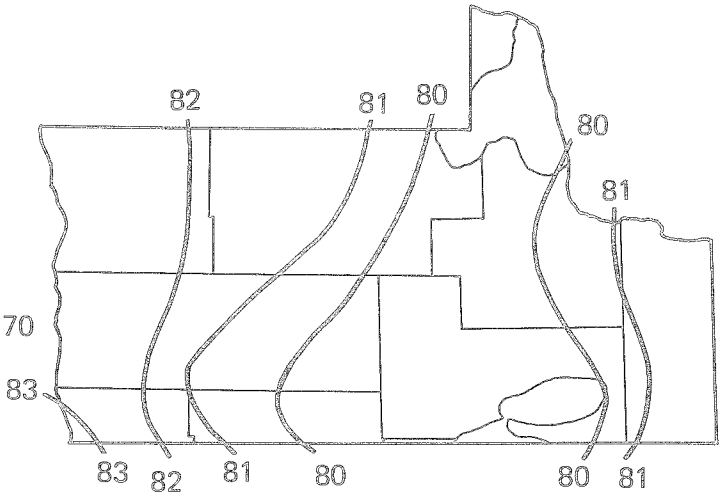


Figure 8. Average daily maximum temperatures during July, 1931-1960, Roseau Sheet. (Adapted from Minnesota Technical Bulletin 248, 1965)

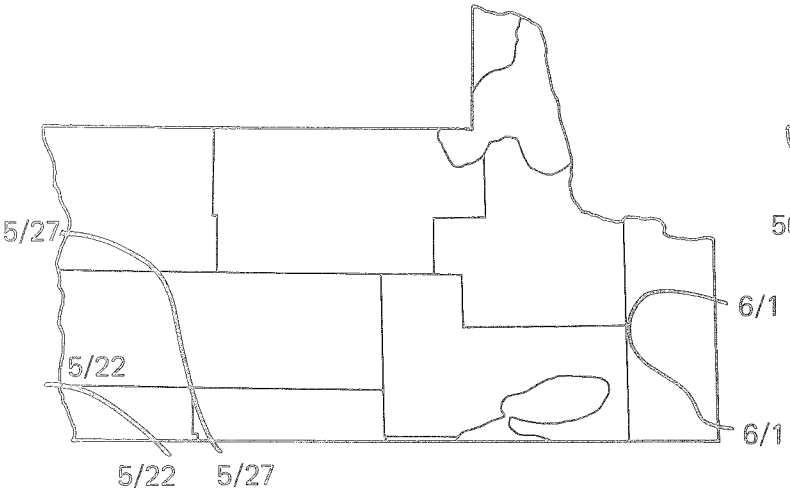


Figure 6. Average date of last occurrence of 32°F or lower in the spring, Roseau Sheet. (Adapted from Minnesota Technical Bulletin 243, 1963)

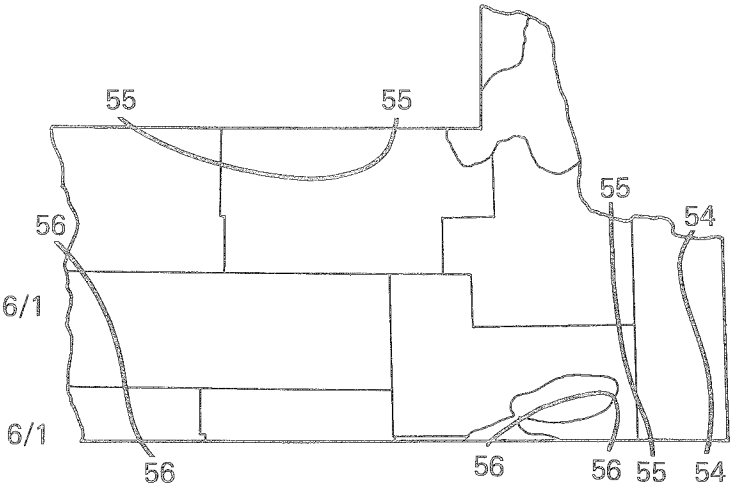
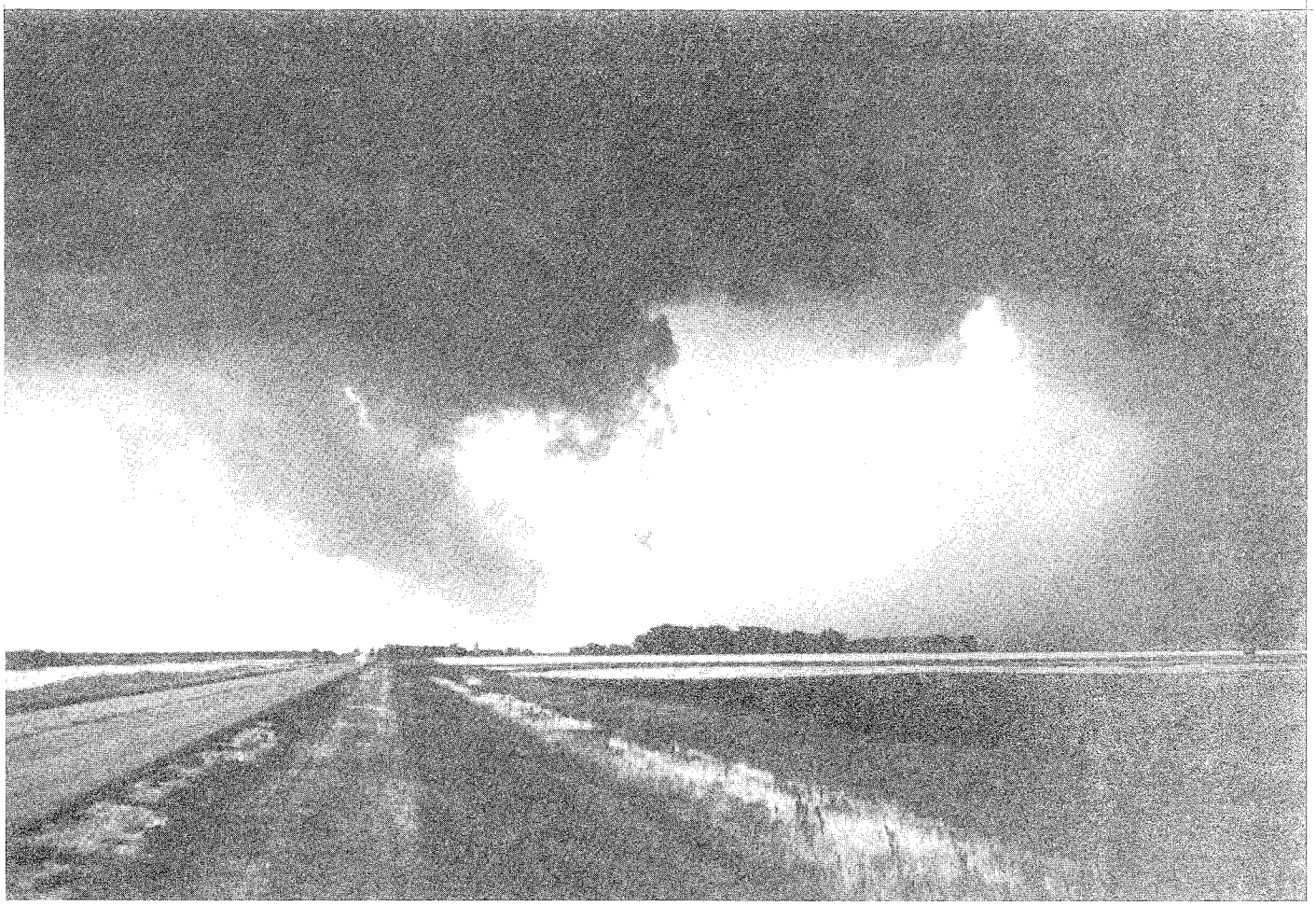


