Soil Survey Investigations Report No. 9

Soil Survey Laboratory Data and Descriptions for Some Soils of...

...MINNESOTA

SOIL CONSERVATION SERVICE • U.S. DEPARTMENT OF AGRICULTURE
In cooperation with
MINNESOTA AGRICULTURAL EXPERIMENT STATION

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August 1966

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1. SAMPLE COLLECTION AND PREPARATION
   A. Field sampling
      1. Site selection
      2. Soil sampling
         a. Stony soils
   B. Laboratory preparation
      1. Standard (airdry)
         a. Square-hole 2-mm sieve
         b. Round-hole 2-mm sieve
      2. Field moist
      3. Carbonate-containing material
      4. Carbonate-indurated material
2. CONVENTIONS
   A. Size-fraction base for reporting
      1. <2-mm
      2. <size specified
   B. Data-sheet symbols
      tr: trace, not measurable by quantitative procedure used or less than reportable amount
      tr(s): trace, detectable only by qualitative procedure more sensitive than quantitative procedure used
      : analysis run but none detected
      -(s): none detected by sensitive qualitative test
      blank: analysis not run
      nd: analysis not run
      <: less than reported amount or none present
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         a. Carbonate and noncarbonate clay
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   B. Water retention
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         a. Sieved samples
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      2. NaOAc, pH 8.2
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         a. Acidity by $BaCl_2$-TEA, pH 8.2; bases by NH_4OAc, pH 7.0
      4. KOAc, pH 7.0
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      1. NH_4OAc extraction
         a. Uncorrected
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      2. KCl-TEA extraction, pH 8.2
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      1. NH_4OAc, pH 7.0
      2. NaOAc, pH 8.2
      3. Sum of cations
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      2. Dry combustion
         a. CO_2 evolution I
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      3. Peroxide digestion
         a. Weight loss
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         a. Ammonia distillation
      2. Semimicro Kjeldahl
         a. Ammonia distillation
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         a. Dichromate titration
         b. EDTA titration
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         a. Orthophenanthroline colorimetry
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      4. NaOAc extraction
         a. Aluminon III
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         a. Back-titration with HCl
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   M. Nitrate
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         d. Oxalate-cerate
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         a. Oxalate-permanganate
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         a. EDTA titration
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         a. Flame photometry
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         a. Flame photometry
   R. Sulfur
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      2. X-ray diffraction
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      1. To total clay
      2. To noncarbonate clay
      3. Ca to Mg (extractable)

PREFACE

This publication is one in a new U.S. Department of Agriculture series established to preserve and make available technical information resulting from soil survey investigations. These investigations have been going on for about two decades. Data from them have been distributed in unpublished form to those immediately concerned. Some of the data and descriptions have appeared in technical journals, in regional bulletins, in USDA technical bulletins, and in the text of published soil surveys. But most were not available to all who might use them.

We intend to publish in this series all data from the soil survey laboratories that form reasonably complete characterizations of soils. Already-assembled data and descriptions will be published just as rapidly as they can be prepared for printing. Fragmentary data collected as reference points for specific soil surveys will not be included.

While these data were being assembled, there were many changes in laboratory methods. Some were improved and some new ones were devised. Consequently, laboratory data for different soils cannot always be directly compared without allowance for the method.

The method used is indicated by symbol in the column headings of the data table. These symbols are identified in the code sheet on the opposite page. Each method is described in the first number of this series, "Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples," SSIR No. 1.

Ways of describing soils have also changed. Soil descriptions have become explicit on more and more features. The systems for designating horizons and for classifying soils have been changed.

The soil descriptions published here were prepared as working documents to meet a specific need of a soil survey at the time the soil samples were collected. The soil scientists who wrote them had no idea they would be published. Editing has been limited for the most part to that necessary for conformance to the "Soil Survey Manual." Field textural estimates have been retained, even though some are at variance with the laboratory data, because the field estimates themselves are important data.

There were several reasons for sampling these soils. Some were sampled to study soil genesis, some to facilitate classification, and some to obtain data to permit more useful interpretations. Those sampled for genesis or classification studies do not always fit neatly into our present concepts of soil series. Partly because of these studies, our concepts of some soil series have been modified. As a consequence, the soil series name assigned a soil at the time of sampling is not always the name that would be assigned today. Soil series names in this publication follow 1965 series definitions.

Soil Survey
Soil Conservation Service

Soil Series	County	Soil Survey No.	Page	Soil Series	County	Soil Survey No.	Page
Adolph	Mille Lacs	S57Minn-48-2	3	Lerdal	Freeborn	S54Minn-24-138A	43
	Mille Lacs	S57Minn-48-5	5		Freeborn	S54Minn-24-138B	45
Anoka	Isanti	S61Minn-30-1	7	Menahga	Wadena	S61Minn-80-1	47
	Isanti	S61Minn-30-2	9		Wadena	S61Minn-80-2	49
Brainerd	Crow Wing	S54Minn-18-33-A	11	Nokay	Crow Wing	S54Minn-18-32-A	51
	Crow Wing	S54Minn-18-33-B	13		Crow Wing	S54Minn-18-32-B	53
Erin	Rice	S60Minn-66-1	15	Nymore	Sherburne	S60Minn-71-2	55
	Rice	S60Minn-66-2	17		Sherburne	S60Minn-71-3	57
Fayette	Fillmore	MN-SCD-4-(7-13)	19	Swatara	St. Louis	S61Minn-69-1	59
	Fillmore	MN-SCD-4-(40-46)	21		St. Louis	S61Minn-69-2	61
	Fillmore	Z-1-2-8-(75-89)	23	Synnes	Stevens	S61Minn-75-1	63
	Houston	Z-1-2-8-(60-74)	25		Stevens	S61Minn-75-2	65
	Winona	Z-1-2-8-(48-59)	27	Webster	Waseca	S54Minn-81-113A	67
Flak	Crow Wing	S54Minn-18-34-A	29		Waseca	S54Minn-81-113B	69
Hayden	Wright	S60Minn-86-1	31		Waseca	S54Minn-81-113HA	71
	Wright	S60Minn-86-2	33		Waseca	S54Minn-81-113HB	73
Hiwood	Lake of the Woods	S61Minn-39-1	35	Wildwood	Koochiching	S58Minn-36-1	75
	Lake of the Woods	S61Minn-39-2	37	Zimmerman	Sherburne	S60Minn-71-1	77
Hubbard	Wright	S60Minn-86-3	39		Sherburne	S60Minn-71-4	79
	Wright	S60Minn-86-4	41				

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County	Soil Series	Soil Survey No.	Page
Crow Wing	Brainerd	S54Minn-18-33-A	11
	Brainerd	S54Minn-18-33-B	13
	Flak	S54Minn-18-34-A	29
	Nokay	S54Minn-18-32-A	51
	Nokay	S54Minn-18-32-B	53
Fillmore	Fayette	MN-SCD-4-(7-13)	19
	Fayette	MN-SCD-4-(40-46)	21
	Fayette	Z-1-2-8-(75-89)	23
Freeborn	Lerdal	S54Minn-24-138A	43
	Lerdal	S54Minn-24-138B	45
Houston	Fayette	Z-1-2-8-(60-74)	25
Isanti	Anoka	S61Minn-30-1	7
	Anoka	S61Minn-30-2	9
Koochiching	Wildwood	S58Minn-36-1	75
Lake of the Woods	Hiwood	S61Minn-39-1	35
	Hiwood	S61Minn-39-2	37
Mille Lacs	Adolph	S57Minn-48-2	3
	Adolph	S57Minn-48-5	5
Rice	Erin	S60Minn-66-1	15
	Erin	S60Minn-66-2	17
St. Louis	Swatara	S61Minn-69-1	59
	Swatara	S61Minn-69-2	61
Sherburne	Nymore	S60Minn-71-2	55
	Nymore	S60Minn-71-3	57
	Zimmerman	S60Minn-71-1	77
	Zimmerman	S60Minn-71-4	79
Stevens	Synnes	S61Minn-75-1	63
	Synnes	S61Minn-75-2	65
Wadena	Menahga	S61Minn-80-1	47
	Menahga	S61Minn-80-2	49
Waseca	Webster	S54Minn-81-113A	67
	Webster	S54Minn-81-113B	69
	Webster	S54Minn-81-113HA	71
	Webster	S54Minn-81-113HB	73
Winona	Fayette	Z-1-2-8-(48-59)	27
Wright	Hayden	S60Minn-86-1	31
	Hayden	S60Minn-86-2	33
	Hubbard	S60Minn-86-3	39
	Hubbard	S60Minn-86-4	41

SOIL SURVEY LABORATORY Lincoln, Nebr. 5/19/58

SOIL TYPE Adolph silty clay loam **LOCATION** Mille Lacs County, Minnesota

SOIL NOS. S57Minn-48-2-(1-7) **LAB. NOS.** 6464-6470

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)	TEXTURAL CLASS
0-6	A1	0.2a	0.6a	1.0a	1.7a	2.3a	49.3	44.9	22.7	29.8	Tr.	sic
6-12	A1g	0.3b	1.5b	2.1b	3.2b	5.6b	57.6	29.7	37.9	26.8	Tr.	sicl
12-22	C1g	2.0b	2.1b	2.6b	5.2b	8.9b	58.4	20.8	48.2	21.7	3	sil
22-32	C2g	2.9b	3.8b	5.0b	9.9b	12.9b	48.5	17.0	49.1	17.2	5	l
32-42	D1	2.4b	6.0b	7.7b	13.3b	16.8b	42.1	11.7	52.4	12.7	2	l
42-48	D2	4.9b	7.2b	8.6b	16.6b	15.1b	38.4	9.2	49.3	12.6	6	fsl
48-54	D3	7.0b	8.9b	9.9b	25.9b	17.0b	25.1	6.2	46.8	9.7	4	fsl

1:1	pH 8C1a 1:5	1:10	ORGANIC MATTER 6A1a ORGANIC CARBON %	6B1a NITROGEN %	C/N	6E1a $CaCO_3$ equivalent %	MOISTURE TENSIONS 1/10 ATMOS. %	1/3 ATMOS. %	4B2 15 ATMOS. %
	6.5		12.82	.996	12.9				41.5
6.5			1.75	.124	14.1				15.2
6.6			0.26	.027	10				9.7
7.0			0.16	.022					8.4
7.4			0.09	.010		-			5.7
7.7			0.06	.010		-			4.6
7.8			0.07	.008		-			3.3

5A1a CATION EXCHANGE CAPACITY NH_4Ac	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	BASE SAT. % NH_4Ac EXCH. 5C1	Base Sat. % on Sum Cations 5C3	5B1a Sum Bases	5A3a Sum Cations	8D3 Ca/Mg
←	milliequivalents per 100g. soil →							←me/100g→		
73.1	59.6	12.4	21.5	0.1	0.9	100	77	73.0	94.5	4.8
33.6	24.7	7.9	7.2	0.1	0.3	98	82	33.0	40.2	3.1
19.3	12.8	6.4	2.5	0.1	0.2	100	89	19.5	22.0	2.0
15.7	10.4	5.3	2.1	0.1	0.2	100	88	16.0	18.1	2.0
10.2	6.8	3.7	1.6	0.1	0.2	100	87	10.8	12.4	1.8
8.3	5.7	2.9	0.8	0.1	0.1	100	92	8.8	9.6	2.0
6.3	4.2	2.0	0.8	0.1	0.1	100	89	6.4	7.2	2.1

a. Common smooth brown concr. (Mn-Fe?)
b. Few irregular and smooth dk. brown to black concr. (Mn?)

Soil type: Adolph silty clay loam
Soil No.: S57Minn-48-2-(1-7)
Location: Southwest quarter of southwest quarter of Sec. 21, T38N, R26W, Mille Lacs County, Minnesota. Site is in a woodlot .4 mile south of the junction of state route 23 and county road 11, 50 yards east of county road 11 and 30 yards north of the south edge of the woodlot.
Vegetation: Aspen, elm, and alder with some raspberries in the understory.
Parent material: A two-story profile with silts overlying reddish noncalcareous sandy loam or sandy clay loam till.
Physiographic position: Relatively large depressions, 3 to 5 feet below the general level of the ground moraine.
Topography: Nearly level.
Slope: 1 percent toward center of depression.
Drainage: Poor; surface runoff is slow and often ponded.
Ground water: At 56 inches at time of sampling.
Permeability: Slow.
Moisture: Moist.
Stoniness: A few boulders and stones occur on and through the soil mass.
Sampled by and date: A. H. Paschall, August 1957.

Horizon and Lincoln Lab. Number	
A1 6464	0 to 6 inches. Black (N 2/0) silty clay loam; strong fine subangular blocky structure; friable when moist, slightly plastic and slightly sticky when wet; roots plentiful; clear wavy boundary.
A1g 6465	6 to 12 inches. Black (5Y 2/1) silty clay loam; moderate fine subangular blocky structure; plastic and sticky when wet; contains a few gravel 1 to 2 inches in size; roots plentiful; clear wavy boundary.
C1g 6466	12 to 22 inches. Olive gray (5Y 5/2) silty clay loam with many fine distinct mottles of olive (5Y 5/6); massive to weak very fine angular blocks; plastic and sticky when wet; few live roots, many old root channels are lined with black; gradual smooth boundary.
C2g 6467	22 to 32 inches. Olive gray (5Y 5/2) silty clay loam with many medium distinct strong brown (7.5YR 5/6) mottles; massive to weak very fine angular blocks; plastic and sticky when wet; a few gravel about 1 to 2 inches in size; clear smooth boundary.
D1 6468	32 to 42 inches. Reddish gray (5YR 5/2) sandy clay loam till with many medium distinct strong brown (7.5YR 5/6) mottles; massive to weak coarse subangular blocky structure; friable when moist; many fine root channels lined with black, some channels still open; gradual boundary.
D2 6469	42 to 48 inches. Sandy clay loam with a 50-50 mixture of brown to dark brown (7.5YR 5/2 to 4/2) and strong brown (7.5YR 5/6); weak to moderate medium and coarse angular blocky structure; friable; many fine root channels lined with black; contains a few fine pebbles and gravel.
D3 6470	48 to 54 inches. Dark reddish brown (5YR 3/4) sandy loam till; weak coarse angular blocky structure; reddish-gray (5YR 5/2) color around a few old root channels, others are lined with black.

SOIL SURVEY LABORATORY Lincoln, Nebr. 5/19/58

SOIL TYPE Adolph silty clay loam **LOCATION** Mille Lacs County, Minnesota

SOIL NOS. S57Minn-48-5-(1-5) **LAB. NOS.** 6473-6477

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)	TEXTURAL CLASS
0-5	A1	0.7a	1.7a	1.4a	2.6a	3.3a	57.6	32.7	28.2	34.0	Tr.	sicl
5-13	A12g	1.7a	2.6a	2.2a	4.2a	6.2a	61.1	22.0	43.4	26.0	4	sil
13-32	C1	0.6a	0.8a	0.9a	2.0a	7.2a	71.7	16.8	53.8	26.1	3	sil
32-44	D1	6.4a	8.4a	10.7a	23.1a	16.8a	26.5	8.1	44.7	10.2	8	sl
44-54	D2	11.2a	10.6a	10.5a	19.6a	11.4a	28.7	8.0	34.4	15.2	19	sl

	pH 8C1a		ORGANIC MATTER 6A1a	6B1a			6E1a		MOISTURE TENSIONS		
1:1	1:5	1:10	ORGANIC CARBON %	NITROGEN %	C/N		$CaCO_3$ equivalent %		1/10 ATMOS. %	1/3 ATMOS. %	4B2 15 ATMOS. %
5.8			7.95	.654	12.2						23.4
6.0			0.72	.056	13						10.6
6.9			0.14	.013							8.1
7.7			0.05	.014			-				3.8
7.7			0.04	.015			-				3.7

5A1a CATION EXCHANGE CAPACITY NH_4Ac	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	BASE SAT. % NH_4Ac EXCH. 5C1	Base Sat. % on Sum Cations 5C3	5B1a Sum Bases	5A3a Sum Cations	8D3 Ca/Mg
← milliequivalents per 100g. soil →								← me/100g →		
48.6	31.3	8.4	23.4	0.1	0.8	84	63	40.6	64.0	3.7
22.1	14.7	6.3	5.4	0.1	0.2	96	80	21.3	26.7	2.3
15.9	10.6	5.8	2.1	0.1	0.2	100	89	16.7	18.8	1.8
7.7	5.3	2.7	1.2	0.1	0.1	100	87	8.2	9.4	2.0
6.7	4.6	1.9	1.2	0.1	0.1	100	85	6.7	7.9	2.4

a. Few irregular black plates. (charcoal?)

Soil type: Adolph silty clay loam
Soil No.: S57Minn-48-5-(1-5)
Location: Northwest quarter of southwest quarter of southwest quarter of Sec. 15, T39N, R27W, Mille Lacs County, Minnesota. Site is .2 mile north of southwest section corner in woodlot and approximately 100 yards east of road and 20 feet north of south boundary of woods.
Vegetation: Aspen, elm, and alder.
Parent material: A two-story profile with silts overlying reddish noncalcareous sandy loam or sandy clay loam till.
Physiographic position: Relatively large depression, 3 to 5 feet below the general level of the ground moraine.
Topography: Nearly level.
Slope: 1 percent toward center of depression.
Drainage: Poor; surface runoff is slow and often ponded.
Ground water: At 54 inches at time of sampling.
Permeability: Slow.
Moisture: Moist.
Stoniness: A few boulders and smaller stones occur on and through the soil mass. (See note below).
Sampled by and date: A. H. Paschall, August 1957.

Horizon and Lincoln Lab. Number	
A1 6473	0 to 5 inches. Black (N 2/0) silty clay loam; strong, fine and medium subangular blocky structure; friable; abundant roots; clear wavy boundary.
A12g 6474	5 to 13 inches. Very dark gray (N 3/0) to dark gray (N 4/0) silt loam with many medium distinct mottles of dark reddish brown (5YR 3/4); none to weak thin plate-like structure that breaks to weak very fine subangular blocks; friable when moist; slightly plastic when wet; many live roots; clear wavy boundary.
C1 6475	13 to 32 inches. Gray (5Y 5/1) heavy silt loam to silty clay loam; appears massive in place but breaks into weak very fine subangular blocks; friable; contains a few live roots; clear wavy boundary.
D1 6476	32 to 44 inches. Reddish gray (5YR 5/2) coatings on sandy clay loam aggregates of glacial till which show interiors of reddish brown (5YR 4/3) with many medium distinct mottles of strong brown colors; weak coarse subangular blocky structure; friable; a few old root channels lined with materials from horizon above; gradual smooth boundary.
D2 6477	44 to 54 inches. Reddish brown (5YR 4/4) sandy clay loam till with smears of reddish gray (5YR 5/2) and with a few medium distinct mottles of yellowish red (5YR 5/6); weak coarse subangular blocks; slightly plastic; contains many gravel 1/2 to 2 inches in diameter and exhibits some tendency towards horizontal breakage.

Note: The 5 to 13-inch layer has several stones 3 to 4 inches in diameter. There is a dark reddish brown (5YR 3/4) color around these stones. A few old root channels also occur in this horizon. These also show a dark reddish brown band around the channel. The channel is filled with material from horizon above. There is a definite stone lag at the surface of the 32- to 44-inch layer; stones are 2 to 4 inches in size.

SOIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Anoka loamy fine sand **LOCATION** Isanti County, Minnesota

SOIL NOS. S61Minn-30-1 **LAB. NOS.** 15849-15858

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)
0-10	Ap	0.2	0.7	2.6	32.0	55.1	7.3	2.1	85.5	2.9	Tr.
10-26	A21	0.1	0.6	2.0	31.7	55.7	8.3	1.6	86.5	3.8	-
26-36	A22	<0.1	0.4	2.0	35.4	55.1	5.4	1.7	87.7	2.4	-
36-40	B21	<0.1	0.3	1.6	29.3	53.1	4.2	11.5	80.5	1.2	-
40-43	B22	0.1	0.3	1.4	27.0	54.8	3.8	12.6	80.9	0.4	-
43-50	A'2orC	0.1	0.2	0.6	23.7	66.9	5.2	3.3	93.0	0.8	-
50-54	B'2	0.7	2.4	5.9	51.9	30.7	1.1	7.3	67.5	0.1	Tr.
54-55	A''2orC	0.2	1.2	2.7	33.0	56.2	2.6	4.1	84.5	0.1	Tr.
55-56	B''2	0.2	1.8	3.1	31.1	53.9	2.3	7.6	80.7	0.1	Tr.
56-70	C1	<0.1	1.6	2.9	39.2	48.5	3.2	4.6	80.0	0.3	-

8C1a pH 1:1	6C1a Ext. Iron as Fe %	Organic Matter 6A1a O.C. % [a]	6B1a N %	C/N	Bulk Density Field Moist. 4B4 % M.	4A1a g/cc	30 Cm. 4B3 % M.	4A1c g/cc	A.D. 4A1b g/cc	Moisture Retention 1/10-Atm. Pieces %	4B1a 1/10-Atm. Sieved %	4B2 15-Atm. Sieved %
5.9	0.4	0.43	0.039	11		1.58b					10.3	1.9
6.0	0.3	0.14	0.014			1.46b					10.4	1.1
6.0	0.3	0.10									8.7	
5.6	0.6	0.10			10.2	1.63	14.9	1.58	1.64		18.2	5.0
5.5	0.7	0.10									20.3	5.5
5.8	0.4	0.06									11.8	1.4
5.9	0.5	0.06									10.4	3.0
5.8	0.4	0.10									10.0	2.0
5.9	0.4	0.10									13.4	3.2
6.1	0.4	0.03				1.56b					10.2	2.0

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a Sum	Base Sat. 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8D1 NH_4OAc CEC	Ext. Iron	
←	milliequivalents per 100g. soil →										
4.1	1.8	0.5	2.7	Tr.	0.1	5.1	47	58	2.0	0.2	
2.0	1.3	0.3	2.1	Tr.	Tr.	3.7	43	80			
1.9	1.2	0.2	1.6	Tr.	Tr.	3.0	47	74			
7.5	4.3	1.4	4.2	Tr.	0.2	10.1	58	79	0.6	0.1	
8.4	5.0	1.8	3.9	Tr.	0.2	10.9	64	83	0.7	0.1	
3.0	1.7	1.0	1.6	Tr.	0.1	4.4	64	93	0.9	0.1	
5.1	2.9	1.4	2.1	Tr.	0.1	6.5	68	86	0.7	0.1	
										0.1	
										0.1	
3.8	2.3	0.9	1.4	Tr.	0.1				0.8	0.1	

a. 3.1 Kg/M^2 to depth of 40 inches (field moist bulk density)

b. Average of 2 cores.

Concretions, organic matter fragments or other special formations were not evident in the sand fractions.

Soil type: Anoka loamy fine sand
Soil No.: S61Minn-30-1
Location: Southwest quarter of northwest quarter of Sec. 30, T35N, R23W, Isanti County, Minnesota, about 1 mile west of Isanti Village, 550 feet north of a point 300 feet east of east end of bridge over Rum River on county road 5 which runs along south side of Section 30.
Vegetation: Corn stubble.
Parent material: Outwash sand; possibly wind sorted.
Physiographic position: Outwash plain.
Topography: Gently rolling.
Slope: Two percent.
Aspect: West.
Drainage: Well drained.
Ground water: Deep, over 10 feet.
Permeability: Very rapid in sand; moderate in bands.
Root distribution: Few to 36 inches; none observed in bands.
Erosion: Slightly wind eroded.
Stoniness: None.
Sampled by and date: Klaus Flach, R. S. Farnham, R. H. Rust, and A. S. Robertson, September 15, 1961.

Horizon and Lincoln Lab. Number	
Ap 15849	0 to 10 inches. Dark grayish brown (10YR 4/2) to brown to dark brown (10YR 4/3) loamy fine sand; massive; loose; abrupt smooth boundary.
A21 15850	10 to 26 inches. Grayish brown (10YR 5/2) fine and very fine sand tending to brown (10YR 5/3) and with streaks of light brownish gray (10YR 6/2); single grain; loose; clear wavy boundary.
A22 15851	26 to 36 inches. Dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) fine and very fine sand with streaks of light brownish gray (10YR 6/2); single grain; loose; abrupt smooth boundary.
B21 15852	36 to 40 inches. Brown to dark brown (10YR 4/3) fine sandy loam tending to dark brown (7.5YR 3/2) and with a few streaks of 10YR 2/2. Massive; very hard when dry; friable to firm when moist; clear wavy boundary.
B22 15853	40 to 43 inches. Brown to dark brown (10YR 4/3) fine sandy loam tending to dark brown (7.5YR 3/2) and with a few streaks of yellowish brown (10YR 5/4) and a few splotches of light brownish gray (10YR 6/2); massive; hard when dry; friable to firm when moist; clear wavy boundary.
A'2 or C 15854	43 to 50 inches. Grayish brown (10YR 5/2) and brown (10YR 5/3) fine and very fine sand; single grain; loose; clear wavy boundary. One thin (1/2 inch) irregular band of dark yellowish brown (10YR 4/4) in middle of this horizon.
B'2 15855	50 to 54 inches. Brown to dark brown (10YR 4/3) loamy sand grading to dark brown (10YR 3/3) in the lower part; some streaks of yellowish brown (10YR 5/4); massive; slightly hard; friable to firm; weakly coherent; abrupt wavy boundary.
A''2 or C 15856	54 to 55 inches. Yellowish brown (10YR 5/4) fine and medium sand tending to light olive brown (2.5Y 5/4); single grain; loose; abrupt wavy boundary.
B''2 15857	55 to 56 inches. Dark yellowish brown (10YR 3/4) loamy fine sand with very thin seams of brown to yellowish brown (10YR 5/3 to 5/4); massive; friable; weakly coherent; abrupt wavy boundary.
C1 15858	56 to 70 inches. Brown (10YR 5/3) to yellowish brown (10YR 5/4) fine and very fine sand; single grain; loose; a few 1/8 to 1/4-inch dark yellowish brown (10YR 4/4) loamy sand bands in this horizon.

Note: All colors for moist soil. Native vegetation was an oak forest. C1 horizon continued to 100 inches; at this depth calcareous sand was reached. It was light brownish gray (10YR 6/2) with many dark-colored minerals present. This calcareous material continued to 15 feet and no deeper examination was made.

SOIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Anoka loamy fine sand **LOCATION** Isanti County, Minnesota

SOIL NOS. S61Minn-30-2 **LAB. NOS.** 15859-15866

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)
0-9	Ap	0.5	1.9	2.4	22.8	48.4	19.0	5.0	78.9	7.0	Tr.
9-20	A21	1.1	1.8	2.3	23.4	48.2	18.8	4.4	79.4	6.5	Tr.
20-25	A22	0.9	2.0	2.7	25.2	49.6	16.3	3.3	81.3	4.6	Tr.
25-30	B2	2.2	4.4	4.7	26.9	44.1	7.2	10.5	70.4	1.3	Tr.
30-34	A'2 or C	1.2	1.8	1.5	25.0	60.0	7.7	2.8	89.3	1.1	Tr.
34-41	B'2	<0.1	0.2	0.3	18.0	63.1	8.1	10.3	87.3	1.0	Tr.
41-52	B-C	0.2	0.2	0.4	6.4	59.5	24.5	8.8	86.7	2.5	Tr.
52-65	C	0.1	0.2	0.5	10.8	64.5	19.6	4.3	90.8	2.4	Tr.

8C1a pH 1:1	Ext. Iron as Fe %	Organic Matter 6A1a O.C. %	6B1a N %	C/N	Bulk Density Field Moist % M.	Field Moist g/cc	30 Cm. % M.	30 Cm. g/cc	A.D. g/cc	Moisture Retention 1/10-Atm. Pieces %	1/10-Atm. Sieved %	4B2 15-Atm. Sieved %
5.8		1.07	0.088	12								3.4
6.1		0.23	0.026									2.1
6.0		0.14	0.009									1.6
5.9		0.14										4.0
6.0		0.06										1.3
5.7		0.10										4.2
5.7		0.10										4.4
5.6		0.06										2.6

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a Sum	Base Sat., 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8D1 NH_4OAc CEC	Ext. Iron
← milliequivalents per 100g. soil →										
7.1	4.4	0.6	5.3	Tr.	0.1	10.4	49	72	1.4	
4.2	2.1	0.6	3.0	Tr.	Tr.	5.7	47	64	1.0	
2.9	1.5	0.7	2.1	Tr.	Tr.	4.3	51	76	0.9	
6.4	3.8	1.8	3.0	Tr.	0.1	8.7	66	89	0.6	
2.8	1.5	0.8	1.4	Tr.	Tr.	3.7	62	82	1.0	
6.7	3.8	1.7	3.9	Tr.	0.2	9.6	59	85	0.6	
6.7	3.9	1.5	2.8	Tr.	0.2	8.4	67	84	0.8	
4.9	2.8	1.3	2.1	Tr.	0.1	6.3	67	86	1.1	

Concretions, organic matter fragments or other special formations were not evident in the sand fractions.

Soil type: Anoka loamy fine sand
Soil No.: S61Minn-30-2
Location: 625 feet north and 180 feet east of the southwest corner of Sec. 2, T36N, R25W, Isanti County, Minnesota.
Vegetation: Mainly quackgrass and timothy with some red clover. Some pigeon grass and hoary alyssum.
Parent material: Outwash sand; possibly reworked by wind.
Physiographic position: Outwash plain.
Topography: Gently rolling.
Slope: Three percent.
Aspect: East.
Drainage: Well drained.
Ground water: Deep, over 10 feet.
Permeability: Rapid in sand; moderate in bands.
Root distribution: Common to 10 inches; few to 36 inches.
Stoniness: None.
Sampled by and date: Klaus Flach, R. S. Farnham, R. H. Rust, and A. S. Robertson, September 15, 1961.

Horizon and Lincoln Lab. Number	
Ap 15859	0 to 9 inches. Very dark gray (10YR 3/1) loamy very fine sand; weak fine crumb structure; loose; abrupt smooth boundary.
A21 15860	9 to 20 inches. Brown (10YR 5/3) and dark brown (10YR 3/3 to 4/3) very fine sand and fine sand; single grain tending to weak medium subangular blocky structure; loose; gradual wavy boundary.
A22 15861	20 to 25 inches. Brown (10YR 5/3) very fine sand and fine sand; single grain tending to weak medium subangular blocky structure; loose; abrupt smooth boundary.
B2 15862	25 to 30 inches. Dark brown (10YR 3/3) fine sandy loam tending to dark brown (7.5YR 3/3) with irregular streaks of brown (10YR 5/3); massive; tending to weak coarse subangular blocky structure; consistence estimated to be hard when dry; friable to firm; weakly calcareous; gradual wavy boundary.
A'2 or C 15863	30 to 34 inches. Brown (10YR 5/3) fine and very fine sand; single grain; loose; abrupt wavy boundary.
B'2 15864	34 to 41 inches. Dark brown (7.5YR 3/2 to 3/4) light sandy loam with a few streaks of brown (10YR 5/3); massive, tending to weak coarse subangular blocky structure; friable to firm; consistence estimated to be hard when dry, weakly coherent when moist; a few thin patchy clay films on vertical ped faces; abrupt wavy boundary.
B - C 15865	41 to 52 inches. Brown to dark brown (10YR 4/3) loamy fine sand with splotches and streaks of brown (10YR 5/3); single grain; loose; clear wavy boundary. This horizon contains thin irregular discontinuous bands. A thin layer (less than 1/2 inch) of yellowish brown sand at the top of this horizon was not sampled.
C 15866	52 to 65 inches. Grayish brown (10YR 5/2) to brown (10YR 5/3) fine and very fine sand with a few medium-sized distinct dark reddish brown (5YR 3/4) mottles; single grain; loose when moist, but has some coherence; a few pipestems; clear wavy boundary.
D	65 to 86 inches. Light olive brown (2.5Y 5/4) sandy clay loam with a few reddish brown mottles; massive; friable; this is noncalcareous glacial till.

Note: Native vegetation was an oak forest. Till material is not usually reached within 7 feet of the surface, but this site was considered well within the range of the Anoka series. All colors are for moist soils unless otherwise noted.

SOIL SURVEY LABORATORY
Beltsville, Maryland

LOCATION Crow Wing County, Minnesota SOIL TYPE Brainerd sandy loam

LAB NOS. 55305 - 55312 SURVEY NOS. 54Minn18-33-(A1 - A8)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	INTERNATIONAL II 0.2-0.02	INTERNATIONAL III 0.02-0.002	2A2 > 2 <76mm	TEXTURAL CLASS
55305	1-0	Ao											
55306	0-3	A1	4.3	13.8	14.9	18.6	7.4	33.2	7.8	31.2	18.1	Tr.	
55307	3-17	A2	4.6	13.3	16.5	22.5	10.2	27.1	5.8	35.6	13.0	26	
55308	17-21	B1	9.1	16.8	15.9	19.3	9.0	18.3	11.6	26.3	10.1	27	
55309	21-28	B2	6.5	16.9	17.5	22.6	8.0	17.5	11.0	26.4	9.6	26	
55310	21-30	(?)	6.5	16.2	17.9	23.0	10.8	17.3	8.3	29.5	9.0	15	
55311	28-33	C1	5.3	12.8	13.3	25.9	18.5	16.3	7.9	43.5	6.5	18	
55312	33-48	C2	6.4	16.7	17.0	20.5	10.1	18.2	11.1	28.0	9.4	28	

LABORATORY NUMBER	pH 8C1a H_2O 1:1	pH 1:4		ORGANIC MATTER 6A1a ORGANIC CARBON %	NITROGEN %	C/N	FREE IRON OXIDE Fe_2O_3 %			BULK DENSITY g/cc	MOISTURE RETAINED AT 1/10 ATMOS. %	1/3 ATMOS. %	15 ATMOS. %
55305		5.6											
55306	4.7			3.33									
55307	5.2			0.37									
55308	5.2			0.06									
55309	5.4			0.02									
55310	5.4			0.07									
55311	5.6			0.08									
55312	5.6			0.02									

LABORATORY NUMBER	5A3a CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	6H1a H	BASE SATURATION % 5C3 (SUM)
		milliequivalents per 100g soil					
55305							
55306	20.2	4.2	1.0	Tr.	0.2	14.8	27
55307	5.5	1.7	0.2	Tr.	Tr.	3.6	34
55308	8.2	3.6	1.2	0.1	Tr.	3.3	60
55309	8.9	4.2	1.9	Tr.	Tr.	2.8	68
55310	6.1	2.5	1.2	Tr.	Tr.	2.4	61
55311	7.2	2.9	1.7	0.1	Tr.	2.5	65
55312	8.7	3.9	2.2	0.1	0.1	2.4	72

BRAINERD SANDY LOAM S54Minn-18-33-(A1-A8)

Location: Crow Wing County, Minnesota. N. E. Corner of S. E. 1/4 sec. 28, T45N R30W.

Samples Collected by: H. F. Arneman

Profile Described by: H. F. Arneman

Horizon and Beltsville Lab. No.		
Ao 55305	1-0 inch	Well rotted leaf mold.
A1 55306	0-3 inches	10 YR 2/2 (moist) loam numerous fibrous roots, moderate fine granular structure.
A2 55307	3-17 inches	10 YR 4/3 to 10 YR 4/4 (moist), loam to sandy loam, structureless.
B1 55308	17-21 inches	7.5 YR 4/4 mottled with brown (moist) sandy clay loam, structureless.
B2 55309	21-28 inches	7.5 YR 4/4 mottled with yellow and pink (moist) sandy clay loam, weak medium subangular blocky structure.
(?) 55310	21-30 inches	This is a pocket of A2 material with a few inclusions of B2 material. It has the appearance of a B horizon that is disintegrating into an A horizon.
C1 55311	28-33 inches	7.5 YR 4/4 (moist) sandy loam, very weak medium sub-angular blocky structure.
C2 55312	33-48 inches	7.5 YR 4/4 (moist) sandy loam, structureless, with clay balls of 7.5 YR 5/2 (moist) sandy clay common to all brown till soils.

SOIL SURVEY LABORATORY
Beltsville, Maryland

LOCATION Crow Wing County, Minnesota SOIL TYPE Brainerd loam

LAB NOS. 55313 - 55319 SURVEY NOS. 54Minn-18-33-(B1 - B7)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b VERY COARSE SAND 2-1	PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	INTERNATIONAL II 0.2-0.02	INTERNATIONAL III 0.02-0.002	2A2 > 2 (<76mm)	TEXTURAL CLASS
55313	0-3	A1	1.8	10.4	12.5	19.5	10.5	36.1	9.2	37.0	19.3	0	
55314	3-13	A2	5.0	12.1	13.5	20.9	12.6	30.3	5.6	37.9	15.4	17	
55315	13-18	A3	7.4	16.6	16.9	21.6	10.0	21.7	5.8	31.8	10.4	28	
55316	18-28	B1	6.2	17.0	17.7	22.0	9.3	18.4	9.4	28.7	9.6	33	
55317	28-38	B2	7.5	17.2	17.2	21.0	9.0	18.1	10.0	27.7	9.4	26	
55318	38-50	B3	7.4	17.7	17.5	21.2	9.1	17.3	9.8	27.3	9.2	30	
55319	50-60	C	5.2	16.9	17.7	21.6	9.2	17.8	11.6	27.8	9.5	31	

	pH 8C1a			ORGANIC MATTER			FREE IRON OXIDE			MOISTURE RETAINED AT		
	H_2O 1:1			6A1a ORGANIC CARBON %	NITROGEN %	C/N	Fe_2O_3 %		BULK DENSITY g/cc	1/10 ATMOS. %	1/3 ATMOS. %	15 ATMOS. %
55313	5.1			4.8								
55314	5.2			0.32								
55315	5.2			0.03								
55316	5.2			0.15								
55317	5.4			0.08								
55318	5.6			0.06								
55319	5.6			0.05								

	5A3a CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5R1a 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	6H1a H	BASE SATURATION % 5C3 (SUM)
		milliequivalents per 100g soil					
55313	24.7	8.2	2.1	Tr.	0.3	14.1	43
55314	6.2	1.9	0.5	Tr.	Tr.	3.8	39
55315	4.8	1.4	0.6	Tr.	Tr.	2.8	42
55316	6.9	2.5	1.0	Tr.	Tr.	3.4	51
55317	7.7	3.4	1.4	0.2	Tr.	2.7	65
55318	7.2	3.3	1.8	0.2	Tr.	1.9	74
55319	8.6	3.9	2.1	0.1	0.1	2.4	72

BRAINERD LOAM S54Minn-18-33-(B1 - B7)

Location: Crow Wing County, Minnesota. S. W. Corner of N. W. 1/4 sec. 28, T44N R30W.

Samples Collected by: H. F. Arneman

Profile Described by: H. F. Arneman

Horizon and Beltsville Lab. No.		
A1 55313	0-3 inches	10 YR 2/2 (moist) loam, moderately medium granular, moderately friable.
A2 55314	3-13 inches	10 YR 5/4 (moist) loam, weak fine platy, moderately friable.
A3 55315	13-18 inches	10 YR 4/4 (moist) sandy loam, weak fine sub-angular blocky, slightly hard when dry.
B1 55316	18-28 inches	10 YR 4/3 - 10 YR 4/4 (moist) sandy loam, weak fine sub-angular blocky, hard when dry.
B2 55317	28-38 inches	7.5 YR 4/4 with common medium distinct 7.5 YR 6/8 mottles (moist), sandy loam, weak medium sub-angular blocky, hard when dry.
B3 55318	38-50 inches	7.5 YR 4/4 with common medium distinct 7.5 YR 6/8 mottles (moist), sandy loam, massive, hard when dry, with inclusions of 7.5 YR 6/2 (moist) sandy clay.
C 55319	50-60 inches	7.5 YR 4/4 with few medium distinct 7.5 YR 6/8 mottles (moist), sandy loam, massive, hard when dry, with numerous inclusions of 7.5 YR 6/2 (moist) sandy clay.

SCS-421
10-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL *Erin silt loam SOIL Nos. S60Minn-66-1 LOCATION Rice County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13687-13694 February 1965

Depth (in.)	Horizon	1B1a Total Sand (2–0.05)	Total Silt (0.05–0.002)	Total Clay (< 0.002)	Sand: Very coarse (2–1)	Sand: Coarse (1–0.5)	Sand: Medium (0.5–0.25)	Sand: Fine (0.25–0.1)	Sand: Very fine (0.1–0.05)	Silt: 0.05–0.02	Silt: Int. III (0.02–0.002)	Int. II (0.2–0.02)	3A1 (2–0.1)			Coarse fragments 2A2: >2	2–19	19–76
		Pct. of < 2 mm														Pct.	Pct. of < 76mm	
0-3	A1	27.4	52.6	20.0	1.6	3.3	3.8	11.1	7.6	19.9	32.7	33.4	19.8			Tr.	Tr.	-
3-9	A2	28.5	52.7	18.8	1.0	3.4	4.2	11.6	8.3	20.1	32.6	34.6	20.2			Tr.	Tr.	-
9-14	B1	31.0	41.5	27.5	2.9	3.5	4.2	12.2	8.2	15.6	25.9	30.2	22.8			Tr.	Tr.	-
14-24	B21	30.0	37.2	32.8	2.2	4.1	4.3	11.4	8.0	13.2	24.0	27.1	22.0			Tr.	Tr.	-
24-33	B22	34.4	32.9	32.7	2.1	6.7	6.0	12.3	7.3	10.6	22.3	23.9	27.1			Tr.	Tr.	-
33-42	B23	34.4	32.6	33.0	4.4	6.4	5.3	11.2	7.1	11.0	21.6	23.5	27.3			10c	10c	-
42-59	B3	35.5	33.1	31.4	2.2	3.8	4.4	14.8	10.3	11.2	21.9	29.5	25.2			Tr.	Tr.	-
59-65	C	38.1	35.7	26.2a	3.1b	4.3b	4.5b	15.5b	10.7b	13.1	22.6	32.3	27.4			Tr.	Tr.	-

Depth (in.)	6A1a Organic carbon	6B1a Nitrogen	C/N		6E1c Carbonate as $CaCO_3$	6C1a Ext. Iron as Fe	Bulk density: 4A1a Field-State	4A1c 30-Cm.	4A1h Oven-Dry	4D1 Extensibility in. per horizon	Water Content: 4B4 Field-State	4B3 30-Cm.	4B1b 1/3-Bar Pieced	4B2 15-Bar	4C1 1/3- to 15-Bar in. per horizon	pH		8C1a (1:1)
	Pct.	Pct.			Pct.	Pct.	g/cc	g/cc	g/cc		Pct.		Pct.	Pct.				
0-3	6.38	0.438	14			0.6								17.4				5.9
3-9	1.83	0.158	12			0.6								10.1				5.2
9-14	0.41	0.044	9			0.7								11.8				4.9
14-24	0.37	0.048	8			0.9							20.3	15.8				4.7
24-33	0.29					1.0	1.56	1.45	1.60	0.28	16.1	24.8	26.8	16.0	1.4			4.8
33-42	0.26					1.1								17.5				4.8
42-59	0.20					0.9	1.49	1.44	1.54	0.34	20.6	27.4	26.8	17.6	2.2			5.4
59-65	0.15				5d	1.0								15.9				7.7

Depth (in.)	Extractable bases 5B1a: 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	5B1a Sum	6H1a Ext. Acidity	Cat. Exch. Cap.: 5A3a Sum Cations	5A1a NH_4OAc	6G1a KCl Ext. Al	8D3 Ca/Mg	Base saturation: 5C3 Sum Cations	5C1 NH_4OAc
	meq/100 g										Pct.	Pct.
0-3	21.6	3.5	Tr.	0.8	25.9	12.3	38.2	28.3	-	6.2	68	92
3-9	9.1	1.7	Tr.	0.5	11.3	10.2	21.5	15.8	0.1	5.4	52	72
9-14	8.8	3.6	0.1	0.6	13.1	6.5	19.6	16.1	0.5	2.4	67	81
14-24	9.2	3.5	Tr.	0.7	13.4	7.9	21.3	20.5	0.7	2.6	63	65
24-33	12.1	5.7	0.3	0.4	18.5	7.9	26.4	21.8	0.8	2.1	70	85
33-42	12.7	6.2	0.4	0.3	19.6	8.0	27.6	22.4	0.6	2.0	71	88
42-59	14.8	6.9	0.4	0.2	22.3	5.2	27.5	23.0	0.1	2.1	81	97
59-65		7.0	0.4	0.3				20.7				

Depth (in.)	Ratios to Clay 8D1: NH_4OAc CEC	Ext. Iron	15-Bar Water
0-3	1.42	0.03	0.87
3-9	0.84	0.03	0.54
9-14	0.58	0.02	0.43
14-24	0.62	0.03	0.48
24-33	0.67	0.03	0.49
33-42	0.68	0.03	0.53
42-59	0.73	0.03	0.56
59-65	0.79	0.04	0.61

a. No carbonate clay detected.
b. 5-25% carbonate.
c. Mostly siltstone and shale; minor component of igneous rock.
d. A considerable proportion of the carbonate is dolomite, with a little calcite.

Soil type: *Erin silt loam
Soil No.: S60Minn-66-1
Location: Approximately 1,000 feet south and 200 feet east of the northwest corner of the northwest quarter of the northeast quarter of Sec. 28, T111N, R22W, Erin Township, Rice County, Minnesota.
Vegetation: Dominantly hard maple, some prickly ash, oak and hickory.
Parent material: Friable to firm calcareous gray clay loam till, containing small rounded shale particles.
Physiographic position: End moraine (Leverett's Altamont).
Topography: Strongly rolling.
Slope: 10 percent.
Aspect: North-northeast.
Drainage: Well drained.
Ground water: Deep.
Permeability: Moderately slow.
Moisture: Dry.
Stoniness: Very few in the profile, few on the surface.
Root distribution: Plentiful to 9 inches, common to 42 inches, and few below 42 inches.
Sampled by and date: J. S. Allen, E. D. Rivers, J. F. Cummins, C. Carlson, A. S. Robertson and R. H. Rust, August 1, 1960.

Horizon and Lincoln Lab. Number	
A1 13687	0 to 3 inches. Black (10YR 2/1) to very dark gray (10YR 3/1) silt loam, very dark gray (10YR 3/1) to dark gray (10YR 4/1) when dry; moderate medium granular structure; very friable; medium acid; abrupt smooth boundary.
A2 13688	3 to 9 inches. Very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) when dry; moderate thin platy structure; very friable; silica coatings increase in amount in the lower part; strongly acid; clear wavy boundary.
B1 13689	9 to 14 inches. Very dark grayish brown (10YR 3/2) loam to clay loam, very dark brown (10YR 2/2) to very dark gray to dark grayish brown (10YR 3/1 to 4/2 dry) coatings; moderate to strong fine and medium subangular blocky structure; dry, slightly hard; moist, friable; wet, plastic; clay films are thick and continuous; medium acid; gradual wavy boundary.
B21 13690	14 to 24 inches. Dark brown to brown (10YR 5/3) clay loam, very dark grayish brown (10YR 3/2) to light brownish gray (10YR 6/2 dry) coatings on all peds; strong fine and medium subangular and angular blocky structure; moist, firm; wet, plastic; clay films thick and continuous; strongly acid; gradual wavy boundary.
B22 13691	24 to 33 inches. Yellowish-brown (10YR 5/4) to light olive brown (2.5Y 5/4) clay loam; strong coarse and medium angular blocky structure; moist, firm; wet, plastic; very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) coatings, some silica coatings; clay films thick and continuous; very strongly acid; gradual wavy boundary.
B23 13692	33 to 42 inches. Light olive brown (2.5Y 5/4) clay loam; moderate to strong coarse to medium subangular blocky structure; moist, very firm; wet, plastic; very dark grayish brown (10YR 3/2) coatings; some light brownish gray (2.5Y 6/2) to light yellowish brown (2.5Y 6/4) silica coatings on some peds; crushed color yellowish brown (10YR 5/4) to olive brown (2.5Y 4/4); clay films are thick and continuous; very strongly acid; gradual wavy boundary.
B3 13693	42 to 59 inches. Grayish brown (2.5Y 5/2) to light olive brown (2.5Y 5/4) clay loam; moderate coarse prismatic structure; moist, firm; wet, plastic; very dark grayish brown (10YR 3/2) coatings; few fine distinct grayish brown and prominent reddish mottles; clay films thick and continuous; small rounded shale particles; many root channels filled with organic material; iron-manganese concretions common; strongly acid; gradual wavy boundary.
C 13694	59 to 65 inches. Light olive brown (2.5Y 5/4) clay loam with a few fine distinct grayish brown (2.5Y 5/2) mottles; massive with a tendency to vertical cleavage; moist, friable to firm; wet, plastic; small iron-manganese concretions; small rounded shale particles; root channels coated or filled with waxy organic material; slight effervescence.

Note: All colors are for moist soils unless otherwise noted. In the 9 to 14, 14 to 24 and 24 to 33 inch horizons there are thin seams (less than 1 inch thick) without evident silica coatings; these seams are somewhat horizontally oriented. Shale fragments are common throughout the profile.

SCS-421
10-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL *Erin silt loam SOIL Nos. 360Minn-66-2 LOCATION Rice County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13695-13703 February 1965

Depth (In.)	Horizon	1B1a Total Sand (2–0.05)	Total Silt (0.05–0.002)	Total Clay (< 0.002)	Sand: Very coarse (2–1)	Sand: Coarse (1–0.5)	Sand: Medium (0.5–0.25)	Sand: Fine (0.25–0.1)	Sand: Very fine (0.1–0.05)	Silt: 0.05–0.02	Silt: Int. III (0.02–0.002)	Int. II (0.2–0.02)	(2–0.1)			Coarse fragments 2A2: > 2	2 – 19	19 – 76
		Pct of < 2 mm														Pct	Pct of < 76mm	
0-3	A1	20.4	56.3	23.3	1.4	2.7	3.1	7.8	5.4	20.6	35.7	30.0	15.0			Tr.	Tr.	-
3-9	A21	23.3	59.9	16.8	1.3	2.7	3.1	9.2	7.0	21.5	38.4	33.3	16.3			Tr.	Tr.	-
9-12	A22	27.4	50.6	22.0	1.7	3.4	3.8	10.5	8.0	18.9	31.7	32.7	19.4			Tr.	Tr.	-
12-22	B21	32.5	32.1	35.4	2.4	4.5	4.7	12.3	8.6	10.4	21.7	25.5	23.9			Tr.	Tr.	-
22-33	B22	22.7	33.8	43.5	1.8	3.3	3.3	8.2	6.1	9.6	24.2	20.1	16.6			Tr.	Tr.	-
33-44	B23	25.4	35.6	39.0	3.3	3.9	3.6	8.4	6.2	9.8	25.8	20.6	19.2			11c	11c	-
44-57	B24	26.9	35.3	37.8	2.9	4.0	4.0	9.4	6.6	9.8	25.5	21.4	20.3			Tr.	Tr.	-
57-65	B3	34.5	34.9	30.6	3.0	4.1	4.4	13.4	9.6	11.7	23.2	28.9	24.9			Tr.	Tr.	-
65-71	C	32.4	36.7	30.9a	4.1b	5.3b	4.7b	10.8b	7.5b	11.9	24.8	25.1	24.9			4	4	-

Depth (In.)	6A1a Organic carbon	6B1a Nitrogen	C/N		6E1c Carbonate as $CaCO_3$	6C1a Ext. Iron as Fe	Bulk density: 4A1a Field-State	Bulk density: 4A1c 30-Cm.	Bulk density: 4A1h Oven-Dry	4D1 Extensibility in. per horizon	Water Content: 4B4 Field-State	Water Content: 4B3 30-Cm.	Water Content: 4B1b 1/3-Bar Pieces	Water Content: 4B2 15-Bar	Water Content: 4C1 1/3- to 15-Bar in. per horizon	pH		8C1a (1:1)
	Pct.	Pct			Pct.	Pct.	g/cc	g/cc	g/cc		Pct.	Pct.	Pct	Pct.				
0-3	6.52	0.515	13			0.6								18.4				6.3
3-9	0.95	0.092	10			0.6	1.42	1.40	1.44	0.06	15.2	23.3	21.8	8.3	1.1			6.0
9-12	0.46	0.056	8			0.6								9.8				5.8
12-22	0.42	0.049	8			0.9								16.4				5.1
22-33	0.35	0.046	8			1.0	1.46	1.36	1.55	0.46	23.5	29.4	28.4	21.5	1.0			4.5
33-44	0.26					1.0								20.9				4.5
44-57	0.23					1.0	1.50	1.46	1.56	0.26	21.3	26.3	27.8	20.4	1.4			5.1
57-65	0.17				Tr.	1.0								18.6				7.0
65-71	0.13				7d	0.9								17.6				7.6

Depth (In.)	Extractable bases 5B1a: 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	5B1a Sum	6H1a Ext. Acidity	Cat. Exch Cap.: 5A3a Sum Cations	Cat. Exch Cap.: 5A1a NH_4OAc	6G1a KCl Ext. Al	8D3 Ca/Mg	Base saturation: 5C3 Sum Cations	Base saturation: 5C1 NH_4OAc
	meq/100 g										Pct.	Pct
0-3	25.2	4.9	Tr.	1.2	31.3	8.7	40.0	31.0	-	5.1	78	101
3-9	7.4	2.1	Tr.	0.5	10.0	5.5	15.5	11.7	-	3.5	64	85
9-12	8.0	2.7	Tr.	0.5	11.2	4.5	15.7	12.1	Tr.	3.0	71	92
12-22	12.1	5.9	0.2	0.4	18.6	7.1	25.7	20.3	0.8	2.0	72	92
22-33	13.7	7.5	0.4	0.4	22.0	12.2	34.2	26.8	2.4	1.8	64	82
33-44	13.1	7.1	0.5	0.3	21.0	10.3	31.3	24.3	1.8	1.8	67	86
44-57	14.7	7.5	0.6	0.4	23.2	5.9	29.1	24.4	0.2	2.0	80	95
57-65		7.8	0.6	0.4				21.7				
65-71		7.4	0.6	0.4				19.7				

Depth (In.)	Ratios to Clay 8D1: NH_4OAc CEC	Ext. Iron	15-Bar Water
0-3	1.33	0.02	0.79
3-9	0.70	0.04	0.49
9-12	0.55	0.03	0.44
12-22	0.57	0.02	0.46
22-33	0.62	0.02	0.49
33-44	0.62	0.02	0.54
44-57	0.64	0.03	0.54
57-65	0.71	0.03	0.61
65-71	0.64	0.03	0.57

a. No carbonate clay detected.
b. 5-25% carbonate.
c. Mostly subrounded siltstone and shale; subordinate igneous rock.
d. Most of the carbonate is dolomite; very little calcite present.

Soil type: *Erin silt loam
Soil No.: S60Minn-66-2
Location: 700 feet east of the northeast corner of southwest quarter of northeast quarter of Sec. 17, T110N, R22W, Shieldsville Township, Rice County, Minnesota.
Vegetation: Maple, red and white oak, prickly ash, and bluegrass.
Parent material: Firm, calcareous gray clay loam till.
Physiographic position: End moraine (Leverett's Altamont).
Topography: Strongly rolling.
Slope: 12 percent.
Aspect: West-northwest.
Drainage: Well drained.
Ground water: Deep.
Permeability: Moderately slow.
Moisture: Dry.
Stoniness: Very few in the profile.
Root distribution: Plentiful from 0 to 12 inches, common 12 to 57 inches.
Sampled by and date: J. S. Allen, R. H. Rust, E. D. Rivers, J. F. Cummins, C. R. Carlson, August 1, 1960.