Figure 9. Average daily minimum temperatures during July, 1931-1960, Roseau Sheet. (Adapted from Minnesota Technical Bulletin 248, 1965)



Violent thunderstorms are a common summer occurrence in the Roseau Sheet area.

Agriculture

Contrasting soil conditions give rise to very different types of agriculture in the Roseau Sheet area. These differences are evident in statistical data (table 8) taken from the four counties that lie entirely within the limits of the map. Generalizations made from this information can be applied to the entire area included in the Roseau Sheet.

The most obvious generalization is that agriculture decreases in importance from west to east. This trend is seen in the proportion of each of the four counties that is in farmland, and also in the total incomes received by farmers from each county. The best agricultural soils are located within about 20 miles of the Red River in western Kittson, Marshall, and Polk counties. Artificial drainage has made these soils well suited for small grain farming. In sharp contrast are the peatlands that cover most of the eastern half of the region and are generally too wet for agriculture. Soils of intermediate productivity are found in Roseau, eastern Marshall, and northern Pennington counties. Soil wetness is a problem over much of this area, but there are pockets of excellent cropland where soils are naturally well drained or can be artificially drained.

In recent years there has been an expansion of commercial agriculture from the Red River Valley to the less pro-

Table 8. Selected agricultural data (Source: Minnesota Agricultural Statistics of the Minnesota Crop and Livestock Reporting Service, 1978, 1979)

County	Total land area, acres	Land in farms, acres	Average size of farm, acres	Cash income received by farmers ($1,000)	Income from crops ($1,000)	Income from livestock ($1,000)	Wheat, acres	Hay, acres	Timothy seed, acres
Kittson	719,000	582,700	715	60,250	53,958	3,581	214,200	27,500	800
Lake of the Woods	838,800	122,400	445	5,628	3,951	1,521	13,600	20,000	4,400
Marshall	1,145,200	916,700	475	88,097	77,051	7,693	317,500	46,000	4,800
Roseau	1,072,800	644,300	422	36,894	22,674	13,528	134,800	70,000	25,200

Wheat is the most important cash crop on the large grain farms in the western portion of the Roseau Sheet area. (Photo courtesy of USDA-Soil Conservation Service)

ductive land to the east. Sizable acreages of aspen and brush have been cleared and drained for crop production. This has been facilitated by the use of heavy equipment to construct drains and remove trees and boulders and also by the use of chemical herbicides to control weeds and brush.

Throughout the Roseau Sheet area most agricultural income comes from crop production. Income from livestock, however, accounts for a significant portion of the total on the less productive soils east of the Red River Valley. Although most farm income is derived from crops in these areas, pasture and forage production are a viable alternative where soils are not well suited to most grain crops.

Most farms in the western portion of the Roseau Sheet area are large cash grain operations. This is reflected in table 8 by the large average farm size and large acreages planted to wheat in both Kittson and Marshall counties. Wheat is the most important cash crop, but there is also significant production of barley, oats, sugarbeets, and on coarser-textured soils, potatoes. Sunflowers, a relatively new crop to the area, are expanding rapidly to land that was formerly planted to oats or barley.

In Roseau County small grains and specialty crops such as timothy and other grass seed crops account for most of the agricultural income. Nevertheless, more than one third of the total farm income in 1978 was derived from livestock, mainly from beef cattle, but also from dairy herds. The importance of livestock is also evident from the large acreage of hay in the county.

Agriculture in the Agassiz Peatlands (geomorphic area 1F) is typified by the statistics from Lake of the Woods County. Only about 15 percent of the county is considered farmland and of that even less is actually cropped. Even though attempts have been made to drain some of the peat

Fire has destroyed part of this black spruce stand. Spruce and tamarack cover much of the eastern portion of the Roseau Sheet area.

Lake Bronson State Park in Kittson County is a good place to cool off on a hot summer day. (Photo courtesy of USDA-Soil Conservation Service)

bogs, the majority of the area remains too wet for agriculture. In areas that are suitable for farming, the main crops are small grains, timothy, and hay. Income from livestock, while small, still represents more than one fourth of the total agricultural income for the county.

If properly managed some of the peatlands of geomorphic areas 1D and 1F are suitable for wild rice cultivation. Most of the commercial wild rice production is in Clearwater County, south of the Roseau Sheet area, but there are several thousand acres in Beltrami County near Washkish.