Horizon and Lincoln Lab. Number	
A1 13695	0 to 3 inches. Black (10YR 2/1) to very dark gray (10YR 3/1) silt loam, very dark gray (10YR 3/1) when dry; weak fine granular structure; moist, very friable; wet, slightly stick; slightly acid; abrupt smooth boundary.
A21 13696	3 to 9 inches. Dark grayish brown (10YR 4/2) silt loam, dark grayish brown to grayish brown (10YR 4/2 to 5/2) when dry; weak to moderate medium platy structure; moist, very friable; wet, slightly sticky; medium acid; abrupt smooth boundary.
A22 13697	9 to 12 inches. Dark gray (10YR 4/1) silt loam; grayish brown to light grayish brown (10YR 5/2 to 6/2) when dry; weak fine to medium subangular blocky structure; moist, friable; wet, slightly plastic; strongly acid; clear wavy boundary.
B21 13698	12 to 22 inches. Dark grayish brown (10YR 4/2) clay loam, grayish brown to brown (10YR 5/2 to 5/3) when dry; moderate to strong fine to medium angular structure; moist, firm; wet, plastic; light brownish gray (10YR 6/2 dry) silica coatings; many fine rounded shale particles; strongly acid; clear smooth boundary.
B22 13699	22 to 33 inches. Olive brown (2.5Y 4/4) to light olive brown (2.5Y 5/4) clay loam with a few fine red mottles; strong medium prismatic structure that breaks to strong fine to medium angular and subangular blocks; moist, very firm; wet, plastic; very dark gray to very dark grayish brown (10YR 3/1 to 3/2) coatings; clay films thick and continuous; many fine rounded shale fragments; few soft iron and manganese concretions; very strongly acid; gradual wavy boundary.
B23 13700	33 to 44 inches. Light olive brown (2.5Y 5/4 to 5/6) clay loam with a few fine red mottles; strong coarse prismatic structure that breaks to strong medium angular blocks; moist, very firm; wet, plastic; very dark grayish brown (10YR 3/2) coatings; crushes to dark yellowish brown (10YR 4/4) to olive brown (2.5Y 4/4); clay films thick and continuous; many fine rounded shale fragments; extremely acid; gradual wavy boundary.
B24 13701	44 to 57 inches. Light olive brown (10YR 5/4 to 5/6) clay loam with common medium distinct light brownish gray (2.5Y 6/2) mottles and a few fine prominent reddish mottles; strong coarse prismatic structure that breaks to strong medium angular blocks; moist, firm; wet, plastic; very dark brown (10YR 2/2) to dark grayish brown (10YR 4/2) coatings; clay films and organic coatings thick and continuous; many fine rounded shale fragments; many fine root channels filled with organic matter; strongly acid; gradual wavy boundary.
B3 13702	57 to 65 inches. Light olive brown (2.5Y 5/4) clay loam with medium distinct light brownish gray (2.5Y 6/2) mottles and a few fine prominent reddish mottles; massive with a tendency to vertical cleavage; moist, firm; wet, plastic; very dark brown (10YR 2/2) to dark grayish-brown (10YR 4/2) coatings on vertical faces; many fine shale fragments; few iron and manganese concretions; common root channels filled with waxy organic matter; neutral; clear wavy boundary.
C 13703	65 to 71 inches. Olive brown (2.5Y 4/4) to light olive brown (2.5Y 5/4) clay loam with common fine distinct light olive brown (2.5Y 5/6) mottles and a few fine prominent reddish mottles; massive with a tendency to vertical cleavage; moist, firm; wet, plastic; many fine shale fragments; slight effervescence.

Note: All colors are for moist soils unless otherwise noted.

SOIL SURVEY LABORATORY
Beltsville, Maryland

LOCATION Fillmore County, Minnesota SOIL TYPE Fayette silt loam

LAB NOS. D2661 - D2667 SURVEY NOS. MN-SCD-4-(7-13)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY <0.002	INTERNATIONAL II 0.2-0.02	INTERNATIONAL III 0.02-0.002	2A2 >2	TEXTURAL CLASS
D2661	0-2½	A1	0.1	0.2	0.2	0.9	6.1	76.7	15.8	45.8	37.6	0	
D2662	2½-8	A21	0.0	0.1	0.1	0.5	6.8	79.5	13.0	47.5	39.1	0	
D2663	8-12	A22	0.0	0.0	0.1	0.5	6.7	78.0	14.7	46.3	38.7	0	
D2664	12-16	B1	0.0	0.0	0.1	0.3	6.2	70.2	23.2	43.8	32.8	Tr.	
D2665	16-26	B21	0.0	0.1	0.1	0.6	9.7	60.4	29.1	46.4	24.0	0	
D2666	26-35	B22	0.0	0.1	0.1	0.5	10.9	59.4	29.0	48.1	22.5	0	
D2667	35-60+	C1	0.0	0.2	0.3	1.0	13.1	58.6	26.8	49.0	23.2	0	

LABORATORY NUMBER	pH 8C1a H_2O 1:1			ORGANIC MATTER 6A1a ORGANIC CARBON %	NITROGEN %	C/N	FREE IRON OXIDE Fe_2O_3 %			BULK DENSITY g/cc	MOISTURE RETAINED AT 1/10 ATMOS. %	1/3 ATMOS. %	15 ATMOS. %
D2661	5.3			6.0									
D2662	4.6			0.9									
D2663	5.0			0.9									
D2664	4.9			0.6									
D2665	5.2			0.3									
D2666	5.2			0.2									
D2667	5.3			0.2									

LABORATORY NUMBER	CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	Na	K	6H1a H	BASE SATURATION % (SUM)
		milliequivalents per 100g soil					
D2661		7.3	2.1			9.3	
D2662		0.9	0.8			6.4	
D2663		1.9	1.2			5.2	
D2664		4.9	2.1			6.3	
D2665		9.7	3.5			6.2	
D2666		11.7	4.0			5.6	
D2667		10.8	3.5			5.0	

FAYETTE SILT LOAM MN-SCD-4-(7-13)

Location: Fillmore County, Minnesota. (Type #91) SW¼, SW¼, Sec. 8, T101N, R9W.

Samples collected by: Iver J. Nygard in the spring of 1944.
Horizon designations by: Alex S. Robertson and Dick Rust.

Horizon and Beltsville Lab. No.		
A1 D2661	0-2½ inches	Dusky brown crumbly silt loam containing much organic matter.
A21 D2662	2½-8 inches	Breaks into a moderate yellowish brown friable silt loam which becomes a light yellowish brown when crushed. Moderate supply of organic matter.
A22 D2663	8-12 inches	Grades into a light yellowish brown silt loam; weak platy structure; aggregates 2 to 4 mm. in thickness. This layer becomes a light ashy gray when dry.
B1 D2664	12-16 inches	Breaks into a moderate yellowish brown silty clay loam; becomes light yellowish brown when crushed; weak angular nut-like structure; aggregates 5 to 10 mm. in size, coated with organic matter and silica flour; aggregates crush with slight pressure.
B21 D2665	16-26 inches	Grades into a strong yellowish brown silty clay loam to clay loam; subangular nut-like structure; aggregates are 6 to 12 mm. in size becoming larger with depth; aggregates are slightly stained with organic matter and moderately covered with silica flour; aggregates are firm but crush with slight pressure; become moderate yellowish brown when crushed.
B22 D2666	26-35 inches	Grades into a strong yellowish brown silty clay loam; color becomes a moderate yellowish brown when crushed; subangular nut-like structure; aggregates 1 to 1½ cm. slightly stained with organic matter, heavily coated with silica flour. Aggregates are firm but will crush with moderate pressure.
C1 D2667	35-60 inches plus	Grades into a moderate yellowish brown silt loam; blocky structure; silica flour carried down into this layer; aggregates are firm, perforated with small tubular holes.

SOIL SURVEY LABORATORY

Beltsville, Maryland

LOCATION Fillmore County, Minnesota SOIL TYPE Fayette silt loam

LAB NOS. D2668 - D2674 SURVEY NOS. MN-SCD-4-(40-46)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1									2A2	TEXTURAL CLASS
			VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY <0.002	INTERNATIONAL II 0.2-0.02	INTERNATIONAL III 0.02-0.002	>2	
D2668	0-9	Ap	0.0	0.1	0.3	1.6	12.5	71.8	13.7	54.6	30.7	0	
D2669	9-12	A2	0.0	0.2	0.4	1.7	12.8	67.5	17.4	53.0	28.4	0	
D2670	12-19	B1	0.0	0.1	0.3	1.5	11.2	67.6	19.3	51.8	28.0	0	
D2671	19-33	B21	0.0	0.1	0.3	1.4	11.7	59.9	26.6	50.0	22.6	0	
D2672	33-43	B22	0.0	0.1	0.3	1.7	14.5	59.1	24.3	56.4	18.3	0	
D2673	43-64	C1	0.0	0.2	0.4	1.4	14.0	61.1	22.9	57.8	18.1	0	
D2674	64-84+	C2	0.0	0.1	0.3	1.2	12.0	62.5	23.9	52.7	22.6	0	

LABORATORY NUMBER	pH 8C1a H_2O 1:1	ORGANIC MATTER 6A1a ORGANIC CARBON %	NITROGEN %	C/N	FREE IRON OXIDE Fe_2O_3 %	BULK DENSITY g/cc	MOISTURE RETAINED AT 1/10 ATMOS. %	1/3 ATMOS. %	15 ATMOS %
D2668	5.1	1.1							
D2669	5.7	0.5							
D2670	5.7	0.5							
D2671	5.5	0.2							
D2672	5.3	0.1							
D2673	5.3	0.0							
D2674	5.6	0.0							

LABORATORY NUMBER	CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	Na	K	6H1a H	BASE SATURATION % (SUM)
		milliequivalents per 100g soil					
D2668		3.0	0.8			4.4	
D2669		3.2	1.9			3.3	
D2670		6.0	2.6			3.4	
D2671		9.6	4.5			4.5	
D2672		9.1	4.4			4.8	
D2673		7.4	4.7			4.1	
D2674		9.6	5.6			3.6	

FAYETTE SILT LOAM MN-SCD-4-(40-46)

Location: Fillmore County, Minnesota. (Type #1), SE¼, NW¼, Sec. 15, T103N, R9W.

Samples collected by: Iver J. Nygard in the spring of 1944

Horizon designations by: Alex S. Robertson and Dick Rust.

Horizon and Beltsville Lab. No.		
Ap D2668	0-9 inches	Light brownish gray mellow silt loam; soft crumb structure; aggregates 2 to 5 mm. in size; moderate amount of organic matter; color changes to light yellowish brown when aggregates are crushed; layer slightly phylliform due to frost action.
A2 D2669	9-12 inches	Breaks into a light yellowish brown silt loam; platy structure; aggregates 3 mm. in thickness, soft consistency, heavily coated with silica flour; this layer is very light gray in color when dry.
B1 D2670	12-19 inches	Breaks into a light yellowish brown silty clay loam; subangular nut-like structure; aggregates 5 to 9 mm. long and 3 to 5 mm. wide, medium hard, stained with organic matter; color becomes a strong yellowish brown when aggregates are crushed.
B21 D2671	19-33 inches	Grades into a moderate yellowish brown silty clay loam; subangular nut-like structure; aggregates 5 to 12 mm. in diameter, medium hard consistency, slightly stained with organic matter and moderately coated with silica flour; color becomes a strong yellowish brown when aggregates are crushed.
B22 D2672	33-43 inches	Grades into a moderate yellowish brown silty clay loam slightly lighter in texture than the layer above; subangular or nut-like or blocky structure; aggregates 10 to 20 mm. in size, medium hard consistency, coated with silica flour; color becomes a light yellowish brown when aggregates are crushed.
C1 D2673	43-64 inches	Grades into a moderate yellowish brown silty clay loam; massive structure but with horizontal and vertical cleavage planes each 2 to 3 cm; cleavage planes are slightly stained with organic matter; numerous tubular pores 1 mm. in diameter, are throughout the layer.
C2 D2674	64-84 inches plus	Grades into a light yellowish brown heavy silt loam; massive structure but with cleavage planes 3 to 4 cm. apart; small tubular pores filled with organic matter or iron or both occur from 64 to 76 inches. Mottled with moderate to strong brown below 76 inches.

SOIL SURVEY LABORATORY
Beltsville, Maryland

LOCATION Fillmore County, Minnesota SOIL TYPE Fayette silt loam

LAB NOS. D3314 - D3328 SURVEY NOS. Z-1-2-8-(75 - 89)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY <0.002	3A1 INTERNATIONAL II 0.2-0.02	III 0.02-0.002	2A2 >2	TEXTURAL CLASS
D3314	0-2	A1	0.1	0.4	0.4	1.4	7.5	70.6	19.6	46.2	32.7	0	
D3315	2-6	A21	0.1	0.3	0.3	1.1	8.3	69.8	20.1	46.6	32.2	Tr.	
D3316	6-9	A22	0.1	0.2	0.2	0.7	8.0	73.0	17.8	47.1	34.4	0	
D3317	9-13	A23	0.0	0.1	0.2	0.6	7.8	73.1	18.2	46.7	34.5	0	
D3318	13-15	A24	0.1	0.2	0.2	0.9	7.2	71.0	20.4	45.9	32.9	0	
D3319	15-17	B11	0.0	0.1	0.2	0.6	7.3	70.9	20.9	46.0	32.6	Tr.	
D3320	17-21	B12	0.0	0.1	0.2	0.5	7.6	66.8	24.8	44.3	30.3	0	
D3321	21-24	B21	0.0	0.1	0.1	0.4	8.2	62.9	28.3	45.3	26.1	0	
D3322	24-28	B22	0.0	0.1	0.1	0.4	8.9	61.8	28.7	46.5	24.5	0	
D3323	28-33	B23	0.0	0.1	0.1	0.5	9.0	60.8	29.5	46.3	23.8	0	
D3324	33-38	B24	0.0	0.2	0.2	0.7	9.6	60.2	29.1	47.8	22.3	0	
D3325	38-45	B31	0.1	0.4	0.4	1.1	10.7	59.3	28.0	47.3	23.3	0	
D3326	45-48	B32	0.0	0.1	0.1	0.4	8.6	61.5	29.3	44.8	25.6	0	
D3327	48-58	C1	0.0	0.2	0.2	0.7	10.5	62.6	25.8	47.7	25.8	0	
D3328	112-118		0.1	0.1	0.1	0.4	13.8	71.5	14.0	66.7	18.9	0	

LABORATORY NUMBER	pH 8C1a H_2O 1:1	ORGANIC MATTER 6A1a ORGANIC CARBON %	NITROGEN %	C/N	FREE IRON OXIDE Fe_2O_3 %	BULK DENSITY g/cc	MOISTURE RETAINED AT 1/10 ATMOS. %	1/3 ATMOS %	15 ATMOS %
D3314	6.8	10.6							
D3315	6.2	2.8							
D3316	5.4	1.6							
D3317	4.9	0.8							
D3318	5.2	0.6							
D3319	5.2	0.9							
D3320	5.2	0.6							
D3321	5.0	0.4							
D3322	5.1	0.4							
D3323	5.0	0.0							
D3324	5.1	0.0							
D3325	5.2	0.0							
D3326	5.1	0.1							
D3327	5.2	0.0							
D3328	7.7	0.0							

LABORATORY NUMBER	CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5B2 6N4a Ca	6O4a Mg	Na	K	6H3a H	BASE SATURATION % (SUM)
		milliequivalents per 100g soil					
D3314		19.4	2.9			4.7	
D3315		9.3	1.6			5.2	
D3316		5.3	1.4			6.2	
D3317		3.3	1.7			6.5	
D3318		5.2	2.1			5.4	
D3319		5.4	2.1			5.8	
D3320		7.8	2.9			5.3	
D3321		9.0	3.7			6.3	
D3322		8.9	3.4			6.7	
D3323		10.7	4.5			6.5	
D3324		11.1	4.7			6.2	
D3325		11.2	4.9			5.7	
D3326		11.8	5.3			5.7	
D3327		10.5	4.7			4.8	
D3328		9.5	4.1			0.0	

FAYETTE SILT LOAM Z-1-2-8-(75 - 89)

Location: Fillmore County, Minnesota. SW¼ of NE¼ Section 1, T 101 N, R 10 W. Sample taken from 2 feet into road bank 100 feet E of N-S line through middle of Section 1, 400 feet W. of schoolhouse along edge of grazed woods.

Slope: 4 percent

Samples Collected by: R. J. Muckenhirn, P. R. McMiller, and I. J. Nygard, 8/2/44.

Horizon designations by: Alex S. Robertson and Dick Rust.

Horizon and Beltsville Lab. No.		
A1 D3314	0-2 inches	Light brownish gray silt loam. Finely granular, held together firmly by dense mat of fibrous roots.
A21 D3315	2-6 inches	Pale brown silt loam. Thin platy and well-developed medium granular structure; aggregates sprinkled with gray, crushing easily to light yellowish brown. Fibrous roots, worm and insect burrows very abundant. Rodent burrows frequent, often horizontal
A22 D3316	6-9 inches	Light brownish gray to pale brown floury silt loam. Fine platy structure; aggregates moderately vesicular, abundantly sprinkled with gray, crushing easily to light yellowish brown. Insect burrows, worm casts, and roots up to 1/4 inch in diameter abundant. This layer grades into the one below, which is more compact and slightly darker.
A23 D3317	9-13 inches	Light yellowish brown friable silt loam. Fine to medium platy and medium granular structure; aggregates highly vesicular, abundantly sprinkled with gray, crushing easily to light yellowish brown. Roots and worm burrows frequent but less than above.
A24 D3318	13-15 inches	Light yellowish brown silt loam. Faintly platy and medium granular structure; aggregates somewhat flattened, with gray coating abundant but irregularly distributed, and crushing easily without color change. Worm burrows and roots fairly common.
B11 D3319	15-17 inches	Same as 13-15 inch layer except aggregates vesicular, not flattened, with slight gray coating. No worm burrows noted. This layer is transitional to the B, has lost its platiness, and is more compact.
B12 D3320	17-21 inches	Light to moderate yellowish brown heavy silt loam. Medium nut structure; aggregates moderately vesicular, sprinkled with gray, crushing with moderate resistance. Worm casts and roots fairly abundant.
B21 D3321	21-24 inches	Moderate yellowish brown silty clay loam. Well-developed medium nut structure; aggregates slightly vesicular, moderately resistant to crushing. Worm burrows abundant, roots few.
B22 D3322	24-28 inches	Moderate to dark yellowish brown silty clay loam or silty clay. Medium nut structure; aggregates slightly vesicular, slightly gray-coated, moderately to strongly resistant to crushing. Few worm burrows and roots.
B23 D3323	28-33 inches	Dark yellowish brown silty clay loam or silty clay. Fine to medium blocky structures; aggregates slightly vesicular, slightly gray-coated. Worm burrows and roots few; roots 1/16 - 1/8 inch in diameter.
B24 D3324	33-38 inches	Dark yellowish brown silty clay. Coarse blocky structure; aggregates slightly vesicular, slightly gray-coated, strongly resistant to crushing. A few large tree roots.
B31 D3325	38-45 inches	Same as 33-38 inch layer except moderately resistant to crushing. A few roots 1/8 inch in diameter. This layer was interpreted as being the lower part of the B.
B32 D3326	45-48 inches	Dark yellowish brown silty clay loam. Similar to 38-45 inch layer but coarser in structure and apparently coarser in texture.
C1 D3327	48-58 inches	Moderate yellowish brown heavy silt loam. Very coarse blocky structure; aggregates moderately vesicular, weakly resistant to crushing. Very few roots.
D3328	112-118 inches	Light yellowish brown silt loam. Calcareous (non-calcareous above 112 inches).

SOIL SURVEY LABORATORY
Beltsville, Maryland

LOCATION Houston County, Minnesota SOIL TYPE Fayette silt loam

LAB NOS. D3299 - D3313 SURVEY NOS. Z-1-2-8-(60 - 74)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	INTERNATIONAL II 0.2-0.02	INTERNATIONAL III 0.02-0.002	2A2 > 2	TEXTURAL CLASS
D3299	0-2	A1	0.1	0.3	0.3	1.2	6.6	75.7	15.8	46.9	36.1	0	
D3300	2-5	A21	0.1	0.2	0.3	1.0	6.9	76.1	15.4	46.8	36.8	Tr.	
D3301	5-10	A22	0.0	0.1	0.2	0.5	6.8	75.9	16.5	46.3	36.7	0	
D3302	10-13	A23	0.0	0.1	0.2	0.4	6.2	75.2	17.9	45.9	35.7	0	
D3303	13-15	B1	0.0	0.1	0.1	0.5	6.7	70.8	21.8	44.5	33.2	0	
D3304	15-18	B21	0.0	0.1	0.1	0.4	6.7	66.8	25.9	44.0	29.8	0	
D3305	18-21	B22	0.0	0.1	0.1	0.3	6.5	65.2	27.8	44.1	27.9	0	
D3306	21-25	B23	0.0	0.1	0.1	0.4	6.6	62.2	30.6	42.9	26.1	0	
D3307	25-31	B24	0.0	0.0	0.1	0.4	7.3	62.7	29.5	42.9	27.3	0	
D3308	31-37	B25	0.0	0.1	0.2	0.5	7.5	63.3	28.4	40.8	30.4	0	
D3309	37-44	B31	0.0	0.1	0.2	0.5	8.3	63.6	27.3	46.6	25.6	0	
D3310	44-50	B32	0.0	0.1	0.1	0.5	7.4	63.6	28.3	46.3	25.0	0	
D3311	50-68	C1	0.0	0.1	0.2	0.6	7.2	67.6	24.3	49.2	26.0	0	
D3312	68-86	C2	0.0	0.1	0.2	0.4	5.5	70.7	23.1	49.0	27.5	0	
D3313	96-106	C3	0.0	0.0	0.1	0.5	4.9	79.7	14.8	53.5	31.4	0	

LABORATORY NUMBER	pH 8C1a H_2O 1:1			ORGANIC MATTER 6A1a ORGANIC CARBON %	NITROGEN %	C/N	FREE IRON OXIDE Fe_2O_3 %			BULK DENSITY g/cc	MOISTURE RETAINED AT 1/10 ATMOS. %	1/3 ATMOS. %	15 ATMOS. %
D3299	6.3			8.2									
D3300	5.0			1.3									
D3301	4.8			0.5									
D3302	4.8			0.3									
D3303	4.8			0.4									
D3304	4.8			0.3									
D3305	5.0			0.2									
D3306	5.0			0.1									
D3307	5.0			0.0									
D3308	5.3			0.0									
D3309	5.3			0.0									
D3310	5.3			0.1									
D3311	5.6			0.0									
D3312	5.8			0.0									
D3313	8.1			0.0									

LABORATORY NUMBER	CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5B2 6N4a Ca	6O4a Mg	Na	K	6H3a H	BASE SATURATION % (SUM)
		milliequivalents per 100g soil					
D3299		11.7	3.5			7.4	
D3300		1.4	0.8			6.2	
D3301		1.8	1.0			6.2	
D3302		2.6	1.4			6.0	
D3303		4.0	2.0			6.8	
D3304		5.9	2.6			7.2	
D3305		7.5	3.4			7.6	
D3306		9.3	3.9			7.8	
D3307		9.8	4.1			6.5	
D3308		10.5	4.5			5.4	
D3309		10.3	4.4			5.2	
D3310		11.2	5.0			5.1	
D3311		10.0	4.7			3.9	
D3312		9.8	4.8			3.2	
D3313		9.2	4.1			0.0	

FAYETTE SILT LOAM Z-1-2-8-(60 - 74)

Location: Houston County, Minnesota. NE¼ of SW¼ Section 34, T 103 N, R 5 W. Sample taken 100 feet W of road in brushy ungrazed woodlot.

Vegetation: Oak, hickory, hazel brush, and blackberry vines. This profile was thought by the samplers to represent the "heavy subsoil phase" of Fayette as mapped in Minnesota.

Slope: 4 percent.

Samples Collected by: R. J. Muckenhirn, P. R. McMiller, and I. J. Nygard, 8/1/44.

Horizon designations by: Alex S. Robertson and Dick Rust.

Horizon and Beltsville Lab. No.		
A1 D3299	0-2 inches	Brownish black silt loam. Fine granular structure; high in organic matter, thickly permeated by roots.
A21 D3300	2-5 inches	Light brownish gray silt loam. Fine to very fine platy structure; sharply separated from 0-2 inch layer. Wormholes, worm casts, and roots abundant.
A22 D3301	5-10 inches	Moderate yellowish brown silt loam. Very thin platy and fine granular structure with gray coating on surfaces of aggregates. Wormholes and casts less abundant than in 2-5 inch layer.
A23 D3302	10-13 inches	Moderate yellowish brown silt loam. Medium granular and very slightly platy structure; aggregates moderately gray-coated. Wormholes and roots abundant. This layer is transitional between the layer above and the layer below but resembles the layer above more strongly.
B1 D3303	13-15 inches	Moderate yellowish brown silt loam. Weakly developed medium nut structure; aggregates lightly coated with gray. Roots and wormholes abundant.
B21 D3304	15-18 inches	Moderate yellowish brown heavy silt loam. Medium nut structure; crushes with moderate resistance to moderate yellowish brown. Wormholes abundant but few roots. Transitional to B horizon.
B22 D3305	18-21 inches	Moderate yellowish brown silty clay loam. Fine to medium nut structure; aggregates irregularly sprinkled with gray, moderately resistant to crushing. Roots and wormholes few.
B23 D3306	21-25 inches	Dark yellowish brown silty clay loam or silty clay. Medium nut structure; aggregates irregularly coated with gray, dark brownish specks on some surfaces; crushing with strong resistance to yellowish brown. A few fibrous roots and wormholes.
B24 D3307	25-31 inches	Dark to moderate yellowish brown silty clay loam or silty clay. Medium blocky structure; aggregates slightly vesicular, thinly sprinkled with gray, speckled with dark brown, crushing with strong resistance. Abundant fibrous roots, occasional root 1/8 inch in diameter; a few wormholes.
B25 D3308	31-37 inches	Moderate to dark yellowish brown silty clay loam. Medium to coarse blocky structure; aggregates slightly vesicular, thinly coated with gray, having an occasional dark speck or splotch, crushing with strong resistance. Fibrous roots abundant.
B31 D3309	37-44 inches	Moderate yellowish brown silty clay loam. Coarse blocky structure; aggregates slightly vesicular, unevenly coated with gray, crushing with moderate resistance. A few fibrous roots.
B32 D3310	44-50 inches	Moderate yellowish brown silt loam. Weakly developed coarse blocky structure; aggregates slightly vesicular, with dark yellowish brown surfaces and lighter-colored interiors—surfaces irregularly and thinly gray-coated, both surfaces and interiors speckled and spotted with dark brown. A few roots 1/8 to 1/4 inch in diameter; some worm and insect burrows.
C1 D3311	50-68 inches	Moderate to strong yellowish brown silt loam. Some dark splotches.
C2 D3312	68-86 inches	Moderate yellowish brown heavy silt loam. Soft Consistency and slightly plastic.
C3 D3313	96-106 inches	Yellowish brown silt loam, calcareous, slightly mottled.

SOIL SURVEY LABORATORY
Beltsville, Maryland

LOCATION Winona County, Minnesota SOIL TYPE Fayette silt loam

LAB NOS. D3287 - D3298 SURVEY NOS. Z-1-2-8-(48 - 59)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY <0.002	INTERNATIONAL II 0.2-0.02	INTERNATIONAL III 0.02-0.002	2A2 >2	TEXTURAL CLASS
D3287	0-5	Ap	0.0	0.2	0.3	1.0	5.4	77.6	15.5	46.3	37.4	0	
D3288	5-8	A21	0.0	0.1	0.3	0.7	5.5	75.5	17.9	43.0	38.5	0	
D3289	8-13	A22	0.0	0.1	0.3	0.6	4.6	74.7	19.7	42.3	37.4	Tr.	
D3290	13-17	B1	0.0	0.1	0.1	0.4	6.6	67.1	25.7	45.2	28.7	0	
D3291	17-20	B21	0.0	0.0	0.1	0.3	5.8	69.0	24.8	44.9	30.1	0	
D3292	20-25	B22	0.0	0.1	0.1	0.4	5.6	70.6	23.2	44.4	32.1	0	
D3293	25-29	B23	0.0	0.0	0.1	0.3	6.1	67.6	25.9	45.0	28.9	0	
D3294	29-32	B24	0.0	0.0	0.1	0.4	6.4	63.8	29.3	43.9	26.5	0	
D3295	32-36	B25	0.0	0.1	0.1	0.4	6.5	65.0	27.9	45.3	26.4	0	
D3296	36-42	C1	0.1	0.4	0.6	0.8	8.2	67.0	22.9	51.3	24.2	Tr.	
D3297	42-50	C2	0.1	0.5	0.6	0.9	9.0	67.3	21.6	53.6	23.1	Tr.	
D3298	50-62	C3	0.5	1.3	2.1	3.6	7.1	63.8	21.6	48.8	23.8	2	

LABORATORY NUMBER	pH 8C1a H_2O 1:1	ORGANIC MATTER 6A1a ORGANIC CARBON %	NITROGEN %	C/N	FREE IRON OXIDE Fe_2O_3 %	BULK DENSITY g/cc	MOISTURE RETAINED AT 1/10 ATMOS. %	1/3 ATMOS. %	15 ATMOS. %
D3287	6.1	1.8							
D3288	5.8	0.8							
D3289	5.7	0.3							
D3290	5.4	0.2							
D3291	5.4	0.4							
D3292	5.4	0.4							
D3293	5.2	0.4							
D3294	5.1	0.3							
D3295	5.2	0.4							
D3296	5.2	0.3							
D3297	5.3	0.4							
D3298	5.4	0.2							

LABORATORY NUMBER	CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5B2 6N4a Ca	6O4a Mg	Na	K	6H3a H	BASE SATURATION % (SUM)
		milliequivalents per 100g soil					
D3287		6.7	1.9			4.0	
D3288		6.2	1.7			3.9	
D3289		6.6	2.1			3.5	
D3290		9.1	3.6			4.9	
D3291		8.6	3.5			4.6	
D3292		7.6	3.0			4.5	
D3293		9.4	3.8			5.4	
D3294		10.9	4.3			7.0	
D3295		11.9	4.2			5.9	
D3296		9.1	3.7			4.5	
D3297		9.1	3.5			4.1	
D3298		9.2	3.6			3.8	

FAYETTE SILT LOAM Z-1-2-8-(48 - 59)

Location: Winona County, Minnesota. NE¼ of SW¼ of SW¼ Section 16, T 106 N, R 7 W. Sample taken in clover strip 150 feet S of the intersection of the side road north with the E-W road through the SW¼ of Section 16.

Slope: 5 percent.

Samples collected by: R. J. Muckenhirn, P. R. McMiller, and I. J. Nygard, 7/31/44.

Horizon designations by: Alex S. Robertson and Dick Rust.

Horizon and Beltsville Lab. No.		DESCRIPTION
Ap D3287	0-5 inches	Weak brown friable silt loam. Weakly platy and medium granular structure. Slight admixture of yellowish brown soil from layer below. Earthworms fairly abundant, grass roots abundant.
A21 D3288	5-8 inches	Moderate brown silt loam. Medium granular structure; aggregates crush to moderate yellowish brown. Abundant worm casts give this layer its dark shade. Grass roots abundant but less than in 0-5 inch layer.
A22 D3289	8-13 inches	Moderate yellowish brown silt loam. Medium platy structure; aggregates moderately vesicular, elongated rather than rounded with some gray coating. Fibrous roots, wormholes, and worm casts less abundant than in 5-8 inch layer.
B1 D3290	13-17 inches	Moderate yellowish brown silt loam. Fine to medium nut structure; aggregates well-coated with gray, crushing easily to light yellowish brown. Worm holes and fibrous roots abundant.
B21 D3291	17-20 inches	Moderate yellowish brown heavy silt loam. Medium nut structure; aggregates vesicular, irregularly coated with gray, crushing easily to lighter yellowish brown.
B22 D3292	20-25 inches	Moderate to dark yellowish brown silty clay loam. Medium blocky structure; aggregates slightly vesicular, fairly abundantly gray-coated, crushing with moderate resistance to moderate yellowish brown. Fibrous roots abundant; worm activity slight.
B23 D3293	25-29 inches	Dark yellowish brown silty clay loam. Medium to coarse blocky structure; aggregates moderately vesicular, slightly to moderately gray-coated, crushing with moderate resistance to moderate yellowish brown. Fibrous roots not very abundant.
B24 D3294	29-32 inches	Same as 25-29 inch layer except that there is a little less gray coating and aggregates contain dark specks and yellowish brown material.
B25 D3295	32-36 inches	Moderate yellowish brown silty clay loam. Similar to 29-32 inch layer but more silty and with more light yellowish brown. Roots infrequent.
C1 D3296	36-42 inches	Light yellowish brown silt loam. Weakly developed coarse blocky structure; aggregates slightly vesicular with occasional dark specks. Few roots.
C2 D3297	42-50 inches	Moderate yellowish brown silt loam. Weakly developed coarse blocky structure; aggregates slightly vesicular. Few roots.
C3 D3298	50-62 inches	Moderate yellowish brown silt loam containing some grit from limestone or sandstone bedrock.

No carbonates present in whole section.

Estimates of .002 mm. clay in B horizon: Muckenhirn 31%
Nygard 29%
McMiller 32%

SOIL SURVEY LABORATORY
Beltsville, Maryland

LOCATION Crow Wing County, Minnesota SOIL TYPE *Flak loam

LAB NOS. 55320 - 55326 SURVEY NOS. S54Minn-18-34-(A1 - A7)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	INTERNATIONAL II 0.2-0.02	INTERNATIONAL III 0.02-0.002	2A2 > 2 <76mm	TEXTURAL CLASS
55320	0-6	A1	7.1	16.4	15.6	20.2	9.5	26.2	5.0	33.0	13.0	26	
55321	6-15	A2	7.4	18.6	16.4	20.0	8.3	24.7	4.6	30.5	11.9	31	
55322	15-19	A31	8.7	18.8	16.6	20.7	9.3	19.5	6.4	28.1	10.2	35	
55323	19-23	A32	8.3	16.7	16.2	20.5	8.8	19.4	10.1	28.0	10.0	32	
55324	23-27	B1	5.5	14.4	14.9	18.7	8.9	19.1	18.5	27.1	9.6	25	
55325	27-46	B2	5.4	15.3	14.5	17.7	8.4	17.7	21.0	25.4	9.0	28	
55326	46-60	C	7.1	17.0	15.4	17.4	7.3	17.2	18.6	23.1	9.3	33	

LABORATORY NUMBER	pH 8C1a H_2O 1:1	ORGANIC MATTER 6A1a ORGANIC CARBON %	NITROGEN %	C/N	FREE IRON OXIDE Fe_2O_3 %	BULK DENSITY g/cc	MOISTURE RETAINED AT 1/10 ATMOS. %	1/3 ATMOS. %	15 ATMOS. %
55320	5.7	1.16							
55321	6.2	0.09							
55322	6.0	0.03							
55323	6.0	0.06							
55324	5.8	0.11							
55325	5.7	0.11							
55326	5.8	0.06							

LABORATORY NUMBER	5A3a CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	6H1a H	BASE SATURATION % 5C3 (SUM)
		milliequivalents per 100g soil					
55320	9.8	4.0	0.9	0.1	0.2	4.6	53
55321	3.6	1.6	0.3	Tr.	Tr.	1.7	53
55322	4.1	2.3	0.4	0.1	0.1	1.2	71
55323	5.9	3.3	0.8	0.1	0.1	1.6	73
55324	9.7	6.2	1.7	0.1	0.3	1.4	86
55325	13.8	7.5	2.5	0.2	0.3	3.3	76
55326	12.3	7.0	2.4	0.2	0.3	2.4	80

*FLAK LOAM S54Minn-18-34-(A1 - A7)

Location: Crow Wing County, Minnesota. Center of sec. 24, T138N, R 26W.

Samples Collected by: H. F. Arneman

Profile Described by: H. F. Arneman

Horizon and Beltsville Lab. No.		DESCRIPTION
A1 55320	0-6 inches	10 YR 3/2 (moist) loam, weak fine granular, very friable.
A2 55321	6-15 inches	10 YR 5/3 (moist) sandy loam, weak fine platy, friable.
A31 55322	15-19 inches	10 YR 6/3 (moist) sandy loam, with about 25 percent of 10 YR 5/4 sandy clay loam, structureless moderately firm.
A32 55323	19-23 inches	10 YR 6/3 (moist) sandy loam with about 50 percent of 10 YR 5/4 sandy clay loam, structureless, moderately firm.
B1 55324	23-27 inches	10 YR 5/4 (moist) sandy clay loam with about 25 percent of 10 YR 5/3 sandy loam, structureless, moderately firm.
B2 55325	27-46 inches	7.5 YR 5/6 (moist) sandy clay loam, weak medium sub-angular blocky, moderately firm.
C 55326	46-60 inches	7.5 YR 4/4 (moist) sandy clay loam, massive, moderately firm.

SCS-421
10-64

U. S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL Hayden loam SOIL Nos. 860Minn-86-1 LOCATION Wright County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13704-13711 February 1965

Depth (In.)	Horizon	1B1a Total Sand (2-0.05)	Total Silt (0.05-0.002)	Total Clay (<0.002)	Sand: Very coarse (2-1)	Sand: Coarse (1-0.5)	Sand: Medium (0.5-0.25)	Sand: Fine (0.25-0.1)	Sand: Very fine (0.1-0.05)	Silt: 0.05-0.02	Silt: Int III (0.02-0.002)	3A1 Int. II (0.2-0.02)	(2-0.1)			Coarse fragments 2A2: >2	2-19	19-76
		Pct of <2 mm														Pct	Pct of <76mm	
0-3	A1	44.5	38.8	16.7	1.9	6.5	8.5	18.6	9.0	16.2	22.6	34.2	35.5			Tr.	Tr.	-
3-5	A21	52.4	35.8	11.8	4.4	8.1	9.0	20.8	10.1	16.0	19.8	35.7	42.3			7	7	-
5-7	A22	49.8	35.4	14.8	4.6	8.0	8.5	19.2	9.5	15.4	20.0	33.7	40.3			6	6	-
7-17	B21	50.8	20.8	28.4	4.0	8.9	10.4	19.8	7.7	8.4	12.4	24.6	43.1			6	6	-
17-30	B22	50.6	27.6	21.8	2.8	4.9	5.8	20.3	16.8	14.7	12.9	43.0	33.8			6	6	-
30-38	C1	58.2	21.7	20.1	5.0	9.4	10.2	22.8	10.8	9.4	12.3	30.8	47.4			7	7	-
38-44	Cu	53.4	28.5	18.1	9.4	10.9a	7.1a	15.3	10.7	11.1	17.4	29.7	42.7			4	4	-
44-57	C2	34.4	51.1	14.5b	1.5c	3.9c	4.2c	12.8c	12.0c	24.8	26.3	43.7	22.4			Tr.	Tr.	-

Depth (In.)	6A1a Organic carbon	6B1a Nitrogen	C/N		6E1c Carbonate as $CaCO_3$	6C1a Ext. Iron as Fe	Bulk density: 4A1a Field-State	4A1c 30-Cm.	4A1h Oven Dry	4D1 Extensibility in. per horizon	Water Content: 4B4 Field-State	4B3 30-Cm.	4B1b 1/3-Bar Pieces	4B2 15-Bar	4C1 1/3- to 15-Bar in. per horizon	pH		8C1a (1:1)
	Pct	Pct.			Pct.	Pct.	g/cc	g/cc	g/cc		Pct	Pct.	Pct	Pct.				
0-3	11.44	0.836	14		Tr.	0.5								23.4				6.6
3-5	2.11	0.175	12			0.5								7.1				6.4
5-7	0.84	0.073	12			0.6								5.8				6.7
7-17	0.53	0.053	10			0.8	1.67	1.52	1.68	0.34	11.0	21.0	19.7	12.3	1.1			6.5
17-30	0.21	0.028				0.7	1.57	1.48	1.59	0.30	12.8	21.6	19.5	11.1	1.6			6.4
30-38	0.18				-	1.0								11.0				7.0
38-44	0.10				Tr.	0.4								7.0				7.4
44-57	0.06				17d	0.8	1.58	1.56	1.58	0.04	11.2	23.5	18.8	8.7	2.1			7.9

Depth (In.)	Extractable bases 5B1a: 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	5E1a Sum	6H1a Ext. Acidity	Cat. Exch. Cap.: 5A3a Sum Cations	5A1a NH_4OAc	8D3 Ca/Mg	Base saturation: 5C3 Sum Cations	5C1 NH_4OAc
	meq/100 g									Pct.	Pct.
0-3	36.7	5.4	Tr.	1.5	43.6	7.4	51.0	39.6	6.8	85	110
3-5	13.9	1.2	Tr.	0.3	15.4	4.5	19.9	15.8	11	77	97
5-7	9.6	0.8	Tr.	0.2	10.6	2.5	13.1	11.1	12	81	95
7-17	16.5	3.0	0.1	0.4	20.0	3.0	23.0	20.0	5.5	87	100
17-30	11.1	3.4	Tr.	0.4	14.9	2.8	17.7	15.2	3.3	84	98
30-38	12.6	3.6	0.1	0.3	16.6	2.2	18.8	14.4	3.5	88	115
38-44		2.8	Tr.	0.2				11.9			
44-57		3.2	0.1	0.2				11.5			

Depth (In.)	Ratios to Clay 8D1: NH_4OAc CEC	Ext. Iron	15-Bar Water
0-3	2.37	0.03	1.40
3-5	1.34	0.04	0.60
5-7	0.75	0.04	0.39
7-17	0.70	0.03	0.43
17-30	0.70	0.03	0.51
30-38	0.72	0.05	0.55
38-44	0.66	0.02	0.39
44-57	0.79	0.06	0.60

a. 5-25% mica-like.
b. No carbonate clay detected.
c. 5-25% carbonate.
d. Carbonates include both calcite and dolomite.

Soil type: Hayden loam
Soil No.: S60Minn-86-1
Location: 300 yards west of road intersection and 70 yards north of east-west road, southeast quarter of southwest quarter of Sec. 25, T121N, R26W, Maple Lake Township, Wright County, Minnesota.
Vegetation: Pastured woodland; elm, maple and ash with ground cover of bluegrass.
Parent material: Calcareous loam to clay loam till of Mankato age.
Physiographic position: Rolling to hilly moraine.
Topography: Rolling.
Slope: 5 percent.
Aspect: Northwest.
Ground water: Deep, over 10 feet.
Permeability: Moderate.
Stoniness: Very few stones.
Root distribution: Roots are frequent to 24 inches and few between 24 and 40 inches.
Sampled by: J. S. Allen, E. D. Rivers, R. J. Edwards, R. S. Farnham, and R. H. Rust.

Horizon and Lincoln Lab. Number	
A1 13704	0 to 3 inches. Black (10YR 2/1) loam, black to very dark gray (10YR 2/1 to 3/1) when dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.
A21 13705	3 to 5 inches. Very dark gray (10YR 3/1) loam, mixed very dark gray (10YR 3/1), 20 percent, and gray to grayish-brown (10YR 5/1 to 5/2), 80 percent, when dry; weak very thin platy structure; friable; slightly acid; abrupt smooth boundary.
A22 13706	5 to 7 inches. Dark gray (10YR 4/1) to dark grayish brown (10YR 4/2) loam, gray to grayish brown (10YR 5/1 to 5/2) when dry; moderate thin platy structure; friable; slightly acid; clear wavy boundary.
B21 13707	7 to 17 inches. Yellowish brown (10YR 5/4) clay loam; strong fine subangular blocky structure; peds have very dark grayish brown (10YR 3/2) to dark brown (10YR 3/3) coatings; continuous thick clay films on all surfaces; firm; slightly acid; clear wavy boundary.
B22 13708	17 to 30 inches. Light olive brown (2.5Y 5/4 and 5/6) clay loam; moderate coarse prismatic structure; firm; peds have dark grayish brown (10YR 3/2) coatings with very dark brown (10YR 2/2) in root channels. When dry the peds have a dusty grayish brown (10YR 5/2) coating; continuous distinct clay films on vertical faces of peds with patchy coatings on the horizontal faces; occasional fine shale fragments; a few horizontal seams 1 to 2 inches thick which are darker in color than the material above or below; slightly acid; abrupt wavy boundary.
C1 13709	30 to 38 inches. Olive brown (2.5Y 4/4) mixture of loam, clay loam and sandy clay loam with local pockets of sand; heavy, very dark grayish brown (10YR 3/2) organic stains and numerous red and dark red iron stains; massive; weakly cemented; frequent small limestone and granitic pebbles; mildly alkaline; slight effervescence with acid; abrupt irregular boundary.
Cu 13710	38 to 44 inches. Olive gray (5Y 4/2 and 5/2) sandy clay loam; moderate fine and very fine angular blocky structure; friable; frequent small granitic pebbles; mildly alkaline; abrupt irregular boundary.
C2 13711	44 to 57 inches. Light olive brown (2.5Y 5/4 and 5/6) light clay loam with many medium prominent mottles of yellowish red; massive, with horizontal cleavage; friable; effervesces strongly with acid.

Note: All colors are for moist soils unless otherwise noted.

SCS-421
10-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL Hayden loam SOIL Nos. 960Minn-86-2 LOCATION Wright County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13712-13719 February 1965

Depth (In.)	Horizon	1B1a Total Sand (2–0.05)	Total Silt (0.05–0.002)	Total Clay (< 0.002)	Size class and particle diameter (mm) 3A1 Sand: Very coarse (2–1)	Sand: Coarse (1–0.5)	Sand: Medium (0.5–0.25)	Sand: Fine (0.25–0.1)	Sand: Very fine (0.1–0.05)	Silt: 0.05–0.02	Silt: Int. III (0.02–0.002)	Int II (0.2–0.02)	(2–0.1)			Coarse fragments 2A2: > 2	2 - 19	19 - 76
		Pct. of < 2 mm														Pct.	Pct. of < 76mm	
0-2	A1	44.2	39.4	16.4	2.5	5.3	6.8	18.8	10.8	16.4	23.0	36.8	33.4			Tr.	Tr.	-
2-7	A2	47.7	39.1	13.2	3.7	5.9	6.9	19.4	11.8	16.5	22.6	38.5	35.9			Tr.	Tr.	-
7-10	A2& B	46.8	31.5	21.7	3.2	5.8	7.0	19.0	11.8	13.4	18.1	35.3	35.0			Tr.	Tr.	-
10-15	B21	45.4	24.6	30.0	3.6	7.1	7.2	17.1	10.4	10.3	14.3	29.4	35.0			Tr.	Tr.	-
15-22	B22	42.0	25.1	32.9	4.2	7.7	7.2	14.3	8.6	9.6	15.5	25.4	33.4			Tr.	Tr.	-
22-32	B23	48.4	22.2	29.4	5.7	8.8	8.0	16.2	9.7	8.6	13.6	26.6	38.7			9d	9d	-
32-39	C1	50.9	30.3	18.8a	4.8b	8.8b	8.1	18.1	11.1	13.1	17.2	33.4	39.8			6	6	-
39-55	C2	49.9	31.5	18.6a	3.9c	6.6c	7.3	19.9	12.2	13.5	18.0	35.9	37.7			Tr.	Tr.	Tr.

Depth (In.)	6A1a Organic carbon	6B1a Nitrogen	C/N		6E1c Carbonate as $CaCO_3$	6C1a Ext. Iron as Fe	Bulk density: 4A1a Field-State	4A1c 30-Cm.	4A1h Oven-Dry	4D1 Extensibility in. per horizon	Water Content: 4B4 Field-State	4B3 30-Cm.	4B1h 1/3-Bar Pieces	4B2 15-Bar	4C1 1/3- to 15-Bar in. per horizon			pH: 8C1a (1:1)
	Pct	Pct			Pct	Pct.	g/cc	g/cc	g/cc		Pct.	Pct.	Pct.	Pct.				
0-2	5.59	0.488	11		Tr.	0.4								16.6				6.4
2-7	1.01	0.085	12			0.4	1.57	1.52	1.56	0.05	9.6	16.9	15.0	5.5	0.7			6.8
7-10	0.48	0.055	9			0.6								9.4				6.7
10-15	0.47	0.049	10			0.8								13.8				6.5
15-22	0.34	0.040	8			1.0							23.0	15.6				6.4
22-32	0.24	0.037				1.1	1.44	1.35	1.50	0.33	16.7	25.8	22.2	14.5	1.0			6.2
32-39	0.20				11g	0.8								9.9				7.9
39-55	0.14				17g	0.7	1.50e		1.53f		13.2			9.3				8.0

Depth (In.)	Extractable bases 5B1a: 6N2b Ca	6Q2b Mg	6P2a Na	6Q2a K	5B1a Sum	6H1a Ext. Acidity	Cat. Exch. Cap.: 5A3a Sum Cations	5A1a NH_4OAc		8D3 Ca/Mg	Base saturation: 5C3 Sum Cations	5C1 NH_4OAc
	meq/100 g										Pct	Pct.
0-2	25.2	2.4	Tr.	0.3	27.9	6.6	34.5	27.5		10	81	101
2-7	10.0	0.6	Tr.	0.2	10.8	2.7	13.5	11.2			80	96
7-10	12.0	2.8	0.1	0.3	15.2	2.5	17.7	15.2		4.3	86	100
10-15	16.1	5.3	0.1	0.4	21.9	2.8	24.7	21.3		3.0	89	103
15-22	15.7	6.3	0.1	0.4	22.5	3.3	25.8	22.1		2.5	87	102
22-32	14.1	6.1	0.1	0.4	20.7	4.3	25.0	21.0		2.3	83	98
32-39		4.2	0.1	0.2				13.5				
39-55		3.4	0.1	0.2				13.2				

Depth (In.)	Ratios to Clay 8D1: NH_4OAc CEC	Ext. Iron	15-Bar Water
0-2	1.68	0.02	1.01
2-7	0.85	0.03	0.42
7-10	0.70	0.03	0.43
10-15	0.71	0.03	0.46
15-22	0.67	0.03	0.47
22-32	0.71	0.04	0.49
32-39	0.72	0.04	0.53
39-55	0.71	0.04	0.50

a. No carbonate clay detected.
b. < 5% mica-like. 5-25% carbonate.
c. 5-25% carbonate.
d. Mostly siltstone and shale; substantial portion of igneous rock.
e. Range is 0.14 g./cc.
f. Range is 0.12 g./cc.
g. Carbonates include both calcite and dolomite.

Soil type: Hayden loam
Soil No.: S60Minn-86-2
Location: 80 yards east of quarter line and 230 yards north of black top road, southeast quarter of northwest quarter of Sec. 26, T120N, R26W, Chatham Township, Wright County, Minnesota.
Vegetation: Mostly elm, ironwood, basswood, tansy, milkweek and bluegrass.
Parent material: Friable, calcareous loam to clay loam till of Mankato age.
Physiographic position: Rolling to hilly moraine.
Topography: Strongly rolling to hilly.
Slope: 5 percent.
Aspect: West.
Drainage: Well drained.
Ground water: Deep.
Permeability: Moderately rapid.
Moisture: Dry.
Stoniness: Very few stones.
Root distribution: Roots are frequent to 24 inches and few between 24 and 36 inches.
Sampled by: J. S. Allen, E. D. Rivers, R. H. Rust, R. S. Farnham, A. S. Robertson and R. J. Edwards.

Horizon and Lincoln Lab. Number	
A1 13712	0 to 2 inches. Very dark brown (10YR 2/2) loam; weak very fine granular structure; friable; many grass roots; neutral; abrupt smooth boundary.
A2 13713	2 to 7 inches. Very dark gray (10YR 3/1) to dark gray (10YR 4/1) loam, grayish brown (10YR 5/2) to light brownish gray (10YR 6/2) when dry; weak thin platy structure; friable; neutral; clear smooth boundary.
A2 and B 13714	7 to 10 inches. Dark gray (10YR 4/1) to dark grayish brown (10YR 4/2) loam with some areas of clay loam; moderate fine subangular blocky structure; firm; thick light brownish gray (10YR 6/2 dry) silica coatings; slightly acid; gradual smooth boundary.
B21 13715	10 to 15 inches. Dark grayish brown (10YR 4/2) clay loam; strong fine subangular blocky structure; firm; thin light brownish gray (10YR 6/2 dry) silica coatings; continuous distinct clay films on all faces; occasional fine shale fragments; slightly acid; gradual wavy boundary.
B22 13716	15 to 22 inches. Dark grayish brown (10YR 4/2) to brown or dark brown (10YR 4/3) clay loam; strong fine and medium subangular blocky structure; firm; thin silica coatings on peds, light brownish gray when dry; continuous distinct clay films on all faces of peds; frequent fine shale fragments; slightly acid; gradual wavy boundary.
B23 13717	22 to 32 inches. Olive brown (2.5Y 4/4) to light olive brown (2.5Y 5/4) clay loam; weak to moderate coarse prismatic structure that breaks to moderate to strong medium and coarse subangular blocks; firm; very dark grayish brown (10YR 3/2) organic coatings most prominent in old root channels; continuous distinct clay films on all faces; small shale fragments are common; medium acid; clear wavy boundary.
C1 13718	32 to 39 inches. Olive brown (2.5Y 4/4) to light olive brown (2.5Y 5/4) heavy loam with occasional small reddish iron stains; massive; friable; small lime pebbles are common; slight to strong effervescence with HCl; gradual smooth boundary.
C2 13719	39 to 55 inches. Light olive brown (2.5Y 5/4) loam with light reddish iron stains and light horizontal seams and threads of light brownish gray (2.5Y 6/2) segregated lime; massive; friable; small shale fragments and lime pebbles are common; violent effervescence with HCl.

Note: All colors are for moist soils unless otherwise noted.

SOIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Hiwood sand **LOCATION** Lake of the Woods County, Minnesota

SOIL NOS. S61Minn-39-1 **LAB. NOS.** 15820-15827

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	3A1 0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)	
0-2	A1	3.6	15.0	21.4	42.5	4.1	9.5	3.9	22.3	6.3	Tr.	
2-6	A2	2.0	11.6	21.7	51.3	5.6	6.2	1.6	26.0	3.8	Tr.	
6-13	B21	3.5	13.9	22.6	47.0	5.5	4.7	2.8	25.3	2.5	Tr.	
13-27	B22	1.6	14.5	26.8	47.0	6.3	2.7	1.1	23.0	1.3	Tr.	
27-43	C1	2.6	4.7	5.6	66.7	18.9	0.7	0.8	61.1	0.6	Tr.	
43-48	IIC2	13.4	36.3	6.4	24.9	11.5	3.5	4.0	26.9	1.9	20	
48-60	IIIC3	0.1	0.6	4.4	84.3	9.3	0.5	0.8	54.3	0.3	Tr.	
27-43	a										Tr.	

8C1a pH 1:1	6C1a Ext. Iron as Fe %	Organic Matter 6A1a O.C. b %	6B1a N %	C/N	Bulk Density Field Moist 4B4 % M.	4A1a g/cc	30 Cm. 4B3 % M.	4A1c g/cc	A.D. 4A1b g/cc	Moisture Retention 4B1b 1/10-Atm Pieces %	4B2 15-Atm. Sieved %
5.2	0.2	4.21	0.201	21	31.3	0.98			1.02		8.1
5.2	0.1	0.26	0.013	20		1.42c				6.4d	1.1
5.5	0.4	0.20	0.012			1.50c				5.3d	1.5
5.5	0.3	0.05	0.016								1.0
5.5	0.2	0.08				1.60c				3.2d	1.0
5.4	0.6	0.09									2.6
5.5	0.2	0.04									0.4
5.3	0.4	0.13									

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a Sum	Base Sat. 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8D1 NH_4OAc CEC	Ext. Iron
← milliequivalents per 100g. soil →										
13.1	7.0	1.4	10.2	Tr.	0.4	19.0	46	67	3.4	
2.1	0.5	0.1	3.2	Tr.	0.1	3.9	18	33		
2.1	0.1	0.2	4.1	Tr.	0.1	4.5	9	19	0.8	0.1
1.1	0.1	0.1	1.6	Tr.	Tr.	1.8	11	18		
0.9	0.1	0.1	1.6	Tr.	0.1	1.9	16	33		
3.6	1.6	0.6	2.5	Tr.	0.1	4.8	48	64	0.9	0.2
0.9	0.1	0.1	1.4	Tr.	Tr.	1.6	12	22		

a. Red mottles in C1 horizon.
b. 3.8 Kg/M^2 to depth of 43 inches.
c. Average of 2 cores.
d. Core sample.
Concretions, organic matter fragments or other special formations were not evident in the sand fractions.

Soil type: Hiwood sand
Soil No.: S61Minn-39-1
Location: Northwest quarter of northwest quarter of southwest quarter of Sec. 30, T160N, R33W, Lake-of-the-Woods County, Minnesota. 345 feet east and 63 feet south of west quarter corner of Section.
Vegetation: Mainly jackpine, fair to poor stand, height 30 feet. Ground cover of a few bracken and bearberry; thin covering of pine needles.
Parent material: Lacustrine sand.
Physiographic position: Lake plain.
Topography: Very gently undulating.
Slope: One-half of one percent.
Aspect: Southeast.
Drainage: Moderately well drained.
Ground water: Not reached; probably within 10 feet.
Permeability: Very rapid.
Root distribution: Common in upper 20 inches; few from 20 to 30 inches.
Stoniness: None.
Sampled by and date: Klaus Flach, L. I. Harmon, R. H. Rust, and A. S. Robertson, September 13, 1961.