Forestry

Forestry is an important land use in the eastern portion of the Roseau Sheet area. In the early logging days it was within the pine and spruce country. Today aspen, spruce, jack pine, and tamarack occur extensively and are important in the logging industry and esthetic beauty of the area.

See table 9 for selected timber interpretations on principal soil landscape units within geomorphic regions. The timber interpretations with respect to seedling mortality, productivity for pulpwood and sawtimber, and species recommendations are based on physical and chemical characteristics of the soils, prevailing water table positions, and general climatic considerations. Prevalence of disease and insect control problems are also reflected in the interpretations.

Recreation

Recreation is an important industry in parts of the Roseau Sheet area: Lake of the Woods and Red Lakes are its more important lakes. Fishing, canoeing, boating, swimming, and water-skiing are popular summer activities. Autumn brings deer, grouse, duck, and geese hunters into the area and snowmobiling is a popular winter sport. See table 10 for limitations to specific recreational uses within geomorphic regions.

Information for the Engineer

Because soil landscape units include several major and minor soil series, it is impossible to give specific engineering data such as engineering classification, particle size, liquid limit, plasticity index, percolation rates, shrink-swell potential, and corrosivity. These can be obtained from on-site investigations. Table 11 gives an approximate range in AASHTO and Unified classification of materials als in the respective soil landscape units.

Engineers may find this map useful for locating sources of sand and gravel. Prime sources of gravel will be found in the Inter-Beach area (1C). Large peat areas which may cause difficulties in road location can be observed. Landscape units with clayey soils will likely have high shrink-swell potential. Some outcrops of bedrock occur along Rainy River in the Big Fork area (1B).

Table 9. Selected timber interpretations within geomorphic regions of the Roseau Sheet area based on soil characteristics

Geormorphic region	Most common: Soil landscape units	Most common: Texture	Water table position	Seedling mortality	Root restrictions	Forest productivity: Pulpwood	Forest productivity: Saw timber	Recommended species
Agassiz Lacustrine Plain – Inter-Beach (1C)	SSWL	loamy sand over sand and gravel	low	slight	slight	fair	fair	white pine, red pine, white spruce, jack pine
– Red River Valley (1) – Big Fork Valley (1B) Agassiz Lacustrine Plain – Inter-Beach (1C) – Red Lake Area (1D) – Beltrami Island (1E) – Agassiz Peatlands (1F)	LSPD LSPL	loamy sand and fine sand over loam	high to medium	moderate to severe	moderate to severe	fair	poor	black spruce white spruce aspen white pine
– Red River Valley (1) – Big Fork Valley (1B) Agassiz Lacustrine Plain – Red Lake Area (1D) – Beltrami Island (1E) – Agassiz Peatlands (1F)	LLPL	loam and silt loam	high to medium	moderate to severe	moderate to severe	good	fair	white spruce aspen
– Big Fork Valley (1B) Agassiz Lacustrine Plain – Beltrami Island (1E) – Agassiz Peatlands (1F)	CCPL CCPD	silty clay	high to medium	moderate to severe	moderate to severe	good	fair	white spruce aspen
Agassiz Lacustrine Plain – Big Fork Valley (1B) – Beltrami Island (1E)	CCWL CLWL	silty clay and loam over clay	medium to low	moderate to severe	moderate	good	good to fair	white pine red pine, white spruce
– Big Fork Valley (1B) – Red Lake Area (1D) Agassiz Lacustrine Plain – Beltrami Island (1E) – Agassiz Peatlands (1F)	SSWL SSPL SSPD	loamy fine sand and fine sand	medium to high	moderate to severe	moderate to severe	fair	poor	black spruce white spruce aspen white pine
– Big Fork Valley (1B) – Red Lake Area (1D) Agassiz Lacustrine Plain – Beltrami Island (1E) – Agassiz Peatlands	LLWL LSWL	loam, silt loam and sand over loam	medium to low	slight to moderate	slight	good	fair to good	white spruce red pine aspen white birch
– Peat (in all regions)	LP, NP SP, AP, BP	peat	high	moderate to severe	severe	fair	poor	black spruce tamarack

Table 10. Degree and kinds of limitations to specific recreational uses – Roseau Sheet

Landscape unit	Description	Playground, athletic field and intensive play areas	Picnic areas, parks and extensive play areas	Bridle paths, nature and hiking trails	Golf course fairways	Cottages, service and utility buildings	Tents and trailer sites
SSWD SSWL	deep sandy and sandy over sandy and gravelly well drained	moderate – difficult to maintain vegetation; sandy surface	moderate – difficult to maintain vegetation; sandy surface	moderate – sandy surface	severe – difficult to maintain vegetation; sandy surface	slight	moderate – sandy surface soil
LSWD	sandy over loamy – moderately well drained	slight	slight	slight	slight	slight	slight
LSWL	sandy over loamy – moderately well drained	moderate – vegetation difficult to maintain in some places	moderate – vegetation difficult to maintain in some places	slight	moderate – vegetation may be difficult to maintain	moderate – sandy surface soil makes vegetation difficult to maintain	slight
SLWD	loamy over sandy – moderately well and somewhat poorly drained	slight	slight	slight	slight	slight	slight
LLWD LLWL CLWD CLWL	deep silty or loamy, and loamy over clayey – moderately well and somewhat poorly drained	slight	slight	slight	slight	slight	slight
CCWL CCWD	deep clayey soils moderately well drained	moderate – surface soil is sticky when wet. Moderately slow permeability	moderate – surface soil is sticky when wet. Moderately slow permeability	moderate – surface soil is sticky when wet	moderate – surface soil is sticky when wet	slight	moderate – surface soil is sticky when wet
CCPD CCPL	deep clayey soils – poorly drained	severe – high seasonal water table; poor trafficability	severe – high seasonal water table; poor trafficability	severe – high seasonal water table; moderate – surface soil is sticky when wet	severe – high seasonal water table; moderate – surface soil is sticky when wet	severe – high seasonal water table; slow permeability	severe – high seasonal water table; poor trafficability slow permeability
SLPD LLPD LLPL	loamy over sandy; deep loamy and deep silty – poorly drained	severe – high seasonal water table; occasional ponding	severe – high seasonal water table; occasional ponding	severe – high seasonal water table; occasional ponding	severe – high seasonal water table	severe – high seasonal water table; occasional ponding	severe – high seasonal water table; occasional ponding