Horizon and Lincoln Lab. Number	
A00	1/2 to 0 inch. *Pine needles, twigs, and leaves.*
A1 15820	0 to 2 inches. Black (10YR 2/1) fine and medium sand with clean light brownish gray sand grains scattered throughout; weak fine granular structure; loose; abrupt smooth boundary.
A2 15821	2 to 6 inches. Grayish brown (10YR 5/2) to dark grayish brown (10YR 4/2) fine and medium sand, light brownish gray (10YR 6/2) when dry; very weak medium subangular blocky structure; loose; clear irregular boundary.
B21 15822	6 to 13 inches. Yellowish brown (10YR 5/6) tending towards strong brown (7.5YR 5/6) fine and medium sand; very weak medium subangular blocky structure; loose; clear irregular boundary.
B22 15823	13 to 27 inches. Yellowish brown (10YR 5/6) fine and medium sand with a few medium faint strong brown mottles; very weak subangular blocky structure; loose; clear wavy boundary.
C1 15824	27 to 43 inches. Light gray (10YR 7/2) fine sand with common medium faint light yellowish brown mottles; single grain; loose; abrupt smooth boundary. Within this horizon were large masses of roughly spherical yellowish red (5YR 4/6 to 5/6) fine sand; single grain; these areas comprise up to 15 to 20 percent of the horizon. One of the spherical masses was sampled separately (LSL 15827).
IIC2 15825	43 to 48 inches. Variegated dark brown to brown (7.5YR 4/4), very pale brown (10YR 7/3), and dark yellowish brown (10YR 4/4) coarse sand and fine gravel; massive; weakly coherent; abrupt wavy boundary.
IIIC3 15826	48 to 60 inches. Light gray (2.5Y 7/2), 75 percent, and yellowish brown (10YR 5/6) to brownish yellow (10YR 6/6), 25 percent, fine sand; single grain; loose.

Note: The upper one inch of the B21 horizon showed some interfingering of the A2. Till material was reached at 7½ feet.

SOIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Hiwood sand **LOCATION** Lake of the Woods County, Minnesota

SOIL NOS. S61Minn-39-2 **LAB. NOS.** 15828-15834

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent)									3A1
		VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)
1-0	Ao							a			-
0-5	A2	0.4	5.4	14.3	48.9	21.6	7.3	2.1	52.8	4.2	Tr.
5-11	B21	0.4	6.3	14.3	51.3	20.7	4.6	2.4	51.6	2.8	Tr.
11-18	B22	0.3	6.1	13.8	49.3	25.2	3.7	1.6	56.3	1.4	Tr.
18-30	B3	3.4	8.2	16.1	47.9	17.4	5.3	1.7	45.2	2.9	Tr.
30-37	C1	1.0	3.1	10.8	58.4	23.0	2.1	1.6	59.3	0.6	Tr.
37-50+	C2	0.2	2.4	11.8	62.7	20.8	1.3	0.8	59.3	0.4	Tr.

8C1a pH 1:1	6C1a Ext. Iron as Fe %	Organic Matter 6A1a O.C. %	6B1a N %	C/N	Bulk Density Field Moist % M.	Field Moist g/cc	30 Cm. % M.	30 Cm. g/cc	A.D. g/cc	Moisture Retention 1/10-Atm. Pieces %	1/10-Atm. Sieved %	4B2 15-Atm. Sieved %
5.2b	0.2	16.5	0.640	26								
4.9	0.2	0.39	0.018	22								
5.8	0.3	0.29	0.015	19								2.5
5.9	0.3	0.09	0.007									1.3
5.6	0.3	0.05	0.007									1.0
5.8	0.3	0.05										0.5
5.8	0.2	0.04										0.4

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a Sum	Base Sat. 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8D1 NH_4OAc CEC	Ratios to Clay 8D1 Ext. Iron
← milliequivalents per 100g. soil →										
43.0	9.3	3.1	29.4	0.4	0.5	42.7	31	31		
3.7	1.0	0.3	2.6	Tr.	0.1	4.0	35	38	1.8	0.1
2.8	0.3	0.2	4.8	Tr.	0.1	5.4	11	21	1.2	0.1
1.4	0.1	0.2	2.5	Tr.	Tr.	2.8	11	21		
1.3	0.3	0.2	1.4	Tr.	Tr.	1.9	26	38		
1.2	0.8	0.2	1.4	Tr.	Tr.	2.4	42	83		
0.8	0.3	0.2	0.5	Tr.	Tr.	1.0	50	62		

a. No PSD due to high organic matter content.

b. 1:5 soil-water ratio used due to high organic matter content.

Concretions, organic matter fragments or other special formations were not evident in the sand fractions.

Soil type: Hiwood sand
Soil No.: S61Minn-39-2
Location: Southwest quarter of southwest quarter of southwest quarter of Sec. 33, T161N, R33W, Lake-of-the-Woods County, Minnesota. 600 feet north and 180 feet east of the southwest corner of the section.
Vegetation: Mainly jackpine and a few birch; ungrazed.
Parent material: Lacustrine sand.
Physiographic position: Lake plain.
Topography: Very gently undulating.
Slope: One-half of one percent.
Aspect: South.
Drainage: Moderately well drained.
Ground water: 8 feet.
Permeability: Very rapid.
Root distribution: Common in upper 18 inches; few from 18 to 40 inches.
Sampled by and date: Klaus Flach, L. I. Harmon, R. H. Rust, and A. S. Robertson, September 13, 1961.

Horizon and Lincoln Lab. Number	
A00	2 to 1 inch. Pine needles, twigs, and leaves.
A0 15828	1 to 0 inch. Organic remains of above. Black (10YR 2/1) to very dark brown (10YR 2/2); abrupt smooth boundary.
A2 15829	0 to 5 inches. Grayish brown (10YR 5/2) fine sand, light brownish gray (10YR 6/2) when dry; single grain; loose; abrupt wavy boundary.
B21 15830	5 to 11 inches. Yellowish brown (10YR 5/8) tending to strong brown (7.5YR 5/8) fine sand; very weak coarse subangular blocky structure; loose; clear wavy boundary.
B22 15831	11 to 18 inches. Yellowish brown (10YR 5/6) fine sand; very weak coarse subangular blocky structure; loose; clear wavy boundary.
B3 15832	18 to 30 inches. Yellowish brown (10YR 5/4) fine sand with common medium faint pale brown mottles; single grain; slightly hard; loose; clear wavy boundary.
C1 15833	30 to 37 inches. Yellowish brown (10YR 5/4) fine sand with many coarse distinct light brownish gray to pale brown mottles; single grain; loose; abrupt irregular boundary.
C2 15834	37 to 50 inches plus. Light gray (10YR 7/2) fine sand with common medium and coarse distinct yellowish red and dark reddish brown mottles; single grain; loose.

Note: Soil examined to 9 feet; no till reached. Cover was a very good stand of jackpine, height ranging from 40 to 60 feet. Ground cover included bracken, many blueberry plants, some bearberry, also many rotting branches and tree trunks.

SCS-421
10-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL Hubbard loamy sand SOIL Nos. 36OMinn-86-3 LOCATION Wright County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13720-13725 February 1965

Depth (In)	Horizon	1B1a Total Sand (2-0 05)	Total Silt (0.05-0.002)	Total Clay (< 0.002)	Sand Very coarse (2-1)	Sand Coarse (1-0.5)	Sand Medium (0.5-0 25)	Sand Fine (0 25-0 1)	Sand Very fine (0.1-0.05)	Silt Int. III (0 05-0 02)	Silt Int. III (0 02-0.002)	Int II (0.2-0.02)	(2-0 1)	Coarse fragments 2A2 ≥ 2 Pct.	Coarse fragments 2A2 2-19 Pct of < 76mm	Coarse fragments 2A2 19-76 Pct of < 76mm
		Pct of < 2 mm														
0-9	Ap	87.9	7.5	4.6	2.8	25.7	36.9	21.0	1.5	2.7	4.8	8.0	86.4	Tr.	Tr.	-
9-16	B21	86.4	8.1	5.5	2.0	20.9	37.5	24.4	1.6	2.8	5.3	8.9	84.8	Tr.	Tr.	-
16-24	B22	90.7	5.5	3.8	1.8	23.1	40.2	24.2	1.4	2.1	3.4	7.5	89.3	-	-	-
24-31	B3	95.9	2.3	1.8	3.7	35.3	40.0	16.2	0.7	0.5	1.8	3.7	95.2	Tr.	Tr.	-
31-42	C1	96.5	1.9	1.6	4.0	22.7	41.3	27.9	0.6	0.7	1.2	5.3	95.9	Tr.	Tr.	-
42-62	C2	97.9	0.9	1.2	7.9	25.3	34.2	29.8	0.7	0.3	0.6	6.0	97.2	3	3	-

Depth (In)	6A1a Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Carbonate as $CaCO_3$ Pct.	6C1a Ext. Iron as Fe Pct.	Bulk density g/cc	Bulk density g/cc	Bulk density g/cc	Water content Pct.	4B1a 1/10-Bar Pct.	4B2 15-Bar Pct.	pH 8C1a (1:1)
0-9	0.58	0.060	10		0.4					8.4	2.6	5.2
9-16	0.42	0.046	9		0.4					7.1	2.5	5.4
16-24	0.18	0.026			0.4					4.3	2.0	5.5
24-31	0.05				0.4					2.4	0.9	5.8
31-42	0.04				0.4					2.0	1.1	6.0
42-62	0.01				0.4					1.5	0.6	6.2

Depth (In)	Extractable bases 5B1a 6N2b Ca	6Q2b Mg	6P2a Na	6Q2a K	5B1a Sum	6H1a Ext. Acidity	Cat. Exch. Cap. 5A3a Sum Cations	Cat. Exch. Cap. 5A1a NH_4OAc	Base saturation 5C3 Sum Cations a Pct.	Base saturation 5C1 NH_4OAc a Pct.
	meq/100 g									
0-9	1.9	0.2	Tr.	Tr.	2.1	5.7	7.8	5.0	27	42
9-16	2.5	Tr.	Tr.	Tr.	2.5	4.0	6.5	4.7	38	53
16-24	1.4	0.2	Tr.	Tr.	1.6	2.0	3.6	2.9	44	55
24-31	1.1	0.2	Tr.	Tr.	1.3	1.5	2.8	1.8	46	72
31-42	1.2	Tr.	Tr.	Tr.	1.2	0.7	1.9	1.7	63	70
42-62	0.9	Tr.	Tr.	Tr.	0.9	0.5	1.4	1.4	64	64

Depth (In.)

a. One or more horizons has relatively low cation exchange capacity. As cation exchange capacity decreases, the relative error of base saturation increases. Trace quantities are omitted from the sum of bases. For very low CEC values, this omission contributes significantly to the relative error of base saturation.

Soil type: Hubbard loamy sand
Soil No.: S60Minn-86-3
Location: 100 yards east of quarter line and 150 yards north of east-west road, southeast quarter of northeast quarter of Sec. 15, T122N, R26W, Wright County, Minnesota.
Vegetation: Old field; mostly weeds with a few grasses.
Parent material: Outwash sands, Grantsburg sublobe of Mankato.
Physiographic position: Outwash plain.
Topography: Gently undulating.
Slope: 1 percent.
Drainage: Excessively drained.
Ground water: Deep.
Permeability: Rapid.
Moisture: Dry.
Stoniness: None.
Root distribution: Few to 18 inches.
Sampled by and date: J. S. Allen, E. D. Rivers, R. H. Rust, R. S. Farnham, A. S. Robertson, and R. J. Edwards, August 3, 1960.

Horizon and Lincoln Lab. Number	
Ap 13720	0 to 9 inches. Black (10YR 2/1) loamy sand, dark gray (10YR 4/1) when dry; cloddy; very friable when moist; medium acid; abrupt smooth boundary.
B21 13721	9 to 16 inches. Dark yellowish brown (10YR 3/4) loamy sand, brown (10YR 4/3 to 5/3) when dry; single grain; slightly hard; medium acid; gradual wavy boundary.
B22 13722	16 to 24 inches. Dark yellowish brown (10YR 4/4 to 3/4) sand, brown to yellowish brown (10YR 5/3 to 5/4) when dry; single grain; slightly hard; medium acid; gradual wavy boundary.
B3 13723	24 to 31 inches. Dark yellowish brown (10YR 4/4) sand, brown (10YR 5/3) when dry; single grain; slightly hard; medium acid; gradual wavy boundary.
C1 13724	31 to 42 inches. Dark brown (10YR 5/3) sand; single grain; slightly hard; slightly acid; gradual wavy boundary.
C2 13725	42 to 62 inches. Dark grayish brown (10YR 4/2) and dark brown (10YR 4/3 and 5/3) coarse sand with some fine gravel; single grain; loose; neutral.

Note: All colors are for moist soils unless otherwise noted.

SCS-421
10-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL Hubbard loamy sand SOIL Nos. S60Minn-86-4 LOCATION Wright County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13726-13731 February 1965

Depth (In.)	Horizon	1B1a Total Sand (2-0.05)	Total Silt (0.05-0.002)	Total Clay (<0.002)	Sand Very coarse (2-1)	Sand Coarse (1-0.5)	Sand Medium (0.5-0.25)	Sand Fine (0.25-0.1)	Sand Very fine (0.1-0.05)	Silt 0.05-0.02	Silt Int. III (0.02-0.002)	Int. II (0.2-0.02)	(2-0.1)			Coarse fragments 2A2 >2	2-19	19-76
		Pct. of <2 mm														Pct.	Pct. of <76mm	
0-10	Ap	80.1	13.2	6.7	3.3	24.3	23.7	23.8	5.0	4.4	8.8	18.2	75.1			Tr.	Tr.	-
10-16	A3 or B1	83.2	9.8	7.0	6.1	24.8	24.2	23.5	4.6	5.3	4.5	18.5	78.6			Tr.	Tr.	-
16-24	B21	87.4	8.1	4.5	5.3	20.7	25.5	29.5	6.4	3.8	4.3	21.2	81.0			Tr.	Tr.	-
24-36	B22	94.5	2.8	2.7	4.7	21.5	26.2	36.5	5.6	1.6	1.2	23.8	88.9			Tr.	Tr.	-
36-43	C1	96.8	2.2	1.0	6.2	32.4	29.6	23.3	5.3	1.3	0.9	18.9	91.5			Tr.	Tr.	-
43-54	C2	97.6	1.8	0.6	20.7	42.6	21.0	12.4	0.9	0.9	0.9	6.7	96.7			16	16	-

Depth (In.)	6A1a Organic carbon	6B1a Nitrogen	C/N		Carbonate as $CaCO_3$	6C1a Ext. Iron as Fe	Bulk density 4A1a Field-State	Bulk density 4A1c 30-Cm.	Bulk density 4A1h Oven-Dry	4D1 Extensibility in. per horizon	Water Content 4B4 Field-State	Water Content 4B3 30-Cm.	Water Content 4B1a 1/10-Bar	Water Content 4B2 15-Bar	Water Content 4C2 1/10- to 15-Bar in. per horizon	pH		8C1a (1:1)
	Pct.	Pct			Pct.	Pct.	g/cc	g/cc	g/cc		Pct.	Pct	Pct.	Pct.				
0-10	1.02	0.112	9			0.5	1.65	1.61	1.62	0.03	3.9	11.8	13.4	3.8	1.5			5.3
10-16	0.68	0.064	11			0.6							9.4	3.1				5.5
16-24	0.29	0.035	8			0.5							6.7	2.5				5.6
24-36	0.08					0.4							3.0	1.3				5.7
36-43	0.02					0.4							1.4	0.8				6.0
43-54	0.01					0.4							1.6	0.9				6.1

Depth (In.)	Extractable bases 6N2b Ca	6O2b Mg	6P2a Na	5B1a 6Q2a K	5B1a Sum	6H1a Ext. Acidity	Cat. Exch. Cap. 5A3a Sum Cations	Cat. Exch. Cap. 5A1a NH_4OAc	Base saturation 5C3 Sum Cations a	Base saturation 5C1 NH_4OAc a
	meq/100 g								Pct.	Pct.
0-10	3.2	0.2	Tr.	0.1	3.5	7.9	11.4	7.8	31	45
10-16	3.0	Tr.	Tr.	0.1	3.1	6.4	9.5	6.2	33	50
16-24	1.6	Tr.	Tr.	Tr.	1.6	3.0	4.6	3.7	35	43
24-36	1.3	0.1	Tr.	Tr.	1.4	1.5	2.9	2.1	48	67
36-43	0.8	Tr.	Tr.	Tr.	0.8	1.2	2.0	1.4	40	57
43-54	0.9	0.1	Tr.	Tr.	1.0	0.7	1.7	1.6	59	62

Depth (In.)

a. One or more horizons has relatively low cation exchange capacity. As cation exchange capacity decreases, the relative error of base saturation increases. Trace quantities are omitted from the sum of bases. For very low CEC values, this omission contributes significantly to the relative error of base saturation.

Soil type: Hubbard loamy sand
Soil No.: S60Minn-86-4
Location: 270 yards west of road intersection and 50 yards north of the east-west road, northwest quarter of northwest quarter of Sec. 4, T121N, R25W, Monticello Township, Wright County, Minnesota.
Vegetation: Bromegrass.
Parent material: Outwash sands, Grantsburg sublobe of Mankato.
Physiographic position: Outwash plain.
Topography: Gently undulating.
Slope: 1 percent.
Drainage: Excessive.
Ground water: Deep.
Permeability: Rapid.
Moisture: Dry.
Stoniness: None.
Root distribution: Roots common to 18 inches with a very few reaching to 24 inches.
Sampled by and date: J. S. Allen, E. D. Rivers, R. H. Rust, R. S. Farnham, A. S. Robertson and R. J. Edwards, August 3, 1960.

Horizon and Lincoln Lab. Number	
Ap 13726	0 to 10 inches. Black (10YR 2/1) loamy sand, dark gray (10YR 4/1) when dry; cloddy to weak very fine granular structure; loose when moist; strongly acid; abrupt smooth boundary.
A3 or B1 13727	10 to 16 inches. Very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) loamy sand, dark grayish brown to brown (10YR 4/2 to 4/3) when dry; single grain; loose when moist, slightly hard when dry; medium acid; gradual wavy boundary.
B21 13728	16 to 24 inches. Dark brown (10YR 4/3 to 3/3) sand, brown (10YR 4/3 to 5/3) when dry; single grain; loose when moist, slightly hard when dry; medium acid; gradual wavy boundary.
B22 13729	24 to 36 inches. Dark brown (10YR 4/3) sand, brown to yellowish brown (10YR 5/3 to 5/4) when dry; single grain; loose when moist, soft when dry; medium acid; gradual wavy boundary.
C1 13730	36 to 43 inches. Dark brown (10YR 3/3 to 4/3) coarse sand with some fine gravel; single grain; loose when moist; slightly acid; gradual wavy boundary.
C2 13731	43 to 54 inches. Dark brown (10YR 3/3 to 4/3) gravelly coarse sand; single grain; loose when moist; slightly acid; clear wavy boundary.

Note: All colors are for moist soils unless otherwise noted.

SOIL SURVEY LABORATORY Beltsville, Maryland

SOIL TYPE *Lerdal silt loam **LOCATION** Freeborn County, Minnesota

SOIL NOS. S54Minn-24-138A-1 to 138A-9 **LAB. NOS.** 55113-55121

DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<76mm)	TEXTURAL CLASS
0-7	A11	0.3	1.2	1.3	2.6	2.5	60.4	31.7	27.8	36.5	0	sicl
7-9	A2	0.4	1.2	1.4	2.1	2.1	62.4	30.4	29.2	36.4	0	sicl
9-16	B1	0.3	1.0	1.0	1.6	2.1	60.8	33.2	28.4	35.3	Tr.	sicl
16-20	B21	0.4	1.0	0.8	1.3	1.8	61.4	33.3	29.3	34.5	0	sicl
20-25	B22	1.1	1.7	1.7	3.2	3.1	49.8	39.4	27.0	27.7	Tr.	sicl/sic
25-35	B23	1.8	3.5	3.5	6.3	4.7	36.4	43.8	19.1	25.5	Tr.	c
35-55	B3	0.1	0.6	0.4	0.8	2.6	65.1	30.4	35.9	32.2	Tr.	sicl
55-72	C1	2.1	3.9	3.8	6.7	5.2	35.8	42.5	19.7	24.9	8	c
72-84	--	2.5	4.2	4.0	7.8	6.5	46.0	29.0	26.1	30.7	14	cl

8C1a pH 1:1	pH 1:5	pH 1:10	6A1a ORGANIC MATTER ORGANIC CARBON %	NITROGEN %	C/N
6.2			6.9		
4.6			1.59		
4.4			0.66		
4.4			0.84		
4.4			0.33		
4.7			0.24		
4.8			0.14		
5.9			0.12		
7.6			0.12		

5A3a CATION EXCHANGE CAPACITY (Sum)	EXTRACTABLE CATIONS 6N2d Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a BASE SAT. %	MOISTURE AT SATURATION %
← milliequivalents per 100g. soil →						5C3	
45.8	26.4	7.6	11.2	0.1	0.5	76	
30.3	11.0	4.9	13.5	0.2	0.7	55	
28.1	11.3	5.4	10.8	0.1	0.5	62	
29.8	12.0	5.9	11.2	0.2	0.5	62	
32.5	14.1	7.2	10.4	0.3	0.5	68	
36.3	17.1	9.2	8.7	0.6	0.7	76	
28.0	13.7	7.1	6.3	0.3	0.6	78	
33.6	19.0	9.2	4.0	0.8	0.6	88	

Last horizon calcareous--not run.

Soil type: *Lerdal silt loam
Soil No.: S54Minn-24-138A-1 to 138A-8
Location: Near south center of the NW1/4, Section 13, T103N, R21W, Freeborn County, Minnesota.

The soil is classified as an intergrade from Prairie to Gray-Brown Podzolic. Native vegetation is open woodlot--mostly oak and bluegrass. The parent material is heavy till, probably older than Mankato. The sample was obtained on a nearly level upland area which broke sharply about 100 feet from sampling spot; slope.1 percent or less; moderately well to somewhat poor drainage; ground water deep. There is no apparent erosion and permeability is slow. Soil moist at time of examination; essentially stone free but a few stones do occur.

Described by: A. H. Paschall.

Horizon and Beltsville Lab. Number	
A11 55113	0 to 7 inches. Black (10YR 2/1 moist) silt loam; weak to moderate very fine subangular blocky structure; friable when moist; pH is 6.5; grades with a wavy boundary into A2.
A2 55114	7 to 9 inches. Very dark gray (10YR 3/1 moist) heavy silt loam; weak medium platy structure; friable when moist; grades with a smooth boundary into B1.
B1 55115	9 to 16 inches. Dark gray to dark grayish brown (10YR 4/1, 2.5Y 4/2 moist) silty clay loam; moderate very fine angular blocky structure; friable when moist and slightly sticky when wet; pH is 5.3; grades into B21.
B21 55116	16 to 20 inches. Dark gray to dark grayish brown (10YR 4/1, 4/2 moist), crushed color dark grayish brown (10YR 4/2 moist), silty clay loam; moderate fine angular blocky structure; friable when moist and sticky when wet; pH is 5.1; grades with a smooth boundary to B22.
B22 55117	20 to 25 inches. Grayish brown (2.5Y 5/2 moist) silty clay loam; moderate fine angular blocky structure; sticky when wet; pH is 5.5; grades with a smooth boundary into B23.
B23 55118	25 to 35 inches. Grayish brown (2.5Y 5/2 moist) with white streaks (5Y 8/1 moist) and olive (5Y 5/6 moist) spots, silty clay loam; moderate medium-sized prismatic structure which breaks down to moderate fine to medium angular blocky structure; very firm when moist; pH is 5.5; clear smooth boundary to B3.
B3 55119	35 to 55 inches. Pale olive (5Y 6/3 moist) with many fine distinct mottles of yellowish brown to brownish yellow (10YR 5/6, 6/8 moist), silt loam; firm when moist (auger boring); pH is 5.8.
C1 55120	55 to 72 inches. Olive gray to light olive gray (5Y 5/2, 6/2 moist) silt loam; firm when moist; weak effervescence at 72 inches.
55121	72 to 84 inches. No description.

SOIL URVEY LABORATORY Beltsville, Maryland

SOIL TYPE *Lerdal silt loam **LOCATION** Freeborn County, Minnesota

SOIL NOS. S54Minn-24-138B-1 to 138B-9 **LAB. NOS.** 55122-55130

DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<76mm)	TEXTURAL CLASS
0-5	A11	0.4	1.3	1.8	3.9	3.2	56.1	33.3	28.4	32.9	Tr.	sicl
5-8	A12	0.3	1.2	1.9	4.2	3.7	57.7	31.0	29.7	34.0	0	sicl
8-10	A2	0.2	1.1	1.8	4.0	3.6	56.9	32.4	29.4	33.3	0	sicl
10-15	B1	0.2	0.8	1.2	2.9	2.9	53.2	38.8	24.8	32.9	0	sicl
15-21	B21	0.1	0.7	1.2	3.1	3.1	49.0	42.8	25.9	28.0	Tr.	sic
21-29	B22	0.3	1.2	1.8	3.8	3.0	45.9	44.0	21.6	29.3	0	sic
29-38	B23	0.4	1.3	2.2	6.0	4.9	45.8	39.4	28.5	25.7	0	sicl/sic
38-55	B24	0.5	0.7	0.8	5.8	8.3	43.2	40.7	29.0	26.7	Tr.	sic/sicl
55+	C	0.1	0.4	0.4	0.8	2.1	61.0	35.2	25.1	38.5	0	sicl

	pH		ORGANIC MATTER 6A1a									
8C1a	1:5	1:10	ORGANIC CARBON %	NITROGEN %	C/N							
1:1												
5.2			6.3									
4.5			1.78									
4.4			1.22									
4.6			0.84									
4.4			0.53									
4.6			0.39									
4.6			0.25									
5.8			0.23									
7.5			0.19									

5A3a	EXTRACTABLE CATIONS 5B1a					BASE SAT. %					
CATION EXCHANGE CAPACITY (Sum)	6N2d Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K						MOISTURE AT SATURATION %
← milliequivalents per 100g. soil →											
40.9	19.0	5.1	15.4	Tr.	1.4	62					
26.6	8.5	3.6	13.9	Tr.	0.6	48					
26.5	8.2	3.8	13.9	Tr.	0.6	48					
29.9	10.4	5.7	13.3	Tr.	0.5	56					
33.9	12.9	7.8	12.5	0.1	0.6	63					
34.3	14.0	8.5	10.8	0.4	0.6	68					
33.0	14.9	8.5	8.4	0.6	0.6	74					
32.9	17.3	9.9	4.2	0.8	0.7	87					

Horizon C calcareous--not run

Soil type: *Lerdal silt loam
Soil No.: S54Minn-24-138B-1 to 138B-9
Location: Open woodlot in NW NE1/4, Section 30, T103N, R20W, Freeborn County, Minnesota.

Trees were mainly oak which provided almost a forest canopy, but still enough light to permit some grass growth. Sample was taken in the upland on a simple slope facing southeast; slope approximately 3 percent. Soil moderately well drained and moist at time of examination; no erosion apparent; permeability considered slow.

Described by: A. H. Paschall.

Horizon and Beltsville Lab. Number	
A11 55122	0 to 5 inches. Black (10YR 2/1 moist) silt loam with weak very fine subangular blocky structure; friable when moist.
A12 55123	5 to 8 inches. Very dark gray (10YR 3/1 moist) heavy silt loam; weak very fine subangular blocky structure; friable when moist and slightly sticky when wet; grades with a wavy boundary into A2.
A2 55124	8 to 10 inches. Dark grayish brown (2.5Y 4/2 moist) with many fine faint mottlings of light brownish gray (2.5Y 6/2 moist) heavy silt loam; weak to moderate very fine angular blocky structure; friable when moist and slightly sticky when wet; grades with a smooth boundary to B1.
B1 55125	10 to 15 inches. Dark grayish brown to grayish brown (2.5Y 4/2, 5/2 moist), crushed color light olive brown (2.5Y 5/4 moist), silty clay loam; moderate very fine angular blocky structure; friable when moist and slightly sticky when wet; grades with a smooth boundary into B21.
B21 55126	15 to 21 inches. Grayish brown (2.5Y 5/2 moist), crushed light olive brown (2.5Y 5/4 moist), silty clay loam; moderate to strong very fine and fine angular blocky structure; firm when moist and slightly sticky when wet. There are some lighter colored coatings on aggregates faces. This layer grades with a smooth boundary into B22.
B22 55127	21 to 29 inches. Dark grayish brown (2.5Y 4/2 moist) silty clay loam; moderate medium prismatic structure; prism faces are coated with very dark grayish brown (2.5Y 3/2 moist) material; prisms break down to moderate to strong medium angular blocky structure; prisms are firm when moist; abrupt smooth boundary into B23.
B23 55128	29 to 38 inches. Grayish brown to light brownish gray (2.5Y 5/2, 6/2 moist) with many fine distinct mottlings of dark brown to very dark grayish brown (7.5YR 3/2 to 2.5Y 3/2 moist) silty clay loam; moderate thick platy structure which breaks to moderate fine to medium angular blocky structure; very firm when moist; abrupt smooth boundary to B24.
B24 55129	38 to 55 inches. Dark grayish brown and light yellowish brown (2.5Y 4/2 and 6/4 moist) silty clay loam; many fine distinct mottlings of dark brown (7.5YR 3/2 moist); moderate medium prisms which break to moderate medium to coarse angular blocky structure; firm when moist; clear smooth boundary to C.
C 55130	55 inches plus. Light brownish gray (2.5Y 6/2 moist) with few fine distinct mottles, heavy silt loam; firm when moist; weak effervescence with acid.

OIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Menahga loamy sand **LOCATION** Wadena County, Minnesota

SOIL NOS. S61Minn-80-1 **LAB. NOS.** 15808-15813

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)
0-2	Ao&A1							a			-
2-4	A3?	1.1	33.5	27.1	25.0	2.8	6.9	3.6	15.1	4.4	-
4-10	B21	1.0	33.0	28.5	26.4	2.4	5.3	3.4	14.4	3.3	Tr.
10-19	B22	1.1	27.5	25.9	32.5	4.5	4.7	3.8	20.9	2.7	Tr.
19-24	B3	1.0	31.6	29.1	31.9	3.3	1.5	1.6	17.3	0.6	Tr.
24-48	C1	0.9	28.6	27.8	37.0	4.7	0.4	0.6	21.2	0.1	Tr.

8C1a pH 1:1	6C1a Ext. Iron as Fe %	Organic Matter 6A1a O.C. b %	6B1a N %	C/N	Bulk Density Field Moist 4B4 % M.	4A1a g/cc	30 Cm. 4B3 % M.	4A1c g/cc	A.D. 4A1b g/cc	Moisture Retention 4B1b 1/10-Atm. Pieces %	4B1a 1/10-Atm. Sieved %	4B2 15-Atm. Sieved %
5.7	0.4	5.93	0.321	18	30.9	0.86c	21.6	0.88c	0.92c			10.8
5.8	0.4	1.53	0.072	21	10.2	1.48	11.5	1.45	1.48			3.2
5.8	0.4	0.39	0.024	16		1.50d				5.6e	5.7	1.7
5.6	0.4	0.14	0.011			1.56d				4.4e	5.2	2.0
5.7	0.3	0.09	0.009									1.1
5.7	0.3	0.04	0.006									0.3

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a Sum	Base Sat. 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8D1 NH_4OAc CEC	Ext. Iron
← milliequivalents per 100g. soil →										
22.7	8.8	1.4	12.8	Tr.	0.3	23.3	45	46		
7.1	3.7	0.7	6.0	Tr.	0.2	10.6	43	65	2.0	0.1
3.7	1.6	0.3	3.0	Tr.	0.1	5.0	40	54	1.1	0.1
3.0	1.4	0.3	2.3	Tr.	0.1	4.1	44	60	0.8	0.1
2.3	0.5	-	2.1	Tr.	Tr.	2.6	19	22		
0.9	0.2	0.1	1.1	Tr.	Tr.	1.4	21	33		

a. No PSD due to high organic matter content.
b. 5.1 Kg/M² to depth of 19 inches.
c. Range is 0.12 g/cc.
d. Average of 2 cores.
e. Core sample.

Concretions, organic matter fragments or other special formations were not evident in the sand fractions.

Soil type: Menahga loamy sand
Soil No.: S61Minn-80-1
Location: Southwest quarter of southeast quarter of northeast quarter of Sec. 25, T135N, R33W, Wadena County, Minnesota.
Vegetation: Mainly a poor and uneven stand of jackpine, some bearberry plants and a few clumps of big and little bluestem.
Parent material: Outwash sand.
Physiographic position: Outwash plain.
Topography: Undulating; site is on top of a knoll.
Slope: Two percent.
Aspect: Southeast.
Drainage: Excessive.
Ground water: Deep, over 10 feet.
Permeability: Very rapid.
Root distribution: Few to 24 inches.
Stoniness: None.
Sampled by and date: Klaus Flach, R. H. Rust, L. I. Harmon and A. S. Robertson, September 12, 1961.

Horizon and Lincoln Lab. Number	
A0 and A1 15808	0 to 2 inches. Black (10YR 2/1) mixed organic matter and loamy sand; weak fine crumb structure; loose; abrupt smooth boundary.
A3? 15809	2 to 4 inches. Very dark grayish brown (10YR 3/2), 80 percent, loamy sand with some very dark gray (10YR 3/1) and very thin seams of dark gray (10YR 4/1); very weak fine and medium subangular blocky structure; loose; clear wavy boundary.
B21 15810	4 to 10 inches. Dark brown (10YR 3/3 to 4/3) sand; very weak fine and medium subangular blocky structure; loose; clear wavy boundary.
B22 15811	10 to 19 inches. Dark yellowish brown (10YR 4/4) sand; very weak fine and medium subangular blocky structure; loose; clear wavy boundary.
B3 15812	19 to 24 inches. Brown (10YR 5/3) to yellowish brown (10YR 5/4) sand; single grain; loose; gradual wavy boundary.
C1 15813	24 to 48 inches. Pale brown (10YR 6/3) to light yellowish brown (2.5Y 6/2) sand; single grain; loose.

Note: Soil was examined to 96 inches. Very little change in material and it did not become calcareous.

SOIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Menahga loamy sand **LOCATION** Wadena County, Minnesota

SOIL NOS. S61Minn-80-2 **LAB. NOS.** 15814-15819

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1								2A2	
		VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	> 2 (<19mm)
0-2	A1	2.1	29.4	31.7	25.6	1.5	6.1	3.6	10.8	3.7	Tr.
2-4	A3?	0.9	22.0	35.1	33.3	1.5	4.7	2.5	11.7	3.7	Tr.
4-11	B21	0.9	21.1	36.3	34.5	1.6	4.0	1.6	11.7	2.9	Tr.
11-21	B22	1.2	19.0	33.6	38.6	2.9	2.1	2.6	15.4	1.3	Tr.
21-28	B3	1.1	22.6	34.7	37.0	2.4	1.0	1.2	13.3	1.0	Tr.
28-48	C1	1.1	20.7	36.9	36.6	2.6	0.9	1.2	13.2	0.9	Tr.

8C1a pH 1:1	6C1a Organic Matter Ext. Iron as Fe %	6A1a O.C. %	6B1a N %	C/N	Bulk Density Field Moist % M.	Field Moist g/cc	30 Cm. % M.	30 Cm. g/cc	A.D. g/cc	Moisture Retention 1/10-Atm. Pieces %	1/10-Atm. Sieved %	4B2 15-Atm. Sieved %
5.6	0.2	1.62	0.080	20								2.7
5.6	0.2	0.65	0.027	24								1.8
5.7	0.2	0.18	0.009									1.1
5.9	0.2	0.08	0.006									1.0
5.9	0.2	0.04	0.005									1.2
6.1	0.2	0.03										1.1

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a Sum	Base Sat. 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8N1 NH_4OAc CEC	Ext. Iron
← milliequivalents per 100g. soil →										
7.2	3.9	0.6	4.8	Tr.	0.1	9.4	49	64	2.0	0.1
4.3	1.7	0.2	3.4	Tr.	0.2	5.5	38	49	1.7	0.1
2.1	0.8	0.2	1.8	Tr.	0.1	2.9	38	52		
1.7	0.7	0.2	1.8	Tr.	0.1	2.8	36	59	0.6	0.1
1.2	0.4	0.1	1.4	Tr.	Tr.	1.9	26	42		
1.0	0.3	0.2	0.9	Tr.	Tr.	1.4	36	50		

Concretions, organic matter fragments or other special formations were not evident in the sand fractions.

Soil type: Menahga loamy sand
Soil No.: S61Minn-80-2
Location: .25 mile west and 400 feet south of the northeast corner of Sec. 36, T136N, R33W, Lyons Township, Wadena County, Minnesota. A trail leads directly into this site from the road along the north line of Sec. 36.
Vegetation: Thick stand of fair jackpine.
Parent material: Outwash sand.
Physiographic position: Outwash plain.
Topography: Gently undulating.
Slope: One-half of one percent.
Aspect: East.
Drainage: Excessive.
Ground water: Deep, over 10 feet.
Permeability: Very rapid.
Root distribution: Numerous in A1 horizon; few to 24 inches.
Stoniness: None.
Sampled by and date: Klaus Flach, R. H. Rust, L. I. Harmon, and A. S. Robertson, September 12, 1961.

Horizon and Lincoln Lab. Number	
A1 15814	0 to 2 inches. Black (10YR 2/1) loamy sand; weak to moderate fine crumb structure; very friable; abrupt smooth boundary.
A3? 15815	2 to 4 inches. Very dark grayish brown (10YR 3/2) to dark brown (10YR 3/3) sand; very weak medium subangular blocky structure; loose; clear smooth boundary.
B21 15816	4 to 11 inches. Brown (10YR 4/3) to dark yellowish brown (10YR 4/4) sand; very weak medium subangular blocky structure; loose; slight coherence; clear wavy boundary.
B22 15817	11 to 21 inches. Yellowish brown (10YR 5/6) sand; very weak medium subangular blocky structure; loose; slight coherence; clear wavy boundary.
B3 15818	21 to 28 inches. Yellowish brown (10YR 5/4 to 5/6) sand; single grain; loose; clear wavy boundary.
C1 15819	28 to 52 inches. (Sample taken was from 28 to 48-inch zone.) Yellowish brown (10YR 5/4) sand; single grain; loose.
C2 (Not sampled)	52 to 68 inches. Brown (10YR 5/3) to pale brown (10YR 6/3) medium sand; single grain; loose.
C3 (Not sampled)	68 to 70 inches. Dark brown (7.5YR 3/2) loamy sand to sandy loam.
C4 (Not sampled)	70 inches plus. Yellowish brown (10YR 5/4) sand with a few medium faint grayish brown mottles; single grain; loose; noncalcareous.

Note: All colors are for moist soil.

SOIL SURVEY LABORATORY
Beltsville, Maryland

LOCATION Crow Wing County, Minnesota SOIL TYPE Nokay sandy loam

LAB NOS. 55327 - 55333 SURVEY NOS. 54Minn-18-3a-(A1 - A7)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	3A1 INTERNATIONAL II 0.2-0.02	III 0.02-0.002	2A2 > 2 <76mm	TEXTURAL CLASS
55327	1½-0	Ao											
55328	0-4	A21	1.4	7.7	14.1	29.2	12.5	26.9	8.2	40.7	14.6	Tr.	
55329	4-8	A22g	2.6	8.4	14.6	31.0	13.6	24.3	5.5	42.2	12.8	4	
55330	8-14	A3g	4.4	10.6	16.0	31.9	13.9	19.0	4.2	41.2	9.1	14	
55331	14-24	B1	5.3	15.4	16.1	20.4	9.2	20.9	12.7	28.4	11.3	22	
55332	24-38	B2	5.8	15.6	16.7	21.0	9.4	20.9	10.6	29.2	11.0	26	
55333	38-48	C	6.2	16.3	16.7	20.8	9.2	19.3	11.5	28.7	9.8	24	

LABORATORY NUMBER	pH 8C1a H_2O 1:1	pH 8C1a 1:4	ORGANIC MATTER 6A1a ORGANIC CARBON %	ORGANIC MATTER NITROGEN %	ORGANIC MATTER C/N	FREE IRON OXIDE Fe_2O_3 %	BULK DENSITY g/cc	MOISTURE RETAINED AT 1/10 ATMOS. %	1/3 ATMOS. %	15 ATMOS. %
55327		5.4								
55328	5.2		0.81							
55329	5.2		0.25							
55330	5.2		0.14							
55331	5.0		0.10							
55332	5.1		0.05							
55333	5.4		0.08							

LABORATORY NUMBER	5A3a CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	6H1a H	BASE SATURATION % 5C3 (SUM)
		milliequivalents per 100g soil					
55327							
55328	10.0	2.2	0.6	Tr.	Tr.	7.2	28
55329	4.8	0.9	0.3	Tr.	Tr.	3.6	25
55330	4.3	0.8	0.5	Tr.	Tr.	3.0	30
55331	9.8	3.0	1.9	0.1	0.1	4.7	52
55332	8.4	3.2	2.2	0.1	0.1	2.8	67
55333	9.4	3.7	3.0	0.2	0.1	2.4	74

NOKAY SANDY LOAM S54Minn-18-32-(A1 - A7)

Location: Crow Wing County, Minnesota. S. E. corner, sec. 15, T43N R 30W.

Samples Collected by: H. F. Arneman

Profile Described by: H. F. Arneman

Horizon and Beltsville Lab. No.		
Ao 55327	1½-0 inch	Forest floor.
A21 55328	0-4 inches	10 YR 4/2 (moist) with a few fine faint 10 YR 5/6 mottles, sandy loam, weak fine platy, friable when moist.
A22g 55329	4-8 inches	10 YR 5/3 (moist) with common fine distinct 7.5 YR 5/8 mottles, sandy loam, weak medium sub-angular blocky, friable when moist.
A3g 55330	8-14 inches	7.5 YR 5/4 (moist) with common medium faint 7.5 YR 5/8 mottles, sandy loam, weak sub-angular blocky, friable when moist.
B1 55331	14-24 inches	Mixture of 7.5 YR 5/2 and 7.5 YR 4/4 in equal proportions, sandy loam, weak medium sub-angular blocky, firm when moist.
B2 55332	24-38 inches	Mixture of 7.5 YR 5/6 and 7.5 YR 4/4 (moist) with a few medium faint 7.5 6/2-6/8 mottles, sandy clay loam, weak medium sub-angular blocky, very firm when moist.
C 55333	38-48 inches	7.5 YR 4/4 (moist) contains numerous clay balls of 7.5 YR 6/2 ringed with 5 YR 4/8 - sandy loam to sandy clay, massive, firm when moist.

SOIL SURVEY LABORATORY
Beltsville, Maryland

LOCATION Crow Wing County, Minnesota SOIL TYPE Nokay sandy loam

LAB NOS. 55334 - 55340 SURVEY NOS. 54Minn-18-32-(B1 - B7)

LABORATORY NUMBER	DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (In mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	INTERNATIONAL II 0.2-0.02	INTERNATIONAL III 0.02-0.002	2A2 > 2 (<76mm)	TEXTURAL CLASS
55334	0-3	A1	1.8	12.0	13.5	17.3	6.6	35.8	13.0	30.2	20.2	Tr.	
55335	3-9	A2g	2.4	11.9	16.2	22.6	9.5	31.2	6.2	35.9	15.6	25	
55336	9-15	A31g	3.1	13.1	17.4	24.6	10.6	20.2	11.0	34.2	8.2	6	
55337	15-22	A32g	6.2	16.8	17.2	21.6	9.6	18.3	10.3	29.3	8.7	21	
55338	22-32	B1	6.7	18.4	17.7	20.8	9.2	17.9	9.3	27.3	9.2	24	
55339	32-48	B2	5.1	16.7	18.2	22.3	10.0	17.5	10.2	29.0	8.9	25	
53340	48-60	C	6.8	18.0	17.8	21.6	9.0	17.3	9.5	27.7	8.6	25	

	pH 8C1a		ORGANIC MATTER 6A1a			FREE IRON OXIDE			BULK DENSITY	MOISTURE RETAINED AT 1/10 ATMOS.	1/3 ATMOS.	15 ATMOS.
	H_2O 1:1		ORGANIC CARBON %	NITROGEN %	C/N	Fe_2O_3 %			g/cc	%	%	%
55334	5.3		3.66									
55335	5.0		0.37									
55336	4.8		0.24									
55337	4.8		0.18									
55338	5.1		0.14									
55339	5.6		0.09									
55340	5.8		0.06									

	5A3a CATION EXCHANGE CAPACITY (SUM)	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	6H1a H	BASE SATURATION % 5C3 (SUM)
		milliequivalents per 100g soil					
55334	27.4	9.5	2.4	0.1	0.3	15.1	45
55335	5.2	1.2	0.6	Tr.	Tr.	3.4	35
55336	8.5	1.8	1.4	0.1	Tr.	5.2	39
55337	8.3	1.9	1.4	0.1	Tr.	4.9	41
55338	7.4	2.0	1.7	0.1	Tr.	3.6	51
55339	8.0	2.9	2.4	0.2	Tr.	2.5	69
55340	6.9	2.8	2.2	0.2	Tr.	1.7	75

NOKAY SANDY LOAM S54Minn-18-32-(B1 - B7)

Location: Crow Wing County, Minnesota. S. E. corner, sec. 32, T45N, R 30W.

Samples Collected by: H. F. Arneman

Profile Described by: H. F. Arneman

Horizon and Beltsville Lab. No.		
A1 55334	0-3 inches	10 YR 2/2 (moist) sandy loam, moderate fine granular, friable when moist.
A2g 55335	3-9 inches	10 YR 4/3 (moist) with few fine faint 10 YR 5/6 mottles, sandy loam, weak fine platy, friable when moist.
A31g 55336	9-15 inches	10 YR 5/3 (moist) with many fine prominent 7.5 YR 5/8 mottles, sandy loam, structureless, friable when moist.
A32g 55337	15-22 inches	10 YR 5/3 (moist) with many medium prominent 5 YR 4/8 mottles, sandy loam, structureless, friable when moist.
B1 55338	22-32 inches	7.5 YR 4/4 (moist) sandy loam, structureless, firm when moist, containing inclusions of 10 YR 5/2 (moist) sandy clay.
B2 55339	32-48 inches	7.5 YR 4/4 (moist) sandy loam, weak firm sub-angular blocky, very firm, when moist, with numerous inclusions of 10 YR 5/2 (moist) sandy clay.
C 55340	48-60 inches	7.5 YR 4/4 (moist) sandy loam, massive, very firm when moist, with numerous inclusions of 10 YR 5/2 (moist) sandy clay.

SCS-421
10-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL Nymore fine sand SOIL Nos. S60Minn-71-2 LOCATION Sherburne County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13737-13741 February 1965

Depth (In.)	Horizon	1B1a Size class and particle diameter (mm) Total: Sand (2–0.05)	Silt (0.05–0.002)	Clay (< 0.002)	Sand: Very coarse (2–1)	Coarse (1–0 5)	Medium (0 5–0 25)	Fine (0.25–0 1)	Very fine (0.1–0.05)	Silt: 0.05–0 02	Int III (0 02–0 002)	Int. II (0 2–0.02)	(2–0 1)	Coarse fragments 2A2: >= 2 Pct	2 – 19 Pct of < 76mm	19 – 76 Pct of < 76mm
		Pct of < 2 mm														
0-6	A1	91.8	5.8	2.4	0.8	8.2	30.4	48.3	4.1	2.7	3.1	20.9	87.7	Tr.		
6-12	A3?	94.0	3.3	2.7	0.5	7.1	29.5	52.1	4.8	1.9	1.4	23.0	89.2	Tr.		
12-28	C1	94.4	3.8	1.8	0.4	7.6	30.3	51.1	5.0	1.8	2.0	22.3	89.4	Tr.		
28-36	C2	96.0	2.7	1.3	0.5	7.8	30.7	52.8	4.2	1.3	1.4	21.5	91.8	Tr.		
36-48	C3	98.4	1.2	0.4	0.2	4.9	35.0	55.3	3.0	0.3	0.9	17.5	95.4	Tr.		

Depth (In.)	6A1a Organic carbon	6B1a Nitrogen	C/N	Carbonate as $CaCO_3$	6C1a Ext. Iron as Fe	Bulk density			Water content: 4B1a 1/10-Bar	4B2 15-Bar	pH: 8C1a (1.1)
	Pct.	Pct		Pct.	Pct.	g/cc	g/cc	g/cc	Pct.	Pct.	Pct
0-6	0.71	0.071	10		0.4					6.5	2.0	5.8
6-12	0.26	0.028	9		0.4					4.1	1.4	5.9
12-28	0.19	0.019			0.4					3.2	1.4	6.1
28-36	0.10				0.4					2.5	0.6	6.2
36-48	0.02				0.3						0.7	6.3

Depth (In.)	Extractable bases 5B1a: 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	5B1a Sum	6H1a Ext. Acidity	Cat. Exch. Cap.: 5A3a Sum Cations	5A1a NH_4OAc	Base saturation: 5C3 Sum Cations[a]	5C1 NH_4OAc [a]
	meq/100 g								Pct.	Pct
0-6	2.4	0.3	0.1	0.1	2.9	3.4	6.3	4.6	46	63
6-12	1.7	0.1	Tr.	0.1	1.9	2.2	4.1	2.9	46	66
12-28	1.5	Tr.	Tr.	Tr.	1.5	2.0	3.5	2.4	43	62
28-36	1.2	Tr.	Tr.	Tr.	1.2	1.2	2.4	1.8	50	67
36-48	0.7	Tr.	Tr.	Tr.	0.7	1.5	2.2	1.1	32	64

Depth (In.)

a. One or more horizons has relatively low cation exchange capacity. As cation exchange capacity decreases, the relative error of base saturation increases. Trace quantities are omitted from the sum of bases. For very low CEC values, this omission contributes significantly to the relative error of base saturation.

Soil type: Nymore fine sand
Soil No.: S60Minn-71-2
Location: Southwest quarter of Southeast quarter of Sec. 11, T35N, R29W, Sherburne County, Minnesota; 250 feet north and 350 feet east of the southwest corner of the southeast quarter of the section; photo No. BJL-5-31.
Vegetation: Deciduous trees, mainly red and Burr oaks; shrubs chiefly hazelnut and chokecherry; a variety of native grasses and forbs.
Parent material: Outwash sands, Grantsburg sublobe of Mankato.
Physiographic position: Outwash plain.
Topography: Nearly level to undulating.
Slope: 1 percent.
Drainage: Excessive.
Ground water: Deep.
Permeability: Rapid.
Moisture: Dry.
Stoniness: None.
Root distribution: Common to 28 inches.
Sampled by and date: J. S. Allen, E. D. Rivers, R. H. Rust, R.S. Farnham, M. F. Grimes and A. S. Robertson, August 4, 1960.

Horizon and Lincoln Lab. Number	
A1 13737	0 to 6 inches. Very dark gray (10YR 3/1) fine sand, dark gray (10YR 4/1) when dry; single grain; loose when moist but with very slight coherence; medium acid; clear smooth boundary.
A3? 13738	6 to 12 inches. Blotched very dark grayish brown (10YR 3/2), 80 percent, and dark grayish brown (10YR 4/2) to brown (10YR 4/3), 20 percent, fine sand, dark grayish brown to grayish brown (10YR 4/2 to 5/2) when dry; single grain; loose when moist but with very slight coherence; medium acid; gradual wavy boundary.
C1 13739	12 to 28 inches. Blotched dark brown (10YR 3/3), 70 percent, and dark brown to brown (10YR 4/3), 30 percent, fine sand, grayish brown to brown (10YR 5/2 to 5/3) when dry; single grain; loose when moist but with very slight coherence; medium acid; gradual wavy boundary.
C2 13740	28 to 36 inches. Dark grayish brown (10YR 4/2) to brown (10YR 4/3) fine sand; single grain; loose when moist but with very slight coherence; slightly acid; gradual wavy boundary.
C3 13741	36 to 48 inches. Brown (10YR 5/3) fine sand; single grain; loose when moist; neutral.

Note: All colors are for moist soils unless otherwise noted. Some bands of coarse sand and fine gravel were encountered at depths of 90 inches.

SCS-421
10-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL Nymore fine sand SOIL Nos. 960Minn-71-3 LOCATION Sherburne County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13742-13747 February 1965

Depth (In)	Horizon	1B1a Total Sand (2-0.05)	Total Silt (0.05-0.002)	Total Clay (<0.002)	Sand: Very coarse (2-1)	Sand: Coarse (1-0.5)	Sand: Medium (0.5-0.25)	Sand: Fine (0.25-0.1)	Sand: Very fine (0.1-0.05)	Silt: 0.05-0.02	Silt: Int III (0.02-0.002)	Int II (0.2-0.02)	(2-0.1)			3A1 Coarse fragments 2A2: >2 Pct	2-19 Pct. of <76mm	19-76 Pct. of <76mm
		Pct of <2 mm																
0-5	A1	90.6	6.1	3.3	0.8	10.6	20.7	51.8	6.7	1.5	4.6	31.9	83.9			Tr.		
5-9	A3?	91.2	5.3	3.5	0.8	8.0	19.0	55.6	7.8	2.4	2.9	37.6	83.4			Tr.		
9-20	B?	91.0	5.8	3.2	0.6	7.9	18.4	55.1	9.0	3.1	2.7	39.6	82.0			Tr.		
20-33	B?	92.8	4.4	2.8	0.5	7.0	18.7	58.5	8.1	2.3	2.1	38.9	84.7			Tr.		
33-45	C1	96.8	1.8	1.4	0.7	14.1	23.4	52.1	6.5	1.2	0.6	33.0	90.3			Tr.		
45-55	C2	98.7	0.6	0.7	0.4	13.3	51.8	32.1	1.1	0.1	0.5	6.8	97.6			Tr.		

Depth (In.)	6A1a Organic carbon	6E1a Nitrogen	C/N		Carbonate as $CaCO_3$	6C1a Ext. Iron as Fe	Bulk density				Water content: 4B1a 1/10-Bar	Water content: 4B2 15-Bar			pH: 8C1a (1:1)
	Pct.	Pct			Pct.	Pct.	g/cc	g/cc	g/cc		Pct	Pct.	Pct		
0-5	0.75	0.070	11			0.5						7.5	2.4		5.8
5-9	0.40	0.044	9			0.5						5.9	2.0		6.1
9-20	0.26	0.029	9			0.4						6.8	1.9		6.4
20-33	0.14	0.017				0.5						6.2	1.2		6.5
33-45	0.04					0.4						3.8	0.8		6.8
45-55	Tr.					0.3						1.4	0.2		7.1

Depth (In.)	Extractable bases 5B1a: 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	5B1a Sum	6H1a Ext. Acidity	Cat. Exch. Cap.: 5A3a Sum Cations	5A1a NH_4OAc	Base saturation: 5C3 Sum Cations [a] Pct	5C1 NH_4OAc [a] Pct.
	meq/100 g									
0-5	3.3	0.4	Tr.	0.1	3.8	3.0	6.8	5.0	56	76
5-9	2.9	0.2	Tr.	Tr.	3.1	2.5	5.6	3.9	55	79
9-20	2.5	0.2	Tr.	Tr.	2.7	1.7	4.4	3.3	61	82
20-33	1.7	0.3	Tr.	0.1	2.1	1.7	3.8	2.6	55	81
33-45	1.3	0.2	Tr.	Tr.	1.5	0.7	2.2	1.6	68	94
45-55	0.8	Tr.	Tr.	Tr.	0.8	0.2	1.0	1.0	80	80

Depth (In)

a. One or more horizons has relatively low cation exchange capacity. As cation exchange capacity decreases, the relative error of base saturation increases. Trace quantities are omitted from the sum of bases. For very low CEC values, this omission contributes significantly to the relative error of base saturation.

Soil type: Nymore fine sand
Soil No.: S60Minn-71-3
Location: 1450 feet north and 250 feet east of the southwest corner of northwest quarter of southwest quarter of Sec. 15, T35N, R29W, Sherburne County, Minnesota.
Vegetation: Deciduous trees, mainly scattered oaks; shrubs, mainly hazelnut and chokecherry; bluegrass. This site was in a closely grazed pasture.
Parent material: Outwash sands, Grantsburg sublobe of Mankato.
Physiographic position: Outwash plain.
Topography: Nearly level to undulating.
Slope: 1 percent.
Drainage: Excessively drained.
Ground water: Deep.
Permeability: Rapid.
Moisture: Dry.
Stoniness: None.
Sampled by and date: J. S. Allen, E. D. Rivers, R. H. Rust, R. S. Farnham, A. S. Robertson, and M. F. Grimes, August 4, 1960.