Table 10 (continued). Degree and kinds of limitations for specific recreational uses — Roseau Sheet

Landscape unit	Description	Playground, athletic field and intensive play areas	Picnic areas, parks and extensive play areas	Bridle paths, nature and hiking trails	Golf course fairways	Cottages, service and utility buildings	Tents and trailer sites
SSPD SSPL LSPD LSPL	deep sandy, and sandy over loamy — poorly drained	severe — high water table	severe — high water table	severe — high water table	severe — high water table	severe — high water table	severe — high water table
SP LP NP AP BP	all organic soils, peat and muck	severe — high water table; seasonally ponded; soft organic surface	severe — high water table; seasonally ponded; soft organic surface	severe — high water table; seasonally ponded; soft organic surface	severe — high water table; seasonally ponded; soft organic surface	severe — high water table; seasonally ponded; soft organic surface	severe — high water table; seasonally ponded; soft organic surface
M	marsh — organic and mineral soils; ponded most of the time	severe	severe	severe	severe	severe	severe
A	alluvial land frequently flooded	severe	severe	severe	severe	severe	severe

Water Resources [2]

Ground Water

The quality and availability of ground water in the Roseau Sheet area depends largely on whether it is derived from lacustrine sediments, glacial till, beaches, or Paleozoic rocks. The main area of lacustrine sediments is in the western portion of geomorphic area 1, where thicknesses may reach 150 feet. These sediments overlie glacial till and Paleozoic rocks. Area 1C consists mainly of beaches and shoreline deposits underlain by glacial till. The remaining geomorphic areas (1B, 1D, 1E, 1F) generally have a thin mantle of lake sediments and/or peat overlying about 200 feet of glacial till. Paleozoic rocks underlie much of the lacustrine sediments and glacial till in the western third of the Roseau Sheet area.

The quality of ground water is a problem in much of the western part of the Roseau Sheet area. In geomorphic area 1 a number of flowing wells were dug around the turn of the century and later had to be capped because of the highly saline water that was produced. The salts probably originate from deep sedimentary rocks which formed in a marine environment. As ground water moves through these rocks it becomes contaminated with salts. The saline water is then transported toward the surface under hydrostatic pressure.

Lacustrine clays yield little or no water to wells. Silts and very fine sands yield small quantities, usually less than 1 gallon per minute (gpm), and the wells may go dry in late summer. Water from lacustrine sources is generally unfit for human consumption because of its bitter taste and high chloride content, which ranges from 500 to 1,000 parts per million (ppm). The total concentration of dissolved solids usually exceeds 2,000 ppm.

In areas underlain by glacial till, wells placed in lenses of sand and gravel commonly yield from 1 to 10 gpm. Aquifers of sand, silt, or gravel yield from 5 to 20 gpm, but may locally produce much larger quantities. Quality of the water is generally good although a high chloride content in some areas may preclude domestic and livestock uses. The water is very hard and contains from a trace to 20 ppm iron. Incrustations of well screens result from the precipitation of carbonates and manganese minerals. Manganese contents range from 0 to as high as 0.5 ppm.

The sands and gravels in beaches and shoreline deposits of geomorphic area 1C may reach a thickness of 30 feet and a width up to 1/2 mile. Wells placed in the larger beaches often yield 20 gpm or more. Although very hard, the water is generally suitable for domestic and livestock uses. The total content of dissolved solids is usually less than 500 ppm.

Area 1C in Kittson County is underlain by a large aquifer capable of producing from 50 to 1,000 gpm. The most productive wells are near Lake Bronson where the saturated thickness of coarse sand and gravel is about 150 feet. Water from the aquifer is of high quality and suitable for domestic, livestock, and irrigation uses. The water is very hard and contains up to 5 ppm of iron. Water from some of the deeper wells contains hydrogen sulfide gas. The total dissolved solids are generally less than 100 ppm.

The Paleozoic shales and sandstones have potential yields of from 5 to 50 gpm. Water quality is good in some instances but in others a boron content in excess of 3 ppm

[2] This information is based primarily on "Water Resources of the Two Rivers Watershed Northwestern Minnesota," Hydrologic Investigation HA-237.

Table 11. Approximate engineering classification of materials at the surface and at 5 feet in the soil landscape units in the Roseau Soil Atlas Sheet area

Soil landscape unit	AASHTO[1]		Unified[2]	
	Surface	5 feet +	Surface	5 feet +
SSWL	A-1, A-2, A-3	A-1, A-3	SM, SP-SM, SC	SC, SP-SM
SSPL	A-2, A-3	A-2, A-3	SM, SP-SM	SP, SP-SM
SSWP	A-1, A-2, A-4	A-1, A-2	SM, SC, ML, CL, GM, GC	GM, GC, SM, SC
SSPD	A-2, A-3, A-4	A-2, A-4	SP, SP-SM, SM	SP, SP-SM, SM
LSWL	A-2, A-3	A-4, A-6	SP-SM, SM	ML, CL
LSPL	A-2, A-3	A-4, A-6	SP-SM, SM	ML, CL
LSWD	A-2, A-4, A-3	A-4, A-6	SM, SM-SC, ML, CL, SP-SM	SC, GL, SM-SC, CL-ML
LSPD	A-4	A-6	SM, SM-SC, ML, CL-ML, OL	CL, ML
SLWD	A-4	A-4	OL, ML, CL-ML	ML, CL-ML
SLPD	A-2-4, A-4, A-6	A-4	OL, ML, CL-ML	ML, CL-ML
LLWL	A-2-4, A-4, A-6	A-2-4, A-4, A-6	SM-ML, CL	SM, ML, ML-CL, CL
LLPL	A-4, A-6, A-7	A-2-4, A-4, A-6	SM, ML, CL	SM, ML, ML-CL, CL
LLWD	A-4, A-6, A-7	A-4, A-6	ML, ML-CL, CL	CL, ML-CL
LLPD	A-4, A-6, A-7	A-6, A-7	SC, CL, CL, CL-ML	CL
CLWL	A-6, A-7	A-7	CL, CH	CH
CLWD	A-4, A-7, A-6	A-7, A-6	OH, ML, CL-ML, CL, CH	CH, CL
CLPD	A-4, A-6, A-7	A-7	ML, ML-SL, CL, CH	CH
CCWL	A-7	A-7	CH	CH
CCPL	A-7	A-7	CH	CH
CCWD	A-7	A-7	CH	CH
CCPD	A-6, A-7	A-7	CL, CH	CH
LP	A-8, A-4, A-6	A-4, A-6	Pt, SM, ML, SC, CL	SM, CL
SP	A-8, A-1, A-2, A-3, A-4	A-1, A-2, A-3	Pt, OL, ML, SM, SP	SM, SP
NP	A-8, A-2, A-3	A-8, A-2, A-3	Pt, SP, SM	SP, SN
AP	A-8, A-1, A-2, A-3, A-4	A-8, A-1, A-2, A-3, A-4	Pt, OL, ML, SM, SP	SC, CL, SL, SM, SP
BP	–	–	Pt	Pt
A	variable	variable	variable	variable
M	unclassified	unclassified	unclassified	unclassified