Horizon and Lincoln Lab. Number	
A1 13742	0 to 5 inches. Black (10YR 2/1) to very dark gray (10YR 3/1) fine sand, dark gray (10YR 4/1) when dry; single grain; loose when moist; neutral; gradual wavy boundary.
A3? 13743	5 to 9 inches. Very dark gray (10YR 3/1) to very dark brown (10YR 2/2) fine sand, dark grayish brown (10YR 4/2) when dry; single grain; loose when moist but with slight coherence; neutral; gradual wavy boundary.
B? 13744	9 to 20 inches. Dark brown (10YR 3/3) fine sand, dark grayish brown (10YR 4/2) when dry; single grain; loose when moist but with very slight coherence; neutral; diffuse wavy boundary.
B? 13745	20 to 33 inches. Blotchy dark brown (10YR 3/3) and dark brown to brown (10YR 4/3) sand, grayish brown to brown (10YR 5/2 to 5/3) when dry; single grain; loose when moist but with very slight coherence; neutral; diffuse wavy boundary.
C1 13746	33 to 45 inches. Dark yellowish brown (10YR 4/4) sand, brown (10YR 5/3) when dry; single grain; loose when moist; mildly alkaline; diffuse wavy boundary.
C2 13747	45 to 55 inches. Brown (10YR 5/3) sand, pale brown (10YR 6/3) when dry; single grain; loose when moist; effervesces strongly with acid.

Note: All colors are for moist soils unless otherwise noted.

SOIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Svatara fine sand **LOCATION** St. Louis County, Minnesota

SOIL NOS. S61Minn-69-1 **LAB. NOS.** 15835-15841

DEPTH INCHES	HORIZON	1R1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	3A1 0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)
0-1	A1							a			-
1-2½	A2	0.1	0.7	3.5	56.1	27.5	9.5	2.6	70.2	5.6	-
2½-6	B21hir	0.1	0.7	3.6	55.4	28.1	8.5	3.6	69.7	5.2	-
6-10	B22ir	<0.1	0.7	3.3	58.4	31.1	5.6	0.9	76.3	2.5	-
10-14	B23ir	0.1	0.5	2.8	59.1	34.1	2.9	0.5	79.9	0.5	-
14-20	C1	0.1	0.6	2.9	57.7	36.3	2.2	0.2	80.3	0.4	-
20-48+	C2	<0.1	0.4	3.0	58.8	36.1	1.6	0.1	80.4	0.3	-

8C1a pH 1:1	6C1a Ext. Iron as Fe %	Organic Matter 6A1a O.C. % [b]	6R1a N %	C/N	Bulk Density Field Moist 4B4 % M.	4A1a g/cc	30 Cm. 4B3 % M.	4A1c g/cc	A.D. 4A1b g/cc	Moisture Retention 4B1b 1/10-Atm. Pieces %	4B2 15-Atm. Sieved %
5.0[c]	0.4	8.75	0.262	33	96.3	0.52	57.5	0.52	0.55		15.0
4.4	0.3	1.14	0.049	23							2.9
5.8	0.7	0.94	0.052	18		1.18[d]				15.0[e]	4.6
5.8	0.6	0.54	0.036	15		1.27[d]				10.9[e]	3.7
6.0	0.4	0.24	0.014								1.5
6.0	0.4	0.13	0.006								0.7
6.1	0.3	0.07	0.006			1.49[d]				4.8[e]	0.4

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 6M2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5R1a Sum	Base Sat. 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8M1 NH_4OAc CEC	Ext. Iron
←	milliequivalents per 100g. soil					→				
32.0	6.5	1.2	23.7	Tr.	0.3	31.7	25	25		
7.2	0.6	0.1	8.5	Tr.	0.1	9.3	9	11	3	0.1
7.0	1.8	0.4	10.9	Tr.	0.1	13.2	18	33	2	0.2
4.8	0.8	0.2	8.3	Tr.	0.1	9.4	12	23		
2.2	0.5	0.2	4.1	Tr.	Tr.	4.8	14	32		
1.5	0.1	0.1	2.5	Tr.	Tr.	2.7	7	13		
1.1	0.1	0.1	1.6	Tr.	Tr.	1.8	11	18		

a. No PSD due to high organic matter content.
b. 4.7 Kg/M^2 to depth of 48 inches.
c. 1:5 soil-water ratio used due to high organic matter content.
d. Average of two cores.
e. Core sample.

Concretions, organic matter fragments or other special formations were not evident in the sand fractions.

Soil type: Swatara fine sand
Soil No.: S61Minn-69-1
Location: Northeast quarter of the southwest quarter of Sec. 23, T57N, R17W, St. Louis County, Minnesota, .4 mile east of T junction of county road 95 and county road 536; then 700 feet north of county road 95 along logging trail where the trail forks. The site is 90 feet southwest of the fork in trail.
Vegetation: Largely red pine with a few balsam, birch and jackpine.
Parent material: Noncalcareous fine sand; may have been reworked by wind.
Physiographic position: Outwash plain. Site was on low ridge.
Topography: Undulating.
Slope: Three percent.
Aspect: Northeast.
Drainage: Well drained.
Ground water: Deep, over 10 feet.
Permeability: Rapid.
Root distribution: Common to 20 inches; a few to 4 feet.
Stoniness: None.
Sampled by and date: Klaus Flach, R. H. Rust, L. I. Harmon, and A. S. Robertson, September 14, 1961.

Horizon and Lincoln Lab. Number	
A00 and A0 (Not sampled)	1 to 0 inch. Pine needles, twigs, etcetera.
A1 15835	0 to 1 inch. Black (10YR 2/1) loamy fine sand, very high in organic matter; weak very fine crumb structure; friable; clean sand grains throughout horizon; abrupt wavy boundary.
A2 15836	1 to 2½ inches. Light gray (10YR 5/1) fine sand; single grain; loose; abrupt wavy boundary.
B21hir 15837	2½ to 6 inches. Dark reddish brown (5YR 3/4) tending to dark brown (7.5YR 3/4) loamy fine sand; very weak medium and coarse subangular blocky structure; loose; clear wavy boundary.
B22ir 15838	6 to 10 inches. Dark yellowish brown (10YR 4/4) to dark brown (7.5YR 4/4) fine sand; very weak medium and coarse subangular blocky structure; loose; clear wavy boundary.
B23ir 15839	10 to 14 inches. Yellowish brown (10YR 5/6) fine sand; very weak, very coarse subangular blocky structure; loose; clear wavy boundary.
C1 15840	14 to 20 inches. Light yellowish brown (10YR 6/4) fine sand; single grain; loose; gradual wavy boundary
C2 15841	20 to 48 inches plus. Pale brown (10YR 6/3) fine sand; single grain; loose.

Note: Very good stand of red pine 40 to 50 feet in height. Ground cover is sweet fern, bearberry, lichen, and some bracken.

SOIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Swatara fine sand **LOCATION** St. Louis County, Minnesota

SOIL NOS. S61Minn-69-2 **LAB. NOS.** 15842-15848

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	3A1 0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)
0-½	A1							a			Tr.
½-2	A2	1.4	3.3	6.1	52.0	21.0	12.6	3.6	60.6	7.7	Tr.
2-6	B21hir	2.6	3.2	6.6	53.7	22.4	9.0	2.5	61.8	5.0	Tr.
6-12	B221r	1.7	3.0	5.8	56.6	24.3	7.1	1.5	66.2	2.8	Tr.
12-15	B23	1.9	1.9	4.9	59.1	26.6	4.8	0.8	70.1	1.6	Tr.
15-22	C1	1.1	2.2	7.8	62.5	23.2	2.6	0.6	65.0	0.6	Tr.
22-30	C2	3.6	4.2	6.4	59.7	23.2	2.5	0.4	66.0	0.5	Tr.

8C1a pH 1:1	6C1a Ext. Iron as Fe %	Organic Matter 6A1a O.C. %	6B1a N %	C/N	Bulk Density Field Moist % M.	Field Moist g/cc	30 Cm. % M.	30 Cm. g/cc	A.D. g/cc	Moisture Retention 1/10-Atm. Pieces %	1/10-Atm. Sieved %	4B2 15-Atm. Sieved %
5.1b	0.7	7.61	0.349	22								
5.4	0.4	0.48	0.027	18								
5.7	0.7	0.61	0.034	18								4.3
5.8	0.6	0.29	0.022	13								2.9
5.7	0.4	0.18	0.010									1.6
6.1	0.4	0.10	0.008									1.2
5.9	0.4	0.08	0.003									0.6

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a Sum	Base Sat. 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8D1 NH_4OAc CEC	Ext. Iron
← milliequivalents per 100g. soil →										
19.4	9.5	1.6		Tr.	0.5			60		
4.0	1.8	0.4		Tr.	0.1			58	1.1	0.1
5.3	0.7	0.2	10.4	Tr.	0.1	11.4	9	19	2.1	0.3
3.2	0.2	Tr.	6.4	Tr.	0.1	6.7	4	9		
2.0	0.4	0.3	4.4	Tr.	Tr.	5.1	14	35		
1.5	0.2	0.2	3.0	Tr.	Tr.	3.4	12	27		
1.2	0.3	0.2	1.8	Tr.	Tr.	2.3	22	42		

a. No PSD due to high organic matter content.
b. 1:5 soil-water ratio used due to high organic matter content.
Concretions, organic matter fragments or other special formations were not evident in the sand fractions.

Soil type: Swatara fine sand
Soil No.: S61Minn-69-2
Location: Northeast quarter of northwest quarter of Sec. 1, T56N, R20W, St. Louis County, Minnesota, along south side of county road 16; .6 mile west of intersection of county roads 5 and 16 and then 100 feet south of center line of road. Site is 90 feet east and 80 feet south of power line pole 1285 located along south side of county road 16.
Vegetation: Mainly jackpine and a few balsams; very good stand of jackpine 40 feet high. Understory of small aspen; also considerable bracken.
Parent material: Noncalcareous sand.
Physiographic position: Outwash or lake plain.
Topography: Undulating.
Slope: Three percent.
Aspect: Southeast.
Drainage: Well drained.
Ground water: Deep, over 10 feet.
Permeability: Rapid.
Root distribution: Common in upper 20 inches; few to 4 feet.
Stoniness: None.
Sampled by and date: Klaus Flach, R. H. Rust, L. I. Harmon and A. S. Robertson, September 14, 1961.

Horizon and Lincoln Lab. Number	
A00 and A0	1 to 0 inch. Pine needles, twigs, lichen and mycelium present. Abrupt smooth boundary.
A1 15842	0 to 1/2 inch. Very dark gray (10YR 3/1) fine sand high in organic matter; weak fine crumb structure; abrupt smooth boundary.
A2 15843	1/2 to 2 inches. Dark gray (10YR 4/1) to gray (10YR 5/1) fine sand; single grain; loose; abrupt wavy boundary.
B21hir 15844	2 to 6 inches. Dark brown (7.5YR 4/4 to 3/4) fine sand; very weak medium subangular blocky structure; loose; clear wavy boundary.
B22ir 15845	6 to 12 inches. Brown to dark brown (7.5YR 4/4) fine sand tending to dark yellowish brown (10YR 4/4); very weak medium and coarse subangular blocky structure; loose; clear wavy boundary.
B23 15846	12 to 15 inches. Yellowish brown (10YR 5/6) fine sand; very weak coarse subangular blocky structure; loose; clear wavy boundary.
C1 15847	15 to 22 inches. Yellowish brown (10YR 5/4) fine sand; very weak coarse and medium subangular blocky structure; loose; gradual wavy boundary.
C2 15848	22 to 30 inches. Yellowish brown (10YR 5/4) to light yellowish brown (10YR 6/4) fine sand; single grain; slightly coherent; gradual wavy boundary.
C3 Not sampled	30 to 44 inches. Yellowish brown (10YR 5/4) to light yellowish brown (10YR 6/4) fine and medium sand with many dark-colored sand grains; single grain; loose; clear smooth boundary.
C4 Not sampled	44 to 50 inches. Light yellowish brown (10YR 6/4) stratified fine and medium sand with a few 1/8-inch bands of yellowish brown; many dark-colored sand grains; single grain; loose.

OIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Synnes silty clay loam **LOCATION** Stevens County, Minnesota

SOIL NOS. S61Minn-75-1 **LAB. NOS.** 15796-15801

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	3A1 0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)
0-6	Ap	0.4	1.1	1.4	3.4	3.2	33.7	56.8	18.8	19.9	Tr.
6-10	A12	0.5	1.1	1.2	3.1	3.1	31.3	59.7	17.2	18.9	Tr.
10-20	A13	0.4	1.3	1.5	3.6	3.4	29.7	60.1	15.3	19.7	Tr.
20-32	AC	0.9a	1.1a	0.9a	2.5a	2.5a	29.2	62.9	9.7	23.4	Tr.
32-42	C1	1.0b	1.3b	1.2a	2.8a	2.6a	29.3	61.8	9.4	24.0	11
42-60	C2	1.0b	1.4b	1.2a	2.7a	2.7a	28.6	62.4	9.0	23.6	Tr.

8C1a pH 1:1	6C1a Ext. Iron as Fe %	Organic Matter 6A1a O.C. % c	6B1a N %	C/N	Bulk Density Field Moist 4B4 % M.	4A1a g/cc	30 Cm. 4B3 % M.	4A1c g/cc	A.D. 4A1b g/cc	Moisture Retention 4B1b 1/3-Atm Pieces %	4B2 15-Atm. Sieved %
7.1	0.8	3.96	0.277	14	41.9	1.03	39.6	1.08	1.45	41.7	24.4
6.4	1.0	2.75	0.167	16						37.7	23.6
7.0	1.0	1.90	0.117	11	32.0	1.28			1.65	37.4	23.6
7.8	0.7	0.72	0.054	13						34.1	21.6
7.9	0.8	0.58								33.6	21.3
8.0	0.9	0.43			26.2	1.44	30.4	1.38	1.64	31.4	22.2

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a Sum	Base Sat. 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8D1 NH_4OAc CEC	Ext. Iron	Carbonate as $CaCO_3$ 6E1c < 2mm. %	Clay %
←	milliequivalents per 100g. soil					→						
43.8	32.2	13.8	5.3	0.1	1.2	52.6	90	108	.77	.014	-	
40.8	25.3	15.0	7.3	0.1	0.4	48.1	85	100	.68	.017	-	
38.8			4.4	0.1	0.4				.64	.017	1	-
31.7			-	0.3	0.6				.50	.011	21	10
28.3			-	0.4	0.7				.46	.013	22	10
27.6			-	0.6	0.7				.44	.014	20	8

a. Few carbonates (nodules and limestone fragments).
b. Common carbonates (nodules and limestone fragments).
c. 23 Kg/M^2 to depth of 60 inches.

Soil type: Synnes silty clay loam
Soil No.: S61Minn-75-1
Location: 750 feet west and 639 feet south of the northeast corner of Sec. 8, T123N, R43W, Stevens County, Minnesota.
Vegetation: Legume-grass mixture.
Parent material: Silty clay till.
Physiographic position: Ground moraine.
Topography: Gently undulating.
Slope: One percent.
Aspect: East.
Drainage: Somewhat poor.
Ground water: Deep.
Permeability: Slow.
Sampled by and date: Klaus Flach, R. Lewis, R. H. Rust and L. I. Harmon, September 11, 1961.

Horizon and Lincoln Lab. Number	
Ap 15796	0 to 6 inches. Black (10YR 2/1) heavy silty clay loam; strong very fine granular structure; friable; abrupt smooth boundary.
A12 15797	6 to 10 inches. Mixed dark grayish brown (2.5Y 4/2) very dark gray (10YR 3/1) and black (N 2/ to 10YR 2/1) silty clay; strong very fine subangular blocky structure; friable; gradual smooth boundary.
A13 15798	10 to 20 inches. Black (10YR 2/1) to very dark gray (10YR 3/1) silty clay with streaks of black (N 2/ to 10YR 2/1) and dark grayish brown (2.5Y 4/2); strong medium prismatic structure which breaks to strong very fine and fine subangular blocks; friable; slight effervescence; clear wavy boundary.
AC 15799	20 to 32 inches. Olive gray (5Y 4/2 to 5Y 5/2) silty clay; moderate fine and very fine subangular blocky structure; friable to firm; slight effervescence; gradual smooth boundary.
C1 15800	32 to 42 inches. Olive gray (5Y 5/2 to 4/2) silty clay with a few fine faint yellowish brown mottles; moderate very fine and fine subangular blocky structure; friable to firm; slight effervescence; common weak slickensides; gradual smooth boundary.
C2 15801	42 to 60 inches. Mottled dark grayish brown (2.5Y 4/2), olive gray (5Y 4/2), dark olive gray (5Y 3/2) and olive (5Y 4/4) light silty clay; moderate very fine subangular blocky structure; firm to friable; common weak slickensides.

Note: Slickensides moderate, many in A12, A13 and AC. More strongly expressed in gray rather than dark-colored material in AC. Tongues of dark color to depths of 32 inches. The major ones are about 1 foot apart. Few fine tubular pores in C2. Fewer pores in AC horizon where slickensides are more prominent. Shinier ped surfaces are formed by slickensides throughout all the profile. At north end of pit there was not the mixing of colors and there was no effervescence to a depth of 30 inches. All colors moist.

SOIL SURVEY LABORATORY Lincoln, Nebr. August 1963

SOIL TYPE Synnes silty clay loam **LOCATION** Stevens County, Minnesota

SOIL NOS. S61Minn-75-2 **LAB. NOS.** 15802-15807

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<19mm)
0-7	Ap	0.7	1.0	1.4	4.3	3.9	33.7	55.0	17.9	22.1	Tr.
7-11	A12	0.5	1.0	1.2	3.4	3.1	30.8	60.0	13.9	21.9	Tr.
11-17	A13	0.7a	1.1a	1.2a	3.5a	3.1a	34.6	55.8	13.4	26.3	Tr.
17-32	AC	0.6a	1.0a	1.2a	3.8a	3.0a	34.8	55.6	13.1	26.8	Tr.
32-43	C1	0.5b	1.2b	1.2a	3.7a	3.2a	36.6	53.6	13.0	28.9	Tr.
43-54	C2	0.7b	1.1b	1.2a	3.6a	3.2a	37.5	52.7	12.8	29.9	Tr.

8C1a pH 1:1	Ext. Iron as Fe %	Organic Matter 6A1a O.C. %	6B1a N %	C/N	Bulk Density Field Moist % M.	Field Moist g/cc	30 Cm. % M.	30 Cm. g/cc	A.D. g/cc	Moisture Retention 1/3-Atm. Pieces %	1/3-Atm. Sieved %	4B2 15-Atm. Sieved %
7.4		3.87	0.283	14								22.4
6.6		1.94	0.130	15								21.6
7.5		1.31	0.077	17								19.4
7.9		0.64	0.049	13								18.0
8.0		0.50										17.8
8.1		0.46										18.8

5A1a CATION EXCHANGE CAPACITY NH_4OAc	EXTRACTABLE CATIONS 5B1a 6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	5B1a Sum	Base Sat. 5C3 on Sum Cations %	5C1 on NH_4OAc CEC %	Ratios to Clay 8D1 NH_4OAc CEC	Ext. Iron	Carbonate as $CaCO_3$ 6E1c < 2mm %	Clay %
←	milliequivalents per 100g. soil					→						
38.6	31.3	12.8	4.1	Tr.	1.0	49.2	92	117	.70		Tr.	
37.5	24.6	14.7	6.2	0.1	0.9	46.5	87	107	.62		Tr.	-
30.9			0.7	0.1	0.7				.55		12	4
26.4			-	0.2	0.6				.47		25	10
23.7			-	0.3	0.5				.44		29	10
22.7			-	0.4	0.6				.43		27	9

a. Few carbonates (nodules and limestone fragments).
b. Common carbonates (nodules and limestone fragments).

Soil type: Synnes silty clay loam
Soil No.: S61Minn-75-2
Location: 270 feet east and 1050 feet south of northwest quarter corner of Sec. 1, T126N, R42W, Stevens County, Minnesota.
Vegetation: Alfalfa.
Parent material: Silty clay to clay till (calcareous).
Physiographic position: Moraine.
Topography: Gently rolling.
Slope: Three percent.
Aspect: East.
Drainage: Somewhat poor.
Ground water: Deep.
Permeability: Slow.
Sampled by and date: Klaus Flach, R. H. Rust, L. I. Harmon, and R. Lewis, September 11, 1961.

Horizon and Lincoln Lab. Number	
Ap 15802	0 to 7 inches. Black (10YR 2/1 to N 2/) silty clay loam; strong very fine granular structure; abrupt smooth boundary.
A12 15803	7 to 11 inches. Very dark gray (10YR 3/1) and black (10YR 2/1 and N 2/) silty clay; moderate medium prismatic structure breaking to moderate strong very fine and fine subangular blocks; gradual smooth boundary.
A13 15804	11 to 17 inches. Very dark gray (10YR 3/1) siltyclay loam with streaks of black (N 2/), dark grayish brown (2.5Y 4/2) and very dark gray (10YR 3/1) in the lower part; strong fine, medium, and coarse prismatic structure breaking to moderate fine and very fine subangular blocks; clear irregular boundary.
AC 15805	17 to 32 inches. Dark grayish brown (2.5Y 4/2) to grayish brown (2.5Y 5/2) silty clay; crushed color is dark grayish brown (2.5Y 4/2) to light olive brown (2.5Y 5/4); moderate medium prismatic structure breaking to moderate medium andfine subangular blocks; hard; strong effervescence; gradual wavy boundary.
C1 15806	32 to 43 inches. Dark grayish brown (2.5Y 4/2) to olive brown (2.5Y 4/4) silty clay with a few fine prominent reddish brown mottles; crushed color is dark grayish brown (2.5Y 4/2) to light olive brown (2.5Y 5/4); moderate medium, to fine, and very fine subangular blocky structure; hard; strong effervescence; gradual smooth boundary.
C2 15807	43 to 54 inches plus. Olive gray (5Y 5/2) silty clay; dark grayish brown (2.5Y 4/2) to olive brown (2.5Y 4/4) when crushed with a few fine faint dark gray to gray and a few fine distinct olive mottles; moderate medium, fine, and very fine subangular blocky structure; hard; strong effervescence.

Note: All colors moist. Consistence under moist conditions was not determined. Estimated moist consistence as follows: Ap, firm; A12, A13, friable to firm; AC, C1, C2, firm.

SOIL SURVEY LABORATORY Beltsville, Maryland

SOIL TYPE Webster silty clay loam **LOCATION** Waseca County, Minnesota

SOIL NOS. S54Minn-81-113A-1 to 113A-6 **LAB. NOS.** 5599-55104

DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<76mm)	TEXTURAL CLASS
0-7	Ap	1.2	3.4	5.2	15.1	8.4	35.9	30.8	30.4	22.5	0	cl
7-13	A12	1.1	3.4	4.9	14.0	8.0	36.5	32.1	29.2	23.1	0	cl
13-18	B21	1.4	3.4	4.9	14.0	8.4	34.4	33.5	28.8	22.1	Tr.	cl
18-24	B22	2.1	4.0	5.0	14.0	9.2	29.9	35.8	27.6	19.3	Tr.	cl
24-38	C1g	2.4	4.5	5.1	14.2	9.9	33.9	30.0	30.5	21.5	9	cl
38-48	C2g	1.7	2.8	3.5	9.9	8.0	44.0	30.1	26.6	31.3	Tr.	cl

HORIZON	pH 8C1a 1:1	pH 1:5	pH 1:10	ORGANIC MATTER 6A1a ORGANIC CARBON %	NITROGEN %	C/N
Ap	7.5			4.3		
A12	7.4			2.80		
B21	7.6			1.11		
B22	7.7			0.44		
C1g	7.8			0.22		
C2g	7.7			0.13		

CATION EXCHANGE CAPACITY	EXTRACTABLE CATIONS Ca	Mg	H	Na	K	BASE SAT. %	MOISTURE AT SATURATION %
←	milliequivalents per 100g. soil →						

All horizons calcareous--not run.

Soil type: Webster silty clay loam
Soil No.: S54Minn-81-113A-1 to 113A-6
Location: Cornfield in SE SE1/4, Section 25, T105N, R24W, Waseca County, Minnesota.

The soil is classified as a Humic Gley. Parent material is calcareous clay loam till of a ground moraine of Mankato age. Native vegetation tall grasses and marsh grasses; sample was obtained from very shallow depression in nearly level upland. Slope of the soil about 0 percent; drainage poor, ground water approximately 4 feet; soil was moist at time of examination; stone free. There is no apparent erosion and the soil permeability is rated as moderate.

Described by: A. H. Paschall.

Horizon and Beltsville Lab. Number	
Ap 5599	0 to 7 inches. Black (10YR 2/1 moist) silty clay loam; weak very fine granular structure; slightly sticky when wet and firm when moist.
A12 55100	7 to 13 inches. Black (10YR 2/1 moist) silty clay loam; weak very fine angular blocky structure; firm when moist and slightly sticky when wet; gradual wavy boundary into B21.
B21 55101	13 to 18 inches. Very dark gray (10YR 3/1 moist) silty clay loam which breaks out into massive clods and then breaks into weak very fine angular blocky structure; friable when moist; effervesces slightly with acid; gradual and wavy boundary into B22.
B22 55102	18 to 24 inches. Dark gray (5Y 4/1 moist) silty clay loam; weak very fine angular blocky structure; firm when moist and sticky when wet; effervesces slightly with acid. This layer has many worm holes filled with very dark gray (10YR 3/1 moist) material; clear irregular boundary tonguing into C1g.
C1g 55103	24 to 38 inches. Light olive gray to pale yellow (5Y 6/2, 7/3 moist) with few medium distinct yellowish brown (10YR 5/8 moist) mottles, silty clay loam; massive structure; friable when moist; effervesces strongly with acid.
C2g 55104	38 to 48 inches. Light olive gray to pale yellow (5Y 6/2, 7/3 moist) with many fine distinct brownish yellow(10YR 6/8 moist) mottles, few white (5Y 8/2 moist) lime concretions, clay loam; massive structure; friable when moist.

SOIL SURVEY LABORATORY Beltsville, Maryland

SOIL TYPE Webster silty clay loam **LOCATION** Waseca County, Minnesota

SOIL NOS. S54Minn-81-113B-1 to 113B-8 **LAB. NOS.** 55105-55112

DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent)								3A1	2A2	TEXTURAL CLASS
		VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	> 2 ≤76mm	
0-7	Ap	1.0	2.8	4.5	12.9	8.7	37.2	32.9	31.2	22.1	0	cl
7-13	A12	1.0	2.8	4.3	13.3	8.6	37.0	33.0	31.9	21.5	0	cl
13-17	B21	1.0	3.3	5.1	16.0	9.0	33.5	32.1	31.4	20.2	Tr.	cl
17-23	B22	1.2	3.3	5.4	18.2	9.6	32.3	30.0	33.1	18.9	Tr.	cl
23-26	C1	1.8	3.8	6.0	19.0	10.1	29.8	29.5	31.8	18.5	Tr.	cl
26-33	C2	2.6	4.0	5.1	14.8	10.3	34.6	28.6	31.7	21.9	Tr.	cl
33-46	C3	2.0	4.1	4.8	13.6	10.2	38.8	26.5	31.6	25.5	Tr..	1/cl
46+	C4	2.5	4.6	5.9	16.0	11.3	36.7	23.0	34.3	23.1	8	1

	pH		ORGANIC MATTER									
8C1a 1:1	1:5	1:10	6A1a ORGANIC CARBON %	NITROGEN %	C/N							
7.2			4.8									
7.2			4.4									
7.2			1.90									
7.5			0.76									
7.7			0.46									
7.8			0.30									
7.9			0.22									
7.9			0.19									

5A3a	EXTRACTABLE CATIONS 5B1a					BASE SAT. %					
CATION EXCHANGE CAPACITY (Sum)	6N2d Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K						MOISTURE AT SATURATION %
← milliequivalents per 100g. soil →						5C3					
49.9	36.7	8.3	4.0	0.3	0.6	92					
46.9	35.1	8.3	2.8	0.2	0.5	94					
37.8	27.2	7.6	2.1	0.3	0.6	94					
32.6	23.5	6.7	1.7	0.3	0.4	95					

Horizons C1, C2, C3, and C4 calcareous--not run.

Soil type: Webster silty clay loam
Soil No.: S54Minn-81-113B-1 to 113B-8
Location: Cornfield in NW NW1/4, Section 19, T105N, R23W, Waseca County, Minnesota.

The soil is classified as a Humic Gley. The sample was obtained in a shallow depression in nearly level upland ground moraine of Mankato age. The till is a calcareous clay loam; native vegetation tall grasses and marsh grasses. Drainage poor; ground water approximately 4 feet. There is no apparent erosion; permeability is rated as moderate.

Described by: A. H. Paschall.

Horizon and Beltsville Lab. Number	
Ap 55105	0 to 7 inches. Black (10YR 2/1 moist) silty clay loam; breaks out into weak clods which then crush readily into weak very fine angular blocky structure; plastic when wet.
A12 55106	7 to 13 inches. Black (10YR 2/1 moist) silty clay loam. This layer has been compacted by cultivation and so is massive in structure; sticky when wet; clear smooth boundary into B21.
B21 55107	13 to 17 inches. Very dark gray (10YR 3/1 moist) silty clay loam; weak very fine angular blocky structure; friable when moist and slightly sticky when wet; grades with a smooth boundary into B22.
B22 55108	17 to 23 inches. Dark gray (5Y 4/1 moist) with some mixing of olive gray (5Y 5/2 moist) silty clay loam; initial breakage is into large massive clods which then break into weak very fine angular blocky structure; friable when moist; material tongues down into the next horizon.
C1 55109	23 to 26 inches. Olive gray to olive (5Y 5/2, 5/3 moist) clay loam; initial breakage is massive clods; these then break to weak very fine angular blocky structure; friable when moist and sticky when wet; layer is full of worm holes which are filled with very dark gray material (10YR 3/1) moist.
C2 55110	26 to 33 inches. Olive (5Y 5/3 moist) clay loam; initial breakage is into massive clods which then break into weak very fine angular blocky structure; friable when moist and sticky when wet; effervesces strongly with acid.
C3 55111	33 to 46 inches. Olive (5Y 5/3 moist) clay loam; massive; friable when moist and slightly sticky when wet; few shale fragments in layer.
C4 55112	46 inches plus. Gray to olive (5Y 5/1, 5/3 moist) with many medium distinct yellowish brown (10YR 5/8 moist) mottles, clay loam; friable; sample was obtained with an auger, hence no structure determinations.

SOIL SURVEY LABORATORY Beltsville, Maryland

SOIL TYPE Webster silty clay loam **LOCATION** Waseca County, Minnesota

SOIL NOS. S54Minn-81-113HA-1 to 113HA-7 **LAB. NOS.** 5585-5591

DEPTH INCHES	HORIZON	1B1b PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3A1 VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	2A2 > 2 (<76mm)	TEXTURAL CLASS
0-7	A11	1.1	4.3	5.6	13.0	7.4	41.9	26.7	30.5	25.7	0	1/cl
7-15	A12	2.4	5.1	6.2	13.4	7.7	35.8	29.4	30.0	20.7	Tr.	cl
15-20	B21g	3.6	6.4	7.9	13.7	7.5	27.6	33.3	26.8	15.5	Tr.	cl
20-26	B22g	2.1	4.6	5.9	14.9	9.2	27.3	36.0	27.5	17.2	Tr.	cl
26-32	C1g	2.9	4.2	4.7	13.4	9.5	35.2	30.1	28.9	23.5	Tr.	cl
32-37	C2g	2.4	4.3	4.7	13.4	9.6	37.0	28.6	29.3	25.1	Tr.	cl
37-48	C3g	2.1	4.7	5.4	14.5	10.5	36.7	26.1	31.6	24.1	Tr.	1/cl

8C1a pH 1:1	pH 1:5	pH 1:10	ORGANIC MATTER 6A1a ORGANIC CARBON %	NITROGEN %	C/N
6.0			4.5		
6.2			1.83		
6.4			0.76		
6.8			0.40		
7.4			0.25		
7.7			0.22		
7.8			0.17		

5A3a CATION EXCHANGE CAPACITY (Sum)	EXTRACTABLE CATIONS 6N2d Ca	6G2b Mg	6H1a H	6P2a Na	6Q2a K	BASE SAT. % 5C3	MOISTURE AT SATURATION %
	← milliequivalents per 100g. soil →						
40.6	25.1	6.0	8.9	0.3	0.3	78	
35.3	22.2	7.1	5.3	0.3	0.4	85	
36.5	22.0	8.5	5.2	0.3	0.5	86	
34.1	22.7	8.5	2.1	0.3	0.5	94	

Horizons C1g, C2g, and C3g not run--calcareous.

Soil type: Webster silty clay loam
Soil No.: S54Minn-81-113HA-1 to 113HA-7
Location: Approximately 300 yards southeast of the NW corner of SE1/4, Section 27, T108N, R24W, Waseca County, Minnesota.

Sample taken from under bluegrass in the center of an open triangle marked by three large oak trees. The vegetation surrounding the area consisted largely of oak, elm, and popple. The area has been grazed. The soil is a Humic Gley. Parent material is a clay loam till on a ground moraine of Mankato age. The sample came from a very shallow depression from a large, nearly level, upland area. Drainage is poor; soil moist at time of examination. It is stone free. Slope of the land less than 1 percent; no apparent erosion; ground water deep. The permeability of the soil is slow to moderate. Roots penetrate into the C horizon.

Described by: A. H. Paschall.

Horizon and Beltsville Lab. Number	
A11 5585	0 to 7 inches. Black (10YR 2/1 moist) light silty clay loam; weak to moderate very fine subangular blocky; consistency friable when moist and slightly sticky when wet; grades with a gradual and wavy boundary into the A2.
A12 5586	7 to 15 inches. Black (5Y 2/1 moist) silty clay loam; moderate fine angular blocky structure; slightly plastic when wet; grades with a smooth boundary into the A3.
B21g 5587	15 to 20 inches. Very dark gray (5Y 3/1 moist) silty clay loam with moderate fine and medium angular blocky structure; plastic when wet. The aggregates have shiny black coatings of material from above and in a few places have spots that are dark gray (5Y 4/1 moist) in color. There is a noticeable quantity of coarse sand or fine gravel present in this layer; grades with a smooth boundary into B22g.
B22g 5588	20 to 26 inches. Mottled light olive gray, olive gray and dark grayish brown (5Y 6/2, 5Y 5/2, 2.5Y 4/2 moist) silty clay loam; moderate very fine angular blocky structure; slightly plastic when wet; gradual smooth boundary into the C1g.
C1g 5589	26 to 32 inches. A pale yellow (5Y 7/3 moist) clay loam with common small faint mottlings of olive yellow (5Y 6/8 moist); massive structure; friable when moist. Root channels in this layer are lined with dark gray (5Y 4/1 moist) material from above; a few white (5Y 8/2 moist) lime segregations present in the layer; gradual smooth boundary into C2g.
C2g 5590	32 to 37 inches. Pale yellow (5Y 7/3 moist) clay loam with common fine to medium faint olive yellow (5Y 6/8 moist) mottlings; few lime segregations of pale yellow (5Y 8/3 moist); massive structure; friable when moist; grades with a smooth boundary into C3g.
C3g 5591	37 to 48 inches. Pale yellow (5Y 7/3 moist) clay loam with many medium faint olive yellow (5Y 6/8 moist) mottles and a few white (5Y 8/2 moist) lime segregations; massive structure; friable when moist.

SOIL SURVEY LABORATORY Beltsville, Maryland

OIL TYPE Webster silty clay loam **LOCATION** Waseca County, Minnesota

SOIL NOS. S54Minn-81-113HB-1 to 113HB-7 **LAB. NOS.** 5592-5598

DEPTH INCHES	HORIZON	1Rlb PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) 3Al									2A2	TEXTURAL CLASS
		VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	0.02-0.002	> 2 <76mm	
0-8	A11	0.6	2.6	3.7	8.8	5.5	43.5	35.3	25.8	27.9	0	cl
8-12	A12	0.8	2.6	4.0	9.5	6.0	42.5	34.6	26.5	27.3	0	cl
12-17	B21	1.1	2.7	3.6	9.5	6.1	42.8	34.2	26.0	28.2	Tr.	cl
17-23	B22	1.8	2.9	3.6	8.9	6.0	40.0	36.8	24.6	26.4	Tr.	cl
23-31	B3g	1.8	3.6	4.8	13.6	8.8	29.6	37.8	27.2	19.2	Tr.	cl
31-42	C1g	2.4	4.4	5.1	14.1	9.9	35.0	29.1	30.4	22.7	Tr.	cl
42-52	C2g	2.8	5.0	5.4	14.7	10.7	35.3	26.1	31.2	23.1	Tr.	l/cl

pH			ORGANIC MATTER								
8Cla 1:1	1:5	1:10	6Ala ORGANIC CARBON %	NITROGEN %	C/N						
7.0			7.2								
7.0			2.70								
7.4			1.12								
7.4			0.59								
7.4			0.29								
7.6			0.16								
7.8			0.11								

CATION EXCHANGE CAPACITY (Sum)	EXTRACTABLE CATIONS					BASE SAT. %					MOISTURE AT SATURATION %
	Ca	Mg	H	Na	K						
←	milliequivalents per 100g. soil →										

All horizons calcareous--not run.

Soil type: Webster silty clay loam
Soil No.: S54Minn-81-113HB-1 to 113HB-7
Location: An opening in woodland area about 100 yards east of the quarter line and about 50 feet north of road in SE SE1/4, Section 2, T107N, R24W, Waseca County, Minnesota.

The soil is a Humic Gley. Parent material is a clay loam or silty clay loam till on a nearly level ground moraine of Mankato age. The soil was sampled on a slight rise near a shallow depression; slope less than 1 percent; drainage poor; soil moist and stone free. Ground water was at approximately 4½ feet; no apparent erosion. Permeability of the soil slow to moderate. Native vegetation primarily elm with some oak and an occasional wild cherry tree.

Described by: A. H. Paschall.

Horizon and Beltsville Lab. Number	
A11 5592	0 to 8 inches. Black (10YR 2/1 moist) silty clay loam; weak very fine subangular blocky structure; friable when moist and slightly plastic when wet; gradual wavy boundary to A12.
A12 5593	8 to 12 inches. Black (5Y 2/1 moist) silty clay loam; weak to moderate very fine angular blocky structure; friable when moist and plastic when wet; gradual wavy boundary to B21.
B21 5594	12 to 17 inches. Very dark gray (5Y 3/1 moist) heavy silty clay loam; moderate very fine angular blocky structure; plastic when wet; gradual wavy boundary into B22.
B22 5595	17 to 23 inches. Very dark gray (5Y 3/1 moist) with a few coarse faint pale olive (5Y 6/3 moist) mottlings, heavy silt loam; moderate very fine angular blocky structure; plastic when wet; grades with wavy boundary into B3g.
B3g 5596	23 to 31 inches. Olive (5Y 5/3 moist) with a few fine faint mottlings of olive yellow (5Y 6/8 moist) silty clay loam; in place the soil appears massive but breaks readily into weak very fine angular blocks; plastic when wet; gradual wavy boundary into C1g.
C1g 5597	31 to 42 inches. Pale yellow to light olive gray (5Y 7/3, 6/2 moist) with a few fine faint mottlings of olive yellow (5Y 6/8 moist), silty clay loam. The upper 3 inches of this layer will effervesce slightly with acid but does not show lime segregations; lower part shows a few small white segregations (5Y 8/2 moist); massive structure; friable when moist and slightly plastic when wet; effervesces slightly with acid.
C2g 5598	42 to 52 inches. Pale yellow (5Y 7/3 moist) with many medium distinct yellowish brown (10YR 5/6 moist) mottlings, silty clay loam; massive structure; friable when moist and effervesces strongly with acid.

SOIL SURVEY LABORATORY Lincoln, Nebr. May 1959

SOIL TYPE Wildwood silty clay **LOCATION** Koochiching County, Minnesota

SOIL NOS. S58Minn-36-1-(1-6) **LAB. NOS.** 9101-9106

DEPTH INCHES	HORIZON	1B1a PARTICLE SIZE DISTRIBUTION (in mm.) (per cent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY < 0.002	0.2-0.02	3A1 0.02-0.002	2A2 > 2 <19mm	TEXTURAL CLASS
0-5	A1	<0.1	<0.1	0.1a	0.4b	1.7b	58.4	39.4	22.5	37.9	-	sicl/sic
5-9	C1g	0.1a	0.2a	0.1a	0.1b	0.9b	53.0	45.6	18.9	35.1	-	sic
9-15	C2g	<0.1	0.1a	0.1a	0.4b	1.5b	31.5	66.4	5.9	27.4	-	c
15-23	C3g(u)	0.2c	0.4c	0.7c	6.8c	25.3c	34.1	32.5	51.6	12.9	Tr.	cl
23-31	C4g	0.1c	0.4c	0.5c	1.9c	12.6c	35.5	49.0	27.4	22.1	Tr.	c
31-40	C	0.1c	0.2c	0.1c	0.3c	0.5c	20.3	78.5	1.0	20.0	Tr.	c

DEPTH INCHES	pH 8C1a 1:1	pH 1:5	pH 1:10	ORGANIC MATTER 6A1a ORGANIC CARBON %	ORGANIC MATTER 6B1a NITROGEN %	ORGANIC MATTER C/N	6C1a Free Iron Fe_2O_3 %	ELECTRICAL CONDUCTIVITY EC×10³ MILLIMHOS PER CM	6E1a $CaCO_3$ equivalent %	GYPSUM me./100g. SOIL	MOISTURE TENSIONS 1/10 ATMOS. %	MOISTURE TENSIONS 1/3 ATMOS. %	MOISTURE TENSIONS 15 ATMOS. 4B2 %
0-5	6.5			5.33	0.471	11.3	0.5		<1				20.3
5-9	6.4			0.53	0.047	11	0.7						17.2
9-15	6.6			0.45	0.031	14	0.8		<1				22.6
15-23	7.9			0.17	0.016		0.4		7				11.8
23-31	7.9			0.22	0.022		0.8		7				17.1
31-40	7.7			0.40			0.6		3				25.7

DEPTH INCHES	5A1a CATION EXCHANGE CAPACITY NH_4Ac	EXTRACTABLE CATIONS 6N2b Ca	6G2b Mg	6H1a H	6P2a Na	5B1a 6Q2a K	BASE SAT. % NH_4Ac EXCH.	5C3 Base Sat. % on Sum Cations	5B1a Sum Bases	5A3a Sum Cations	8D3 Ca/Mg	MOISTURE AT SATURATION %
	← milliequivalents per 100g. soil →						5C1		←me/100g→			
0-5	40.5	34.4	8.7	10.4	<0.1	0.5	108	81	43.6	54.0	4.0	
5-9	31.9	23.9	12.0	4.6	<0.1	0.3	113	89	36.2	40.8	2.0	
9-15	37.0	27.4	16.1	4.6	0.1	0.4	119	90	44.0	48.6	1.7	
15-23	18.7		9.5	1.2	0.1	0.3						
23-31	23.5		12.1	1.2	0.2	0.4						
31-40	34.7		16.4	0.8	0.3	0.6						

a. Trace smooth and irregular light brown concr. (Fe?)
b. Many smooth and irregular light brown concr. (Fe?)
c. Trace smooth and irregular light brown concr. (Fe?); few $CaCO_3$ concr.

Soil type: Wildwood silty clay
Soil No.: S58Minn-36-1-(1-6)
Location: Northwest quarter of southwest quarter of southwest quarter of Sec. 9, T69N, R25W, Koochiching County, Minnesota; samples collected in wooded area adjacent to a cultivated field.
Vegetation: Mainly aspen with some Balm of Gilead.
Parent material: Lacustrine clays in old Glacial Lake Agassiz.
Topography: Nearly level.
Slope: Less than 1 percent.
Drainage: Poor.
Permeability: Slow.
Ground water: Below sampling depth.
Stoniness: None.
Root distribution: Plentiful to 9 inches, few below.
Collected by: A. H. Paschall, M. Scilley, and J. K. Ableiter.

Horizon and Lincoln Lab. Number	
Ao	1 to 0 inch. Black (10YR 2/1) mat of peaty organic material; some finely divided.
A1 9101	0 to 5 inches. Black (10YR 2/1) silty clay; moderate very fine subangular and angular blocky structure; friable when moist, plastic when wet; structural aggregates are larger with depth; roots plentiful; pH 6.5; clear wavy boundary, 3 to 7 inches thick.
C1g 9102	5 to 9 inches. Olive gray (5Y 5/2) clay; moderate very fine subangular blocky; plastic when wet; many small faint mottles of dark yellowish brown (10YR 4/4) and olive (5Y 5/4); roots plentiful; pH 6.5; clear wavy boundary, 1 to 5 inches thick.
C2g 9103	9 to 15 inches. Gray (5Y 5/1) clay; moderate very fine angular blocks; plastic when wet; few medium faint mottles of dark gray (10YR 4/1) and dark grayish brown (10YR 4/2); few roots; pH 7.0; abrupt smooth boundary.
C3g(u) 9104	15 to 23 inches. Gray (5Y 5/1) to olive gray (5Y 5/2) silty clay loam; massive; friable when moist; many small distinct mottles of dark brown; contains a few pebbles; pH 7.5; clear smooth boundary.
C4g 9105	23 to 31 inches. Dark gray (5Y 4/1) clay; weak fine angular blocky structure; firm when moist, plastic when wet; at intervals contains spots and splotches of strong brown color (7.5YR 5/6); also shows finer materials along root channels; pH over 7; gradual smooth boundary.
C 9106	31 to 40 inches. Dark gray (5Y 4/1) clay; massive; firm when moist; plastic when wet; has dark reddish brown (5YR 3/4) streaks along roots; calcareous.

Note: All colors are for moist soils unless otherwise noted. The 5- to 9-inch layer has some dark gray (5Y 4/1) and very dark gray (5Y 3/1) stains (or flows of clay or organic matter) on aggregate faces. The 15- to 23-inch layer is discontinuous, playing out in relatively short distances (10 to 20 feet). The 31- to 40-inch layer contains many calcareous concretions.

SCS-421
10-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL Zimmerman fine sand SOIL Nos. S60Minn-71-1 LOCATION Sherburne County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13732-13736 February 1965

Depth (In.)	Horizon	1B1a Total Sand (2-0.05)	Total Silt (0.05-0.002)	Total Clay (<0.002)	Sand: Very coarse (2-1)	Sand: Coarse (1-0.5)	Sand: Medium (0.5-0.25)	Sand: Fine (0.25-0.1)	Sand: Very fine (0.1-0.05)	Silt: 0.05-0.02	Silt: Int III (0.02-0.002)	Int. II (0.2-0.02)	(2-0.1)			Coarse fragments 2A2: >2 Pct.	Coarse fragments 2A2: 2-19 Pct of <76mm	Coarse fragments 2A2: 19-76 Pct of <76mm
		Size class and particle diameter (mm) 3A1 — Pct. of < 2 mm																
0-2	A1	92.5	4.1	3.4	0.8	8.5	23.9	50.5	8.8	2.3	1.8	33.4	83.7			-		
2-6	A21	94.4	3.3	2.3	0.7	8.6	22.6	52.4	10.1	1.7	1.6	36.1	84.3			Tr.		
6-18	C1	96.2	2.4	1.4	0.7	8.7	23.6	53.4	9.8	1.2	1.2	34.7	86.4			Tr.		
18-25	C2	96.9	1.7	1.4	0.8	9.8	24.7	49.6	12.0	1.0	0.7	34.4	84.9			-		
25-45	C3	97.7	1.2	1.1	1.4	20.4	33.5	35.4	7.0	0.6	0.6	20.0	90.7			-		

Depth (In.)	6A1a Organic carbon Pct	6B1a Nitrogen Pct.	C/N		Carbonate as $CaCO_3$ Pct.	6C1a Ext. Iron as Fe Pct.	Bulk density g/cc	g/cc	g/cc		Water content Pct.	4B1a 1/10-Bar Pct.	4B2 15-Bar Pct			pH		8C1a (1:1)
0-2	1.39	0.086	16			0.4						8.6	3.3					4.5
2-6	0.36	0.035	10			0.4						4.3	1.5					4.9
6-18	0.26	0.024	11			0.4						3.4	1.3					5.0
18-25	0.16	0.017				0.4						2.6	1.2					5.2
25-45	0.03					0.4						1.6	0.9					5.6

Depth (In.)	Extractable bases 5B1a: 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	5B1a Sum	6H1a Ext. Acidity	Cat. Exch. Cap.: 5A3a Sum Cations	5A1a NH_4OAc	6C1a KCl Ext. Al			Ca/Mg		Base saturation: 5C3 Sum Cations a Pct.	5C1 NH_4OAc a Pct.
	meq/100 g														
0-2	0.7	0.2	Tr.	0.2	1.1	7.2	8.3	5.9	1.2					13	19
2-6	0.2	Tr.	Tr.	0.1	0.3	4.2	4.5	3.1	1.0					7	10
6-18	0.1	Tr.	Tr.	Tr.	0.1	3.2	3.3	2.1	0.7					3	5
18-25	0.4	Tr.	Tr.	Tr.	0.4	2.7	3.1	1.8	0.5					13	22
25-45	0.8	Tr.	Tr.	Tr.	0.8	1.2	2.0	1.5	0.1					40	53

Depth (In.)

a. One or more horizons has relatively low cation exchange capacity. As cation exchange capacity decreases, the relative error of base saturation increases. Trace quantities are omitted from the sum of bases. For very low CEC values, this omission contributes significantly to the relative error of base saturation.

Soil type: Zimmerman fine sand
Soil No.: S60Minn-71-1
Location: Northeast quarter of southeast quarter of Sec. 16, T35N, R27W, 500 feet west and 100 feet south of the northeast corner of the southeast quarter of the section, Sherburne County, Minnesota. Photo No. BJL-8-41.
Vegetation: Scattered deciduous trees, mainly oak; shrubs mainly chokecherry and sumac; various forbs and native and introduced grasses.
Parent material: Outwash sands, wind reworked, Grantsburg sublobe of Mankato.
Physiographic position: Outwash plain.
Topography: Undulating to rolling.
Slope: 3 percent.
Aspect: West.
Drainage: Excessively drained.
Ground water: Deep.
Permeability: Rapid.
Moisture: Dry.
Stoniness: None.
Root distribution: Common to 24 inches.
Sampled by and date: J. S. Allen, E. D. Rivers, R. H. Rust, R. S. Farnham, A. S. Robertson and M. F. Grimes, August 3, 1960.

Horizon and Lincoln Lab. Number	
A1 13732	0 to 2 inches. Very dark gray (10YR 3/1) fine sand, dark gray (10YR 4/1) when dry; single grain; loose when moist; very strongly acid; abrupt smooth boundary.
A2? 13733	2 to 6 inches. Dark grayish brown (10YR 4/2) fine sand, grayish brown to light grayish brown (10YR 5/2 to 6/2) when dry; single grain; loose when moist but with very slight coherence; strongly acid; gradual wavy boundary.
C1 13734	6 to 18 inches. Dark grayish brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) when dry; single grain; loose when moist but with very slight coherence; strongly acid; diffuse wavy boundary.
C2 13735	18 to 25 inches. Dark brown to brown (10YR 4/3) fine sand, brown (10YR 5/3) when dry; single grain; loose when moist but with very slight coherence; strongly acid; diffuse wavy boundary.
C3 13736	25 to 45 inches. Yellowish brown (10YR 5/4) sand; single grain; loose when moist; strongly acid.

Note: All colors are for moist soils unless otherwise noted.

SCS-421
10-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL Zimmerman fine sand SOIL Nos. S60Minn-71-4 LOCATION Sherburne County, Minnesota

SOIL SURVEY LABORATORY Lincoln, Nebraska LAB. Nos. 13748-13752 February 1965

Depth (In.)	Horizon	1B1a Total: Sand (2–0.05)	Silt (0.05–0.002)	Clay (< 0.002)	Sand: Very coarse (2–1)	Coarse (1–0.5)	Medium (0.5–0.25)	Fine (0.25–0.1)	Very fine (0.1–0.05)	Silt: 0.05–0.02	Int. III (0.02–0.002)	Int. II (0.2–0.02)	(2–0.1)			Coarse fragments 2A2: > 2 Pct.	2 – 19	19 – 76 Pct. of < 76mm
		Pct. of < 2 mm																
0–4	A1	91.3	5.1	3.6	0.2	1.8	13.4	62.5	13.4	2.5	2.6	47.0	77.9			-		
4–8	A3	93.5	3.7	2.8	-	2.1	15.2	65.0	11.2	0.4	3.3	42.1	82.3			-		
8–21	B? or C1	93.4	3.4	3.2	-	1.6	13.0	64.6	14.2	2.2	1.2	48.6	79.2			-		
21–36	C2	96.1	1.9	2.0	-	1.2	10.7	68.9	15.3	1.3	0.6	52.6	80.8			-		
36–45	C3	97.4	1.3	1.3	0.1	1.8	11.9	70.6	13.0	0.9	0.4	50.1	84.4			-		

Depth (In.)	6A1a Organic carbon Pct.	6B1a Nitrogen Pct	C/N		Carbonate as $CaCO_3$ Pct.	6C1a Ext. Iron as Fe Pct.	Bulk density g/cc	g/cc	g/cc		Water content Pct.	4B1a 1/10-Bar Pct	4B2 15-Bar Pct.			pH		8C1a (1:1)
0–4	0.75	0.067	11			0.4						10.0	2.1					5.6
4–8	0.48	0.050	10			0.4						8.2	1.7					5.8
8–21	0.20	0.027				0.4						7.2	1.8					5.3
21–36	0.13	0.017				0.4						6.0	0.8					5.3
36–45	0.03					0.4						4.5	0.8					5.8

Depth (In.)	Extractable bases 5B1a: 6N2b Ca	6O2b Mg	6P2a Na	6Q2a K	5B1a Sum	6H1a Ext. Acidity	Cat. Exch. Cap.: 5A3a Sum Cations	5A1a NH_4OAc							Base saturation: 5C3 Sum Cations a Pct.	5C1 NH_4OAc a Pct.
	meq/100 g															
0–4	2.5	0.4	Tr.	0.1	3.0	3.5	6.5	4.6							46	65
4–8	2.3	0.2	Tr.	Tr.	2.5	3.0	5.5	3.8							45	66
8–21	0.8	0.3	Tr.	Tr.	1.1	3.0	4.1	2.5							27	44
21–36	0.8	Tr.	Tr.	Tr.	0.8	2.0	2.8	2.0							28	40
36–45	1.1	Tr.	Tr.	Tr.	1.1	1.7	2.8	1.6							39	69

Depth (In.)

a. One or more horizons has relatively low cation exchange capacity. As cation exchange capacity decreases, the relative error of base saturation increases. Trace quantities are omitted from the sum of bases. For very low CEC values, this omission contributes significantly to the relative error of base saturation.

Soil type: Zimmerman fine sand
Soil No.: S60Minn-71-4
Location: 400 feet east and 100 feet north of the southwest corner of the southwest quarter of the northwest quarter of Sec. 17, T35N, R28W, Sherburne County, Minnesota; photo No. BJL-5-19.
Vegetation: Wooded area with deciduous trees, mainly oaks; shrubs, mainly hazelnut and chokecherry; various native grasses and forbs.
Parent material: Outwash sands, wind reworked, Grantsburg sublobe of Mankato.
Physiographic position: Outwash plain.
Topography: Level to undulating.
Slope: 1 to 2 percent.
Drainage: Excessive.
Ground water: Deep.
Permeability: Rapid.
Moisture: Dry at surface, saturated at 82 inches.
Stoniness: None.
Root distribution: Plentiful to 21 inches, a few tree roots below this.
Sampled by and date: J. S. Allen, E. D. Rivers, R. H. Rust, R. S. Farnham, A. S. Robertson, and M. F. Grimes, August 4, 1960.

Horizon and Lincoln Lab. Number	
A1 13748	0 to 4 inches. Very dark gray (10YR 3/1) to black (10YR 2/1) fine sand, dark gray to gray (10YR 4/1 to 5/1) when dry; single grain; loose when moist; medium acid; temperature 26° C.; abrupt smooth boundary.
A3 13749	4 to 8 inches. Dark brown (10YR 3/3) fine sand, grayish brown (10YR 5/2) when dry; single grain; loose when moist; medium acid; temperature 22° C.; gradual wavy boundary.
B? or C1 13750	8 to 21 inches. Dark brown (10YR 3/3) to brown (10YR 4/3) fine sand, brown (10YR 5/3) when dry; single grain; loose when moist; medium acid; temperature 20° C.; gradual wavy boundary.
C2 13751	21 to 36 inches. Brown (10YR 4/3 to 5/3) fine sand, brown to pale brown (10YR 5/3 to 6/3) when dry; single grain; loose when moist; medium acid; temperature 18° C.; diffuse wavy boundary.
C3 13752	36 to 45 inches. Brown (10YR 4/3 to 5/3) sand, light brownish gray to pale brown (10YR 6/2 to 6/3) when dry; single grain; loose when moist; neutral; temperature 15° C.; diffuse boundary.

Note: All colors are for moist soils unless otherwise noted. Soil temperatures taken with a stem-type thermometer. Air temperature 6 inches above the soil surface, 29° C.; temperature 80 inches below soil surface, 12° C.

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