[1] American Association of State Highway Transportation Officials, Standard Specification for Highway Materials and Methods of Sampling and Testing. 1961

[2] Waterways Experiment Station, Corps of Engineers, The Unified Soil Classification System. Tech. Memo. 3-357. Vol. 2. 1953.

makes the water unsuitable for nearly all uses. The total content of dissolved solids ranges from 5,000 ppm in the upper portion to greater than 35,000 ppm in the lower portion of the Paleozoic strata.

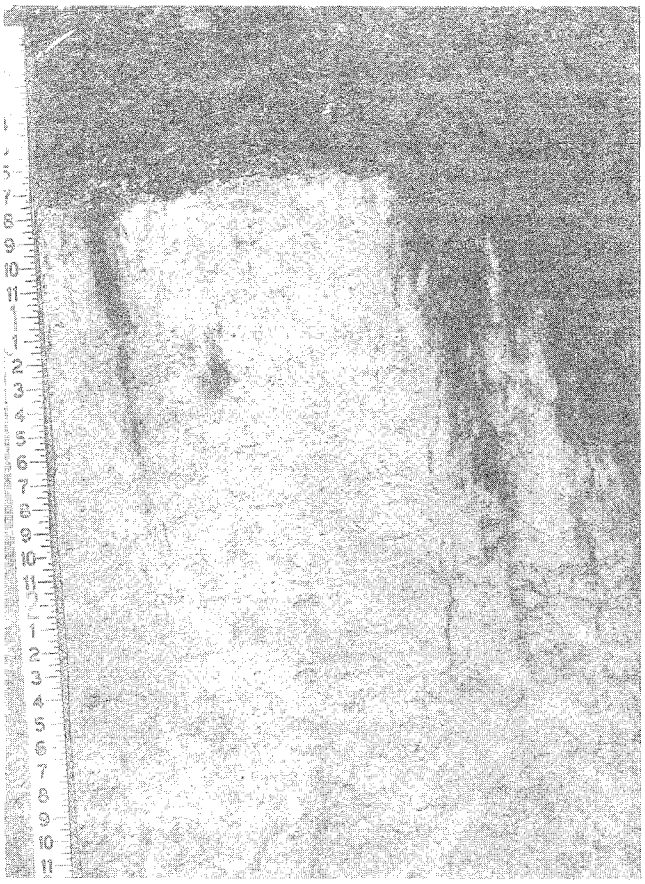
Surface Water

Natural stream flows in the Red River of the North and tributaries are generally inadequate for dependable water supplies. On the Red River high flows normally occur in April through July, with the highest flows in April during snowmelt. Low flows occur during the fall and winter, but are sustained somewhat by storage reservoirs. Flows of less than 50 cubic feet per second may be expected during extreme drought.

Floods of long duration along the Red River and larger tributaries may damage crops or cause delays in seeding. Floods along smaller tributaries occur more frequently but are usually of shorter duration. Crop damage is most prevalent in geomorphic area 1, because of the high concentration of crop land in that area.

Stream flows are more reliable in the Rainy River due to the natural effect of lakes and wetlands which store and slowly release overland runoff. Geomorphic regions 1D, 1E, and 1F contain a high percent of wetland for storage. Annual maximum flows generally occur in April during snowmelt. Annual minimum flows usually occur in February or March. Minimum flows during summer are generally in August when evapotranspiration is high.

With proper treatment, surface waters in the Roseau Sheet area are generally of sufficient quality for municipal, industrial, and agricultural uses. Total dissolved solids in the Red River of the North ranges from 200 to 600 ppm. Two Rivers, a tributary, has fair to good water quality. During low flows the sodium content reaches 70 ppm. The Rainy River at International Falls has total dissolved solids of 21 ppm. Total hardness is 40 ppm, the iron content is 0.10 ppm, and the manganese concentration is less than 0.02 ppm. These values are within the recommended limits for domestic consumption.



Top: Dark "tongues" appear in the subsoil of this Hegne profile where cracks have been filled by surface material.

Bottom: Gravelly textures in the subsoil of this Sioux profile cause the soil to have a very low water holding capacity.

Appendix A

Short descriptions of soil series

Alluvial land, undifferentiated — Consists of recent, river-deposited material of variable textures and of variable drainage. (Unclassified)

Arveson — Dark-colored, poorly and very poorly drained, mildly alkaline fine sandy loam, 10 to 20 inches thick over gray moderately alkaline fine sandy loam. This is underlain at 24 to 36 inches by gray moderately alkaline lacustrine loamy sand or fine sand. (Typic Calciaquolls)

Baudette — Light-colored, moderately well-drained, slightly acid very fine sandy loam to silt loam, with silty clay loam subsoils over calcareous lacustrine silts below 18 to 24 inches. (Aquic Eutroboralfs)

Bearden — Black moderately well and somewhat poorly drained, slightly alkaline silty clay loam about 8 inches thick over light olive brown strongly calcareous silty clay loam. This is underlain at about 30 inches by light brownish gray moderately calcareous, lacustrine silty clay loam or silt loam. (Aeric Calciaquolls)

Borup — Dark-colored, poorly drained very fine sandy loam to sandy clay loam 10 to 15 inches over dark gray to olive gray sandy clay loam underlain at 20 to 30 inches by lacustrine loamy very fine sand. These soils are alkaline throughout. (Typic Calciaquolls)

Cathro — Black, neutral very poorly drained muck or peat, about 23 inches thick over grayish brown, alkaline, sandy loam, or loam. (Terric Borosaprists)

Chilgren — Light-colored, poorly to somewhat poorly drained, neutral silt loam or loam surface about 7 inches thick. The subsoil is very dark grayish brown, slightly alkaline to neutral light silty clay loam, underlain at about 12 inches by pale olive, calcareous clay loam till. (Typic Ochraqualfs)

Colvin — Black, poorly drained, mildly alkaline silty clay loam surface, underlain at about 10 inches by moderately alkaline lacustrine silty clay loam. (Typic Calciaquolls)

Cormant — Dark-colored poorly and very poorly drained, neutral loamy fine sand about 6 inches thick over light brownish gray, neutral fine sand. The soil occurs on lake plains, deltas, and outwash plains. (Mollic Psammaquents)

Deerwood — Black, mildly alkaline, muck or peat, about 10 inches thick over grayish brown moderately alkaline fine sand or gravelly sand. (Histic Humaquepts)

Enstrom — Moderately dark-colored, moderately well-drained neutral fine sand about 8 inches thick over dark brown or brown, neutral fine sand. Glacial till or lacustrine grayish brown, moderately alkaline loam occurs below 20 to 40 inches. (Aquic Udorthents)

Fargo — Black, poorly drained, neutral silty clay surface about 8 inches thick with black surface material generally extending to depths of 36 inches. The subsoil is very dark gray neutral to mildly alkaline silty clay, and is underlain at about 21 inches by olive, moderately alka-

line, firm, very sticky, very plastic, moderately alkaline lacustrine silty clay. (Vertic Haplaquolls)

Foldahl — Black, moderately well-drained, neutral sandy loam about 9 inches thick and dark yellowish brown, neutral loamy sand or sand, underlain at 20 to 40 inches by grayish brown, moderately alkaline, loamy glacial till or lacustrine sediments. (Aquic Haploborolls)

Garnes — Dark grayish brown, moderately well-drained, neutral, loam surface about 6 inches thick, with a dark brown, neutral sandy clay loam subsoil. This is underlain at about 10 inches by grayish brown, moderately alkaline coarse loamy glacial till. (Aquic Eutroboralfs)

Glyndon — Black, moderately well or somewhat poorly drained, loam about 11 inches thick over dark gray to light yellowish brown loam. At about 28 inches the color grades to light brownish gray lacustrine loamy very fine sand. These soils are alkaline throughout. (Aeric Calciaquolls)

Grimstad — Black, moderately well to somewhat poorly drained, sandy loam surface about 9 inches thick over grayish brown loamy fine sand. The substratum below 20 to 40 inches is brownish yellow or brownish gray calcareous glacial till or lacustrine loamy sediments. (Aeric Calciaquolls)

Grygla — Moderately light-colored, poorly to somewhat poorly drained medium acid fine sand 24 to 40 inches thick over calcareous loamy glacial till or lacustrine sediments. (Mollic Haplaquents)

Haug — Black, very poorly drained, neutral peat about 11 inches thick over black, mildly alkaline mucky sandy loam. This is underlain at about 14 inches by grayish moderately alkaline loam. (Histic Humaquepts)

Hegne — Black, poorly drained silty clay surface 7 to 16 inches thick, over dark gray to gray silty clay or clay. At about 28 inches this is underlain by olive gray lacustrine clay. The soil is mildly alkaline throughout. (Typic Calciaquolls)

Hiwood — Light-colored, moderately well to well-drained, medium acid loamy fine sand and fine sand surface 6 to 12 inches thick and brownish, medium acid fine sand subsoil over brownish yellow, neutral lacustrine or deltaic fine sand. (Aquic Udipsamments)

Indus — Light-colored, poorly drained, slightly acid clay about 12 inches thick over mildly to moderately alkaline clay underlain at about 24 inches by olive, strongly calcareous lacustrine clay or silty clay. (Typic Ochraqualfs)

Kittson — Black, moderately well or somewhat poorly drained, neutral loam over dark grayish brown, neutral loam over olive brown, calcareous loamy glacial till. (Aquic Haploborolls)

Kratka — This poorly and very poorly drained soil has a black loamy sand surface and dark grayish brown sand subsoil. Both horizons are mildly alkaline. These are underlain at 12 to 24 inches by olive gray moderately alkaline lacustrine clays or loamy glacial till. (Typic Haplaquolls)

Lohnes — Black, somewhat excessively drained, neutral loamy sand surface 6 to 10 inches thick, and brown mildly alkaline loamy sand subsoil, underlain at 12 to 20 inches by brownish gray calcareous gravelly coarse sand. (Udorthentic Haploborolls)

Maddock — Well-drained soil having a black, neutral loamy fine sand surface over a brown, neutral fine sand subsoil, underlain at about 30 inches by brownish gray mildly to moderately alkaline fine sand on glacio-lacustrine and deltaic plains. (Udorthentic Haploborolls)

Marquette — This soil is somewhat excessively drained, has a light-colored neutral loamy sand to gravelly loamy sand surface, about 11 inches thick and with a brownish mildly to moderately alkaline gravelly sandy loam or very gravelly coarse sand, underlain at about 20 inches by sand and gravel on beach ridges and outwash plains. (Psammentic Eutroboralfs)

Markey — Very dark brown, very poorly drained, mildly alkaline herbaceous peat 16 to 50 inches thick over gray, mildly alkaline sandy or loamy sand. (Terric Borosaprists)

Mavie — A poorly drained soil having a black mildly alkaline loam surface 7 to 16 inches thick over brownish to grayish moderately alkaline gravelly loamy coarse sand or gravelly coarse sand. This is underlain by olive gray moderately alkaline loamy glacial till or silt loam or silty clay loam lacustrine sediments. (Typic Calciaquolls)

Menagha — Light-colored, excessively drained, medium acid loamy sand and fine sand about 33 inches thick over slightly acid to neutral loose sand. (Typic Udipsamments)

Mooselake — Dark reddish brown, very poorly drained, medium acid, moderately decomposed peat, mostly of wood origin and more than 51 inches thick. (Typic Borohemists)

Nereson — Dark-colored, moderately well-drained soils. Sandy loam surface about 6 inches thick underlain by grayish brown sandy loam or loam subsoil. Calcareous throughout. (Aquic Argiborolls)

Northcote — Black, poorly drained, neutral very fine clay about 9 inches thick, with tongues of surface soil generally extending to depths of 30 inches. The subsoil is dark olive gray neutral very fine clay, underlain at 16 to 36 inches by olive gray moderately alkaline very fine clay. (Vertic Haplaquolls)

Percy — Dark-colored, poorly drained, mildly alkaline sandy clay loam 7 to 14 inches thick over light brownish gray, moderately alkaline loamy glacial till high in lime. (Typic Calciaquolls)

Poppleton — Moderately dark, moderately well to somewhat poorly drained neutral fine sand surface 8 to 12 inches thick, and brownish, neutral fine sand subsoil, underlain at 20 to 40 inches by grayish brown, neutral lacustrine fine sand. (Aquic Udipsamments)

Redby — Light-colored, somewhat poorly drained, slightly acid loamy fine sand and fine sand surface 6 to 12 inches thick, and brown, slightly acid fine sand subsoil. This is underlain at about 36 inches by brownish

gray neutral to mildly alkaline lacustrine or deltaic fine sand. (Aquic Udipsamments)

Rockwell — Black, poorly or very poorly drained, mildly alkaline sandy clay loam, over dark gray mildly alkaline fine sandy loam grading to fine sand in lower part. This is underlain at 20 to 40 inches by light olive gray, mildly alkaline loamy calcareous glacial till or lacustrine sediments. (Typic Calciaquolls)

Roliss — Black, poorly and very poorly drained, mildly alkaline loam surface, and olive gray, mildly alkaline loam subsoil. This is underlain at 12 to 20 inches by grayish brown, mildly alkaline loam or clay loam glacial till. (Typic Haplaquolls)

Seelyeville — Black, very poorly drained, medium acid to neutral, muck about 16 inches thick over very dark brown medium acid to neutral peat to depths of 51 inches or more. The fibers mostly are derived from herbaceous plants. (Typic Borosaprists)

Sioux — Black, excessively drained, mildly alkaline, loam surface about 5 inches thick over grayish brown moderately alkaline gravelly loam. This is underlain at 6 to 14 inches by brownish gray, moderately alkaline sand and gravel on beach ridges. (Udorthentic Haploborolls)

Spooner — Light-colored, poorly to somewhat poorly drained, neutral silt loam about 22 inches thick over strongly calcareous lacustrine silts. (Typic Ochraqualfs)

Taylor — Light-colored, moderately well and well-drained, slightly acid loam surface about 8 inches thick, over slightly acid silty clay or clay. This is underlain at about 22 inches by strongly calcareous lacustrine clay. (Aquic Eutroboralfs)

Ulen — Black to very dark gray, somewhat poorly to moderately well-drained moderately alkaline loamy fine sand 10 to 20 inches thick and underlain by yellowish brown, moderately alkaline loamy fine sand. This is underlain at about 32 inches by yellowish moderately alkaline, glacio-lacustrine fine sand. (Aeric Calciaquolls)

Wahpeton — Black, moderately well-drained, mildly alkaline silty clay 24 to 60 inches thick. The soil commonly has one or more buried surface horizons sandwiched between very dark gray silty clay. (Udertic Haploborolls)

Washkish — Brown and reddish brown, very poorly drained, slightly decomposed, extremely acid peat on large raised bogs, primarily derived from sphagnum mosses. (Typic Sphagnofibrists)

Wheatville — Black, somewhat poorly to moderately well-drained, mildly alkaline sandy clay loam 7 to 14 inches thick over brownish, moderately alkaline very fine sandy loam. This is underlain at 20 to 40 inches by brownish, mildly alkaline clay. (Aeric Calciaquolls)

Wildwood — Dark-colored, very poorly drained, slightly acid peat or muck up to 12 inches thick over silty clay or clay about 25 inches thick. This is underlain by calcareous olive gray lacustrine clay. (Histic Humaquepts)

Appendix B

Percent of counties in Roseau Sheet having detailed soil surveys as of July 1, 1979.

Beltrami	0
Clearwater	20
Kittson	100
Koochiching	6
Lake of the Woods	1
Marshall	17
Pennington	55
Polk	12
Roseau	4

Glossary

Calcareous — Material having a high percentage of lime carbonate.

Drift — (glacial drift) — Any deposit in a glaciated area originating as a result of glaciation.

Gypsum — Calcium sulphate.

Lacustrine — Deposits formed on the bottom of lakes.

Laminations — Thin plates.

Limy — See calcareous.

Natural drainage —The conditions that existed during the development of the soil, as opposed to altered drainage which is commonly the result of artificial drainage or irrigation. Six classes of natural drainage are recognized in this report.

— Excessively drained soils are commonly very porous and rapidly permeable (sandy and gravelly) and have a low moisture-storage capacity.

— Well-drained soils are nearly free of mottling and are commonly of intermediate texture.

— Moderately well-drained soils commonly have a moderately and slowly permeable layer in or immediately beneath the rooting zone. They have uniform color in the upper rooting zone and are mottled below 16 to 20 inches.

— Somewhat poorly drained soils are wet for significant periods, and are commonly mottled below a depth of 6 to 16 inches.

— Poorly drained soils are wet for longer periods. They are dark gray or black and are generally mottled within a depth of 18 inches. In some soils, mottling may be absent or nearly absent.

— Very poorly drained soils are wet nearly all the time. They have a dark gray or black surface layer and are gray or light gray, with or without mottling in the rooting zone below the surface soil.

Organic soil — Soils which have more than 16 inches of surface material containing more than 25 percent organic matter.

Peat — A dark brown or black residuum produced by the partial decay of plants growing in wet places.

Permeability — The ability of the soil to transmit air or water.

Reaction — The degree of acidity or alkalinity of soil expressed in pH values or in words as follows:

	pH
Extremely acid	below 4.5
Very strongly acid	4.5-5.0
Strongly acid	5.1-5.5
Medium acid	5.6-6.0
Slightly acid	6.1-6.5
Neutral	6.6-7.3
Mildly alkaline	7.4-7.8
Moderately alkaline	7.9-8.4
Strongly alkaline	8.5-9.0
Very strongly alkaline	9.1 and higher

Relief — In geology, the difference in height from the lowest parts to the highest parts of an area.

Subsoil — Roughly, the part of the soil profile between the subsurface and the substratum.

Substratum — A layer beneath the subsoil consisting of material from which soils were formed, or frequently of dissimilar materials.

Subsurface — Soil layer immediately below the surface soil or plow layer ranging from 6 to 12 inches thick.

Surface soil — Ordinarily the plow layer or the surface 5 to 12 inches.

Texture, soil — Proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles as related to the three classes used in this report, follow:
S — sand and loamy sand (also includes gravel).
L — sandy loam, loam, silt loam, silt, sandy clay loam, and clay loam.
C — silty clay loam, sandy clay, silty clay, and clay.

Till — Unstratified and unsorted glacial drift deposited directly by a glacier.

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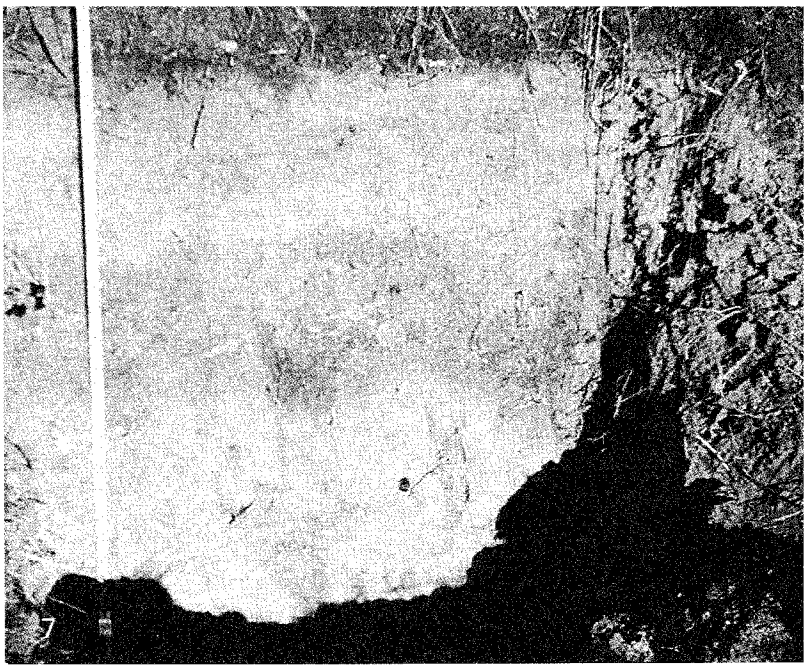

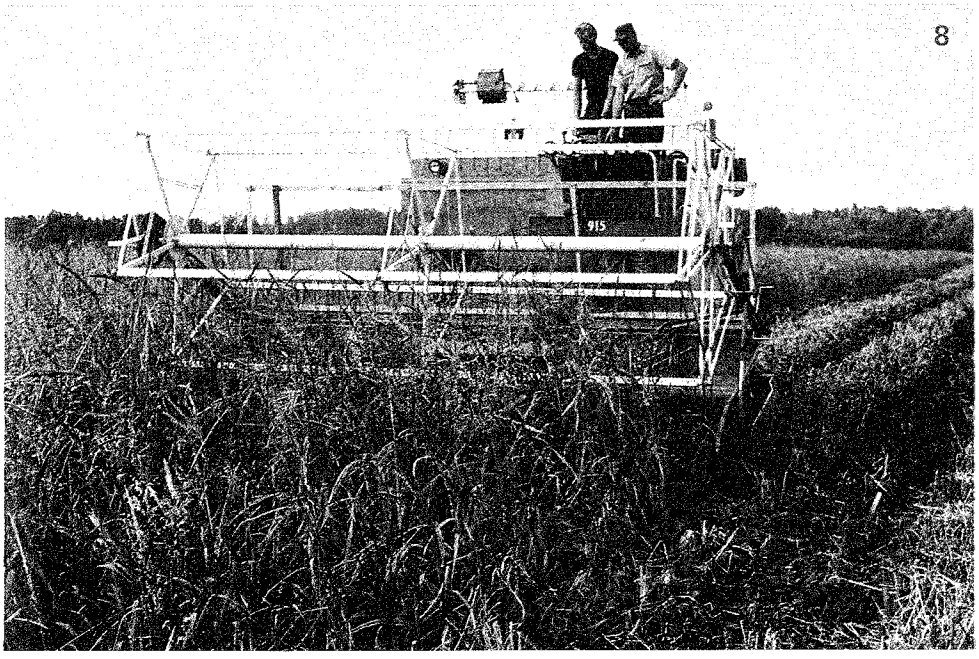

6. Chilgren loam is extensive in soil landscape unit LLPL in the Beltrami Island Area (1E). 7. Bauderte silt loam is the principal soil of unit LLWL in the Big Fork Valley Area (1B). 8. Mechanized wild rice production is one of the commercial uses of the Agassiz Peatlands (1F). 9. A large furrow is created when peat lands are plowed for agriculture. 10. Shallow peat over loamy sediments is a soil found in all geomorphic areas of the Rosseau Sheet. In the Red River Valley (1) and Beltrami Island Area (1E) much of the peat has been removed by burning.